Water Sensitive Urban Design (WSUD) is an approach which integrates the management of all water resources and the total water cycle into the urban development process. WSUD includes:

- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies;
- Storage, treatment and beneficial use of runoff (at building and street level, including stormwater);
- Treatment and reuse of wastewater; and
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity and amenity.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suiting the characteristics of any development (or redevelopment).

Those measures are outlined in this Summary Sheet and described in detail in the WSUD Technical Manual, which can be found online at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud).

WSUD recognises all water streams in the total water cycle as valuable resources, including:

- Rainwater (collected from the roof);
- Runoff (including stormwater) collected from all impervious surfaces;
- Potable mains water (drinking water);
- Groundwater;
- Greywater (water from bathroom taps, showers, and laundries); and
- Blackwater (from kitchen sinks and from toilets).

By applying appropriate measures in the design and operation of development, it is possible to (among other things):

- Stabilise and improve the health of coastal waters, inland watercourses and groundwater systems;
- Make more efficient use of water resources;
- Minimise demand on the reticulated water supply system;
- Reduce flood risk in urban areas; and
- Reduce erosion of waterways, slopes and banks.
Guiding Principles of WSUD

There are a number of guiding principles that underpin the objectives for water management and the implementation of WSUD in the Greater Adelaide Region. These principles should be addressed when undertaking the planning and implementation of water management.

These guiding principles and how they could be applied are outlined below. Many opportunities exist for WSUD measures to address more than one principle.

<table>
<thead>
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<th>WSUD Principle</th>
<th>Example of WSUD Approach</th>
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| Incorporate water resources as early as possible in the land use planning process | - Review what WSUD measures might be appropriate for a site prior to developing a concept design  
- Meet with council early in the concept design phase                          |
| Address water resource issues and conservation of biodiversity at the catchment and subcatchment level | - Develop a stormwater management (or water management) plan to guide actions in the catchment  
- Limit the increase in runoff volume using natural drainage paths and infiltration basins |
| Ensure water management planning is precautionary and recognises inter-generational equity, conservation of biodiversity and ecological integrity | - Protect waterways by providing a buffer of natural vegetation to urban development  
- Use of native vegetation in all runoff management measures and all landscaping to maximise habitat values |
| Recognise water as a valuable resource and ensure its protection, conservation and reuse | - Ensure developments incorporate water efficient appliances  
- Ensure fit for purpose reuse is incorporated on site or in the catchment         |
| Recognise the need for site-specific solutions and implement appropriate non-structural and structural solutions | - Install rainwater tanks to collect rainwater to supply toilet flushing and outdoor uses  
- Minimise the use of hard engineered structures                                  |
| Protect ecological and hydrological integrity | - Use natural channel design and landscaping to ensure that the drainage network mimics the natural ecosystem  
- Control sediment-laden runoff from disturbed areas, in particular during construction of developments |
| Integrate good science and community values in decision making | - Support research and demonstration sites of WSUD measures  
- Conduct community education programs                                             |
| Ensure equitable cost sharing | - Consider life cycle costs of the WSUD measures  
- Provide incentives through the use of rebates for implementation of on-site measures which may reduce the need for drainage infrastructure upgrades |
WSUD measures suitable for Greater Adelaide - the WSUD ‘Toolkit’

There is a wide range of WSUD measures which can be applied to developments in the Greater Adelaide Region. Those that are best suited to our region include (but are not limited to):

- Demand reduction;
- Rainwater tanks;
- Rain gardens;
- Green roofs;
- Infiltration systems;
- Pervious pavements;
- Urban water harvesting and reuse;
- Gross pollutant traps;
- Bioretention swales and basins;
- Swales;
- Buffer strips;
- Sedimentation basins;
- Constructed wetlands; and
- Wastewater management.

An introductory overview of these WSUD measures is provided on pages 4-11 of this Summary Sheet.

Further detail, including technologies and design features, can be found in the *Water Sensitive Urban Design in Greater Adelaide Technical Manual*. The Technical Manual and further information is available at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud) or by contacting the Department of Planning and Local Government on telephone 08 8303 0724 or email plnsa.orders@saugov.sa.gov.au
Demand Reduction

The purpose of demand reduction is to conserve water. New development, redevelopment and alterations to existing buildings can contribute to environmental sustainability and conservation of water supplies by incorporating a variety of water efficiency (or demand reduction) measures.

Demand reduction applies to residential, commercial, industrial, community service and recreational developments, redevelopments and retrofitting. Demand reduction is applicable at the allotment scale.

The following measures can be applied to reduce water demand:

- Water-efficient fixtures and appliances;
- Rainwater tanks plumbed in to the building;
- Improved landscape practices;
- Runoff and treated wastewater reuse; and
- Education and incentives.

Rainwater Tanks

A rainwater tank is designed to capture and store rainwater from gutters or downpipes on a building. Harvested water is then available for toilet flushing, laundry, hot water uses and for outdoor irrigation.

Rainwater tanks provide an excellent opportunity to gain a range of environmental benefits including:

- Potential reduction in peak runoff rates and volumes and the consequent negative environmental impacts these cause (including flooding, stormwater pollution and stream erosion);
- Reduced importation of water from distant catchments; and
- Reduced drinking water consumption (when health standards are met).

Rainwater tanks are generally applied at the allotment level, on residential, commercial and industrial development sites. They can be applied at the street level in larger development projects.
Rain Gardens

Rain gardens resemble a standard garden with one major difference – they have runoff directed into them from downpipes, paved areas or overflow from rainwater tanks. Rain gardens retain runoff for infiltration into the soil, reducing the amount of runoff that would otherwise discharge quickly into the local drainage system (or watercourse). Rain gardens also improve the quality of runoff while providing habitat for native fauna (i.e. biodiversity benefits).

Rain gardens can be applied at the allotment scale as well as within major developments. They are appropriate for commercial, industrial and residential sites, and can be incorporated into new construction or added to existing gardens.

Green Roofs

Green roofs are also known as rooftop gardens, vegetated roof covers, living roofs, eco-roofs and nature roofs. Green roofs are a series of layers on top of built structures, consisting of vegetation, growing medium and a range of drainage and protective layers. The benefits of green roofs include:

- Runoff management;
- Improved water quality;
- Reduced impervious areas;
- Reduced heat island effect;
- Additional living space;
- Reduced air pollution;
- Increased biodiversity;
- Improved insulation; and
- Increased carbon dioxide/oxygen exchange.

Green roofs may be appropriate for commercial, industrial and residential structures, especially those with a wide roof area. Green roofs can be retrofitted to existing structures or installed during construction of a new development.
Infiltration Systems

Infiltration systems generally consist of a shallow excavated trench, designed to detain runoff and enable subsequent infiltration to the surrounding soils. They reduce surface runoff volumes by providing a pathway for treated water to recharge local aquifers.

Infiltration systems are highly dependent on local soil characteristics and are best suited to sandy soils with deep groundwater. Infiltration measures sometimes require pre-treatment of runoff before infiltration to avoid clogging of the surrounding soils and to protect groundwater quality.

Infiltration systems require sufficient setback distances from structures to avoid structural damage from soil shrinkage or expansion.

Pervious Pavements

Pervious pavements (also known as porous and permeable pavements) are load-bearing pavement structures that are permeable to water.

The purpose of pervious pavements is to:

- Minimise the export of sediments and pollutants from the site;
- Provide for on-site retention of runoff, therefore reducing peak flows; and
- Reduce the overall volume of runoff from a site.

Pervious paving can be used as an alternative to conventional paving and hardstand surfaces. It is most appropriately used in residential or commercial situations where vehicle traffic is low and where there are low sediment loads.
Urban Water Harvesting and Reuse

Urban water harvesting and reuse refers to the collection and reuse of various water sources for drinking and non-drinking water substitution purposes.

The purpose of these schemes is to:

- Conserve water;
- Prevent increased stream erosion;
- Maintain water balance;
- Improve water quality; and
- Provide on-site detention and retention and therefore reduce peak runoff rates.

An integrated urban water harvesting and reuse scheme should provide five core functions: (1) collection, (2) treatment, (3) storage, (4) flood and environmental flow protection, and (5) distribution to the end user. They can be applied at the street, precinct or catchment scale and can utilise various sources of water. One of the greatest challenges facing urban water harvesting and reuse is the storage of water for subsequent use.

Typical urban water harvesting and reuse measures include:

- Wetlands, ponds and lakes;
- Rainwater tanks;
- Underground or subsurface tanks;
- Pervious pavement systems with underlying or off-line storages; and
- Managed aquifer recharge (MAR).

Gross Pollutant Traps

Gross pollutant traps (GPTs), also known as litter traps or trash racks, are constructed devices designed to remove solids usually greater than 5 millimetres in diameter from the stormwater drainage system. They remove the large debris washed into the stormwater system before the stormwater enters the downstream receiving waters or treatment device.

There are many differing types of GPTs that are commercially available. They can range from simple to complex constructions.
Bioretention Swales

Bioretention swales (sometimes called filtration or bioretention trenches) are a subsurface water filtration system capable of holding runoff to allow infiltration and/or temporary detention. Vegetation that grows in the filter layer of bioretention swales is an integral component of these treatment systems.

Bioretention swales can provide the following functions:

- Provide infiltration of runoff into the soil;
- Provide on-site detention and retention capacity;
- Conveyance of water;
- Improve water quality discharging from the swale; and
- Reduce the peak flow of a storm event in the system.

Bioretention swales can provide attractive landscape features in an urban development and provide biodiversity benefits. They are commonly located in the median strip of divided roads, in carparks and in parkland areas. Bioretention swales offer opportunities in both new construction and ‘retrofit’ situations.

![Image of bioretention swales](Image)

Bioretention Basins

Bioretention basins operate with the same treatment processes as bioretention swales except they do not have a conveyance function. High flows are either diverted away from the basin or are discharged into an overflow structure.

Bioretention basins are applicable at a range of scales and shapes and have flexibility for use within a new or existing development. Smaller systems may take the form of ‘planters’ that can be located within allotments or along roadways.

A wide range of vegetation can be used allowing them to be easily integrated into the landscape theme of an area and provide biodiversity benefits.
Swales

Swales are linear depressions that are used for the conveyance of runoff instead of, or in association with, underground pipe drainage systems and can be used to capture coarse and medium sediment. They can be grassed or more densely vegetated with a variety of species.

Swales provide a number of functions, including:

- Reduce total runoff through infiltration;
- Add to the local biodiversity and amenity;
- Reduce the speed of runoff;
- Trap sediments and attached pollutants; and
- Accommodate pedestrian movement across and along them, when grassed.

Swales can be incorporated into urban designs along streets, in parklands and between allotments where maintenance access can be preserved. Careful consideration is required with the establishment phase and irrigation requirements during prolonged dry spells.

Buffer Strips

Buffer strips are broad, sloped areas of grass or other dense vegetation, capable of withstanding shallow sheet runoff.

Buffer strips provide:

- Sediment and pollutant removal from runoff prior to entering a drainage system;
- Some reduction in runoff volume through infiltration; and
- A small reduction in peak volumes through attenuated runoff.

The density and length of vegetation used in buffer strips is important as it can impact on treatment performance and conveyance ability.
Sedimentation Basins

Sedimentation basins (otherwise known as sediment basins) can take various forms. They can be used in permanent systems as well as temporary structures to reduce sediment discharge during construction activities.

Sedimentation basins are typically the first element in a treatment train. They play an important role by protecting downstream elements (i.e. constructed wetlands or bioretention basins) from becoming overloaded or smothered with sediments, thus optimising treatment performance and minimising ongoing maintenance costs.

Sedimentation basins are typically installed to provide two key roles:
- Coarse sediment removal; and
- Stormwater flow regulation.

Constructed Wetlands

Constructed wetlands are created versions of a natural wetland system that use vegetation, enhanced sedimentation, fine filtration and biological pollutant uptake processes to improve water quality.

Wetlands improve water quality by:
- Removing sediments and suspended solids, together with their attached pollutants; and
- Removing a range of dissolved nutrients and contaminants.

Wetlands can also have significant biodiversity and community benefits. They provide habitat for wildlife, provide a focus for recreation, improve the aesthetics of a development and can be a central feature in a landscape.

Wetlands can be constructed on many scales, from residential estate scale to large regional (or catchment) systems.
Wastewater Management

The majority of water used for indoor purposes is discharged after use as ‘wastewater’. Wastewater is generally collected by a reticulated sewerage system and treated at a conventional wastewater treatment plant (WWTP). Alternatively, it can be collected, treated and reused on site, thereby promoting more efficient water use. This has many significant economic and environmental benefits for the community.

On-site wastewater management measures include the installation of a greywater treatment system. Larger scale measures include sewer mining and wastewater treatment plants on a community or residential subdivision scale.
Designing a WSUD Strategy for Your Development

There are numerous ways to incorporate Water Sensitive Urban Design (WSUD) in a given development or redevelopment project to meet water quantity and quality targets. WSUD strategies at a given site are dependent on various factors including:

- Site conditions and catchment characteristics;
- Building function and occupancy;
- Development or redevelopment scale;
- Water use and demand;
- Water sources available, including local climate;
- On-site catchment area;
- Urban landscape design; and
- Greenhouse gas emissions.

The most appropriate WSUD approach will require input from a range of disciplines, including architects, landscape architects, engineers, planners, regulators and local community members with an appreciation of WSUD to produce innovative and optimal solutions.

The preferred optimum solution at one site - such as utilising runoff (i.e. rainwater and stormwater) or reusing treated wastewater - may not be appropriate at another. A wide range of feasible solutions are usually available.

As a general rule, site conditions and the characteristics of any target pollutant(s) influence the selection of an appropriate type of treatment measure, while climate conditions and catchment characteristics influence the hydrologic design and ultimately the overall pollutant removal effectiveness of measures.

Examples of WSUD strategies for the following forms of development are contained in the WSUD Technical Manual.

- Single residential development;
- Residential subdivision development;
- Residential multi-unit development;
- Streetscape development;
- Commercial and industrial development;
- Upgrade of drainage systems or pavements; and
- Publicly owned land.

Vehicle parking areas (including driveways, and access ways on public or private property);

An outline of some of these appear on pages 13-15 of this Summary Sheet. Further information can be obtained from the *Water Sensitive Urban Design in Greater Adelaide Technical Manual*. 
**WSUD Measures for Different Types and Scale of Development**

Research and experience demonstrates that WSUD measures can be designed for all different types and scale of development, including inner city areas where limited space is available. Appropriate planning and design are required to ensure successful WSUD outcomes.

The implementation of WSUD, either in a greenfield, brownfield, infill or retrofit context, requires careful consideration of the broad objectives and principles of WSUD for the Greater Adelaide Region and the required objectives and targets that may be specific to a site.

To accomplish this, a formalised process is beneficial to determine whether a proposed strategy is suitable and/or appropriate and whether it integrates detailed planning, engineering, landscaping and ecology.

Consideration of water management should occur in the initial layout and design of a development rather than as an ad-hoc development requirement or one that is left until all other elements (such as lot layouts and street design) have been completed.

**Single Residential Development**

There are various WSUD techniques which can be used when developing water management strategies for single residential developments. For example, a rainwater tank can supply rainwater for toilet flushing, washing machine, and for outdoor use while water-efficient fittings reduce mains water consumption elsewhere. Landscape practices also influence selection (and location) of species to reduce water demand and to achieve biodiversity outcomes.

During prolonged or heavy storms, rainwater can overflow from the rainwater tank to an infiltration (or retention) trench. Runoff from paths, driveways and lawns is directed to garden areas (i.e. a rain garden). Excess runoff from impervious surfaces is directed to the retention trench, or overflows to the street drainage system. Pervious pavements can be installed to minimise runoff and improve infiltration to groundwater.
Residential Subdivision

WSUD use in residential subdivisions offers opportunities for:

- Narrow road reserves which reduce the area requiring irrigation (and maintenance);
- Integrating design of accesses and crossovers to maximise scope for retention of existing vegetation and for new plantings which minimise water requirements;
- Variation in road reserve widths to facilitate integrated stormwater management and substantial plantings;
- Pervious paving for footpaths and parking areas;
- Appropriate landscape practices that include the selection of species to reduce water demand;
- Constructed wetlands to detain, retain and treat urban runoff;
- Wastewater treatment and reuse to irrigate public open spaces.

Streetscape Development

Roads account for a significant percentage of the overall impervious hard surfaces created within a typical development and therefore can significantly change the way water is transported through an area and the volume of runoff that is generated. These areas also generate water borne pollutants that can adversely impact on receiving waterway health (e.g. fine sediments, metals and hydrocarbons). Consequently, it is important to mitigate the impact of runoff generated from road surfaces.

A WSUD streetscape integrates road layout, and vehicular and pedestrian requirements with water management needs. It uses design measures such as maximising pervious areas, local stormwater detention (and retention) in road reserves and managed landscaping.

Water sensitive streetscapes offer opportunities for:

- Varying road and road reserve widths to facilitate integrated stormwater management, maximise and enhance open space and landscaping possibilities and streetscape amenity;
- Integrating footpaths within road reserves to respond to natural features and stormwater management to create spaces that are easy to maintain and efficient to irrigate;
- Incorporating pervious paving in roads, driveways and parking areas where appropriate;
- Incorporating water absorbing drainage facilities (e.g. swales or bioretention swales) into the streetscape, using surface exposed systems, rather than underground piping systems;
- Incorporating local filtration by using rock/gravel filter beds with drainage channels; and
- Appropriate landscape practices that include the selection of species to reduce water demand (including artificial turf).
Industrial and Commercial Sites

Typically in office buildings, water usage is dominated by toilet flushing. Relatively small demand exists for drinking water and garden irrigation. Little greywater generation is expected as there is generally minimal showering in these buildings. The commercial sector goes beyond offices to include schools, universities, hospitals, markets and event venues.

Industrial water use is dependent on the specific industry and site. For example, water use ranges from cooling water for industrial equipment to very high purity water for technology companies. Industry should use ‘fit-for-purpose’ water and be able to demonstrate best water management and practice.

Commercial and industrial sites can reduce water demand through efficient toilets and appliances. Buildings with large catchment areas can harvest rainwater which can be utilised for toilet flushing and irrigation, as such sites often have large garden areas. Runoff can also be harvested from large carpark areas.

Other opportunities for industrial sites include multiple uses of water within a manufacturing site, the use of treated wastewater for process cooling applications and harvesting runoff for onsite use. As industrial developments and their water use are varied throughout the Greater Adelaide Region, approaches should be developed on a case-by-case basis.

Public Open Space

Integration of public open space with conservation corridors, stormwater management systems and recreational facilities is a fundamental objective of WSUD. Public open space areas can potentially incorporate stormwater conveyance, detention, retention and treatment systems as landscape features within a multiple use corridor.

The following are examples of techniques which can be used to integrate water management and the open space network:

- Incorporation of waterways and wetlands within parks as ecological and/or recreational features;
- Integration of playfields within the basin of a dry detention basin;
- Design of subsurface storage and/or infiltration systems beneath playfields within parks or school yards; and
- Development of gardens within open space areas such as bioretention systems.
Other Summary Sheets

Other Water Sensitive Urban Design Summary Sheets for the Greater Adelaide Region are available in this series. To download the summary sheets, visit [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud)

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Water demand can be reduced through behaviour change, technology and design.

Demand reduction is applicable at all development and building scales, is appropriate for retrofitting, and can be achieved by:

- Increasing water use efficiency, with a resultant reduction in the use of mains water; and
- Developing and maximising the resource potential of rainwater, surface runoff (or stormwater) and wastewater to supply a range of water uses usually met by the mains water supply.

Water efficiency is a core component of total water cycle management.

Reducing consumption also minimises wastewater generation and subsequent treated wastewater discharge.

**What is Water Sensitive Urban Design?**

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process.

WSUD incorporates all water resources, including surface water, groundwater, urban and roof runoff, drinking water and wastewater. It includes:

- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies;
- Storage, treatment and beneficial use of runoff (at building and street level, including stormwater);
- Treatment and reuse of wastewater; and
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity and amenity.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suiting the characteristics of each development (or redevelopment).

Those measures are described in detail in the WSUD Technical Manual, which can be found online at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud)

**Demand reduction** is one such measure.
Demand Reduction Approaches

There are numerous steps which can be taken to determine the demand reduction measures which are most appropriate for your particular situation or development. These include:

- Undertaking a site analysis to understand the site conditions and land capability, as demand reduction cannot be applied in a standard way. It is important to understand how much water is used, where it is used, by whom, when and how it is used;
- Setting realistic water conservation objectives and targets, and tracking progress against any targets. If the objectives for selecting a demand reduction approach are clearly defined, the task is simplified;
- Selecting the most appropriate techniques, which involves identifying and prioritising water conservation and water reuse opportunities, and determining which measures will be the most appropriate. Selection needs to consider site conditions, effectiveness, cost, and energy consumption;
- Liaising with local council and other relevant authorities to check whether there are any planning regulations, building regulations or local health requirements that apply to demand reduction measures you have selected; and
- Identifying funding opportunities provided by governments at all levels. Examples include funding from the Adelaide and Mt Lofty Ranges Natural Resources Management Board (community grants), local government (rebate schemes) and the State Government (home rebate scheme).

Techniques for Reducing Water Demand

- Making changes to the maintenance of appliances and fixtures or the type of products purchased (i.e. ensuring no leaks, installing tap aerators and water (and energy) efficient washing machines and toilets);
- Applying WSUD principles to landscape design, including integrated planning of landscape measures with other water management measures (e.g. locating plants with similar water needs together);
- Minimising the area of lawn and selecting the most appropriate species to reduce the demand for water, need for fertiliser, the cost and the maintenance time required for a landscaped area;
- Installing irrigation systems only if needed. Landscape measures that collect and utilise rainwater and runoff by slow infiltration can replace reliance on supplementary water. If irrigation is necessary, it should be applied in the most efficient manner;
- Mulching can reduce irrigation water use by as much as 70 per cent and provides protection from harsh climatic forces, making garden areas more pleasant and reducing moisture loss from soil and plant tissue; and
- Reducing drinking (or mains) water demand. Most domestic, commercial and industrial water does not need to be of drinking standard, so it is possible to obtain water from alternative sources.
Water Restrictions

Permanent water conservation measures are effectively base level water restrictions that South Australians are required to comply with on an ongoing basis. These were introduced in 2003. Depending on water supply issues relating to the River Murray and in the Greater Adelaide Region catchments, the level of water restrictions will be revised to match prevailing circumstances and conditions.

Information on the current level of restrictions can be obtained from the SA Water website, www.sawater.com.au

Water Efficiency Labelling and Standards Scheme

Labelling under the Water Efficiency Labelling Scheme (WELS) is compulsory and applies to items such as showerheads, washing machines, dishwashers, toilets, taps, flow regulators and urinals.

The labels provide valuable information to consumers to enable an assessment of the water efficiency of the products they purchase. Products with an ★★★ rating should be purchased as a minimum.

Education and Incentives

Raising awareness is one of the most cost-effective and sustainable methods to save water. Education and incentive schemes can be used to encourage the uptake of water conservation practices and technologies.

There are two main types of programs; ideally the two should be linked:

- Those that contain incentives of free or discounted products or services, such as offering discounted water-efficient showerheads; and
- Those that consist of education and communication programs.

Further Information

While there is a large range of useful resources and further information available on demand reduction, in the first instance it is suggested that people read Chapter 4 of the Water Sensitive Urban Design in Greater Adelaide: Technical Manual. Further information is available at www.planning.sa.gov.au/go/wsud
### Other Summary Sheets

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A rainwater tank is designed to store rainwater captured via gutters or downpipes on a building.

Rainwater tanks collect only roof runoff (unless it is a ‘dual system’, which can top up with mains water). The captured rainwater can be used for purposes including toilet flushing, laundry uses and outdoor irrigation, or filtered for drinking.

Rainwater tanks can be utilised on residential, commercial, institutional and industrial development sites, and provide a valuable opportunity to:

- Reduce mains (drinking) water consumption; and
- Reduce peak runoff rates and volumes, and consequent environmental impacts (including flooding, stormwater pollution and watercourse erosion).

Types of Rainwater Tanks

Rainwater tanks come in a variety of materials, shapes and sizes and can be incorporated into the building design so they do not impact on the look of the development. There are metal, concrete, plastic, fibreglass and ‘bladder’ type tanks.

What is Water Sensitive Urban Design?

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process. WSUD incorporates all water resources, including surface water, groundwater, urban and roof runoff, drinking water and wastewater. It includes:

- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies;
- Storage, treatment and beneficial use of runoff (at building and street level, including stormwater);
- Treatment and reuse of wastewater; and
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity and amenity.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suiting the characteristics of each development (or redevelopment).

Those measures are described in detail in the WSUD Technical Manual, which can be found online at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud)

Rainwater tanks are one such measure.
Tanks can be located above ground, underground, under the house or can even be incorporated into fences or walls.

**Application and Scale**

Rainwater tanks are often installed to serve one building on one allotment. A large-scale development or building (such as a large shopping centre) could be served by a number of rainwater tanks (for example, located under carparking areas) to provide water for flushing toilets and landscaping.

The amount of rainwater a building can capture and store annually is of course dependent on annual rainfall and its seasonal variation, but also:

- The roof area connected to the tank; and
- The capacity of the chosen tank.

**Rainwater Tank Distribution Systems**

There are three main types of rainwater tank distribution systems:

- Gravity systems – these rely on gravity to supply rainwater to the building and/or garden or landscaped area by placing the tank on a stand at height;
- Dual supply systems – these top up your rainwater tank with mains water when the tank level is low, ensuring reliable water supply; and
- Pressure systems – these use a pump to deliver rainwater to the building and/or garden or landscaped areas.

**How Do I Choose a Rainwater Tank and System?**

The most important thing to consider when choosing a rainwater tank is to first identify what you want from the rainwater tank. The size and type of rainwater tank chosen will vary depending on the water needs and the reliability that is sought from the rainwater tank supply. The following questions should be considered when planning the installation of a rainwater tank:

- What is the water demand of the property?
- What is the intended use of the rainwater?
- What reliability is needed from the rainwater tank – how often and how much water is needed?
- Is there an alternative water supply should the tank run dry?
- What is the total area of roof draining into the tank?
- What is the average annual rainfall of the area?
Once it is known how much water can be collected and how much water is going to be used, then a tank size can be selected that will ensure the reliability of water supply that is needed.

**Checklist for Rainwater Tank Collection System Design and Installation**

- Check that the roof surface is suitable for collecting rainwater. Consider the condition and type of material as well as environmental factors such as airborne pollutants;
- Check the physical constraints of the property, such as available space or level ground;
- Meet with council to determine if any approvals are required for the installation of a rainwater tank in your area;
- Select a tank – consider annual rainfall, its seasonal distribution, roof catchment area and water usage when determining its size;
- Select a pump system (if required) to distribute water for use inside and outside the building;
- Select a tank top up system (if required) to automatically top up the tank with mains water when the water level falls to a designated minimum level;
- Install gutter mesh (6 millimetre wire mesh) to prevent leaves and debris from blocking gutters;
- Fit gutter outlets from the underside of the gutter to prevent obstruction of water flow;
- Fit rain heads to down pipes to stop gutters blocking. Rain heads deflect leaves and debris, and keep mosquitoes out of pipes that hold water;
- Install water diverters to prevent the first flush of most contaminated rainwater from entering the tank;
- Attach insect proof screens or flap valves to the end of all pipes to the tank and to the tank overflow outlets to keep mosquitoes and pests out and to ensure that the tank is vented properly; and
- Develop a maintenance plan for the rainwater tank system.

**Maintenance Requirements**

Installing and regularly maintaining the rainwater tank, gutters and other components will help maintain water quality. Regular maintenance tasks include:

- Cleaning the first flush device every three to six months;
- Removing leaves and debris from the gutters and the inlet mesh every three to six months; and
- Checking the sediment level in the tank every two years.

**Legislative Requirements and Approvals**

**Health**

The Department of Health does not prohibit the use of rainwater for drinking or other purposes. However, the department recommends proper use and maintenance of rainwater tanks and provides various guidelines, particularly on drinking water quality.
Water Supply Authorities

Water supply authorities cannot prohibit the use of rainwater on private land. However, they do require the installation of appropriate backflow prevention devices to prevent possible contamination of mains water by rainwater if rainwater is plumbed into the building using some or all of the same internal pipework as the mains water. SA Water provides guidelines for plumbing configurations of rainwater tanks on private properties (www.sawater.com.au).

Local Councils

Rainwater tanks may require development consent if they exceed certain requirements relating to size, height, siting and other matters. However, a rainwater tank does not need development approval if the tank does not have a floor area exceeding 10 square metres and does not have a height greater than 4 metres (unless you are located in the Hills Face Zone and several other specific zones).
For further details, contact your local council.

State Government

All new dwellings (and some extensions or alterations) are required to have an additional water supply to supplement the mains water. The additional water supply has to be plumbed to a toilet, to a water heater or to all cold water outlets in the laundry of a new home. The same rules apply to new extensions or alterations where the area of the extension or alteration is greater than 50 square metres and includes a toilet, water heater or laundry cold water outlet.

Installing specially plumbed, minimum-sized rainwater tanks will be by far the most common way of meeting the additional water supply requirement.

More information is available from the Department of Planning and Local Government website at www.planning.sa.gov.au

Incentives

Rebates are currently available for plumbing work to tap new or existing rainwater tanks into existing buildings. For further details contact SA Water (www.sawater.com.au) or your local council.

Further Information

While there is a large range of useful resources and further information available on rainwater tanks, in the first instance it is suggested that people read Chapter 5 of the Water Sensitive Urban Design in Greater Adelaide: Technical Manual. Further information is available at www.planning.sa.gov.au/go/wsud
**Other Summary Sheets**

Other Water Sensitive Urban Design Information Sheets for the Greater Adelaide Region are available in this series. To download the summary sheets, visit [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud)

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Rain gardens, green roofs and infiltration systems are source control measures which intercept, treat and promote infiltration of runoff.

Rain gardens are shallow planted depressions designed to receive runoff and assist runoff to infiltrate the underlying soil, recharge the groundwater and reduce peak flows from the site.

Green roofs are a series of layers consisting of living vegetation growing in substrate over a drainage layer on top of built structures. There are four types: extensive, semi-intensive, intensive and elevated landscape. Each type is different in terms of depth of substrate, diversity of plantings, and access provisions.

Infiltration systems typically hold runoff within a subsurface trench prior to infiltrating into the surrounding soils. There are four basic types of infiltration systems: soakaways, infiltration trenches, infiltration basins and leaky wells.

What is Water Sensitive Urban Design?

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process.

WSUD incorporates all water resources, including surface water, groundwater, urban and roof runoff, drinking water and wastewater. It includes:

- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies;
- Storage, treatment and beneficial use of runoff (at building and street level, including stormwater);
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- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity and amenity.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suit the characteristics of each development (or redevelopment).

Those measures are described in detail in the WSUD Technical Manual, which can be found online at www.planning.sa.gov.au/go/wsud

Rain gardens, green roofs and infiltration systems are some such measures.
Purpose

- **Rain gardens** retain runoff for infiltration back into the soil. Some degree of pollutant removal occurs due to the water filtering through the plants and soil before it enters the groundwater. Rain gardens increase the proportion of pervious areas, increase habitat opportunities and biodiversity, and create visual interest through the introduction of water features into the garden;

- **Green roofs** reduce impervious area and runoff volume. Storage and detention of runoff also occurs as water is stored in the substrate and taken up by plants. Peak runoff rates from the roof are delayed before leaving the roof drainage system. Water quality and internal building temperature is improved through the infiltration and bioretention process in the substrate;

- **Infiltration systems** reduce runoff and therefore runoff pollution volumes, reduce peak flows and provide the opportunity for harvesting of runoff. Infiltration systems capture and infiltrate flows, and are generally not designed as a treatment measure (but can provide some level of treatment).

Application and Scale

- **Rain gardens** may be implemented at a variety of scales, from domestic through to commercial and industrial sites. They are an especially useful tool that can be implemented and managed by homeowners;

- **Green roofs** are appropriate for commercial and industrial structures as well as residential buildings. They can be installed on flat roofs but also can be built on slopes up to 30 degrees. They can be incorporated into new construction or retrofitted into existing buildings;

- **Infiltration systems** are limited to soils with good infiltrative capacity and should also be sited with adequate buffer distances from existing inground infrastructure. Infiltration trenches and basins are best suited to residential, commercial and industrial developments with high percentages of impervious areas. Infiltration basins are suited to medium to large (five to 50 hectare) catchments and infiltration trenches to small (less than two hectare) catchments.

Legislative Requirements and Approvals

A thorough investigation of required permits and approvals should be undertaken as part of the conceptual design and this should be discussed with your local council. A proposed system needs to meet the requirements of the following legislation:

- Development Act 1993;
- Environment Protection Act 1993;
- Public and Environmental Health Act 1987; and
Design Considerations

Rain Gardens

Plant selection is very important in the design of a rain garden and selected plants should be suitable for the long dry periods that occur in the Greater Adelaide Region. Perennial species with deep fibrous roots systems that naturally occur in wetlands and soaks should be used.

To prevent mosquitoes breeding, ponding should be limited to no longer than four days, by providing a suitable overflow path or ensuring adequate hydraulic conductivity. An overflow path is required to manage flow from major rain events.

Excessive wetting and drying can cause significant soil movement in some soils, causing damage to adjacent infrastructure. Rain gardens should be located away from infrastructure in heavy soils or installed with an impermeable liner to effectively create a bioretention system once connected to the stormwater chain.

Green Roofs

The factors that need to be taken into consideration for the design of the storage (i.e. detention/retention) component of green roofs include:

- Number and type of layers used in the system;
- Depth of substrate;
- Angle of slope of the roof;
- Local climate;
- Physical properties of the growing media;
- Type of plants incorporated in the roof; and
- Intensity of rainfall.

Structural considerations are critical and include the loads from the saturated growing medium, drainage system, plant mass and any point loads which should be placed over structural supports.

Plant selection is a critical element in green roof success. A wide spectrum of plants from coastal or arid areas of Australia may be suitable for use on green roofs having adapted to extreme environmental conditions, including temperature, high UV load, drought, salt laden winds and shallow nutrient depleted soils.

The most appropriate green roof for the Greater Adelaide Region is the intensive type, which performs better for runoff management given the increased depth of substrate and is better adapted to the dry humidity and heat experienced in summer in Adelaide.

Infiltration Systems

The Development Act 1993 Ministers Specification SA 78AA (Planning SA 2003) contains a variety of considerations that must be adhered to in the design of infiltration systems. These include tables on the required size of infiltration systems and positioning of infiltration systems on a site.
Maintenance Requirements

Rain Gardens

- Rain gardens are a low maintenance, small scale WSUD measure when appropriate vegetation is planted. Under typical climate conditions, they should not need to be watered, mowed or fertilised. Regular weeding may be required once plants have matured;
- There are many species that do not tolerate waterlogging over an extended period of time. These species can be incorporated into the planting plan to identify when substrate infiltration rates change due to silt accumulation;
- Rain gardens should be covered with some form of mulch to retain moisture. Stone mulch varieties are recommended as they do not leach nutrients into ponded water and will not form a potential clogging layer at the surface of the rain garden; and
- Ensure no areas of extended ponding develop that will contribute to breeding of mosquitoes.

Green Roofs

- Initially the plants will need regular watering (in accordance with any water restrictions in place) until they are fully established (usually within six months). If extreme heat wave conditions occur then the use of subsoil dripper irrigation will be required over this period; and
- Regular fertilisation of the soil layer may be required. This can be achieved by applying a slow release fertiliser twice a year.

Infiltration Systems

- Infiltration system characteristics make them susceptible to clogging with sediments. Maintenance should be aimed at ensuring that the system does not clog. This is addressed by Development Act 1993 Minister’s Specification SA 78AA, including inspection and cleaning of retention system components on a regular basis.
Further Information

While there is a large range of useful resources and further information available on rain gardens, green roofs and infiltration systems, in the first instance it is suggested that people read Chapter 6 of the Water Sensitive Urban Design in Greater Adelaide Technical Manual. Further information is available at www.planning.sa.gov.au/go/wsud and the Minister’s Specification SA 78AA can be found at http://dataserver.planning.sa.gov.au/publications/948p.pdf

Other Summary Sheets

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Pervious pavements are load-bearing pavement structures that are permeable to water.

Pervious pavements feature a permeable surface layer overlying an aggregate storage (‘reservoir’) layer. There is a wide variety of pervious pavement types, however, the surface layers fall into two broad categories:

- Porous pavements which are comprised of a layer of highly porous material; and
- Permeable pavements which are comprised of a layer of paving blocks, typically impervious, specially shaped to allow the ingress of water. There are generally large ‘gaps’ between paved areas for infiltration.

The reservoir storage layer consists of crushed stone or gravel which is used to store water before it is infiltrated to the underlying soil or discharged towards a drainage system or to an underground tank.

Pervious paving has many runoff management benefits including:

- Reduced peak runoff discharges;
- Increased groundwater recharge;
- Potential to harvest runoff for reuse; and
- Improved runoff quality.

What is Water Sensitive Urban Design?

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WSUD incorporates all water resources, including surface water, groundwater, urban and roof runoff, drinking water and wastewater. It includes:

- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies;
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There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suiting the characteristics of each development (or redevelopment).

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Pervious pavements are one such measure.
Application and Scale

Pervious paving can be utilised in carparks, streets with low traffic volumes and light traffic weight, and for paving within residential, commercial and institutional developments.

Pervious pavements have been found to be most practical and cost effective when serving catchment areas between 0.1 and 0.4 hectares. As a guide, the contributing catchment area to a pervious area should not exceed 4 to 1. Where sediment and organic loads are high, the ratio should be reduced to 2 to 1.

Design Considerations

- The factors that will maximise the likely success of pervious pavement installation include: low traffic volumes and light vehicle weights, low sediment loads, moderate soil infiltration rates, and regular and appropriate maintenance of the surface;
- Pervious paving must be carefully designed in areas with high water table levels, wind blown or loose sands, clay soils that collapse in contact with water, and soils with a hydraulic conductivity of less than 0.36 millimetres/hour;
- In locations where infiltration will cause shrinking of clays and possible damage to structures, a minimum clearance of 5 metres or an impermeable lining should be used;
- Pre-treatment of surface runoff should be considered to minimise clogging of the paving media and protect groundwater quality. Suitable pre-treatment systems could include leaf and roof guards for roof gutters, buffer strips, swales or a small sediment forebay for larger scale developments;
- Systems with vegetation grown in the voids have demonstrated good long-term performance in the Greater Adelaide Region. Designs need to demonstrate sufficient soil depth and nutrient provision for growth, mitigation of heat retained in pavers, and wear from vehicle movement;
- Where possible, flows that are ‘above design’ flows should be designed to bypass the pervious paving system. This can be achieved in a number of ways, including an overflow pipe or pit which is connected to the downstream drainage system;
- In locations where vehicles may be stopping or turning, structural integrity should be considered as these forces can cause slippage between paver bedding material and the basecourse or geotextile. Lateral forces are better resisted by interlocking pavers;
- Considerations for the safe design of pervious paving systems in pedestrian traffic areas should include minimising trip hazards and falls associated with a slippery pavement surface. Careful construction tolerances and subsequent maintenance regimes are required; and
- Clogging with sediment and oil can occur during construction or through long-term use. The construction process, pre-treatment techniques and maintenance requirements should be designed to minimise clogging.
Design Process

The key steps in the design process include:

- Identify any site constraints and catchment characteristics (e.g. sediment loading, traffic use and loading, soil type, services, current and future groundwater use, groundwater quality and catchment use);
- Establish design objectives and targets (e.g. generally systems operate as infiltration systems – allowance for infiltration to the subsoil between storm events – or detention systems – adequate capacity to reduce peak discharges to specified conditions);
- Liaise with the local council to determine whether a development application is required, and clarify the location and any access requirements of existing services;
- Determine if a design tool is needed. Available tools include hydrological effectiveness curves and the PermPave software;
- Select the type of pervious pavement based on site conditions, desired amenity or local character requirements. The pavement could be one of the many varieties of either permeable or porous pavements available;
- Undertake the structural design of a pervious pavement system. A key consideration is the need for the basecourse to be able to infiltrate runoff;
- The design flow for the surface area, detention (or retention) volume and the overflow pit should be the minor storm event. The overflow or bypass entering the stormwater drainage system should be designed based on the major storm event;
- Size the pervious pavement using the effective design life infiltration rate. A suitable ratio to adopt is 20% of the initial pavement infiltration rate which is consistent with evidence based on 10-year-old pavements;
- Ensure necessary design and specification requirements are documented including pervious paving surface (proprietary requirements/specifications), retention/aggregate layer (material required), geotextile fabric and filter media; and
- Complete a construction plan and maintenance plan assigning specific roles and responsibilities for maintenance and data collation.

Legislative Requirements and Approvals

A thorough investigation of required permits and approvals should be undertaken as part of the conceptual design. A proposed system needs to meet the requirements of the following legislation:

- Development Act 1993;
- Environment Protection Act 1993;
- Public and Environmental Health Act 1987; and
Maintenance Requirements
For efficient operation of pervious pavements it is essential that the gaps between the paver and the underlying bedding layer do not become clogged by fine sediment. These maintenance activities include high pressure hosing/sweeping/vacuuming to remove sediments, repair of potholes/cracks, maintaining surface vegetation and periodic replacement of the aggregate layer (every 20 years).

Following construction, pervious pavements should be inspected every month (or after each major rainfall event) for the initial six months of operation to determine whether or not the infiltration zone requires immediate maintenance. After the initial six months, inspections may be extended to the frequencies stated in the maintenance plan.

Further Information
While there is a large range of useful resources and further information available on pervious pavements, in the first instance it is suggested that people read Chapter 7 of the Water Sensitive Urban Design in Greater Adelaide Technical Manual. Further information is available at www.planning.sa.gov.au/go/wsud

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Sustainable water management involves the use of locally generated rainwater, stormwater and wastewater to supplement traditional water sources.

Urban water harvesting and reuse can be applied at a range of scales as there are numerous methods to utilise rainwater, stormwater and wastewater as a resource.

The capture and use of water on site is environmentally preferable as it reduces the need for piping or pumping. Fewer resources are needed and greenhouse gas emissions are reduced.

This summary sheet does not address reuse of stormwater or wastewater for drinking water purposes. The use of rainwater for drinking water supply is covered in Summary Sheet No. 5 on rainwater tanks.

What is Water Sensitive Urban Design?

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process. It includes:

- Integrated management of groundwater, surface runoff (including stormwater), drinking water and wastewater to protect water related environmental, recreational and cultural values;
- Storage, treatment and beneficial use of runoff;
- Treatment and reuse of wastewater;
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity; and
- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suitting the characteristics of each development (or redevelopment).

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Urban water harvesting and reuse is one such measure.
Applications

The type and scale of water harvesting possible is dependent on:

- The proposed water source and quality (i.e. rainwater, treated wastewater etc);
- The proposed water use (i.e. irrigation);
- The demand pattern and volume (i.e. summer for irrigation);
- The seasonality and volume of water available for harvest (depends on type and source of water);
- The storage options and site constraints;
- Treatment options (if required);
- Objectives for the harvesting system (i.e. reduced mains water supply or reduced runoff from site); and
- Capital and operational costs including monitoring and maintenance costs.

Water Sources

Treated wastewater reuse can provide a relatively constant supply. The primary technical disadvantage of wastewater reuse is the level of treatment, and thus cost, required to achieve the level of water quality necessary for reuse. In addition, the public perception of wastewater reuse and possible health risks needs to be considered using a risk assessment approach.

Stormwater can require a similar level of treatment to wastewater. Supply is dependent on rainfall patterns, thus back up supply from another water source may be needed to maintain continuity of supply. Studies have shown public perceptions of stormwater reuse are more positive than wastewater reuse.

Rainwater captured in rainwater tanks or underground tanks often requires little or no treatment and can be more easily used for a variety of purposes than stormwater and wastewater because of its higher raw water quality. Rainwater supply may not be available during long dry periods and so may require a back up system to ensure continuity of supply.

Water Storage Options

The capacity of any harvesting and reuse scheme is significantly influenced by the size and type of the storage system used. Storage systems used can provide a varying level of treatment in addition to other processes in the treatment train e.g. reduction in suspended solids through settling.

There are various types of storage systems including:

- Rainwater tanks (or above ground storage tanks);
- Underground storage tanks;
- Surface storages (e.g. dams or wetlands); and
- Groundwater (e.g. aquifer).
Public Perception

Public perception is a key issue in the implementation of water harvesting and reuse projects. Investigations have shown that there is a correlation between the scale of a water harvesting and reuse project and its degree of public acceptance. Water from a person’s own home is generally more acceptable than a communal or neighbourhood scale water harvesting system, however, acceptance is high again with respect to a large scale system such as that serving a city.

Regulatory Requirements

A thorough investigation of required approvals and permits should be undertaken as part of the conceptual design of an urban water harvesting and reuse scheme. This should include consultation with local government, SA Water, health and environment agencies.

A proposed urban water harvesting and reuse scheme needs to meet the requirements of a range of legislation and guidelines including:

- The Development Act 1993 under which development approval may be required;
- The Environment Protection Act 1993 under which any development, including the construction of an urban water harvesting and reuse scheme, has a general environmental duty to not cause environmental harm. Aspects of the Act which should be considered include the Environment Protection (Water Quality) Policy 2003, the Environment Protection (Industrial Noise) Policy 1994, the potential effects on air quality, the disposal of waste from the site, the need for a licence for certain activities, the South Australian Reclaimed Water Guidelines and the EPA Code of Practice for Managed Aquifer Recharge;
- The Natural Resources Management Act 2004 which provides the statutory framework for water extraction from rivers, lakes and groundwater;
- The Public and Environmental Health Act 1987 which is implemented by the Department of Health (Environmental Health Branch); and
- The Australian Guidelines for Water Recycling include a risk management framework and specific guidance on managing the health and environmental risks.

Maintenance and Monitoring Requirements

Appropriate maintenance is important to ensure that the scheme continues to meet its design objectives in the long term and does not present public health or environmental risks.

Protection of treatment and retention systems from contamination is necessary and contingency plans should be developed to cater for the possibility of contaminated water being inadvertently utilised.

Regular inspections of a scheme will be needed to identify any defects or required additional maintenance.
Design Process

The degree of complexity of a water reuse scheme is dependent on the number of users, the quality of water to be recycled and the end use. The key steps in the design process are:

- Assess site, catchment and appropriate regulatory requirements. Careful assessment and interpretation of the site conditions is fundamental to effectively incorporate WSUD. The detail of the site and catchment investigation required should match the size and scale of the development and its potential impacts;

- Identify objectives and targets. The design objectives and targets will vary from one location to another and will depend on site characteristics, development form and the requirements of the receiving ecosystems. Specifying the objectives for an urban water harvesting and reuse scheme is an important step for ensuring that it operates as intended;

- Identify potential options. This step identifies various possible layouts for a scheme to meet the project’s objectives and is likely to involve modelling of outcomes. The process needs to consider collection (i.e. swales), storage (i.e. retention basin), treatment (i.e. wetland) and distribution;

- Identify and consult with key stakeholders. This will assist with gaining support for the scheme and ensuring that appropriate approvals are obtained and required information provided;

- Understand and comply with the relevant legislative requirements;

- Identify land and asset ownership to ensure that maintenance and management responsibilities are clearly understood;

- Evaluate options. The various options identified should be evaluated, taking into account social, economic and environmental considerations. Possible analysis techniques include cost benefit, triple bottom-line and multi-criteria decision analysis;

- Detailed design of selected option. During the detailed design of the selected scheme, a risk management strategy should be developed to identify public health and environmental hazards and the controls to be implemented during the design and operational phases; and.

- Obtain approvals.

Further Information

While there is a large range of useful resources and further information available on pervious pavements, in the first instance it is suggested that people read Chapter 7 of the *Water Sensitive Urban Design in Greater Adelaide Technical Manual*. Further information is available at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud).
Other Summary Sheets

Other Water Sensitive Urban Design Summary Sheets for the Greater Adelaide Region are available in this series. To download the summary sheets, visit www.planning.sa.gov.au/go/wsud.

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No. 9  Gross Pollutant Traps  No. 15  Modelling Process and Tools
Gross Pollutant Traps (GPTs) are devices that remove solids conveyed by stormwater.

All forms of development and land use generate gross pollutants, which are a threat to wildlife and aquatic habitats, can look unpleasant, smell and attract vermin.

There are a variety of GPTs suitable for use in urban catchments that remove litter and debris greater than 5 millimetres and coarse sediments before they enter the receiving waters.

**Application and Scale**

The typical application scale for GPTs is the neighbourhood or catchment-wide scale:

- A neighbourhood system would involve smaller traps in side inlet pits, and pit systems that filter runoff from a small number of blocks; and
- Catchment-wide systems are those that include racks and booms across rivers and major stormwater flow corridors.

GPTs can operate in isolation to protect immediate downstream receiving waters or as part of a more comprehensive treatment system to prevent overload of downstream infrastructure.

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**What is Water Sensitive Urban Design?**

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process. It includes:

- Integrated management of groundwater, surface runoff (including stormwater), drinking water and wastewater to protect water related environmental, recreational and cultural values;
- Storage, treatment and beneficial use of runoff;
- Treatment and reuse of wastewater;
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity; and
- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suit the characteristics of each development (or redevelopment).

Those measures are described in detail in the WSUD Technical Manual, which can be found online at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud)

**Gross pollutant traps** are one such measure.
Design Considerations

The key design considerations for the selection of GPTs include:

- A high flow bypass system. This diverts flows higher than the maximum design treatment flow for the GPT over or around a diversion weir. The high flow bypass prevents (i) damage to the trap during floods, (ii) flooding of the surrounding areas being caused by the trap and (iii) excessive scour of the collected pollutants;

- The pollutant storage method. This could be in the form of a wet sump, a basket, net or storage behind screens that are free draining. The pollutant storage method needs to prevent re-suspension of the captured contaminants and the development of anoxic conditions which causes the release of bio-available forms of the pollutants;

- The location of the GPT in the catchment. It is important to understand the pollutant profile of the catchment in order to size the GPT. The pollutant profile is determined by the catchment area, land use and upstream stormwater management infrastructure; and

- Access for inspection and maintenance. A GPT should be located where maintenance and inspection can be carried out using standard maintenance equipment. Adequate access and hardstand areas for maintenance plant (vacuum loader, crane, tippers etc) from the street to the device should be provided.

Most current designs of GPTs are proprietary products. The following are the broad categories of GPTs available:

- Drainage entrance treatments (e.g. grate entrance systems, side entry pit traps and channel net). These are generally used when receiving environments are close to the catchment or the catchment is small and impractical for a large ‘end-of-line’ system. The pollutants are captured at the entry point to the stormwater system and are stored suspended above the pit. They allow high pollutant areas to be targeted and reduce downstream blockages. Maintaining these systems requires visits to numerous locations;

- Direct screening devices (e.g. litter collection baskets, release nets, trash racks and diversion weirs). These use flow passing perpendicular to the screening surface to trap pollutants. They are installed in drainage lines above or below ground (with catchments of 5 to 200 hectares). Above ground systems are highly visible while underground systems are more likely to generate anoxic conditions. Cleaning of the screen is a substantial task but important for maximum efficiency at the start of the next storm;
Non-clogging screens (e.g. circular or downward inclined screen). Few GPTs have this technology which maintains flows at a tangent to the screen face and minimises blockages. Non-clogging screens maintain flow for the duration of a storm event, treating more runoff than direct screening devices.

Floating traps (e.g. flexible floating booms and floating debris traps). These are typically installed in the lower reaches of waterways with low velocities to remove highly buoyant and visible pollutants (typically 10% of the pollutant load). Pollutants are deflected into a retention chamber which generally has limited holding capacity. High velocities and floods can wash out the pollutants and damage the traps; and

Sediment traps (e.g. ponds, circular settling tanks and hydrodynamic separators). There are a range of designs available all creating favourable flow conditions for sedimentation of coarse sediments (greater than 0.125 millimetres). The area required for the device is the primary differentiator. Maintenance is performed using vacuum equipment or by an excavator.

Maintenance Considerations

GPTs require a considerable amount of maintenance to ensure they continue to operate at the design level of performance. A maintenance plan and associated inspection forms should be developed as part of the design process.

Typical maintenance considerations for GPTs include:

- The frequency of emptying to prevent odours, minimise the chance of anoxic conditions developing and the remobilisation of pollutants;
- The disposal method for the captured gross pollutants. Disposal costs depend on whether the collected material is retained in wet or free-draining conditions. Handling of wet material is more expensive and requires sealed handling vehicles;
- The need to monitor the system capture performance and the composition of contaminants; and
- The occupational health and safety requirements such as training for confined space and the handling of potentially hazardous wastes captured.

Design Process

The key steps in the design process include:

- Identify any physical site constraints (e.g. topography, soils, geology, overhead restrictions and services). On sites with steep grades, GPTs may not operate effectively, while on mild slopes head losses can cause local flooding;
- Identify any social factors such as impacts on recreational facilities, odour problems, visual impacts, vermin and safety concerns;
- Establish design objectives and targets (e.g. capture size and type of pollutant);
- Consult with the council and other relevant authorities to ensure the GPT does not cause flooding of existing structures and to determine if any approvals are required;
Identify land and asset ownership to ensure that maintenance and management responsibilities are clearly understood;

Determine the size of the pollutant storage required by calculating the catchment gross pollutant load and specify the desired maintenance frequency (typically between four to 12 times a year);

Determine the design flow rate (the maximum flow rate at which the GPT will operate effectively). Typically a GPT will treat a minimum of the 1 in 3 month ARI flow event and accommodate the bypass of the design 1 in 100 year ARI;

Consider the design tools available to determine the effect of the GPT on the catchment water quality and the potential to achieve the design objectives;

Determine what the maintenance requirements are (i.e. space, hardstand areas and equipment needed, frequency and waste disposal);

Select a GPT design, supplier and construction contractor; and

Determine what temporary protective measures will be needed to protect the GPT components from damage during construction and what sediment and erosion control measures are needed.

Legislative Requirements and Approvals

A thorough investigation of required permits and approvals should be undertaken as part of the conceptual design. A proposed system needs to meet the requirements of the following legislation:

- Development Act 1993
- Environment Protection Act 1993
- Public and Environmental Health Act 1987
- Natural Resources Management Act 2004

Further Information

While there is a large range of useful resources and further information available on gross pollutant traps, in the first instance it is suggested that people read Chapter 9 of the Water Sensitive Urban Design in Greater Adelaide Technical Manual. Further information is available at www.planning.sa.gov.au/go/wsud

Other Summary Sheets

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Runoff is treated in a bioretention system through a vegetated filter media.

A bioretention system is most commonly undertaken as:

- Bioretention swales (or biofiltration trenches) which involve a continuous layer of bioretention along the length of the swale, or a portion of bioretention prior to the outlet of the swale; or
- Bioretention basins which provide flow control and water quality treatment functions. A bioretention basin is characterised by the ability to detain/retain runoff in a depression storage (or ponded area) above the bioretention system.

The most common application of bioretention systems is to recover the runoff using perforated under-drains for discharge or reuse. Bioretention systems are generally not designed to enable runoff exfiltration from the bioretention filter media to the in-situ soil. Exfiltration is appropriate where soil properties, site terrain, building set back and local groundwater requirements permit.

What is Water Sensitive Urban Design?

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process. It includes:

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- Storage, treatment and beneficial use of runoff;
- Treatment and reuse of wastewater;
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity; and
- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suit the characteristics of each development (or redevelopment).

Those measures are described in detail in the WSUD Technical Manual, which can be found online at www.planning.sa.gov.au/go/wsud

Bioretention systems are one such measure.
Bioretention systems can provide both runoff treatment and conveyance functions including:

- The removal of coarse to medium sediments and associated pollutants;
- The removal of fine particulates and associated contaminants by infiltration through the underlying filter media layers;
- Protection of natural receiving waterways from frequent storm events by delaying runoff peaks, providing retention capacity and a reduction in peak flow velocities;
- Swale components can be designed to convey runoff as part of a minor and/or major drainage system; and
- Potential aesthetic and biodiversity benefits.

Application and Scale

Bioretention systems are best suited to small (i.e. less than 5 hectare) catchments with high percentages of impervious areas. Bioretention systems can be appropriate in areas where runoff is insufficient or unreliable, evaporation rates too high, or soils are too pervious to sustain the use of constructed wetlands.

The limitations to the use of bioretention systems include the need for adequate sunlight and pre-treatment for coarse sediments to prevent clogging.

Design Considerations

- Bioretention systems can perform a valuable landscape function. It is important to ensure the planting design addresses runoff quality objectives by incorporating appropriate plant species for treatment of runoff (particularly those with a biologically active root zone);
- Bioretention systems can provide a relatively maintenance free finish if the design considers the type of inorganic mulch, density and type of vegetative plantings and water requirements during dry periods;
- The hydraulic design should prevent scour of the bioretention surface and provide uniformly distributed flow over the surface area. Flow velocities should be below 0.5 metres/second in a minor flood event and not more than 1.0 metres/second for a major flood event to prevent scour;
- Where exfiltration of runoff is not desirable from the drainage layer and the saturated hydraulic conductivity of the bioretention filter media is less than 10 times that of the local soils, it may be necessary to provide an impermeable liner;
- Vegetation that grows in the filter media enhances its function by trapping and absorbing physical pollutants and by preventing erosion of the filter medium. Suitable vegetation characteristics include dense planting, drought tolerant perennial species and no requirement for mowing;
- Selection of bioretention filter media should consider the saturated hydraulic conductivity required (preferably 150-350 millimetres/hour), the depth of extended detention above the filter media and its suitability as a growing medium;
During construction and operation, access should not be given to traffic. Building materials should not be placed on the bioretention system to avoid compaction of the media; and

The design must not compromise the width provided in the road verge for services, not allow services to be located below the system invert and should provide sufficient space for maintenance to be performed.

**Design Process**

The key steps in the design process include:

- Consider site suitability and catchment characteristics (e.g. soil characteristics, local sediment sources, suitability for recharge, traffic volumes, service locations, groundwater depth and quality);
- Establish design objectives and targets. Objectives and targets will differ if the system is designed for detention or infiltration but are likely to include an adequate hydraulic residence time to retain sediments and pollutants;
- Meet with local council to discuss the design objectives, any site constraints and whether approval is required from the council or any other authority;
- Identify land and asset ownership to ensure that maintenance and management responsibilities are clearly understood;
- Consider the design tools available for designing various components of the system;
- Select the type of bioretention system (i.e. swale or basin based on the site constraints and management requirements);
- Size the bioretention system addressing factors including the longitudinal and side slopes, vegetation height, provision of crossings, allowances for services and flow delivery to the system. Consultation with a landscape architect is recommended when selecting the vegetation to ensure the treatment system design integrates with the local area;
- Design the kerb inlets to the system. The inlet must prevent scour while maintaining road safety. Kerbs with gaps are a common design;
- Design the bioretention system components. The design method is determined by the primary function (i.e. conveyance, detention or conveyance and infiltration);
- Check that the bioretention system design meets the design objectives; and
- Develop maintenance and construction plans which contain measures to prevent damage to the system during construction and to assign maintenance tasks and responsibilities for ongoing operation.

**Legislative Requirements and Approvals**

A thorough investigation of required permits and approvals should be undertaken as part of the conceptual design. This can be assisted through discussions with your local council. A proposed system needs to meet the requirements of the following legislation:

- Development Act 1993;
- Environment Protection Act 1993;
- Public and Environmental Health Act 1987; and
Maintenance Requirements

The most intensive period of maintenance is during the plant establishment period (over the first two years) when weed removal and replanting may be required. The following critical items should be monitored every one to three months during this period:

- Ponding, clogging and blockage of the filter media;
- Establishment of desired vegetation/plants and density; and
- Blockage of the outlet from the bioretention system.

Other ongoing maintenance includes removal of debris from inlets and outlets, mowing or slashing if required and maintenance of plant health and density.

Further Information

While there is a large range of useful resources and further information available on bioretention systems, in the first instance it is suggested that people read Chapter 10 of the *Water Sensitive Urban Design in Greater Adelaide Technical Manual*. Further information is available at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud)

Other Summary Sheets

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Swales and buffer strips are formed, vegetated depressions (or channels) that convey runoff.

Swales and buffer strips are typically linear, shallow and wide. They can become features of a landscape, require minimal maintenance once established and are hardy enough to withstand large flows. Swales are used to convey runoff in lieu of, or with, underground pipe drainage systems. Swales provide a number of functions including:
- Removing coarse to medium sized sediments (and attached pollutants) by filtration through the vegetated surface;
- Reducing runoff volumes (by promoting some infiltration to the subsoils);
- Delaying runoff peaks by reducing flow velocities;
- Accommodating pedestrian movement across and along them; and
- Pre-treatment for other WSUD measures.

Buffer zones or strips (also known as filter strips) are grassed or vegetated areas that treat shallow overland flow before it enters the drainage network. They provide a number of functions including:
- Removing sediments by filtration through the vegetation;
- Reducing runoff volumes (by promoting some infiltration to the subsoils);
- Delaying runoff peaks by reducing flow velocities; and
- Removing coarse to medium sized sediments (such as nutrients, free oils/grease and metals).

What is Water Sensitive Urban Design?
Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process. It includes:
- Integrated management of groundwater, surface runoff (including stormwater), drinking water and wastewater to protect water related environmental, recreational and cultural values;
- Storage, treatment and beneficial use of runoff;
- Treatment and reuse of wastewater;
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity; and
- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suiting the characteristics of each development (or redevelopment).

Those measures are described in detail in the WSUD Technical Manual, which can be found online at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud).
Application and Scale

Swales are often used in low density residential developments as an alternative to kerb and gutter systems, or as a pre-treatment to other measures. They can also be used in:

- Road medians and verges;
- Car park runoff areas; and
- Parks and recreation areas to convey runoff.

Swales are most applicable at the subdivision scale (i.e. along median strips, or through parks) but can be applied at the allotment level, depending on the catchment area.

Swales are most effective when serving catchment areas up to 2 hectares and typically should not be used in catchments over 4 hectares in area. Larger than this, flow depths and velocities are such that the water quality improvement function of the swale may be compromised.

Buffer strips are most applicable at the subdivision scale, with catchment areas less than 2 hectares. Buffer strips can also be applied at the allotment level (e.g. buffering runoff from driveways, overflows from rainwater tanks etc) depending on the catchment area.

Design Considerations

- The design capacity of swales or buffer strips to achieve water quality improvement is typically up to the 3 month ARI. To provide for a conveyance flow it may be necessary to augment the capacity with overflow pits to an underground drainage system;
- Driveway crossings of swales take one of two forms: ‘at grade’ (e.g. like a ford) or elevated (e.g. like a culvert). At grade crossings are generally cheaper but require a shallower profile to enable vehicles to traverse;
- The longitudinal slope should ideally be between 1 to 4% to avoid water logging and scouring of vegetation. To ensure adequate treatment velocities should be less than 0.5 metre/second for the 1 year ARI and less than 1.0 metres/second for the 100 year ARI;
- Landscape design of swales and buffer strips along the road edge can assist in defining the boundary of the road or street corridors as well as enhancing landscape character;
- It should be ensured that access for maintenance of services is possible without regular disruption or damage to the swale as the standard location for services is within the verges;
- Public safety should be maintained by providing sufficient conveyance capacity and appropriate flow depth and velocity to satisfy design requirements for adjacent pedestrian and bicycle pathways;
- Vegetation and planting needs to consider both aesthetic and functional requirements, including the capability to withstand design flows and be resilient to long periods of dry weather;
- To avoid sediment accumulation on the edge of the impervious area, a flush kerb or drop down should be used. This requires the finished topsoil surface to be approximately 100 millimetres below the pavement; and
- Vehicles should be prevented from accessing the swale or buffer strip as this reduces performance. This can be achieved by using physical barriers (e.g. vegetation or bollards).
Design Process

Key steps in the design process include:

- Identify any site constraints and opportunities (e.g. landscape, ecology, contamination and services);
- Establish design objectives and targets (e.g. maximise filtration and meet conveyance requirements);
- Meet with local council to check planning, building or health requirements that need to be met and any approvals that are required.
- Identify land and asset ownership to ensure that maintenance and management responsibilities are clearly understood;
- Investigate the range of design tools available;
- Undertake concept design (i.e. topographical survey, design criteria based on water quality objectives, design flows based on catchment characteristics, maintenance access and traffic management requirements);
- Obtain any required approvals;
- Complete detailed design (i.e. detailed design of civil works, design of services relocation, planting plan and maintenance plan);
- Develop a construction plan which contains measures to control the risk or provide temporary protection to swales or buffer strips from damage by traffic and high sediment loads during the construction phase;
- Determine if the available top soil is suitable as a growth medium and free from weed seed banks;
- Source vegetation early and ensure that construction planning corresponds with suitable planting months and includes plans for watering during the establishment period (in accordance with water restrictions);
- Ensure that the planting plan specifies a high planting density rate to combat weed invasion and reduce the cost of maintenance.

Legislative Requirements and Approvals

A thorough investigation of required permits and approvals should be undertaken as part of the conceptual design. This can be assisted through discussions with your local council. A proposed system needs to meet the requirements of the following legislation:

- Development Act 1993;
- Environment Protection Act 1993;
- Public and Environmental Health Act 1987; and
Maintenance Requirements

A maintenance plan and associated inspection forms should be developed as part of the design process. Typical maintenance of swales and buffer strips will include:

- Routine inspection and repair of the swale profile in areas of obvious increased sediment deposition, or scouring of the swale invert from storm flows, rill erosion of the swale batters from lateral inflows or damage to the swale profile from vehicles;
- Removal of sediment where it is impeding the conveyance of the swale and/or smothering the swale vegetation and, if necessary, reprofiling of the swale and revegetating to original design specification;
- Mowing of turf or slashing of vegetation (if required) to preserve the optimal design height for the vegetation (note: heavy machinery for mowing/slashing should be avoided);
- Removal and management of invasive weeds with pruning to remove dead or diseased vegetation and to stimulate new growth; and
- Monitoring of nuisance problems such as mosquitoes and boggy areas as well as litter and debris removal.

Further Information

While there is a large range of useful resources and further information available on swales and buffer strips, in the first instance it is suggested that people read Chapter 11 of the Water Sensitive Urban Design in Greater Adelaide Technical Manual. Further information is available at www.planning.sa.gov.au/go/wsud

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Sedimentation basins (otherwise known as sediment basins) are stormwater detention systems that promote settling of sediments through the reduction of flow velocities and temporary detention.

Sedimentation basins are typically installed as part of an overall stormwater management system to remove coarse sediments and regulate flows.

The removal of coarse sediment generally ensures that the vegetation downstream is not smothered by sediment and allows downstream treatment systems to target finer particulates, nutrients and other pollutants. A sedimentation basin also regulates or controls flows and thus protects downstream vegetation against scour during high flows.

Sedimentation basins are generally included as the first treatment step in constructed wetland systems (i.e. the inlet zone) prior to the heavily vegetated macrophyte zone. Sedimentation basins are deeper than macrophyte zones and are vegetated only around the water’s edge and bank.

What is Water Sensitive Urban Design?

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- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity; and
- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suiting the characteristics of each development (or redevelopment).

Those measures are described in detail in the WSUD Technical Manual, which can be found online at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud).

Sedimentation basins are one such measure.
Application and Scale
Sedimentation basins can take various forms (at a range of scales) and can be used as permanent systems integrated into an urban design or can be used as a temporary measure to control sediment discharge during construction.

Design Considerations
The key design considerations for sedimentation basins include:

- The role the sedimentation basin plays in the treatment train and the surrounding landscape. This determines the target sediment size for settling, and aesthetic and recreational objectives to be met;
- The required water retention capabilities of the base material (i.e. designs typically include a clay base overlain with hard rock);
- Vegetation and landscaping to provide scour and erosion protection and to limit public access where necessary;
- Plant species selection and planting plan to prevent cover of open water zones and enable maintenance access while achieving landscape objectives;
- Maintenance access and frequency to enable sufficient sediment storage capacity and access for sediment removal and drying;
- Identification of land and asset ownership to ensure that maintenance and management responsibilities are clearly understood; and
- Understanding of and compliance with the relevant legislative requirements.
Design Process

Key steps in the design process include:

- Complete site and catchment analysis and identify any site constraints;
- Establish design objectives and targets;
- Consult with local council and other relevant authorities;
- Complete concept design (including target sediment size, design flows, size and shape of basin, storage volume and cross sections);
- Obtain approvals, if required;
- Complete detailed design (including design of hydraulic structures i.e. inlet, outlet and high flow bypass);
- Complete vegetation specification and plan vegetation procurement;
- Develop maintenance plan and assign responsibilities;
- Specify construction tolerances to ensure appropriate hydraulic function.

Legislative Requirements and Approvals

A thorough investigation of required permits and approvals should be undertaken as part of the conceptual design. This can be assisted through discussions with your local council. A proposed system needs to meet the requirements of the following legislation:

- Development Act 1993;
- Environment Protection Act 1993;
- Public and Environmental Health Act 1987; and

Maintenance Requirements

A maintenance plan and associated inspection forms should be developed as part of the design process. Typical maintenance of sedimentation basins will include:

- Routine inspection of the sedimentation basin to identify depth of sediment accumulation, damage to vegetation, scouring or litter and debris build up (after first three significant storm events and then at least every three months);
- Routine inspection of inlet and outlet points to identify any areas of scour, litter build up and blockages;
- Removal of litter and debris and management of invasive weeds (both terrestrial and aquatic); and
- Periodic (usually every five years) draining and desilting, which will require excavation and dewatering of accumulated sediment (and disposal to an approved location).
Further Information

While there is a large range of useful resources and further information available on sedimentation basis, in the first instance it is suggested that people read Chapter 12 of the Water Sensitive Urban Design in Greater Adelaide Technical Manual. Further information is available at www.planning.sa.gov.au/go/wsud

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Application and Scale

Wetlands are most appropriate on sites that meet or exceed the following criteria:

- Catchment area of more than approximately 1 hectare;
- Soils that are silty through clay;
- No steep slopes or slope stability issues; and
- No significant space limitations.

Constructed wetlands should only be used in areas that have enough inflow to ensure the long-term viability of wetland processes.

Constructed wetlands are most applicable on the street scale and precinct or regional scale.

The water quality performance efficiency of constructed wetlands can alter greatly due to changes in environmental conditions over a diurnal and seasonal time period. Treatment efficiencies will also depend on the hydraulic efficiency and the design of the wetland.

Design Considerations

Wetlands generally consist of:

- An inlet zone, which is a sedimentation basin that removes coarse sediments and regulates flows entering the macrophyte zone. The inlet zone typically treats inflows up to 1 year ARI and bypasses higher flows around the macrophyte zone;
- A macrophyte zone which is a shallow, heavily vegetated area to remove fine particulates and uptake soluble pollutants; and
- A high flow bypass channel which protects the macrophyte zone from scour and vegetation damage.

Key design considerations include:

- The notional detention time of a wetland should be 72 hours and not less than 48 hours in order to remove nutrients effectively. The notional detention time is used to provide a point of reference in modelling and to determine the design criteria for outlet structures;
- Hydrologic effectiveness is an important consideration. This is the percentage of the mean annual volume of runoff from the contributing catchment treated by the wetland. The hydrologic effectiveness of the wetland should be greater than 80%. The placement of flow control structures and the length and width ratio of the macrophyte zone influence hydraulic efficiency;
- The macrophyte (wetlands planting) zone design needs to have a suitable extended detention depth for the target pollutants (between 0.25 and 0.5 metres). The bathymetry (underwater ground contours) of the macrophyte zone should provide for a sequence of zones with different wetting and drying characteristics;
- Design features to prevent mosquito breeding are important and include providing access for mosquito predators and reducing opportunities for isolated pools to form when water levels fall or after heavy rainfall. Regular monitoring for mosquito activity should be a component of the maintenance plan; and
Constructed wetlands need to be consistent with public safety requirements for new developments including standard principles of informal surveillance. Safety features include reasonable batter profiles for edges to facilitate public egress from areas with standing water and fencing where water depths and edge profile requires physical barriers to public access.

**Design Process**

Key steps in the design process include:

- Identify any site constraints or opportunities (e.g. landscape, groundwater, contamination, services and ecology);
- Establish design objectives and targets (e.g. specific water quality parameters and flood attenuation targets);
- Meet with local council and other relevant authorities to check planning, building or health requirements that need to be met;
- Identify land and asset ownership to ensure that maintenance and management responsibilities are clearly understood;
- Investigate the range of design tools available (e.g. MUSIC, EPA SWMM, XP-SWMM and HecRas);
- Undertake a concept design including verification of design performance, determination of design flows based on catchment characteristics, inlet and macrophyte zone layout, design of outlet structures and preliminary costing;
- Consider a mechanism to enable the macrophyte zone to be drained for water level management during the plant establishment phase;
- Consider maintenance access requirements of all components of the wetland;
- Consider any requirements for access across the wetland as part of an overall pathway network and provide opportunities to create alternative recreation spaces;
- Obtain relevant approvals;
- Undertake detailed design including design of civil works, additional geotechnical studies, detailed design drawings, procurement plan and planting plan;
- Ensure the planting design aims to fulfil the intended water treatment function as well as integrating with the surrounding landscape. Wetlands can be designed as a significant landscape feature;
- Ensure the outlet structure of the macrophyte zone includes measures to trap debris to prevent clogging;
- Develop a construction and maintenance plan; and
- Put procedures in place to ensure successful vegetation establishment including site preparation, stock sourcing, vegetation establishment and maintenance plans. Vegetation requires approximately two growing seasons to reach design condition i.e. usually 70-80% cover.
Legislative Requirements and Approvals

A thorough investigation of required permits and approvals should be undertaken as part of the conceptual design. This can be assisted through discussions with your local council. A proposed system needs to meet the requirements of the following legislation:

- Development Act 1993;
- Environment Protection Act 1993;
- Public and Environmental Health Act 1987; and

Maintenance Requirements

A detailed maintenance plan should be developed that specifies short and long-term maintenance of the constructed wetland including the monitoring requirements. Maintenance plans should address the inspection frequency, maintenance frequency, data collection requirements and detailed clean out procedures. The plan should be updated at least every three years.

Specific issues that should be addressed in a maintenance plan include:

- A monitoring plan that as a minimum includes monitoring of surface and groundwater levels to determine whether the wetland hydrology matches that of the design intent. Monitoring of the inflow and outflow water quality, in particular total suspended solids and nutrients, during low and high flow periods should also be undertaken;
- Aesthetic maintenance including graffiti removal, grass trimming, weed control and other tasks which require frequent attention to maintain an attractive appearance; and
- Functional maintenance including vegetation inspections during both the growing and non-growing period, litter and debris removal, sediment removal and disposal, mechanical components maintained in accordance with manufacturers instructions, structural damage inspections and remediation including erosion management.

Further Information

While there is a large range of useful resources and further information available on constructed wetlands, in the first instance it is suggested that people read Chapter 13 of the *Water Sensitive Urban Design in Greater Adelaide Technical Manual*. Further information is available at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud)
### Other Summary Sheets

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More than half of the mains water used in homes in the Greater Adelaide Region is returned to sewers as wastewater.

There are two main types of domestic wastewater:

- Greywater is wastewater from the hand basin, shower, spa bath, washing machine, laundry tub, kitchen sink and dishwasher.
- Blackwater is wastewater containing, or likely to be contaminated by, human waste matter (e.g. toilet wastewater or waters contaminated by toilet wastewater); and

A typical household discharges an average of approximately 95 litres of greywater and 35 litres of blackwater, per person per day.

About 95,000 megalitres of domestic wastewater is currently generated in the Greater Adelaide Region each year, of which around 75,000 megalitres is discharged into Gulf St Vincent.

This discharge has a detrimental impact on the health of Adelaide’s coastal waters.

What is Water Sensitive Urban Design?

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process. It includes:

- Integrated management of groundwater, surface runoff (including stormwater), drinking water and wastewater to protect water related environmental, recreational and cultural values;
- Storage, treatment and beneficial use of runoff;
- Treatment and reuse of wastewater;
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity; and
- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies.

There are many different WSUD measures which together form a ‘tool kit’ from which individual measures can be selected to form a specific response suit the characteristics of each development (or redevelopment).

Those measures are described in detail in the WSUD Technical Manual, which can be found online at www.planning.sa.gov.au/go/wsud

Wastewater management is one such measure.
Wastewater Services

In the Greater Adelaide Region, there are two distinct areas of wastewater services – sewered and non-sewered areas.

- Sewered areas. The majority of the Greater Adelaide Region is serviced by a sewer system connected to either one of three major metropolitan coastal wastewater treatment plants (WWTPs) or one of several smaller WWTPs. Wastewater that is not reused is discharged from these plants to receiving waters. SA Water is responsible for the provision of wastewater services in sewered areas; and

- Non-sewered areas. Where a sewer system does not exist, the on-site treatment and reuse options include septic tanks and subsurface disposal systems on individual properties, septic tanks connected to a community wastewater management system (CWMS) and aerobic treatment units with designated irrigation areas. The Department of Health provides information on requirements and approval procedures for new applications. Local councils provide wastewater services to most non-sewered areas.

Purpose

Sustainable water management can assist in achieving targets in South Australia’s Strategic Plan and Water For Good.

The reduction of wastewater discharged to reticulated sewerage systems by more efficient water use, greywater and wastewater reuse, and alternative toilet systems can produce significant economic and environmental advantages to the community. However, this needs to be balanced against health risks.

It is possible that in some locations, properly managed and maintained decentralised reuse might be able to cost-effectively augment or replace existing sewerage infrastructure that would otherwise need to be replaced or upgraded.

Scale and Application

Treated wastewater use should be considered in the context of the specific development and management of the entire water cycle.

The potential for treatment and reuse of wastewater will depend on:

- The scale and location of the development;
- The volume and quality and timing (i.e. seasonality) of wastewater generated; and
- The volume and quality and timing of treated wastewater demand.

For urban developments, reused wastewater is suitable for:

- Toilet flushing;
- Public open space irrigation;
- Private garden irrigation/outdoor use;
- Environmental flows; and
- Ornamental water bodies integrated into the development.
Legislative Requirements and Approvals

Before developing a wastewater treatment and reuse system it is important to check whether there are any planning regulations, building regulations or local health requirements that apply to wastewater reuse in your area. Legislation or requirements which may apply include:

- The Development Act 1993 which may require development approval to be given for the installation of a wastewater reuse scheme;

- The Public and Environmental Health Act 1987 which is implemented by the Department of Health. This agency provides information and assistance in establishing the requirements for installation of an on-site or community scale wastewater treatment system, whether black or greywater;

- The Environment Protection Act 1993, which requires a general environmental duty not to cause environmental harm. Specific aspects of the Act which are relevant to installation of wastewater reuse schemes include the Environment Protection (Water Quality) Policy 2003, the Environment Protection (Industrial Noise) Policy 1994, the need to demonstrate that the operation and maintenance of the plant will avoid nuisance by odours and the need for EPA licensing of some systems;

- The South Australian Sewerage Act 1929 which is administered by SA Water and is applicable to areas where there is a government sewerage system available; and

- The Australian Guidelines for Water Recycling which apply to any wastewater reuse projects and include a risk-based approach to the reuse and recycling of wastewater and greywater from large-scale centralised treatment facilities.

Design Considerations

A key consideration is the intended use of the treated wastewater and the demand profile for that application. Demand management is important to reduce water consumption as the treatment and delivery of recycled water entails significant costs which can be minimised by efficiency of use.

The capacity of the existing infrastructure should be considered to maintain service under expected population increases from new and infill development.

Ensuring human health is protected and the scheme is accepted by the community is important. The following approach may assist in gaining approval and social acceptance of a treated wastewater reuse scheme:

- Adopt a risk-based approach to defining methods of delivery and corresponding water quality requirements as defined in the new Australian Water Recycling Guidelines;

- Define requirements for pre-commissioning monitoring and demonstration of compliance to current health standards for treated wastewater; and

- Identify community receptiveness to different applications of treated wastewater.

The environmental impact of the wastewater scheme should be considered. Possible impacts include greenhouse gas emissions as a result of treatment and transport energy, the impact on the receiving body (i.e. the aquatic environment) and the production of biosoilds and other wastes.
Land and asset ownership needs to be identified to ensure that maintenance and management responsibilities are clearly understood. An understanding of and compliance with the relevant legislative requirements also needs to be gained.

Design Process

The design process is likely to require several rounds of reviews as new information arises and negotiations progress with stakeholders that may alter the objectives and available options. The key steps in the design process include:

- Assess the site, catchment and appropriate regulatory requirements. Development characteristics and location can influence viable options for treated wastewater reuse. The factors influencing water reuse viability include the development size and density, development type, areas requiring irrigation and integration with the surrounding environment;

- Identify objectives and targets. It is essential that objectives and targets are established as part of the conceptual design process and discussed with the relevant council prior to commencing the engineering design. The objectives will vary from one location to another and will depend on site characteristics, development form and the requirements of the receiving ecosystems;

- Undertake a water balance. The water balance provides a starting point to assess the viability of reusing water to complement other available water sources. The development of an end use model enables specific water uses to be matched to appropriate water sources on a fit-for-purpose basis and calculates the water demand for each use;

- Identify potential options. There are various treatment technologies that can be selected depending on the scale and application of the scheme. Each option should be evaluated on a case-by-case basis;

- Consult with key stakeholders and relevant authorities. Meeting with stakeholders generally results in greater user confidence and ensures that the objectives are consistent with council directions;

- Evaluate options. The selection of appropriate, sustainable and suitable water treatment technologies is dependent on economic, environmental and social considerations;

- Detailed design of selected option. During the detailed design, a risk management strategy should be developed identifying public health and environmental hazards and appropriate controls to be implemented during the design and operational phases;

- Check the design objectives;

- Develop a maintenance and monitoring plan. Adequate maintenance of wastewater treatment and reuse schemes is important to ensure that the scheme continues to meet its design objectives and does not present public health or environmental risks.

Further Information

While there is a large range of useful resources and further information available on wastewater management, in the first instance it is suggested that people read Chapter 14 of the *Water Sensitive Urban Design in Greater Adelaide Technical Manual*. Further information is available at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud)
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Models are playing a greater role in water resource management due to the increasing complexity of systems that are being implemented and the range of factors that require consideration.

There are many existing computer models which are powerful tools that can be utilised to design and estimate the performance of various Water Sensitive Urban Design (WSUD) measures. This means that the performance of different development proposals can be assessed and compared using a common measurement system.

Essentially, models allow the extrapolation from existing systems and knowledge to analyse potential situations.

Models can be employed to meet many different objectives during the planning, design and operation of a water management system and therefore different types of models can be more appropriate than others depending on the issues to be considered.

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When is a Model Required?

The level of modelling required to be undertaken will be defined by council development assessment officers and will be based on factors including:

- The level of impact the development is likely to have on the receiving waterways/water bodies; and
- The scale of the development.

For small developments and redevelopments there will be instances where detailed modelling is not required. In such cases, the consenting authority should have a clear understanding of the minimum WSUD measures required for such developments. Type curves can be utilised (where available) for instances when a model is not required.

Modelling Procedure

The modelling procedure should follow logical steps and the following approach is recommended:

- Preliminary consideration of objectives;
- Data collection and site inspections;
- Building a conceptual model of the existing system;
- Model refinement, checking and calibration;
- Detailed runs;
- Identification of problems;
- Scoping (identification and initial assessment) of remedies; and
- Preparation of a report.

In order of importance, the accuracy of models depends on:

- The amount of data used to build and operate the model;
- The experience or skill of the analyst; and
- The quality of the model.

Models are ineffective without data and calibration.

Type of Models Available

There is a wide range of packages and approaches that can be applied to simulate water management systems. The models listed below have been selected due to their availability and wide use through the industry, their applicability to WSUD and South Australian conditions. It is important to note that the inclusion of these models in this list neither endorses any of these modelling systems, nor assures the quality of results that will be obtained from their use.
Further Information

While there is a large range of useful resources and further information available on the modelling process and tools, in the first instance it is suggested that people read Chapter 15 of the *Water Sensitive Urban Design in Greater Adelaide Technical Manual*. Further information is available at [www.planning.sa.gov.au/go/wsud](http://www.planning.sa.gov.au/go/wsud).

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