State Stormwater Strategy

Department of Primary Industries, Parks, Water and Environment

Tasmania
Explore the possibilities

Executive Summary

Stormwater is the water which flows over the surface of the land following precipitation. Stormwater from urban areas typically contains large amounts of litter and other gross pollutants, sediments, faecal bacteria, hydrocarbons, nutrients, heavy metals and other pollutants. Furthermore, because urban catchments typically contain large areas of roads, carparks and other impervious surfaces, large volumes of runoff can be generated in a short period of time, resulting in downstream flooding and erosion. If unmanaged, stormwater can result in severe impacts on downstream waterways.

The Tasmanian *State Policy on Water Quality Management 1997* (SPWQM) highlights the importance of managing stormwater in new developments at both the construction and operational stages and emphasises the need to manage stormwater at source. The SPWQM also identifies Stormwater Management Plans as important tools for councils in managing urban runoff. The SPWQM is currently under review and it is anticipated that stormwater management will continue to be an important component of the revised Environmental Protection Policy. There are also a number of other policies and planning instruments currently under development or review, including the Regional Planning Initiative, local government planning schemes and the *Drains Act* which are relevant to stormwater management.

This document - the *State Stormwater Strategy* sets out key principles and standards for stormwater management in Tasmania, and identifies accepted guidance documents.

Managing stormwater in new developments

All new developments that create 500m^2 or more of additional impervious surface, including subdivisions, roads and other large developments, should incorporate best practice stormwater management. The following standards are recommended:

Construction stage

Soil and water management controls should be required and implemented through the Development Application process, including detailed Soil and Water Management Plans where warranted.

Best practice guidance on sediment and erosion control measures is provided in the document *Soil and Water Management on Building and Construction Sites* (2009).

Operational stage

New developments should be designed to minimise impacts on stormwater quality and, where necessary, downstream flooding or flow regimes. Stormwater should be managed and treated at source using best management design practices (eg Water Sensitive Urban Design) to achieve the following stormwater management targets:

- 80 per cent reduction in the annual average load of total suspended solids
- 45 per cent reduction in the annual average load of total phosphorus
- 45 per cent reduction in the annual average load of total nitrogen

Best practice guidance on stormwater treatment options to achieve these targets is provided in the following documents:

- *Water Sensitive Urban Design Guidelines for Stormwater Management in Southern Tasmania* (2006)
- *Water Sensitive Urban Design Guidelines for Stormwater Management in Tasmania* (in prep) and

- ► Model for Urban Stormwater Improvement Conceptualisation (MUSIC, version 4, 2009)

Managing stormwater in established urban areas

Management of urban runoff from established catchments should be based on a risk-based ***prioritisation of catchments*** and stormwater pollution sources.

Stormwater management plans should be prepared for high priority catchments, with a focus on 'at source' management. In particular, commercial areas, industrial sites and major roads tend to be significant sources of stormwater pollution.

Best practice guidance on the development of stormwater management plans is provided in the document *A Model Stormwater Management Plan for Hobart Regional Councils – Focus on New Town Rivulet Catchment* (2005).

Maintaining natural drainage systems

Urban waterways, including rivulets, creeks and natural drainage lines, provide important water quality, ecological and amenity values and should be maintained, enhanced or restored. Piping or lining of natural channels should be seen only as a last resort. It is recommended that ***buffer zones*** be established to protect the values of urban waterways, and that any development within these areas be carefully managed.

Best practice guidance on managing urban waterways is provided in the document *Tasmanian Waterways and Wetlands Works Manual* (2003).

Other mechanisms to support improved stormwater management

This document also provides information on enabling mechanisms to improve the management of stormwater management in Tasmania. These include:

- ► A review of ***financing options*** to support stormwater management
- ► ***Education and training*** activities to increase community awareness and improve skills of stormwater practitioners

The regulatory environment

Governance of water resources in Australia is the responsibility of state and territory governments, with local government generally responsible for stormwater management.

The Australian Government has encouraged a nationally consistent approach to stormwater management through the *National Water Initiative (NWI*) and *National Water Quality Management Strategy (NWQMS)*.

Under the *NWI* agreement signed between 2004 and 2006, all states and territories have committed to conduct water reform, including urban water reform and the integrated management of water for environmental and public benefit. As signatories to the *NWI*, Tasmania lodged a plan on how it will develop its water management arrangements including urban water reform to meet the requirements of the agreement.

The State endorses urban water reform actions of the *NWI* including encouraging innovation and capacity building to create water sensitive Australian cities and recommends water sensitive urban design as a best management practice for the long-term management of urban runoff quality. National guidelines for water sensitive urban design have been produced as part of the *NWI* urban reform actions.

The *National Water Quality Management Strategy* (*NWQMS*) provides a countrywide approach to improving water quality in Australia's waterways. The *NWQMS* links to the *NWI* through its development of national guidelines.*The Australian Guidelines for Urban Stormwater* are part of the suite of guidelines produced by *NWQMS* to provide a nationally consistent approach for managing urban stormwater in an ecologically sustainable manner.

State Policy on Water Quality Management

The Tasmanian *State Policy on Water Quality Management 1997* (SPWQM) sets the water quality management and objectives for the State including stormwater. The purpose of the SPWQM is to achieve the sustainable management of Tasmania's surface water and groundwater resources by protecting or enhancing their qualities while allowing for sustainable development in accordance with the objectives of Tasmania's Resource Management and Planning System (Schedule 1 of the *State Policies and Projects Act 1993*).

The framework established in the *SPWQM* involves the identification of Protected Environmental Values (PEVs) for Tasmanian waterways following which quantifiable Water Quality Objectives (WQOs) may be set to ensure that the PEVs of a waterway will be maintained or enhanced.

An important means of implementing the SPWQM is via local planning schemes empowered through the *Land Use Planning and Approvals Act 1993*.

The Tasmanian *State Stormwater Strategy* provides a means to fulfil the following provisions contained in the *SPWQM*:

Clause 31 - Runoff from land disturbance

- ► The *SPWQM* states that planning schemes should require *stormwater management strategies* for development proposals that have the potential to give rise to off-site polluted stormwater runoff.
- ► The stormwater management strategies should address both the construction phase and the operational phase with maintenance of WQOs as a performance objective.

Clause 33 - Urban runoff

- ► The SPWQM states that erosion and stormwater controls must be specifically addressed at the design phase of proposals in accordance with Clause 31.
- ► The *SPWQM* states that state and local governments should also develop and maintain strategies for the *reduction of stormwater pollution at source.*
- ► Where stormwater has the potential to prejudice the achievement of water quality objectives, the SPWQM states that councils should prepare and implement a stormwater management plan.

Implications of the State Policy

The *State Stormwater Strategy* has been developed to provide a coherent state-wide approach to the management of stormwater and to assist the range of organisations and professionals with planning, regulatory and operational responsibilities associated with stormwater management in meeting their obligations under the *SPWQM*. The development of the *State Stormwater Strategy* also reflects the direction for a nationally consistent approach to stormwater management under the NWI and NWQMS.

The *State Stormwater Strategy* has been prepared in accordance with the intent of the *SPWQM* to facilitate the implementation of the stormwater provisions contained in Division 3 of the *SPWQM*. Under the *SPWQM* there is an obligation for development appraisal authorities to ensure that a strategy for managing stormwater has been established during the design process to address both the construction phase and operational life of any development. An aim of the *State Stormwater Strategy* is to provide development appraisers with strategies, processes and tools to perform this task. See Section 2.

Construction phase management should be addressed through soil and water management plans. Once plans are approved, it is important to ensure activities on the site conform to instruction contained in the approved plan. See Section 2.1.1.

Operational phase management requires consideration of long term management options at the concept design phase of the development. Ensuring that the stormwater system proposed meets the stormwater management targets that may involve site specific modelling of pollutant generation against management techniques. See Section 2.1.2.and 2.1.3.

Stormwater Management Plans are another tool recommended in the *SPWQM*, particularly for priority catchments where urban stormwater may jeopardise achieving or maintaining WQOs. See Section 3.1.

Contents

Section 1. Introduction and policy context

1.1. State Stormwater Strategy

Stormwater is a potential hazard to life and property in high volumes but is also a potential resource of significant value. Polluted, poor quality stormwater can impact on receiving waters, commonly watercourses, lakes and coastal marine waters and their ecosystems

Stormwater infrastructure in Tasmania like elsewhere in Australia has developed historically as a drainage and conveyance system as local authorities have focused on drainage needs and flood mitigation. In recent years there has been increasing interest in developing a more integrated approach to stormwater management while continuing to acknowledge the imperative for flood management. Yet despite increasing awareness of stormwater use and initiatives to reduce water pollution, including the adoption of stormwater best management practices by many councils in the State, there is no established plan or framework to ensure stormwater management is taken up on a consistent and broader basis in Tasmania. This has led to incremental and somewhat fragmented management approaches with different stormwater practices employed all over state, which create further impact on the quality and quantity of receiving waters.

Better stormwater management in Tasmania is being given the needed impetus through the *State Stormwater Strategy (the Strategy)*. This policy statement reflects the strong direction and commitment from state and local government to ensure a positive change in stormwater management at the local and catchment-wide levels.

The *Strategy* addresses the stormwater requirements detailed in Division 3 of the *SPWQM* which aims to protect Tasmania's receiving waters by promoting improvements in stormwater management. It provides a consistent, state-wide approach to stormwater management that can be used at the regional scale or at the individual site level.

The Strategy is based upon best practice stormwater management principles currently in use at the national and international levels as well as feedback received through consultation with Tasmanian councils and regional planning organisations.

1.1.1. Who is the strategy for?

The *Strategy* is aimed at a range of organisations and professionals with planning, regulatory and operational responsibilities associated with stormwater management. This includes state and local government, builders and developers, landscape architects, urban designers, ecologists, planners and engineers as well as the community.

State Government agencies have planning, assessment, enforcement and operational responsibilities related to stormwater management including major developments, eg roads and highways and regulating licensed premises. Local government has always had the primary responsibility for stormwater management with councils accountable for land use planning and the provision of local stormwater infrastructure as well as its maintenance. These roles remain with local government after the *Tasmanian Water and Sewerage Reform* in 2009.

Builders and developers need to ensure that developments incorporate stormwater management requirements detailed in the *Strategy* for planning approval. The *Strategy* is applicable for homeowners and the community promoting water conservation with landscape design, providing considerable visual amenity benefits.

Table 1 below allows practitioners to preferentially go directly to sections of this *Strategy* most relevant to them.

Table 1. Relevant sections of the *Strategy* for different practitioners

Planners and development appraisers local government, planning consultants, state government, planning authorities *Main relevant sections:* 2.1 Planning and design objectives for developments 3.5 Natural waterways and drainage channels 3.6 State and municipal stormwater infrastructure
Developers, consultants engineers, architects, landscape architects *Main relevant sections:* 2.1 Planning and design objectives for developments
Works managers builders, foremen, local government *Main relevant sections:* 3.5 Natural waterways and drainage channels 3.6 State and municipal stormwater infrastructure 3.7 Temporary works
Infrastructure managers local government, state government, utilities *Main relevant sections:* 3.1 Prioritisation of urban catchments and stormwater management plans 3.2 At-source programs 3.3 Other council management strategies 3.5 Natural waterways and drainage channels 3.6 State and municipal stormwater infrastructure 3.7 Temporary works 3.8 Managing stormwater on commercial and industrial sites 3.9 Financing stormwater management 3.10 Education and training
Broader community private businesses, government businesses, homeowners/occupiers, community groups and schools *Main relevant sections:* 3.7 Temporary works 3.8 Managing stormwater on commercial and industrial sites 3.10 Education and training

1.2. Stormwater Impacts

Impacts of stormwater on the water cycle and receiving water environments have been well-documented and include:

- Increased stormwater runoff volume which reduces the level of soil moisture and groundwater replenishment
- Increased flood peaks which increase erosive, degrading flows on natural drainage channels and waterways, place increased stress on downstream infrastructure and increase the contaminant carrying capacity of stormwater flows
- Increased pollutant generation and conveyance to receiving waters

Urban development across Tasmania, particularly bordering major centres, exaggerates these impacts. Diffuse sources of stormwater contamination from all urban land uses, from residential to industrial and commercial, contribute to a cumulative long-term impact on waterways.

Monitoring of water quality in urban waterways in Tasmania has demonstrated a clear relationship of decreasing water quality with increasing urbanised catchment (DEP, 2005).

Figure 1(a) Stormwater quality shows typical differences in suspended solids loads from stormwater between varying land uses. The 'developed' land uses show a marked increase in pollutant generation as compared to the 'undeveloped' land use (ie 'bushland'). This trend (between residential and bushland) is also typical of that found for a range of other urban stormwater pollutants including pathogens, nutrients and heavy metals.

Figure 1(b) Stormwater quantity shows two conceptual hydrographs displaying the different rainfall-runoff characteristics between urban and natural catchments. The runoff response in a natural catchment is gradual: surface runoff contributes only after rainfall intensity exceeds the infiltrating capacity of soils and/or soil becomes saturated. The runoff (or subsurface flows) then contributes for some time after the rainfall has stopped. In an urban catchment with a high proportion of impervious surfaces, rainfall is collected on roads roofs, etc and is rapidly delivered to receiving waters. In addition to the impacts of increased flow in the urban catchment (eg flooding, erosion, etc.) the increased overall volume of runoff leads to a far greater export of pollution to receiving waters.

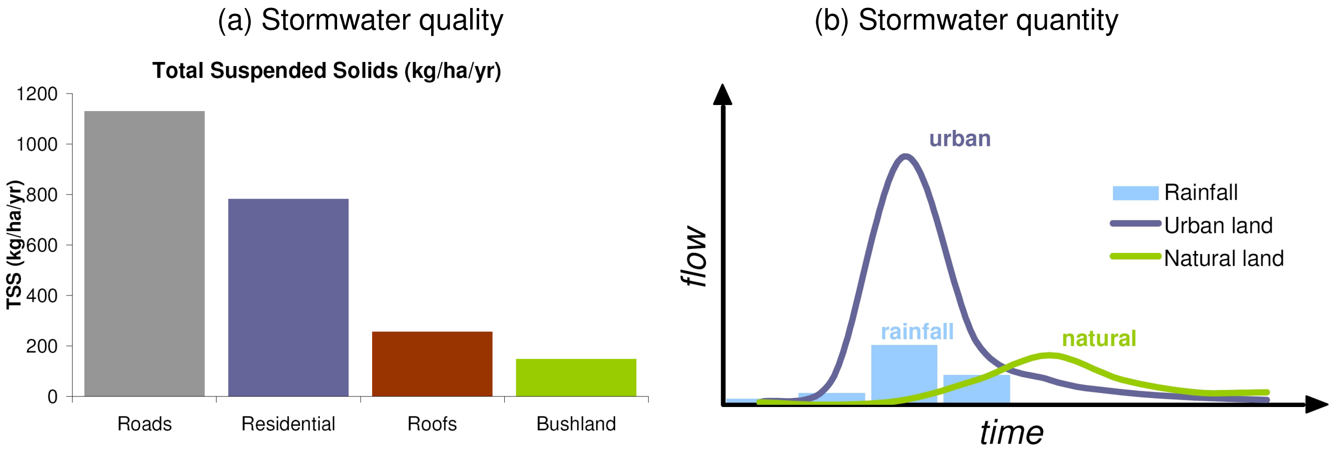


Figure 1. Impacts of urbanisation on (a) stormwater quality and (b) stormwater quantity over a rainfall event (quality data sourced from Eng. Aust., 2006)

1.2.1. Stormwater pollutants

Stormwater runoff collects a range of pollutants that have been deposited on the land surface including litter, pathogens, nutrients, hydrocarbons, heavy metals and pesticides. These pollutants not only affect receiving waters but also the way we use waterways for recreation and economic benefit. Table 2 provides more detail on the types of pollutants found in stormwater, their possible sources and their potential impacts.

Table 2. Typical stormwater pollutants, their possible sources and potential impacts

Pollutants	Sources	Impacts
Suspended solids	• Erosion • Construction sites • Road/footpath wear	• Smother ecosystems • Block sunlight • Cause respiratory problems in fish
Metals	• Vehicle wear & emissions • Atmospheric deposition • Illegal/accidental discharges • Trade waste discharges	• Toxicity to aquatic organisms • Bioaccumulation through the food chain
Nutrients	• Detergents • Decaying organic matter • Fertilisers • Sewage leaks & overflows	• Encourage riparian and aquatic weeds • Encourage algal growth • Increase potential for eutrophication
Pathogens	• Sewage overflows • Illegal connections • Animal faeces	• Cause disease in humans and livestock • Reduce recreational amenity
Hydrocarbons	• Vehicle wear & emissions • Spills • Illegal discharges	• Toxicity to aquatic organisms • Loss of aesthetic amenity

1.3. Source control management

The *Strategy* promotes the use of source control strategies that treat, store and infiltrate stormwater runoff onsite before it can affect receiving waters. Source control strategies - managing stormwater throughout the catchment where rain falls via structural and non-structural techniques - can be an effective means of protecting water quality and suppressing flood peaks. It offers a viable alternative to the traditional approach to managing runoff ie to get stormwater piped and conveyed off-site as quickly as possible.

Managing stormwater at its source can be achieved through the adoption of Integrated Water Cycle Management (IWCM) and Water Sensitive Urban Design principles. For best results WSUD features should be distributed throughout a site to create a treatment train.

1.3.1. Integrated Water Cycle Management

While the *Strategy's* focus is solely on stormwater management, the broader context of Integrated Water Cycle Management (IWCM) and its management of all water sources within a catchment, regional and state context must also be considered.

Managing crossovers in the three main water infrastructure streams (wastewater, potable water and stormwater) provides efficiencies in other areas and achieves 'integrated' management. This could mean utilising water-efficient fixtures along with roof water harvesting to reduce both the demand on reticulated potable supplies and the impacts of stormwater runoff. Large developments might consider tapping into existing effluent reuse schemes or use decentralised wastewater treatment combined with dual reticulation so that treated effluent could be used for toilet flushing and irrigation.

IWCM promotes the coordinated planning, development and management of all urban water resources including the application of WSUD principles within the built environment at the local and on-site scale.

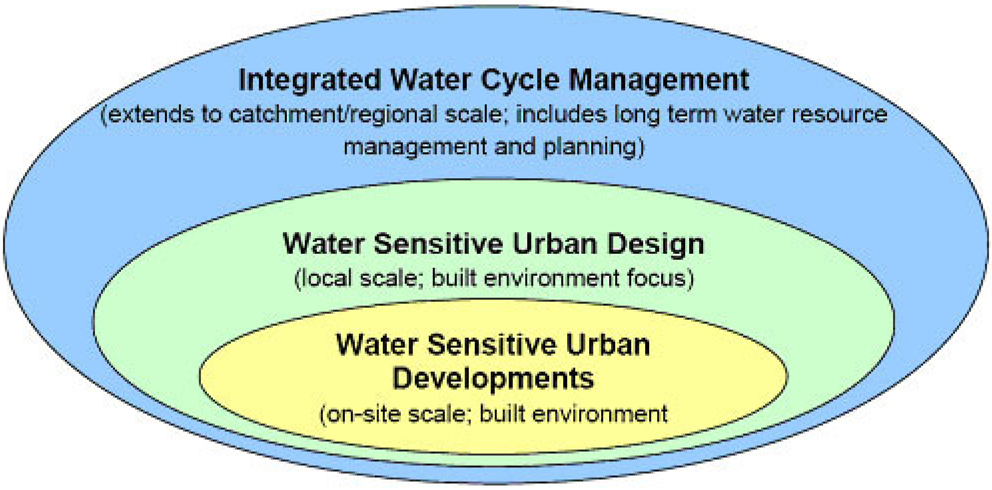


Figure 2. Relationship between IWCM and WSUD (CSIRO Land and Water, 2009).

1.3.2. Water Sensitive Urban Design

Water sensitive urban design (WSUD) aims to bring stormwater management out of pipes in the ground and to treat the entire stormwater treatment network as part of the urban environment. WSUD has evolved from its early association with stormwater management to facilitate the broader agenda of IWCM, minimising impacts of development and maximising efficient use of water resources through the design of water infrastructure for the urban environment.

The multi-disciplinary approach by WSUD incorporates elements of landscape architecture and urban design, ecology, engineering, planning and landscape maintenance with specifically constructed elements, eg vegetated swales, filter strips, biofiltration basins and constructed wetlands. These are all part of fully functioning stormwater treatment systems that can also increase environmental and social amenity.

WSUD promotes water conservation and stormwater retention strategies employed at the urban allotment or cluster level. This reduces infrastructure costs and environmental degradation of receiving waters. The application of WSUD planning and management principles involves:

- incorporating water resources issues very early in the land use planning process
- managing stormwater at the catchment or sub-catchment level
- protecting water quality of surface and ground waters
- maintaining the natural hydrologic behaviour of catchments
- protecting natural features and ecological processes
- minimising demand on potable water supply systems
- integrating water into the landscape to enhance visual, social, cultural and ecological values
- using natural contours to incorporate and enhance functions and characteristics of the natural stormwater system and associated ecosystems
- collecting treating and/or reusing runoff, including roof water and other stormwater
- reusing treated effluent and minimising wastewater generation
- increasing social amenity in urban areas through multi-purpose green space and landscaping
- using carefully selected species of vegetation in stormwater management to promote filtering and slowing runoff to maximise settling of particulate-bound pollutants, and infiltration

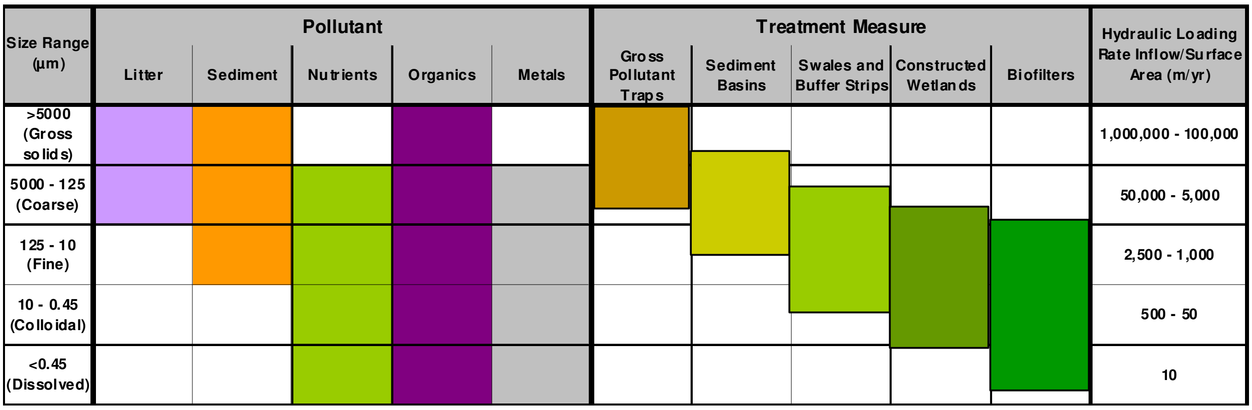
1.3.3. Treatment Trains

Stormwater is best managed by distributing systems within a development or catchment, creating a **treatment train** - a series of treatment systems that complement one another to achieve clean stormwater outcome.

Within a treatment train each stormwater treatment measure operates effectively over particular hydraulic loading rates and pollutant size ranges, treating gross particulates (litter, larger organic matter etc) first, then coarse particulates (sediment) and finally fine colloidal and dissolved material.

Table 3 shows the interrelationship between stormwater pollutant size ranges, hydraulic loading (expressed as the ratio of the design flow to the area of treatment measure) and appropriate stormwater treatment measures (based on their treatment process). It can be seen that to treat all particle size ranges of pollutants, one treatment measure is not enough and a combination of treatment measures should be employed.

Table 3. Interrelationship between stormwater pollutant size ranges, hydraulic loading and appropriate treatment systems (BMT WBM. 2009)



For example, roads and car parks may utilise a combination of grass swales or buffer strips to remove sediment, and biofiltration systems or constructed wetlands to capture fine and dissolved materials. The cleansed stormwater can be collected in sub-surface water storage tanks for reuse. Depending on the land use application, the following elements shown in Table 4 may be used in a treatment train system:

Table 4. Appropriate treatment measures for treatment trains

Gross particulates	Coarse particulates	Colloidal & dissolved materials
Gross pollutant trap	Filter/buffer strips	Constructed ponds
Litter traps	Vegetated swales	Constructed wetlands
Sediment basin	Sand filters	Biofiltration basins
Litter (trash) rack	Proprietary filtration systems	Rain gardens
Floating litter traps	infiltration systems	Biofiltration swales
Floating booms	Extended detention basins	Biofiltration tree pits

Section 2. Stormwater management for new developments

Improved stormwater and surface water quality outcomes can be achieved at the planning and design stages for new developments through the setting of stormwater management targets for quality and quantity. These targets are based upon appropriate practices including IWCM and WSUD principles and meet the requirements of the *State Policy on Water Quality Management*, specifically, Clause 31 "*planning schemes should require stormwater management strategies for development proposals that have the potential to give rise to off-site polluted stormwater runoff"* and Clause 33 whereby "*stormwater controls must be specifically addressed at the design phase of proposals*". The stormwater management targets provide an effective means of managing stormwater during the design process.

The alternative of endeavouring to meet the stormwater management targets as an additional feature after planning and design has been developed, can both limit the opportunities available for effective stormwater management and increase the cost of achieving the required standards.

2.1. Planning and design objectives for developments

This section sets out stormwater management targets that are to be addressed at planning and design stages for any development that creates 500m^2 or greater of additional impervious surface. This applies to larger developments including subdivisions and multi-lot stratum, commercial and industrial developments as well as smaller developments including alterations and changes of use, for example roads, car parks, roofs and paving.

2.1.1. Construction phase

Through the development application process, Soil and Water Management Plans (SWMP) are to be developed and implemented where required. A conditioning framework for development applications and building permits to ensure state-wide consistency in Tasmania is provided in *Appendix v. Model conditioning framework for soil and water management*.

SWMPs should promote current best practice sediment and erosion control measures as detailed in *Soil and Water Management on Building and Construction Sites* (2009). These guidelines comply with the *State Policy on Water Quality Management* (Division 3, Clauses 31 and 33).

2.1.2. Operational life of development

Mitigation of the long-term cumulative impacts on waterway health from urban stormwater pollution necessitates some long-term management practices for new developments. For their operational life new developments should be designed to minimise impacts on both stormwater quality and also, where appropriate, the flow regime of local waterways.

Stormwater management targets: quality

Stormwater management for new developments should be designed to achieve the following stormwater quality targets:

- 80 per cent reduction in the average annual load of Total Suspended Solids (TSS) based on typical urban stormwater TSS concentrations
- 45 per cent reduction in the average annual load of Total Phosphorus (TP) based on typical urban stormwater TP concentrations
- 45 per cent reduction in the average annual load of Total Nitrogen (TN) based on typical urban stormwater TN concentrations

These targets have been selected on the basis of:

- consistency with other Australian states and national practices
- knowledge of the impacts of urban stormwater on receiving waters
- national and international data on stormwater quality characterisation
- performance of best management practice stormwater treatment systems

These objectives have been used in Victoria (Victoria Stormwater Committee, 1999), Queensland (MBWCP and Ecological Engineering, 2006) and other states as a basis for stormwater management and planning, and underpin the WSUD Engineering Manual for Southern Tasmania (DEP, 2006).

Developments should be designed to achieve the stormwater quality targets in accordance accepted Australian practices, such as modelling using *Model for Urban Stormwater Improvement Conceptualisation (MUSIC)* and the guidance provided in *WSUD Engineering Manual for Southern Tasmania* (DEP, 2006).

*For further information on stormwater characterisation and quantifying stormwater treatment performance see *Appendix i.* and *Appendix iv.*

Any alteration or change of use development <u>that creates less 500m^2 of new impervious area</u> does not have stormwater management targets. Nevertheless, it is still the responsibility of all workers, property owners or occupiers to ensure that no activity gives rise to stormwater pollution under State regulations including the *State Policy* and *Environmental Management and Pollution Control Act 1994.*

Stormwater management targets: quantity

Flood management and human safety remains one of the highest priorities in managing urban stormwater. For this reason, drainage design must always comply with requirements of the local authority and be undertaken by a suitable professional.

Flood estimation should be completed in accordance with accepted Australian practices, such as with guidance provided by *Australian Rainfall and Runoff* (Engineers Australia, 2001) and *Storm Drainage Design in Small Urban Catchments: a Handbook for Australian Practice* (Argue, 1986). Overland flow paths (and containment) should be identified for flows exceeding the minor storm drainage design standards established by the local authority.

Water quantity (or flow) management techniques should also be required by the local authority where:

- flows discharge into a creek or natural watercourse
- flows discharge into a creek or natural watercourse via a piped network
- downstream infrastructure is at (or approaching) its design capacity for the minor storm drainage standards of the local authority and further development is likely to generate flows in the system exceeding capacity

See *Appendix iii. Stormwater quantity management targets* for more detail.

2.1.3. Integrating stormwater management targets into site planning and design

The stormwater management targets will need to be integrated into site planning and design. They can be can be applied at a wide range of scales within a development including housing layout (including single residential allotment and subdivision design) and streetscape layout (including road and car park design). The examples below illustrate how different scaled developments can be designed to meet the stormwater management targets.

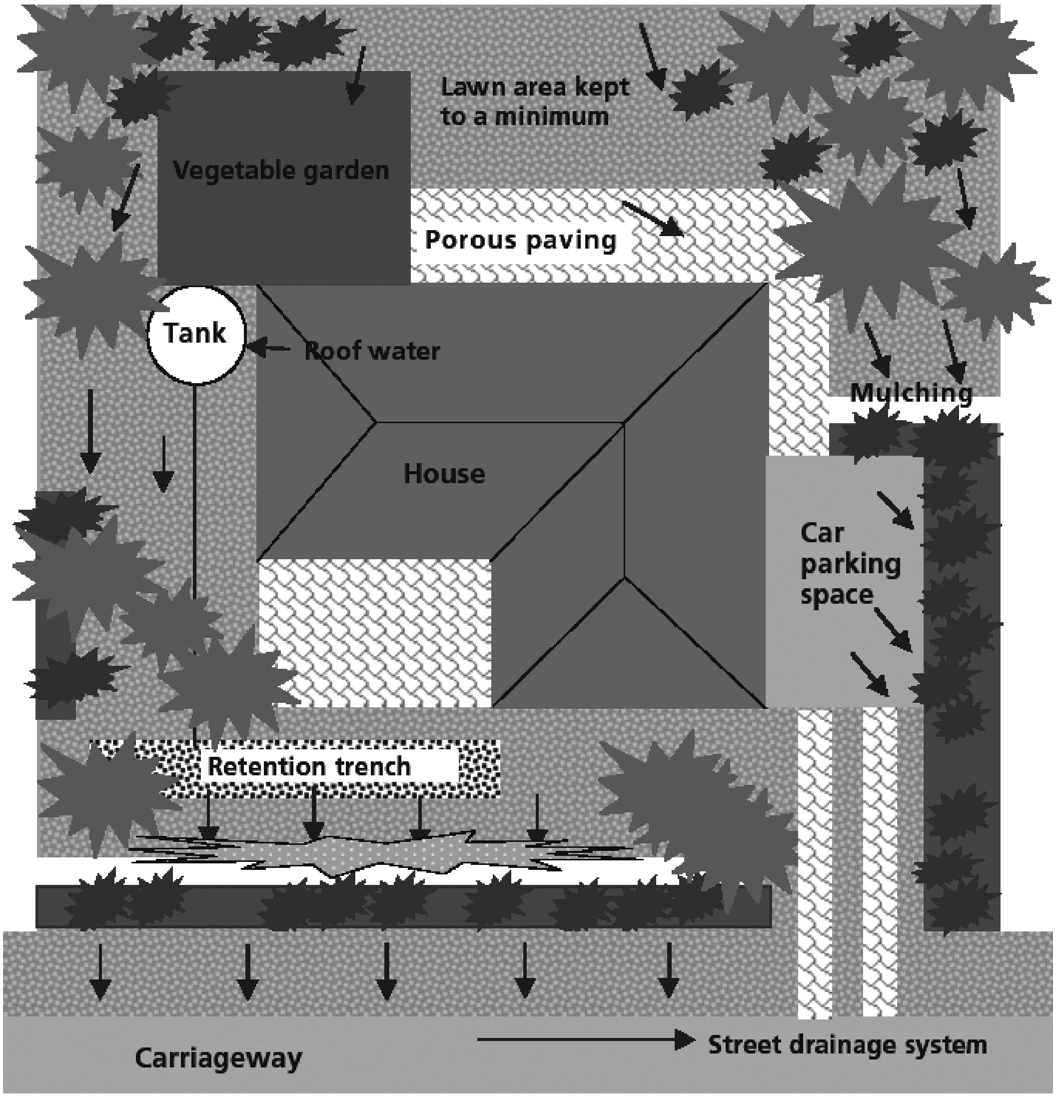


Figure 3. Example of stormwater management strategies for a typical suburban dwelling design (Hobart City Council, 2006)

The figure above shows a combination of techniques for a typical suburban home that can be used to achieve the stormwater management objectives. A rainwater tank supplies rainwater for toilet flushing, washing machine, and for outdoor use whilst water efficient fittings reduce mains water consumption elsewhere. During prolonged or heavy rain, water overflows for a typical suburban home from the rainwater tank to a retention trench. Stormwater runoff from paths, driveways and lawns is directed to garden areas. Excess runoff from impervious surfaces is directed to the retention trench, or overflows to the street drainage system.

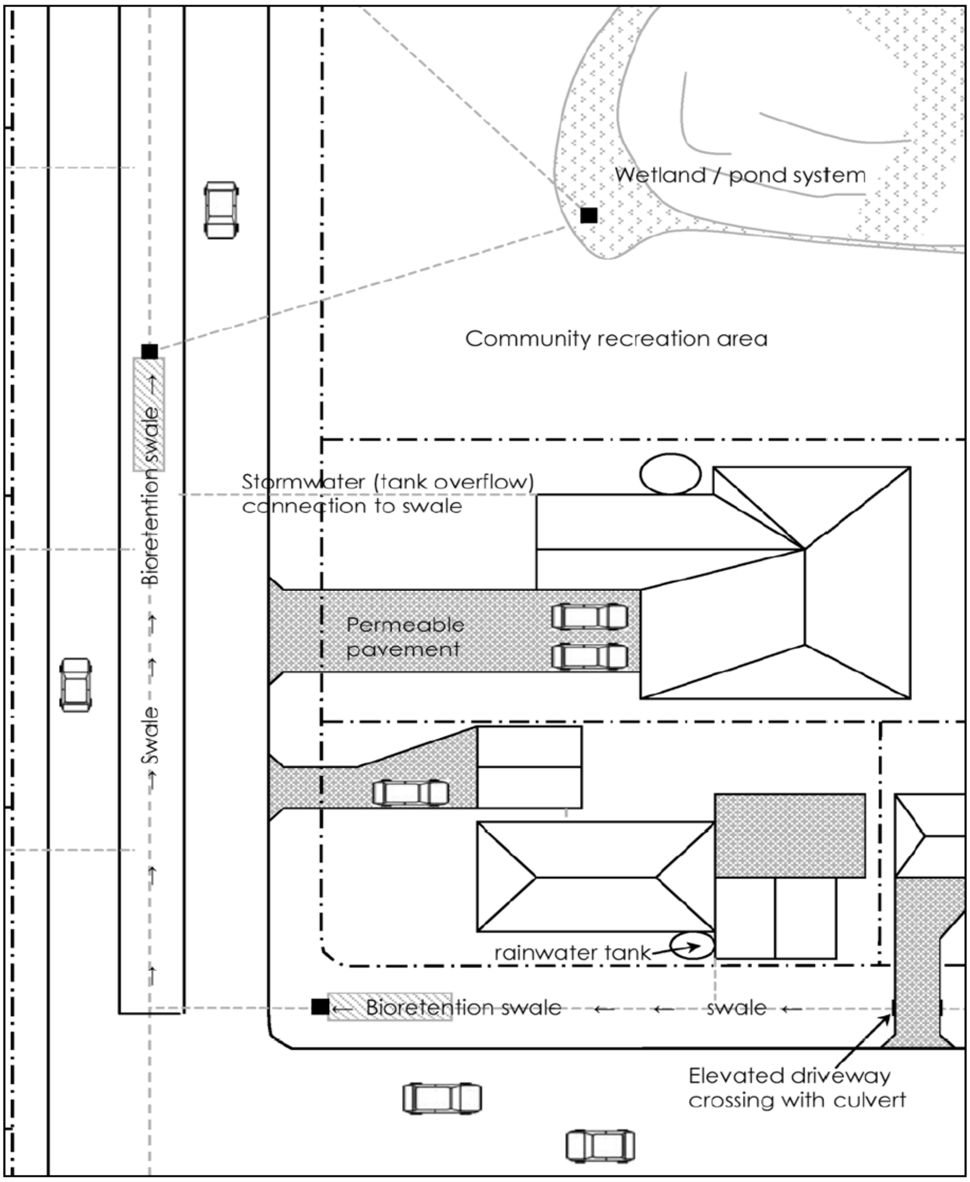


Figure 4. Example of stormwater management strategies for a typical subdivision design (Derwent Estuary Program, 2006)

The figure above shows the layout of a residential subdivision development including integrating public open space with stormwater management systems and a more compact form of development which reduces impervious surfaces and helps protect stormwater quality. The development also incorporates:

- ► Narrow road reserves which reduce the area requiring irrigation
- ► Integrated design of accesses and crossovers to maximise scope for retention of existing vegetation and for new plantings
- ► Variation in road reserve widths to facilitate integrated stormwater management and substantial plantings
- ► Footpath alignments that respond to natural features and stormwater management to create spaces that are easy to maintain and efficient to irrigate
- ► Water tanks and porous paving for accesses, driveways and parking areas
- ► Common trenching and closer alignment of services to improve scope for reduced verges to retain existing vegetation and plant new vegetation

- ► Appropriate landscape practices that include the selection of species to reduce water demand

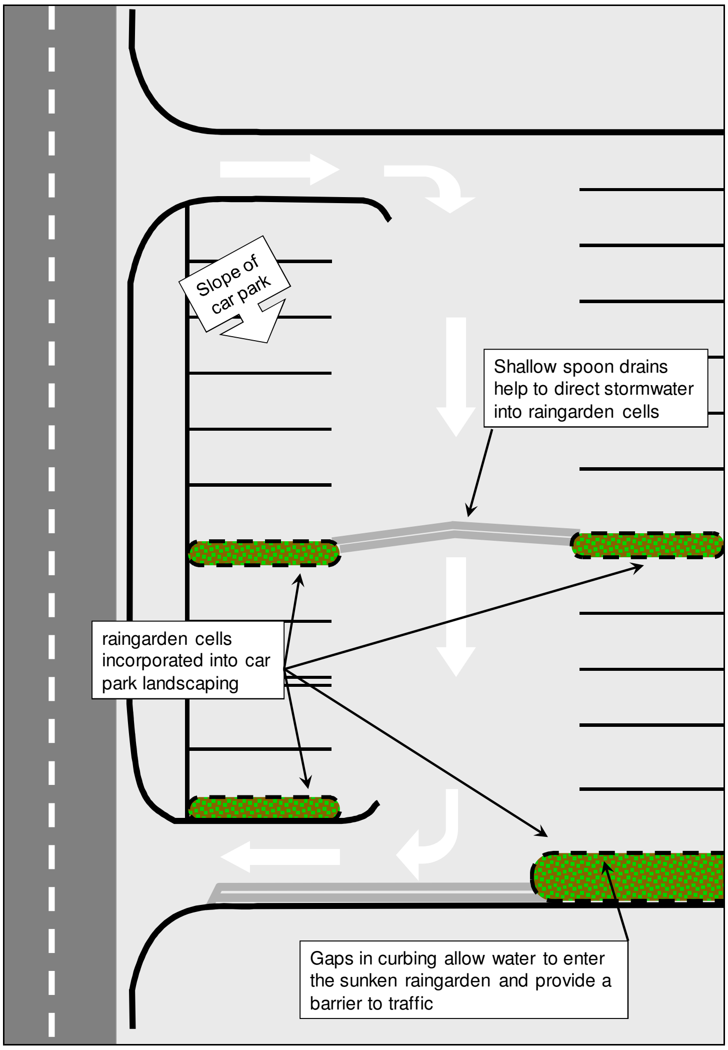


Figure 5. Example of stormwater management strategies for a typical car park design

The figure above shows the layout of a car park. It integrates the car park layout and vehicular and pedestrian requirements with meeting the stormwater management targets. Bioretention raingardens feature in the design; they collect and treat all the car park runoff into specially designed planter beds. Stormwater enters the raingardens via breaks in the curb where it is treated. Note the system varies little from standard design, however, raingardens are utilised for stormwater treatment, in turn negating irrigation requirements.

All the stormwater management measures selected for the different developments need to be carefully designed to ensure that they meet the stormwater management targets (both quality and quantity). Consideration must equally be given to the constraints and opportunities of each individual site including site characteristics such as soil type, slope, groundwater conditions, rainfall, and the scale and density of development. See *Appendix iii. Assessing stormwater management strategies* for more detail.

Section 3. Stormwater management for urbanised catchments

Stormwater from urbanised catchments requires appropriate management. As stated in Clause 33 of the *State Policy on Water Quality Management 1997* "State and Local governments should also develop and maintain strategies for the reduction of stormwater pollution at source". To fulfil this provision, municipalities need to plan and implement comprehensive stormwater management programs. This includes methods to detect and remove illicit discharges entering council stormwater systems, as well as appropriate best management practices (BMPs) to address discharges from industrial, commercial, and development activities.

An integrated approach for addressing stormwater pollution provides a framework that allows a municipality to provide effective management and efficient use of available resources. It also allows a council to integrate its local program effectively with other related stormwater/catchment management programs at the regional, state and federal levels which can assist in securing grants and other resources.

This section discusses actions that state authorities and councils should to undertake to ensure that their operations are effectively managing stormwater pollution in accordance with the *State Policy on Water Quality Management* requirements. These are based effective management practices employed in Tasmania and interstate.

3.1. Prioritisation of urban catchments and stormwater management plans

Local government in Tasmania has always had the primary control for stormwater management, with councils accountable for the provision of local stormwater infrastructure, as well as its maintenance. This responsibility applies to drainage catchments including rivulets as well. Typically, with multiple catchments within one municipality and with a range of competing issues, it is difficult to simultaneously manage and improve stormwater quality for all catchments throughout a council area.

Councils must prioritise their efforts, focussing on those catchments or areas where sources of stormwater pollution are common and/or widespread. These can be readily identified using a risk matrix to compare various threats and receiving water values. From this assessment the comparative catchments can be ranked. The numbers are not necessarily rigorous quantitative scores but are estimates that should reflect local knowledge and experience. Those catchments with the highest scores are identified as the priority catchments. This was done in the Greater Hobart Area as part of the Model Stormwater Plan and identified New Town Rivulet as a priority catchment. See *Appendix vi. Risk matrix assessment for urban catchments*

Stormwater management plans should be prepared for the priority catchments identified. Stormwater management plans assist in the identification of priority issues and areas in the catchment and the selection of management options. Stormwater management planning may also assist in the prioritisation of expenditure and the development of long-term project planning.

The development of stormwater management plans is a requirement for all councils under the *State Policy on Water Quality Management* (Division 3, Clause 33). As an example, *A Model Stormwater Management Plan for Hobart Regional Councils – A Focus on the New Town Rivulet Catchment (2005)* provides guidance to Tasmanian councils on the development stormwater management plans.

3.2. At-source programs

At the local scale councils must address stormwater pollution at-source by implementing a program that progressively installs treatment systems at pollution hotspots, particularly those associated with high levels of public use eg car parks, retail/commercial zones, major intersections and industrial areas. Land use based prioritisation for stormwater treatment retrofit (Figure 6) is a quick and effective assessment tool for identifying pollution 'hot-spots' in most municipalities. It can then be used for selecting appropriate treatment systems to target those pollutants generated from specific urban activities. For best results these systems should be incorporated into a treatment train.

An at-source program progressively implemented will have lower costs and provide higher treatment than an end-of-pipe regional treatment system. It also offers a contingency plan against having major pollution incidents and associated costly clean ups.

3.3. Other council stormwater management strategies

In addition to the preparation of stormwater management plans and implementing at-source treatment programs, councils with their available resources need to conduct the following on-ground activities so that their operations comply with BMP and they are effectively managing their rivulets and the stormwater system in their municipality in accordance with the *State Policy on Water Quality Management*:

- ► Identify stormwater-related flood risks and prepare mitigation strategies and emergency management plans where necessary.
- ► Undertake hydrological modelling and assessment to identify flood levels in developed/developing areas at differing recurrence intervals. This information can then be used to inform land use planning decisions, for example, to condition for the limiting of certain peak discharges in new upstream development to prevent (further) overloading of a system.
- ► Instigate a program to identify and rectify sewage-stormwater cross-connections and sewage infiltration (from either failed on-site wastewater systems or failing sewerage infrastructure). Investigations should be carried out in a strategic manner so that resources (labour, laboratory costs, CCTV contracting, etc) are not wasted in investigations that are not followed through to fruition.
- ► Where infill or redevelopment occurs, on-site management is required through the development application process (see *Section 2. Stormwater management for new developments*)
- ► Incorporate WSUD into urban renewal projects and infrastructure upgrade/replacement
- ► Maintain/restore natural drainage channels (see *3.5 Natural waterways and drainage channels*). Record creeks and ephemeral waterways in planning scheme map overlays and set appropriate riparian buffers for creeks and ephemeral channels.
- ► Conduct audits on commercial and industrial premises like that undertaken by the City of Kingston in Victoria (2008) to identify risks and ensure site practices are satisfactory (see *3.8 Stormwater on commercial and industrial sites*). This activity could be combined with existing inspections by council officers, including environmental health or compliance functions.

- Ensure soil and water management practices are used during all maintenance and construction activities (see *3.7 Temporary works).*

3.4. Stormwater Harvesting

Stormwater harvesting should be considered as an alternative strategy to upgrading stormwater infrastructure that has (or approaching) its design capacity for storm drainage standards. Stormwater harvesting may be a more cost-effective and environmentally sensitive approach to large public works projects to upgrade the stormwater system. Besides eliminating the need for a “Big Pipe” project, other benefits of stormwater harvesting includes providing significant stormwater retention which reduces runoff and downstream flooding, value-adding stormwater as a resource supporting integrated water management and reducing the demand (and costs) on potable water supplies.

3.5. Natural waterways and drainage channels

Unless unavoidable due to significant flood risk, natural waterways and drainage channels should be maintained for stormwater conveyance at surface. Piping or lining natural channels should be seen only as a last resort.

Natural channels should be maintained for stormwater conveyance and for the many benefits they provide, including water quality improvement, aesthetics, habitat, maintenance of biodiversity, flow attenuation, etc. Channels should be maintained to prevent encroachment by weed infestations and to utilise native vegetation for channel stability.

Local government has the power under the *Land Use Planning and Approvals Act 1993* to regulate works in waterways through their planning schemes. These schemes should identify permanent and temporary waterways and specify riparian buffers to conserve existing native vegetation in the zone as well as prevent development close to the waterway. Buffer widths could be set as a standard for all urban waterways (eg 10m from top of bank) or may vary according to stream order (ie wider buffers for higher order streams).

Some recent planning schemes incorporate a Waterways Schedule, which specifies requirements for development in or near natural waterways and drainage channels (DEP, 2005). While the details of the Schedule vary between planning schemes, they can cover general works, road construction, stream order and water quality protection, and riparian vegetation clearance.

The Waterways and Wetlands Works Manual (*2003)* provides guidelines on the environmental best practice principles to assist planning for natural waterways and drainage channels. All of the guidelines must be used in conjunction with the appropriate technical advice and literature.

Figure 6. Land use based prioritisation for stormwater treatment retrofit

higher priority → lower priority

Commercial/ retail areas including CBDs, shopping precincts and car parks	**A** → Removal of gross pollutants using litter traps and gross pollutant traps (GPTs). **B** → Use WSUD-style systems such as biofiltration rain gardens and vegetated swales for cost and maintenance efficiency. These systems effectively treat pollutants adsorbed to fine sediments (common to car parks) and keep the litter from reaching the stormwater network. Maintenance activities are largely limited to (commonly pre-existing) landscaping maintenance. This approach also avoids the high long-term maintenance costs of gross pollutant traps*.
Other car parks, including undercover car parks connected to stormwater	**A** → Use WSUD-style systems such as biofiltration rain gardens and vegetated swales to effectively treat pollutants adsorbed to fine sediments (common to car parks) and keep the litter stream from reaching the stormwater network. **B** → Where vegetated systems are inappropriate (eg covered car parks), remove fine sediments using sand filters or proprietary media filtration systems.
Roads (major and minor)	**A** → Use distributed WSUD-style systems such as biofiltration rain gardens and vegetated swales to effectively treat pollutants adsorbed to fine sediments such as heavy metals and hydrocarbons. **B** → Use regional treatment systems such as bioretention basins and constructed wetlands to treat larger catchments. **C** → Install sediment traps on drainage systems collecting runoff from roads with unconsolidated verges or other areas of high coarse sediment loading.
Residential areas	**A** → Use distributed WSUD-style systems such as biofiltration rain gardens and vegetated swales to effectively treat pollutants adsorbed to fine sediments such as nutrients, heavy metals and hydrocarbons. **B** → Use regional treatment systems such as bioretention basins and constructed wetlands to treat larger catchments.

*Use GPTs ONLY in areas with an observed high litter load. GPTs have high long-term maintenance costs and should not be used in areas not typically producing high litter loads (such as residential areas).

3.6. State and municipal stormwater infrastructure

Where new stormwater drainage infrastructure is to be installed in a new or existing drainage scheme, stormwater management targets need to be addressed to improve stormwater quality and reduce overall stormwater volume.

The following control measures will meet these targets, providing an alternative to traditional stormwater design approaches ie to get stormwater piped and conveyed off-site as quickly as possible. They have already been used by authorities in the State.


Large constructed wetlands


Rainwater tanks


Biofiltration 'rain gardens'


Mini wetlands

3.6.1. Roads

WSUD can be incorporated into road development standards. These include reduced pavement widths and the use of grass swales in place of kerb and gutter and piped stormwater drains.

3.6.2. Biofiltration systems

A small biofiltration system such as a rain garden or biofiltration street tree pit with overflow point can be used for stormwater entry to a piped system. Under low to medium flows, runoff will be filtered through the system with some water stored in soil moisture and some used by the vegetation. During high flow, the biofiltration system will overflow directly to the stormwater pipe, which maintains the same capacity as a standard entry-pit. Using this system cleans and slows runoff. Designed biofiltration systems offer a practical alternative to streetscape plantings including public trees, roadside nature strips and planters that require high maintenance and irrigation.

3.6.3. Car parks

Rain gardens are ideal for retrofitting in car parks. They can be incorporated into the landscaping design whilst providing a high level of treatment for the pollutants generated (sediments, hydrocarbons and heavy metals). Runoff from car parks can also be managed by grass swales instead of kerb and gutter and piped drainage systems.

3.6.4. Porous pavers

Porous pavement is a permeable pavement surface with an underlying stone reservoir that temporarily stores surface runoff before infiltrating into the subsoil. This porous surface replaces traditional pavement, allowing car park runoff to infiltrate directly into the soil thereby further reducing runoff volume and recharging local groundwater.

The ideal application for porous pavement is to treat a low traffic or overflow car parking area; it is not suitable for high traffic areas. Porous pavement requires regular scheduled maintenance. Not performing these maintenance activities will result in clogging and the failure of this practice.

3.6.5. Swales

Vegetated swales and/or biofiltration swales may be used to replace small gauge drainage pipes (eg < 300mm internal diameter) with only trunk mains installed to collect discharge from the swales.

Generally, swales not used in conjunction with sub-surface piped networks should only be used for relatively short stretches after which entry to a piped system or receiving water should occur.

3.6.6. Porous pipes

Porous concrete pipes are designed to allow stormwater to exfiltrate through the permeable walls of the pipe. Oxides added during the manufacture of porous concrete pipes trigger ion exchange or chemical precipitation of soluble heavy metals and phosphorus.

The porous concrete pipes are bedded in gravel media providing enhanced treatment. The media assists with biological reduction, breaking down remaining organic substances and nutrients, particularly nitrates. This system provides a cost effective and sustainable alternative to traditional drainage systems, enabling treated stormwater to be retained for re-use, infiltrated into the ground or discharged into waterways in a controlled manner.

3.6.7. Energy dissipaters

Energy dissipation techniques should always be installed at stormwater outfalls where the receiving environment is erodible (eg creek or river banks, wetlands etc). In many circumstances energy dissipaters (or scour pads) can be replaced by mini-wetlands or strategic placement of rocks/boulders. This reduces the impact on the aquatic system by acting as possible habitat and minimising concrete structures in the riparian zone. Careful planting of native vegetation around the outfall also provides some coarse screening of the stormwater discharge and appears less intrusive in the waterway.

Energy dissipation

Biofiltration swales

Porous pavement

Large biofiltration systems

3.7. Temporary works

Temporary works describes short-term works not regulated through the development application process which involve ground disturbance and the generation of sediment. This may include: road works; street and footpath refurbishments; sewerage, water or other hydraulic infrastructure works; telecommunication, electricity and gas infrastructure works; landscaping; earthworks; or high-pressure cleaning.

3.7.1. Control measures

Soil and water management must be implemented and maintained frequently for temporary works to prevent erosion and control sediment from being discharged into the stormwater system. *Soil and Water Management on Building and Construction Sites* (2009), a code of practice with current best practice sediment and erosion control measures are to be used for temporary works where appropriate. See *Appendix v. Model conditioning framework for soil and water management.*

Techniques to be utilised include:

- Install temporary sediment and erosion control measures before the start of any ground disturbance
- Minimise the area of ground disturbed and exposed to erosion
- Divert 'clean' water flows away from the work site
- Capture sediment from runoff before it leaves the site
- Rehabilitate disturbed areas quickly
- Inspect and maintain erosion and sediment control measures throughout the project

3.8. Stormwater on commercial and industrial sites

Many activities on commercial and industrial sites have the potential to impact on stormwater quality. All land is drained in some manner and, therefore, any contaminated surface open to rainfall or overland flow has the potential to generate polluted stormwater. This is especially the case for commercial and industrial sites which may have work areas where pollutants can accumulate eg loading bays, material collection points, waste storage areas and yards.

3.8.1. Regulating stormwater on commercial and industrial sites

It is the responsibility of all property owners or occupiers to ensure that no activity gives rise to stormwater pollution. Pollution of a natural waterbody is likely to breach the *Environmental Management and Pollution Control Act 1994 (EMPCA).* Where this is a direct result of stormwater discharge from an activity, enforcement action may be taken against the person responsible for the activity. Individual site assessments (formal or informal) need to be undertaken at all scales from small operators to major industries by the relevant regulatory authority to determine that stormwater is properly managed.

3.8.1a. State Government

For premises regulated by the State Government under the provision of *EMPCA*, regulatory officers should consider stormwater contamination risks and mitigation strategies and include appropriate conditions in permits for both new and existing activities.

3.8.1b. Local government

In regulating existing activities under the provisions of *EMPCA* (both level 1 activities and existing uses) each council should establish a program of industry auditing. A stormwater auditing program like that undertaken by the City of Kingston in Victoria (2008) would be appropriate, targeting industries likely to contribute to pollution and potentially having a significant impact on local waterways, eg automotive industries (particularly body workshops), retail outlets (particularly nurseries, chemical retailers, hardware, agricultural products, landscape suppliers, outdoor pubs and cafes etc). To reduce the resourcing burden, industry audits could be completed at the same time as existing inspections by council officers, including environmental health or permit compliance checks.

Councils also respond to public complaints and incidents. Investigations can lead to an assessment of whether an activity is meeting stormwater quality targets. Depending on the severity, frequency and nature of the complaints or incidents appropriate actions can be taken in accordance with the council's enforcement policy. Options available include formal warnings, prosecution or issue of infringement notices under *EMPCA*, the *Litter Act 2007* or council by-laws, and issue of environmental protection notices under *EMPCA* or abatement notices under the *Local Government Act 1993*.

As a result of either auditing programs or complaint investigation, council officers should consider issuing environmental protection notices with appropriate conditions to vary the permit of an existing level 1 activity or to regulate the operation of an existing use. When approving a proposed new level 1 activity officers should consider stormwater contamination risks and mitigation strategies and where necessary include appropriate conditions in the permit.

Councils should have suitably trained staff to address and effectively manage stormwater matters.

3.8.2. Managing stormwater on commercial and industrial sites

Site management is important in all commercial and industrial premises to prevent pollutants from being carried to stormwater system during rainfall. The following control measures will prevent stormwater pollution incidents from commercial and industrial premises:

3.8.2a. Structural separation of work area

Structural separation involves separating relatively clean areas such as driveways and car parking areas from relatively dirty areas like loading bays, material collection points, waste storage areas and yards. This can be achieved by roofing all works areas and directing internal drainage to sewer via a trade waste pre-treatment where required. Likewise, isolate the uncovered works area with the stormwater runoff directed to an alternative means of drainage (other than the stormwater and sewerage system) such as a sump or pond connected to a holding device to isolate the pollutants for later removal.

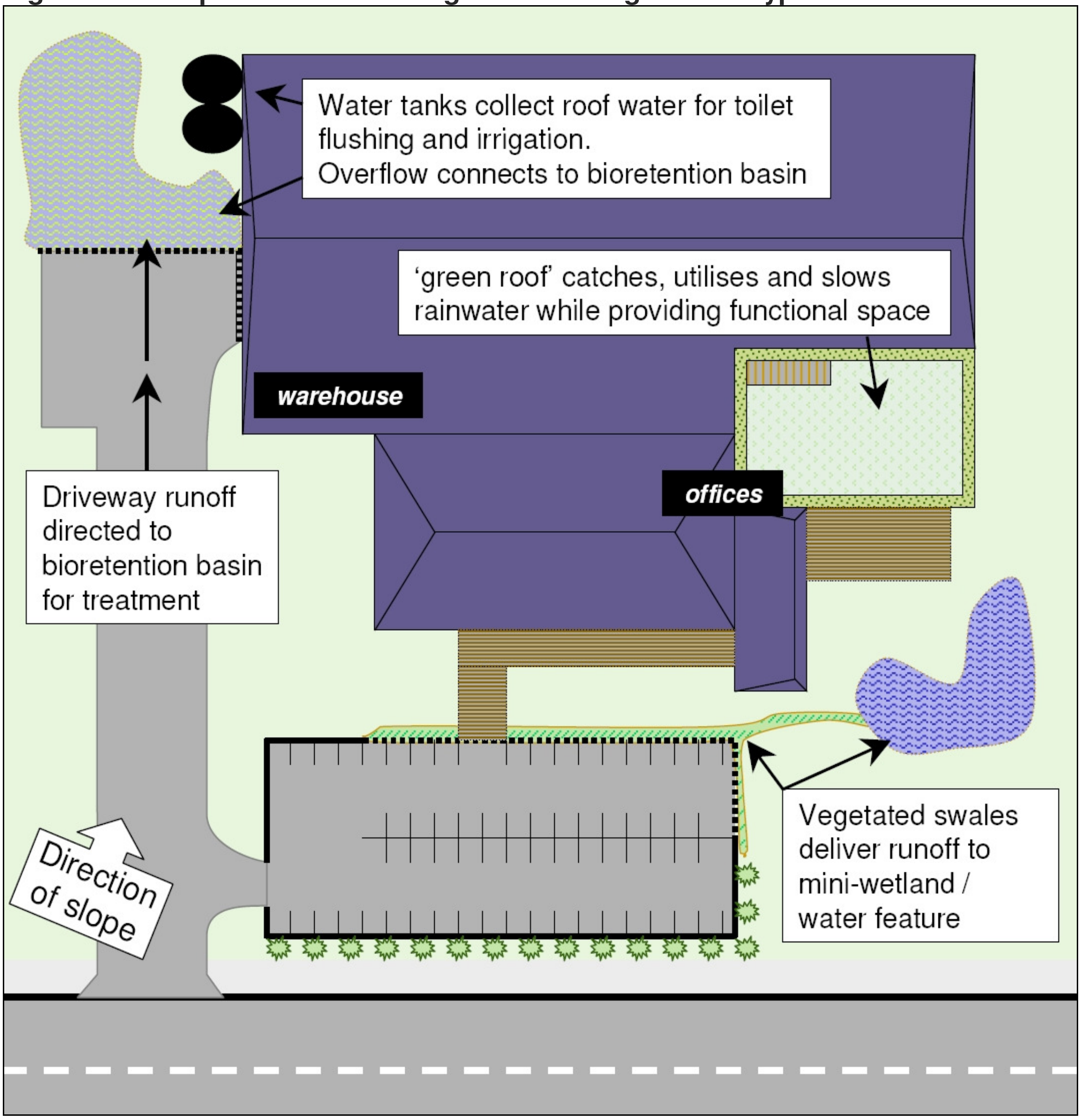
3.8.2b. Structural capture devices

These include devices to capture commercial and industrial pollutants that have been introduced into stormwater ie GPTs, sand filters, media filtration systems, oil water separators, isolation valves and waste enclosures (bunds, skirts and physical barriers that prevent pollutants entering the stormwater system). Install structural treatment in outside areas such as loading areas where spills are considered more likely.

3.8.2c. WSUD systems

Rainwater tanks and biofiltration systems are suitable for the treatment of roofs and car parks on commercial and industrial sites. Financially and performance-wise WSUD systems may not be appropriate for some existing work areas or where there are high concentrations of industrial pollutants. Other practices discussed may be more appropriate.

Figure 7. Example of WSUD management strategies for a typical industrial site



3.8.2d. Non-structural separation

Non-structural separation includes programs for promoting appropriate work practices involving education, engagement and enforcement. Non-structural separation of pollutants from stormwater can be attained by initiatives such as elimination of pollutant source by changing the activity or relocating the activity to an existing area that is structurally separated.

A non-structural separation program can be developed through the management of business activities to minimise the risk of pollution eg environmental management plans including operating procedures, spill response and reporting procedures, quality assurance and regular maintenance. The introduction of environmental management plans and associated procedures should be supported with education and training of all staff.

Note that these practices are not exhaustive and a ‘common sense’ approach should always be taken when assessing a site to identify risks and solutions.

3.9. Financing stormwater management

The financial implications of stormwater management, including on-going maintenance, need to be carefully considered. In addition to operational and/or capital budgeting, activities may be financed through head works charges, external funding (grants etc), levies, special charges, developer contributions and fee/fine funds. See *Appendix i Funding options for stormwater management* for further information.

3.10. Education and training

Education plays an important role for improving urban stormwater management. Often the degradation of urban stormwater quality occurs due to a lack of knowledge, ie people are unaware of the impacts of their actions.

Increasing awareness of stormwater issues through education can change people’s negative behaviour to a positive outcome, circumventing the need for treatment or regulation. It can also be harnessed to create a local sense of place or ownership that can motivate a community into further action (eg land care activities).

Ensuring that the community has a basic understanding of the urban water cycle and urban infrastructure (building ‘water literacy’) is important in linking actions with impacts. For example, the connection between dropping litter on the ground and seeing it float past at the beach is often not made unless it is explicitly pointed out that a roadside drain leads to the local waterway or coastline.

Educators, both in schools and corporate or technical learning environments, need to always be aware of possible impacts of an activity and have a mitigation strategy. For example technical training in the use of a cleaning product is to be delivered with the appropriate warnings and practices to prevent stormwater contamination. Similarly, technical training in a construction technique must be delivered with the appropriate soil and water management practice.

The following broad categories of training and education may be utilised to increase awareness and prevent stormwater pollution:

- Targeted stormwater training courses for professional planners, engineers and contractors
- Curriculum/school based education ie drains stencilling and water quality monitoring
- Community participation in planning ie feedback/input into stormwater management planning
- On-ground community participation ie water quality monitoring, land care activities (eg weeding, planting, etc), educational activities and pollution reporting
- Promotional activities and waterway-themed community days to foster community responsibility and a sense of ownership

3.10.1. Developing effective stormwater education programs

Effective stormwater education programs should result in changing behaviour and be an efficient use of resources. To achieve these outcomes requires careful planning and design. The New South Wales (NSW) EPA's 'What *we need is . . . a community education project'* is a useful guide. Community stormwater campaigns including the NSW's Department of Environment and Conservation's *Drain is Just for Rain, Urban Stormwater Education Program* has successfully applied these guidelines to their project.

The NSW EPA guidelines advocate eight sequential steps for the implementation of a community education project, see Figure 8. Note that some of these steps can be linked together.

Established education programs are a good resource for developing local programs providing a proven framework with tested materials that can be successfully applied to other regions. Local input and planning is still required to ensure that the community education program is effective and tailored for the local audience it is targeted at.

The use of education as a key 'source control' strategy for stormwater management provides real long-term, cost-effective benefits, helping towards the ultimate goal of sustainability in the urban environment.

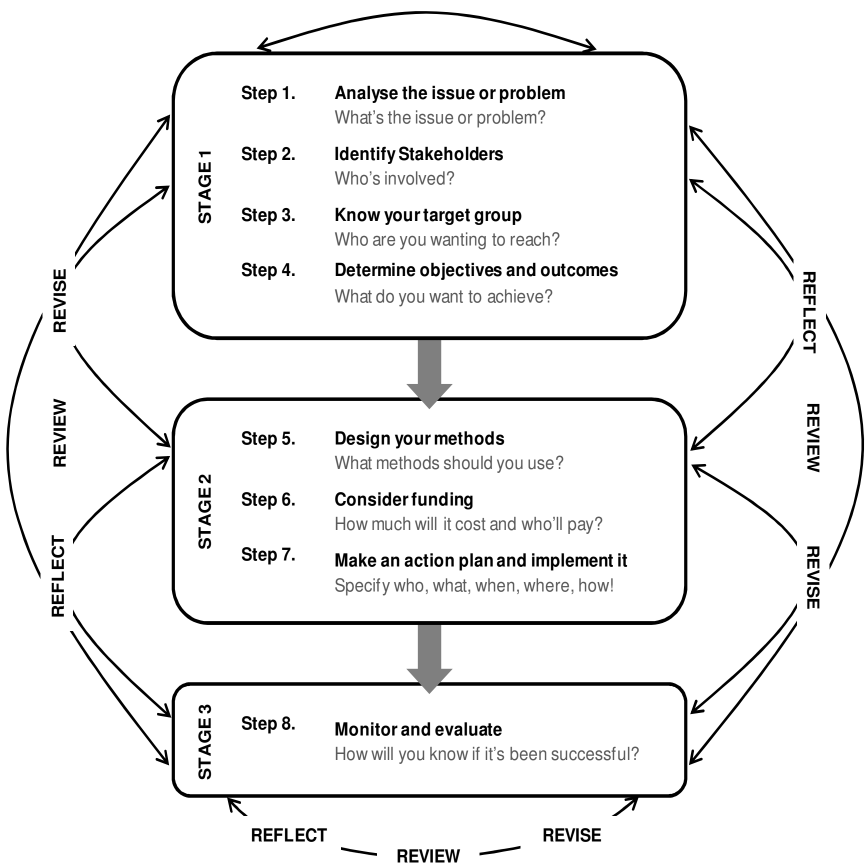


Figure 8. Eight steps to planning a community education project (NSW EPA 2000)

References

Argue, J.R. 1986. Storm Drainage Design in Small Urban Catchments: a Handbook for Australian Practice. (Special Report No. 34), Australian Road Research Board.

BMT WBM. 2009. Evaluating Options for Water Sensitive Urban Design: A National Guide, Joint Steering Committee for Water Sensitive Cities (JSCWSC).

City of Kingston. 2008. Coastal Catchments Initiative Industry Stormwater Project - City of Kingston Final Project Report March 2008. Kingston, Victoria.

Cooperative Research Centre for Catchment Hydrology 2004. Model for Urban Stormwater Improvement Conceptualisation (Version 3). Melbourne: CRC for Catchment Hydrology.

Cooperative Research Centre for Catchment Hydrology. Melbourne, 1999.

CSIRO Land and Water, 2009. ICON Water Sensitive Urban Developments Joint Steering Committee for Water Sensitive Cities (JSCWSC).

Department of Primary Industries,Water and Environment .2003. Waterways and Wetlands Works Manual. Department of Primary Industries, Water and Environment. Hobart.

Derwent Estuary Program 2009. Soil and Water Management on Building and Construction Sites, Derwent Estuary Program, Hobart.

Derwent Estuary Program. 2006. Water Sensitive Urban Design Engineering Procedures for Stormwater Management in Southern Tasmania, Derwent Estuary Program, Hobart.

Derwent Estuary Program. 2005. Stormwater and Rivulet Monitoring Program – Water quality summary report for 2002-2005 and 04/05 report card, Derwent Estuary Program, Hobart.

Derwent Estuary Program. 2005. Stormwater Management Plan: A Model Stormwater management Plan for Hobart Regional Councils - a focus on the New Town Rivulet Catchment, Derwent Estuary Program, Hobart.

Duncan, H. P. 1999. Urban Stormwater Quality: A Statistical Overview, Research Centre for Catchment Hydrology Report No 97/1, Melbourne.

eWater, 2009.Model for Urban Stormwater Improvement Conceptualisation (Version 4) eWater CRC. Canberra.

Fletcher, T.D., Duncan, H. P., Poelsma, P., & Lloyd, S. D. (2003). Stormwater flow and quality and the effectiveness of non-proprietary stormwater treatment measures – a review and gap analysis. Sydney: N W Environment Protection Authority and Institute for Sustainable Water Resources, Department of Civil Engineering, Monash University, Victoria.

Hobart City Council. 2006. Water Sensitive Urban Design Site Development Guidelines and Practice Notes. Hobart.http://www.hobartcity.com.au/HCC/STANDARD/PC_1124.html accessed 27 May 2010

Institution of Engineers. 2006. Australian Runoff Quality. Institution of Engineers,Australia ACT

Institution of Engineers. Reprinted Edition 2001. Australian rainfall and runoff: a guide to flood estimation. (2 Volumes) Engineers Australia. ACT

Landcom (2004). Managing Urban Stormwater: Soils and Construction. 4th Edition Landcom, NSW Australia [aka 'the Blue Book']

Moreton Bay Waterways and Catchments Partnership and Ecological Engineering. 2006. Water sensitive urban design: Developing Design Objectives for Water Sensitive Urban Development in South East Queensland. Queensland Office of Urban Management Department of Infrastructure, Queensland.

New South Wales EPA. 2000. What We need is a Community Education Project. New South Wales Environment Protection Authority, Sydney.

Pfitzner. M. 2006. Best Practice Stormwater Guides for Industry Educating Business Operators in the Plastics, Concrete and Shipping Container Storage Sectors to Reduce Industrial Stormwater. Victorian Stormwater Action Programme, Victoria.

Victoria Stormwater Committee.1999. Urban Stormwater Best Practice Environmental Management Guidelines. CSIRO Publishing, Victoria.

Glossary

biofiltration systems

A soil profile through which water is fed for the purpose of filtration. Vegetation is planted on the surface and a drainage layer underlies the profile with the purpose of conveying excess water away or encouraging deeper infiltration to the surrounding soil.

detention

(in context) The temporary storage of water to be later released, designed to dampen flood peaks.

filtration

Passing a liquid through a filter.

gross pollutant traps (GPTs)

Devices used to remove larger contaminants from stormwater, eg litter, coarse sediments, vegetation etc. Often abbreviated to GPT.

infiltration

(in context) Water percolation into the ground.

Infiltration trenches

Basins or surface depressions designed to encourage infiltration.

integrated water cycle management

The integrated management of water supply, sewerage and stormwater, so that water is used optimally. It promotes the coordinated planning, development and management of water, land and related resources (including energy use) that are linked to urban areas and the application of WSUD principles within the built urban environment.

natural drainage systems

(in context) Creeks, rivers and other naturally formed depressions that convey water.

permeable paving

Paving designed to allow infiltration either through a pervious media or by spacing between pavers allowing water to pass through.

rain gardens

Small biofiltration systems (see biofiltration).

rainwater tanks

Vessels used to store rainwater collected on a roof.

receiving waters

surface waters to collecting drainage discharge from land.

retention

Keeping water within the catchment ie preventing them from reaching receiving waters.

saline

Salty.

soil and water management

Practices used to prevent soil erosion and control the migration of sediments.

sedimentation basin

Basins designed to allow the settling and collection of sediment from the water column.

sodic

Containing sodium. In the context of this Strategy, sodic soils refers to soils of a dispersive nature which can lead to tunnel erosion and gullying.

vegetated swale

A planted trapezoidal channel used to convey, slow and cleanse stormwater.

Water Sensitive Urban Design (WSUD)

The integration of urban planning with the management, protection and conservation of the urban water cycle that ensures urban water management is sensitive to natural hydrological and ecological systems.

wetlands

Wetlands are systems of water bodies and marshes that help in the detention and cleansing of stormwater.

Section 4. Appendices

Appendix i. Funding options for stormwater management

There are a number of means of financing stormwater management such as allocations from general revenue streams, incentives, passing costs to private developers, pay per use, enforcement activities, grant funding and permit charges.

Budget allocations

Budget allocations for stormwater treatment systems are never likely to cover all that is required for an authority's jurisdiction. For this reason, funds made available for stormwater quality/quantity management should be spent only after careful strategic planning. Since the developer should cover costs associated with new developments, funds made available from general revenue streams should be used to target retrofit installations in established areas as well as maintenance programs.

Service or special rates and charges

Through the Tasmanian *Local Government Act* (*LGA*) 1993, there is provision to levy a number of charges that could be used to fund stormwater management systems for pollution control. Service rates or service charges, or special rates or special charges under the LGA could be used for financing the retrofit of stormwater systems. This tool might be used if it becomes apparent that water quality degradation is occurring due to contaminated runoff in an established area and the general works program does not have sufficient funding to cover the capital cost of the management system. The charge could be applied across the municipality or to the specific catchment area generating the problem.

Charges under parallel acts in other Australian states have been used to great effect with strong community support.

Privately funded systems

Greenfield development is the best opportunity to ensure satisfactory stormwater treatment is implemented as land is developed. This also ensures that the developer outlays capital expenditure for the infrastructure rather than less efficient, more expensive retrofits by the local authority when receiving water degradation becomes apparent down the track. However, where infrastructure is to be inherited by the local authority, it is important that maintenance requirements and construction quality are known prior to handover.

Other privately funded systems may be encouraged through communication with private business. For example, where a site audit on commercial premises reveals that practices might lead to pollution entering the stormwater system, an authority can work with the business to find a suitable solution. Where strong resistance is experienced, enforcement activities (eg an EPN) under *EMPCA* may be warranted.

Permit charges

Permit charges can be used to improve the management of urban stormwater. One way of utilising a permit charge is to cover inspection time. For example, where public infrastructure is to be constructed by the private sector during land development, it is vital that works are inspected as needed to ensure sound construction and site practices. Permit charges should be levied to cover administrative and staff related costs associated with required inspection and reporting regimes. Additionally, in purely private developments, permit charges will need to cover inspection for site practices (such as effective sediment and erosion control). An alternative, if inspection costs are already covered, is to require development bonds to ensure soil and water management practices are sound. If it becomes evident that poor practices resulted in a large export of sediment from the site the bond can be retained and used for remediation.

Pay per use

In circumstances where a particular activity leads to stormwater pollution it may be appropriate to level a usage-based charge to install and maintain suitable stormwater treatment systems. For example, in pay car parks where runoff discharges to stormwater, the cost of installation and maintenance of proprietary stormwater filters should be factored into parking charges.

Incentives

Incentive programs are increasingly being used as a way of encouraging the private sector to manage environmental damage. Incentive programs range from small scale schemes such as rebates for the installation of rainwater tanks to financial incentives provided (eg discounts on property rates or permit charges) when stormwater management targets are met. Regulation designed around load-based pollutant charges is also a form of incentive-based pollution control.

Enforcement activities

Enforcement activities are an appropriate element of managing stormwater pollution. Where a fine is levied for environmental offences (eg EIN) the proceeds should be fed into the management of such activities. An example of this would be the establishment of an audit fund whereby, after an initial education program, soil and water management on building sites is audited and fines are issued for non-compliance. The proceeds of this enforcement activity could be reinvested back into further soil and water management education.

Grant funding

External funding sources are an ideal means of gaining capital required for innovative stormwater management systems. Usually some in-kind support is required by the applicant. Australian experience has shown that, in the past, maintenance requirements have been neglected in systems installed through external funding sources. This has often been due to a lack of understanding of long-term requirements by the applicants. For this reason, a basic economic analysis should always be completed prior to the project to ensure that funding for long-term maintenance is within the budgetary constraints of the applicant organisation.

Appendix ii. Stormwater quality management targets

Significance of the targets

The stormwater quality management targets set out in *Section 2.1.2* have been selected as a minimum ‘default’ level of stormwater treatment.

They represent achievable targets based upon current best practice stormwater management infrastructure, pollutant export conditions and economic considerations and will provide a high level of protection for waterways receiving urban runoff. It is expected that the targets will be revised progressively to reflect improvements in WSUD treatment technology and cost.

While these stormwater quality management targets do not guarantee that the stormwater quality leaving a development will be of an equal quality to stormwater from an undisturbed site, they will, however result in less impairment in the health of receiving freshwater aquatic ecosystems when compared with more traditional stormwater designs that pipe stormwater directly into receiving waters without suitable pre-treatment. The targets are designed to mitigate against the long term cumulative impacts of urban stormwater contamination.

The benefits of using the stormwater quality management targets are illustrated in Figure 9, below, which demonstrates the modelled effects of a hypothetical development scenario on water quality. The graph represents the mean concentration of the indicator pollutants in flows from an undisturbed, vegetated 1,200m^2 site as compared to:

- The same site developed into two 600m^2 blocks with driveways and homes using standard construction techniques
- The same site developed into two 600m^2 blocks with driveways and homes, and incorporating WSUD as required meeting the stormwater quality management targets. To meet the targets, each of the homes has a 2000L water tank plumbed for toilet flushing only (40L per day demand) and 4m^2 of biofiltration ‘rain garden’ collecting runoff from all hard surfaces (including tank overflow). The additional cost to each site is approximately $2,500-$4,500 to meet objectives in this case

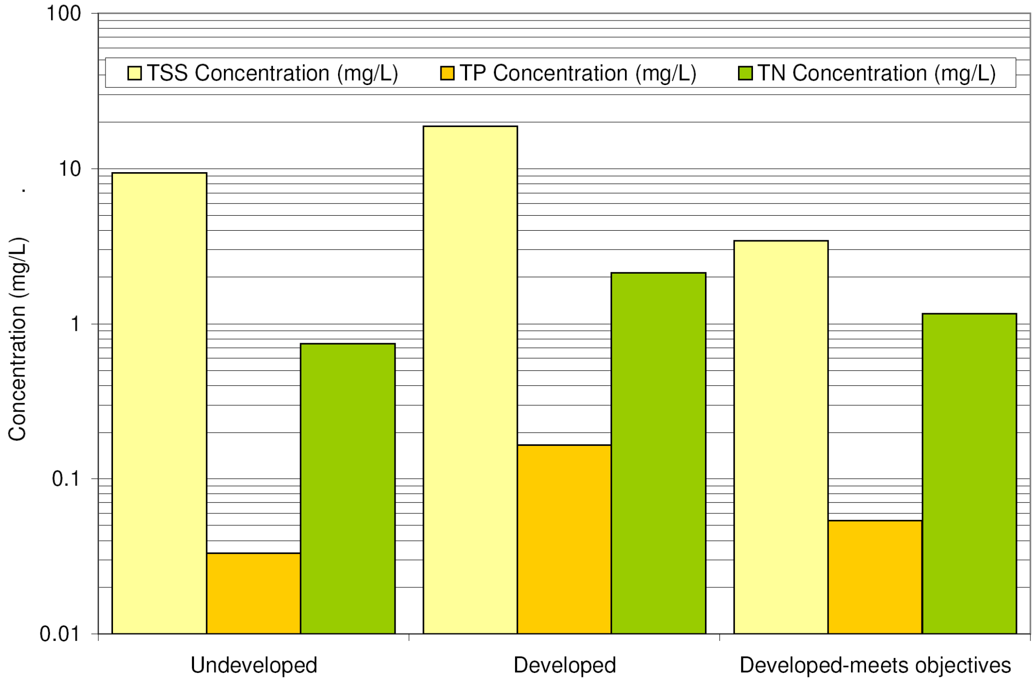


Figure 9. Mean pollutant concentration in flows from site in an undeveloped state, developed state and developed with site management.

Load Based Targets

Receiving water quality objectives are typically specified in terms of desired pollutant concentrations. However, experience within Australia and overseas has identified difficulties with the application of concentration-based receiving water targets as discharge criteria for urban stormwater. These difficulties include the possibility that the median (or some other percentile) concentrations of pollutants in stormwater may be low, but pollutant concentrations and loads during infrequent storm events may be very high. In addition, the increase in runoff volume that typically accompanies urban development can significantly damage urban streams through increased disturbance and erosion, even if discharged pollutant concentrations are low. For these reasons the stormwater quality management targets adopt a load-based approach. It may be necessary to convert concentration-based water quality targets to load based targets.

Required pollutant reductions should be estimated on an **Average Annual Load** basis from ‘typical’ urban stormwater concentrations. Concentration of pollutants in urban stormwater, while varying significantly from site to site and day to day, is found to be similar over time as collated results from long-term monitoring programs. For example, stormwater quality monitoring across greater Hobart over three years delivered results consistent with nationally reported studies, eg Duncan (1999).

Urban Stormwater Quality: a Statistical Overview, Duncan (1999) provides a comprehensive review of available national and international stormwater quality data. Data provided in this report (also summarised in Engineers Australia 2006 and Fletcher, *et. al.* 2004) provided default values in the MUSIC modelling software package (eWater CRC, 2009). These form the basis for ‘typical’ urban stormwater pollutant concentrations for modelling purposes.

For detail on assessment of treatment performance see *Appendix iv. Assessing stormwater management strategies*

Stormwater quality management targets as treatment indicators

The stormwater quality management targets of 80 per cent reduction of Total Suspended Solids (TSS), 45 per cent reduction of Total Nitrogen (TN), 45 per cent reduction of Total Phosphorus (TP) are broad indicators for the removal of other contaminants of concern. TSS removal also indicates potential removal of particulate bound TP and bacteria.

TN is used as treatment indicator for increased protection, as treatment systems capable of removing TN are more likely to have increased performance in the removal of dissolved nutrients and heavy metals and are more likely to contain some form of fine filtration or biological treatment processes.

For detail on stormwater pollutants and their sources see Table 2 in *Section 1.2. Introduction and Background.*

Alternative objectives

The stormwater management quality targets should be used in conjunction with any recognised local site-specific conditions including hydrological, hydraulic, hydro geological, soils, water quality, and biological data to determine the environmental objectives for stormwater at a site and manage the impacts on downstream receiving waters. Where a development proponent disputes the need to meet the stormwater management quality targets to protect the local receiving waters from the proposed development's runoff, an option for detailed assessment by a suitable professional may be considered. This assessment should demonstrate that the pollutant concentrations in the stormwater runoff from the proposed development shall not prejudice the Water Quality Objective(s) (WQO) of the local receiving waters.

Where WQOs have not been identified for the waterway, ANZECC (2000) generic 'default trigger values' should be adopted as WQOs eg if the receiving water is identified as "protection of modified ecosystem" then the ANZECC default trigger value for slightly to moderately disturbed ecosystems should be adopted as a discharge limit.

Appendix iii. Stormwater quantity management targets

The following guidelines provide some general principles that can be used by the appraisal authority in assessing applications. It is strongly encouraged that catchment-specific flow management standards be developed that take into account differing flow management requirements and infrastructure. Applying catchment-specific standards allows flow management standards to be tailored to the needs of the catchment.

For example, where existing infrastructure in a lower catchment is sized only to carry existing flows, new development in the upper catchment should be required to maintain pre-development discharge levels. Alternatively, where drainage from a development is discharged to a natural waterway (either directly or via a piped network), it may be beneficial to require the development to incorporate detention/retention facilities. This helps to prevent erosion of the natural waterway caused by the frequent exaggerated flow of high recurrence interval, low intensity rainfall events.

The stormwater quantity management targets provided here are suggested default guidelines designed to minimise the impacts of developing catchments on urban waterways.

Whilst the lower levels of ‘quantity control’ do not significantly reduce the flood risk of major storms, there are significant benefits to be gained from retaining flow for minor storms. Lowering the peak flow rate of minor storms (eg 0.25 ARI) minimises the erosive capability of frequent exaggerated flows in a developed catchment and the contaminant carrying capacity.

Table 5. Possible default water quantity management objectives for protection of urban streams.

Receiving environment	Stormwater quantity management objective
Piped network discharging to creek	$Q_{natural} \approx Q_{post}$ up to 0.25* yr ARI
Direct discharge to creek	$Q_{natural} \approx Q_{post}$ up to 0.25* yr ARI

ARI – Average recurrence interval

*0.25 ARI assumed to be half of 1yr ARI discharge

Q – discharge (Q = Flow velocity x Cross-sectional area of flow)

$Q_{natural}$= discharge from a fully vegetated site

Q_{post}= discharge from the developed site with onsite management

Specific flow management targets should also be set by local authorities to minimise the impact of new development (and the associated increase in impervious catchment) has on existing infrastructure where flows from ongoing development are likely to exceed the capacity of downstream infrastructure. When calculating Q for a stormwater quantity management target in this scenario, the time of concentration for the critical point in the catchment (T_c) to be protected (ie the lowest capacity downstream point), should be set by the local authority.

Flood estimation should be completed in accordance accepted Australian practices, such as with guidance provided by *Australian Rainfall and Runoff* (Engineers Australia 2001).

See *Appendix iv. Assessing stormwater management strategies*

Appendix iv. Assessing stormwater management strategies

Demonstrating that the stormwater management targets (for both quality and quantity) are met is the responsibility of the development proponent. This section outlines information that should be submitted to the development appraisal authority to demonstrate that required targets will be met.

Stormwater quality management

A number of methodologies are available for the estimation of treatment performance. These include:

- A summary report of site-specific modelling of a treatment scenario using a suitable proprietary software product (eg MUSIC [eWater, 2009], SWMM, Infoworks, etc).
- The detailed methodology outlined in *WSUD Engineering Procedures for Southern Tasmania* (DEP, 2006).
- A report prepared by a suitable professional consultant demonstrating that the pollutant concentrations in runoff from the proposed developments shall not prejudice the Water Quality Objectives (WQO) of the local receiving waters.

Stormwater quantity management

All stormwater flow management estimates should be prepared according to methodologies described in *Australian Rainfall and Runoff* (Engineering Australia 2001) or through catchment modelling completed by a suitable professional. All methodologies and calculations should be provided in a summary report attached to the development application.

Demonstrating compliance

A brief report summarising key information should be submitted to the appraisal authority. This report should include:

- Name of developer, contact for more information, address of development, development application number (if available).
- Site plan showing location, size and nature of development with dimensions.
- Area/proportion of impervious surfaces.
- Stormwater management targets (according to this strategy) that the development will meet.
- Size and type of proposed treatment systems.
- Detailed design calculations (compliant with *WSUD Engineering Procedures for Southern Tasmania*).
- Estimated treatment performance to show how stormwater quality management targets are achieved.
- Flow management calculations, methodologies and assumptions made in the analysis.

Appendix v. Model conditioning framework for soil and water management

Building permits

All Building Permits (under the *Building Act 2000*) should be conditioned with the following requirement to ensure consistency of approach across Tasmania. A consistent approach is encouraged in an effort to institutionalise improved soil and water management practices without the need for excessive enforcement activities. Consistency also allows contractors, who work across municipal boundaries, to know what is expected of them wherever they are working.

Proposed condition for ALL building permits:

> *"Best practice sediment and erosion control measures shall be implemented on the site in accordance with accepted guidelines[†] before any ground disturbance work commences. Control measures must be maintained at all times during construction to prevent soil and other materials entering the local stormwater system, roadways or adjoining properties. Any areas that remain exposed at the completion of building work shall be stabilised using vegetation and/or other appropriate measures to the satisfaction of the council."*

Development Applications

Consistent conditioning of development applications for subdivision or multi-lot stratum developments will also assist in institutionalising effective soil and water management practices in new development through an increased awareness of expectations in developers, designers, foremen and works crews. Consistency will also assist regulatory authorities in enforcement since officers will know that all developments have been issued with conditions. This enables a regulatory or empowered officer to provide warnings or take enforcement action immediately during site inspections without the need to first follow up with the development approval agency whether conditions were actually placed on the permit and the nature of those conditions.

Proposed condition for ALL development applications involving subdivision or activities creating greater than $250m^2$ of ground disturbance (this area excludes small extensions, small driveways and garages):

> *"A soil and water management plan detailing proposed sediment and erosion control measures shall be submitted to Council accompanying detailed engineering drawings prior to the issue of a Building Permit.*
>
> *The soil and water management plan should be completed in accordance with best practice as detailed in accepted guidelines[†], to prevent soil and other materials entering the local stormwater system, waterways, roadways or adjoining properties.*
>
> *The approved facilities shall be regularly inspected and maintained during the construction / demolition period and shall remain in place until such time as all disturbed areas have been stabilised, restored or sealed to the satisfaction of the council."*

†Accepted guidelines for soil and water management

Soil and Water Management on Building and Construction Sites (2009) from the Derwent Estuary Program are considered suitable guidelines for providing best practice soil and water management techniques that complies with the SPWQM (Division 3, Clauses 31 & 33).

Appendix vi. Risk matrix assessment for urban catchments

Prior to developing a stormwater management plan, it is recommended that a risk assessment of all the municipality's urban catchments be undertaken to identifying priority catchments that are most in need of stormwater management plans. The purpose of the risk assessment is to identify and rank the values of receiving environments and the threats posed by stormwater pollution or flows for the different catchments. Through a comparative process, catchments with the highest rankings are identified as priority sites needing stormwater management plans.

Receiving water values & threats

Values of receiving environments are not only limited to "environmental" considerations, but can be categorised under a number of headings as shown in the table below.

Table 6. Receiving water values (Victoria Stormwater Committee, 1999)

Value	
Environment	Physical and ecological attributes of waterways eg stands of intact remnant vegetation that provides habitat for corridors of native vegetation that allow for movement of native fauna.
Recreation/amenity	Areas that are acknowledged for their open space, public access picturesque landscape or areas where people can walk, cycle, picnic or play sports.
Economic	Economic benefits derived from water environment e.g, fishing or aquaculture, tourism, transport and property values
Hydraulic	Extent to which the catchment provides an important drainage function contributing to protection of property and public safety from the risk of flooding;
Cultural	Areas that contain sites of cultural and heritage significance (Aboriginal and European).

Table 7. Example of a scoring system for the different receiving water values (Victoria Stormwater Committee, 1999)

Value	**Score**
Environment	3 = high conservation value 2 = slight to moderately disturbed system 1= highly disturbed system
Recreation/amenity	3 = attractive open space with a diversity of recreational activities 2 = linear park with walking/bike track paths 1= limited visual attraction, no public access or recreational facilities
Economic	3 = significant economic value 2 = positive impact on economic value 1 = neutral or negative impact on economic value
Hydraulic	3 = high level of flood protection 2 = moderate level of flood protection 1= low level of flood protection
Cultural	3 = use/value, 0 = not used/valued

Threats are major site specific (eg sewage treatment plant and industrial) and diffuse activities (eg stormwater) with potential to cause pollution. Common threats, their potential causes, pollutants and impacts are described in Table 2. It is important to list these threats and identify the type of pollution threat. It is necessary to quantify the threat by assigning qualitative, numerical rating, they could have the following scores; 1 = low, 2 = moderate, 3 = high, and 4 = very high.

Identification and rating of receiving water values and threats should be based upon interviews with council officers and other key stakeholders, site inspections (to identify and confirm values); and review of existing documents and available data including history of spills, complaints, age of infrastructure etc..

Risk magnitude

The stormwater threats and receiving water values are systematically translated into risk magnitude, calculated for each of the combinations of values and threats within each catchment, ie, risk magnitude = combined value score x combined threat score. From this assessment the comparative catchments can be ranked. Those catchments with the highest risk magnitude are identified as the priority catchments needing a stormwater management plan.

Table 8. Prioritisation of hypothetical stormwater catchments

Threats	**Catchment A (Pristine)**	**Catchment B (Moderately Disturbed)**	**Catchment C (Very Highly Disturbed)**
Litter	1	2	4
Nutrients	1	2	4
Sediments	1	2	4
Pathogens	1	2	4
Toxicants	1	2	4
BOD	1	2	4
Flow	1	2	4
Total Threat Score	**7**	**14**	**28**
Values			
Protection of aquatic ecosystem	3	2	1
Recreation/amenity	3	2	1
Economic	3	2	1
Hydraulic	1	2	3
Cultural and spiritual	3	0	0
Total Value Score	**13**	**8**	**6**
Risk Magnitude	**91**	**112**	**168**

Tasmania
Explore the possibilities

CONTACT DETAILS

Department of Primary Industries, Parks, Water and Environment

EPA Division

GPO Box 1751 Hobart 7001

http://www.environment.tas.gov.au