Stormwater design considerations

Manage the small and frequent rainfall events first

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Urban Water Management
Stormwater Management Manual for Western Australia

A component of integrated water cycle management
Decision Process for Stormwater Management in WA

1. Planning and designing stormwater management systems
2. Water quantity management
3. Water quality management
4. Protect waterways and wetlands
5. Management of groundwater levels
Urban water management objectives

Better urban water management outcomes can be achieved through the implementation of the following objectives:

- **Manage catchments to maintain or improve water resources**
  - Manage runoff from all rainfall events as high in the catchment as possible.
  - Post development hydrology should mimic pre-development conditions.
  - Maintain or improve water quality of surface water and groundwater.
  - Manage, protect and restore waterways and wetlands.
  - Minimise pollutant inputs through implementation of appropriate non-structural controls.
  - Retain native vegetation and natural landform.
  - Protect public drinking water source areas.
  - Safeguard the quality and availability of water resources for the future.

- **Manage risks to human life and property**
  - Provide adequate clearance from 100-year average recurrence interval flooding and surface or groundwater inundation and waterlogging.
  - Prevent flooding or inundation of upstream or adjacent developed areas.
  - Manage surface water flows to prevent damage to downstream infrastructure and assets.
  - Manage risk to public health from disease vector and nuisance insects.

- **Ensure the efficient use of water resources**
  - Minimise water use within developments.
  - Maximise water reuse, including using wastewater and harvested stormwater.
  - Achieve highest value use of fit for purpose water, considering all available forms of water for their potential as a resource.

- **Ensure that economic, social and cultural values are recognised and maintained**
  - Enhance social amenity through multiple use corridors and by integrating water management measures into the street and lot landscape to increase visual, recreational, cultural, public health and ecological values.
  - Implement water management systems that are economically viable in the long-term.
  - Ensure the delivery of best practice urban water management through planning and design of high quality urban areas in accordance with sustainability and precautionary principles.

Integrating water as early as possible into the land use planning process provides the best opportunity to achieve optimal solutions and implement efficient and effective best management practices.

Treatment train

Stormwater management involves a continuous chain of water quantity and treatment management elements that address hydrologic changes in urbanised catchments, including flooding impacts, water quality, water reuse and ecological objectives. This is achieved by a series of hydrological design responses at four stages in the urban hydrological system. These are a range of structural and non-structural practices that can be used as part of the treatment train. Some have specific purposes and as such should be used for specific stages in the treatment train, while others are applicable to a range of stages in the treatment train.

The design should aim to achieve the urban water management objectives at each part of the treatment train.

Design scale

The selection of management practices (sometimes referred to as best management practices) must also consider the development scale that it can be applied at. This includes practices which are applied at the broad district level, such as wastewater recycling schemes, at a whole of precinct level, such as public open space solutions and neighbourhood reticulated non-drinking water schemes, at the street level in verges and roads, and at the individual lot level, as part of the design and construction of buildings and private spaces. The “Water sensitive urban design” brochures series provide an indication of applicable design scales for each management practice.
Water sensitive urban design

Stormwater design considerations

Introduction

This brochure provides an overview of the factors that need to be taken into account when designing stormwater management systems for new urban developments, or when modifying existing systems.

This brochure is part of a series that explain various aspects of water sensitive urban design. Please see Water sensitive urban design in Western Australia for background information on water sensitive urban design.
Water sensitive developed catchment

- Greater evapotranspiration
- Reduced impervious area
- Greater infiltration at lot scale
- Swale
- Greater stormwater use on site
- Lower surface runoff
1. Maintain the site water balance
2. Prevent or minimise pollutant inputs
3. Preserve or rehabilitate native vegetation and natural water bodies
4. Prevent flooding and property damage
5. Protect public health
6. Promote economic viability in the long term
Management of storm events

Total Rainfall Volume

- ~95% Small Storms
- ~4% Large Storms
- ~1% Extreme Storms

Rainfall capture
Infiltrate and reuse

Stormwater Treatment
Protect receiving environments

Runoff Control
Minimise stream erosion

Flood Management
Safely convey runoff

Area of influence for structural controls on water quality

Event Frequency

High

Low

Discharge

Adapted from British Colombia Ministry of Water, Land and Air Protection, 2002
Perth airport daily rainfall
May 1944 to July 2008
Perth airport hourly rainfall
January 2007 to July 2008

Return Periods taken from B.O.M. 2008
Perth metropolitan area
Analysis of average recurrence interval (ARI) events

<table>
<thead>
<tr>
<th>ARI - Perth</th>
<th>Total rainfall for event</th>
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<tbody>
<tr>
<td>1yr-1hr</td>
<td>16 mm</td>
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<tr>
<td>5yr-6min</td>
<td>9.5mm</td>
</tr>
<tr>
<td>5yr-10min</td>
<td>13mm</td>
</tr>
<tr>
<td>5yr-15min</td>
<td>15mm</td>
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<tr>
<td>10yr-6min</td>
<td>11mm</td>
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<tr>
<td>10yr-10min</td>
<td>15mm</td>
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<tr>
<td>10yr-15min</td>
<td>17.5mm</td>
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</table>
Small events

1. 1-year, 1-hour average recurrence interval event
   - Retain or detain runoff from constructed impervious surfaces as high in the catchment as possible (on-site)

2. 1-year average recurrence interval critical event
   - Maintain pre and post development peak flow rates from the whole sub-catchment at outlet/s from site
Minor events

1. Attenuate the 5-year (residential) and 10-year (commercial and industrial) average recurrence interval critical event to pre-development conditions

2. Maintain road serviceability

3. Check peak flow rates are not causing erosion
Major events

1. Safely convey the 100-year critical catchment event to minimise flooding

2. Maintain downstream flood level

3. Ensure peak flow rate does not exceed capacity of the downstream channel

4. Increases permitted if:
   - Additional downstream capacity exists
   - Impact of change can be shown to be acceptable
   - Approval gained from downstream asset owner/manager
Systems managing different sized rainfall events

1-year ARI events
Retention/detention

5-year ARI events
Attenuation

100-year ARI events
Conveyance

Diagram prepared for Department of Water by TME Consultants 2008
### Management of zero to 100 year events

<table>
<thead>
<tr>
<th>ARI</th>
<th>0</th>
<th>1</th>
<th>5/10</th>
<th>100</th>
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<tbody>
<tr>
<td><strong>Source Control</strong></td>
<td><strong>Runoff Control</strong></td>
<td><strong>Safe Conveyance</strong></td>
<td><strong>Structures</strong></td>
<td></td>
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<tr>
<td><strong>Capture/prevent runoff from constructed hard surfaces</strong></td>
<td><strong>Retain, detain and convey</strong></td>
<td><strong>Convey, protect from flooding</strong></td>
<td><strong>Flood management – safely convey runoff</strong></td>
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<tr>
<td><strong>Water quality management</strong></td>
<td><strong>Manage water quantity for serviceability &amp; to prevent erosion</strong></td>
<td><strong>Convey, protect from flooding</strong></td>
<td><strong>Major system conveyance via overland flow along roads and floodways</strong></td>
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<td><strong>Rainwater tanks</strong></td>
<td><strong>Swales &amp; buffer strips</strong></td>
<td><strong>Major system conveyance via overland flow along roads and floodways</strong></td>
<td><strong>Swales &amp; buffer strips</strong></td>
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<tr>
<td><strong>Pervious paving</strong></td>
<td><strong>Overflow pipes</strong></td>
<td><strong>Major system conveyance via overland flow along roads and floodways</strong></td>
<td><strong>Infiltration basins / trenches</strong></td>
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<td><strong>Soakwells</strong></td>
<td><strong>Infiltration basins / trenches</strong></td>
<td><strong>Major system conveyance via overland flow along roads and floodways</strong></td>
<td><strong>Dry/ephemeral detention areas</strong></td>
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<td><strong>Biofilters</strong></td>
<td><strong>Dry/ephemeral detention areas</strong></td>
<td><strong>Major system conveyance via overland flow along roads and floodways</strong></td>
<td><strong>Living streams</strong></td>
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<td><strong>Tree pits</strong></td>
<td><strong>Living streams</strong></td>
<td><strong>Major system conveyance via overland flow along roads and floodways</strong></td>
<td><strong>Constructed wetlands</strong></td>
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<td><strong>Litter &amp; sediment traps</strong></td>
<td><strong>Litter &amp; sediment traps</strong></td>
<td><strong>Major system conveyance via overland flow along roads and floodways</strong></td>
<td><strong>Hydrocarbon management</strong></td>
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<td><strong>Hydrocarbon management</strong></td>
<td><strong>Hydrocarbon management</strong></td>
<td><strong>Major system conveyance via overland flow along roads and floodways</strong></td>
<td><strong>Soil bioremediation</strong></td>
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Up to 1 year ARI events:

- Manage runoff from up to 1 year ARI events at-source

- Systems designed for the 1 year 1 hour ARI event will manage the majority of pollutants (>99%)
Up to 5 year ARI events in residential/rural-residential and 10 year ARI events in commercial/industrial areas:

- Retention and detention areas and minor system conveyance in road reserves, public open space and multiple use corridors

- Maintain road serviceability and prevent erosion
Summary of design objectives

From 5 to 100 year ARI events:
   – Account for the flow paths of the 100 year ARI event
   – Protect buildings and infrastructure from flooding

- Retain native vegetation and natural landform wherever possible

- Ensure overland flow of stormwater across vegetated surfaces towards water bodies, rather than direct discharge

- Prevent pollution – it is easier and cheaper than collecting and treating large quantities of stormwater and pollutants!
1. Design for management of volume of water of ‘small’ rainfall event, including ‘treatment’ systems to improve water quality.

2. Design for conveyance of groundwater flows (if GW drainage system required).

3. Design ‘minor’ rainfall event runoff control conveyance system.

4. Design ‘major’ rainfall event conveyance and discharge system for flood protection of infrastructure and the safety of the community.