RUNOFF IN URBAN AREAS

Volume Management & Conveyance Systems

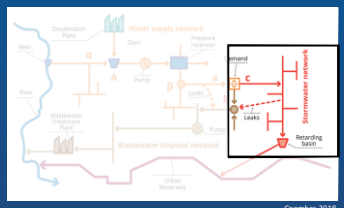
Peter Coombes, Steve Roso & Mark Babister

Australian Rainfall & Runoff

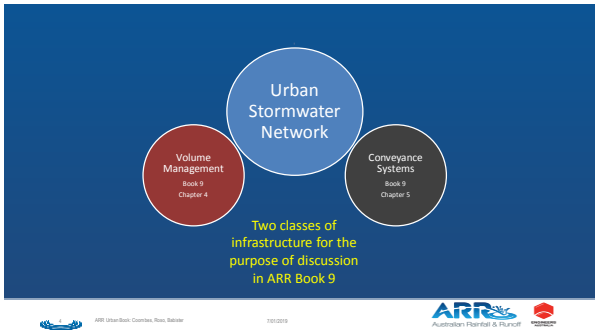
Session Outline

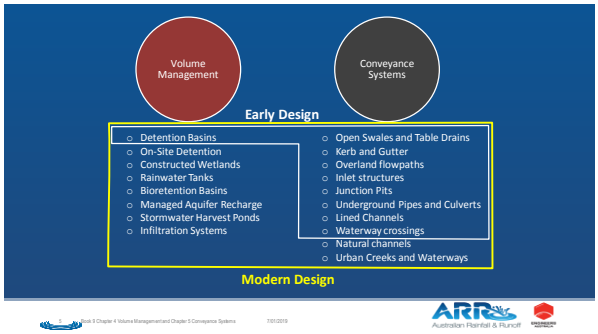
- Stormwater network and infrastructure overview
- Volume Management (ARR Book 9 Chapter 4)
- Conveyance Systems (ARR Book 9 Chapter 5)

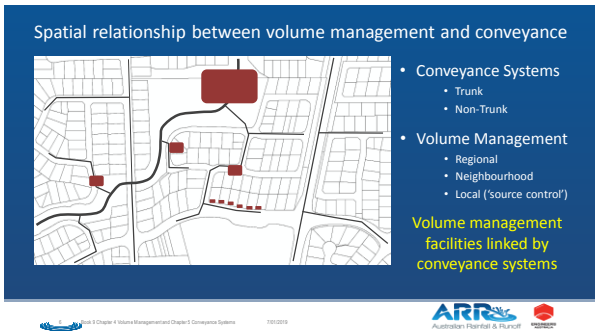
Urban Water Networks



Coombes 2018


Urban Stormwater Network
Volume Management
Book 9
Chapter 4
Conveyance Systems
Book 9
Chapter 5
Two classes of infrastructure for the purpose of discussion in ARR Book 9


Volume Management
Conveyance Systems
Early Design
Detention Basins
On-Site Detention
Constructed Wetlands
Rainwater Tanks
Bioretention Basins
Managed Aquifer Recharge
Stormwater Harvest Ponds
Infiltration Systems
Open Swales and Table Drains
Kerb and Gutter
Overland flowpaths
Inlet structures
Junction Pits
Underground Pipes and Culverts
Lined Channels
Waterway crossings
Natural channels
Urban Creeks and Waterways
Modern Design


Spatial relationship between volume management and conveyance
Conveyance Systems
Trunk
Non-Trunk
Volume Management
Regional
Neighbourhood
Local ('source control')
Volume management facilities linked by conveyance systems

Volume Management

Book 9 Ch 4

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Contributors:
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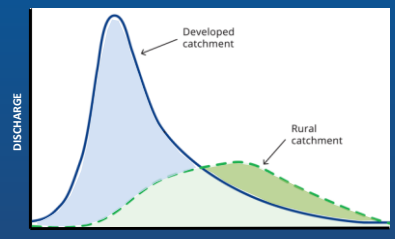
Brett Phillips
Peter Coombes

HIGH RAINFALL INFILTRATION	MODERATE RAINFALL INFILTRATION	LOW RAINFALL INFILTRATION
LOW RUNOFF CONCENTRATION	LOW RUNOFF CONCENTRATION	HIGH RUNOFF CONCENTRATION

Urbanisation increases speed and volume of runoff



Decreased water quality due to urban runoff

- Lawns
- Gardens
- Roadways
- Commercial areas

Decline in aquatic health

Urbanisation increases speed and volume of runoff and reduces aquatic health

Volume Management

Problem

Solution

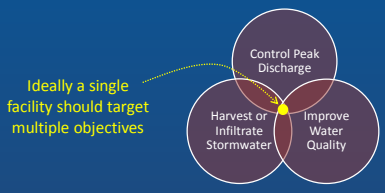
Volume Management Objectives

Control Peak Discharge
- Reduce flood and infrastructure damage
- Flood safety
- Reduce capacity requirements for downstream conveyance

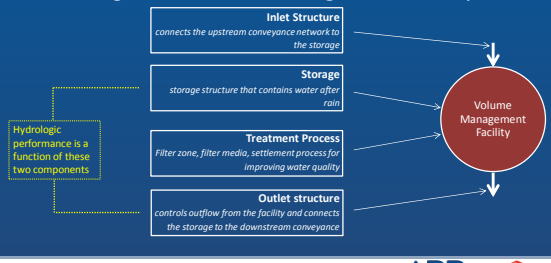
Harvest or Infiltrate Stormwater
- Maintain hydrologic behaviour
- Waterway stability and health
- Increased availability of water for harvesting and use
- Decrease demand on water supply network

Improve Water Quality
- Maintain aquatic health
- Maintain visual amenity
- Pre-treatment of runoff before harvest

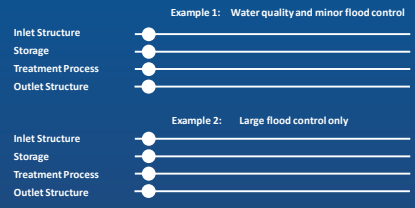
Volume Management Objectives



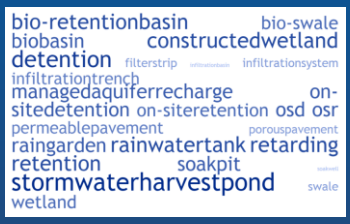
Design of a Volume Management Facility



Volume Management Facility 'Components'



Components are designed for performance against different objectives



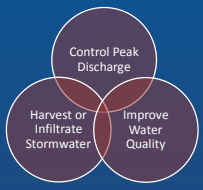
Common Configurations in Australian Practice

- Detention Basins
- On-site detention
- Constructed Wetlands
- Rainwater Tanks
- Bioretention Basins
- Managed Aquifer Recharge
- Stormwater Harvest Ponds
- Infiltration Systems

Table 9.4.4. Indicative Suitability of Common Volume Management Design Solutions

Solution	Control Peak Discharge	Improve Water Quality	Harvest or Infiltrate Stormwater
Detention (Retarding) Basin (see Section 5.4)	Suitable	Not suitable	Not suitable
On-Site Detention (OSD) (see Section 5.2)	Suitable	Not suitable	Not suitable
Rainwater Harvesting (see Section 5.3)	Suitable with limitations	Suitable	Suitable
Bioretention Basin (see Section 5.4)	Suitable with limitations	Suitable	Suitable with limitations
Constructed Wetland (see Section 5.5)	Suitable with limitations	Suitable	Suitable with limitations
Managed Aquifer Recharge (see Section 5.6)	Suitable with limitations	Suitable with limitations	Suitable
Infiltration System (see Section 5.7)	Suitable with limitations	Suitable with limitations	Suitable
Stormwater Harvest Pond (see Section 5.8)	Suitable with limitations	Suitable with limitations	Suitable

Volume Management Objectives



- Detention Basins
- On-site Detention
- Constructed Wetlands
- Rainwater Tanks
- Bioretention Basins
- Managed Aquifer Recharge
- Stormwater Harvest Ponds
- Infiltration Systems

- Detention Basins
- Constructed Wetlands

- On-site Detention
- Rainwater Tanks
- Infiltration Systems

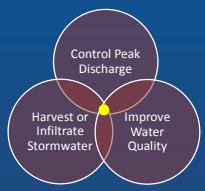
- Detention Basins
- Bioretention Basins

- Constructed Wetlands
- Managed Aquifer Recharge

In modern best practice objectives often overlap

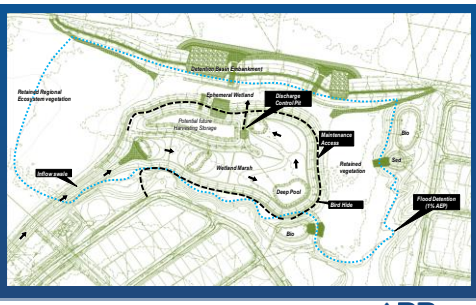
Look for co-location opportunities or hybrid designs

Hybrid Design Example



Key Features:

- 115ML Detention Basin for up to 1% AEP
- 1.4 Hectare Constructed Wetland
- Future Harvesting Option
- Design prepared by DesignFlow



DesignFlow 2018

DesignFlow 2018

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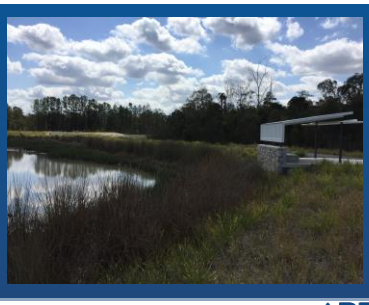


DesignFlow 2018

DesignFlow 2018

Catchment Volume Strategy (Ch 3.6)

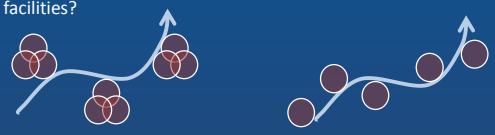
CONSIDERATION

What are the volume management objectives for the Catchment?

Catchment Volume Strategy (Ch 3.6) cont'd

CONSIDERATION

Should the objectives be achieved in combined or separate facilities?

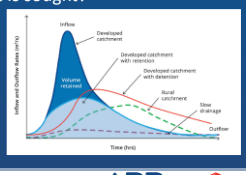


Catchment Volume Strategy (Ch 3.6) cont'd

CONSIDERATION

What is the performance level that is sought?

- Peak discharge
- Volume
- Timing

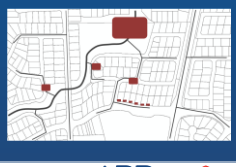


Catchment Volume Strategy (Ch 3.6) cont'd

CONSIDERATION

Where should volume management be achieved?

- 'at source'
- 'neighbourhood' scale
- 'regional' scale
- combinations



Catchment Volume Strategy (Ch 3.6) cont'd

CONSIDERATION

How does existing urban development influence the strategy?

- Future growth areas
- Highly urbanised catchments
- Over-developed catchments

Catchment Volume Strategy (Ch 3.6) cont'd

CONSIDERATION

Other constraints?

- Environmentally sensitive riparian land
- Land ownership and development patterns
- Local asset management policies

Volume Management - Summary

- Urbanisation results in much larger and faster runoff volumes
- Three typical volume management objectives
- Best practice seeks to achieve multiple objectives in a single facility
- Four components of a facility designed for performance against different objectives
- Number of considerations when devising a catchment strategy (See Ch 3.6)

Conveyance Systems

Book 9 Ch 5

Author:
Benjamin Kus

Editors:
Peter Coombes
Steve Roso

Conveyance objectives:
- Maximise utilisation of land
- Minimise nuisance
- Pedestrian and road safety
- Manage disasters

For larger systems:
- Recreational use (in dry)
- Natural amenity/habitat

Conveyance Systems – Minor vs Major Systems

In residential areas

In commercial areas

In park areas

- Minor system – to manage nuisance (often underground and lined)
- Major System – to manage disaster (often above ground. Can be lined or unlined)

Balance Between Minor and Major Capacity

- Influenced by a number of factors:
  - Land availability
  - Rainfall patterns
  - Human exposure
  - Physical constraints
  - Erosion susceptibility
  - Blockage potential
  - Climate change

Conveyance Systems – underground vs surface systems

Underground
- Inlet Structures
- Junction Pits
- Underground Pipes and Culverts
- Waterway Crossings

Surface
- Open Swales and Table Drains
- Kerb and Gutter
- Overland flowpaths
- Lined Channels
- Natural channels
- Urban Creeks and Waterways

Extent of each will depend on hydrology, landuse, urban design objectives

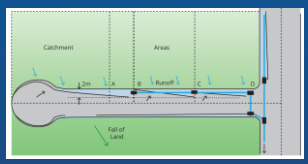
Conveyance Systems – Alignment

- Generally lowest point
- Influenced by urban form
- Co-locate underground and surface systems
- Co-locate with open space, habitat, volume facilities
- Early planning and innovation can yield better outcomes

Underground Systems

Issues to consider:

- Location, type and capacity of inlets
- Likelihood of inlet blockage
- Location and config of junctions
- Head loss through pit structures
- Freeboard, surcharge and bypass flows
- Flow Pressurisation
- Alignment and size of pipes/culverts
- Outlet positioning
- Energy dissipation
- Downstream conditions



Surface Systems

Issues to consider:

- Alignment to public roads and open space
- Cross-sectional shape
- Velocity and depth of flow
- Gutter flow widths
- Exposure of pedestrians and vehicles
- Diversions and 2D flow behaviour
- Trapped sags
- Fences and obstructions

A well designed surface system is critical

Analysis

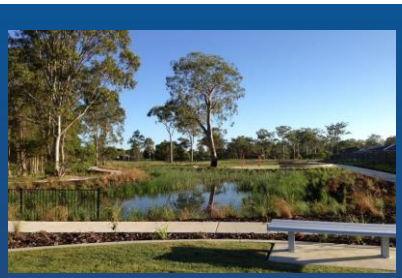
Issues to consider:

- Steady vs unsteady flow
- Complexity of surface hydraulics (1d/2d)
- 'Greenfields' vs 'Brownfields'
- Significance of storage to solution
- Energy loss co-efficients
- Blockage of inlets
- Can the underground system be ignored
- Climate change scenarios
- Temporal pattern ensembles

Iterative process, computer-based analysis now essential (see Chapter 6)

Conveyance Systems - Summary

- Conveyance objectives are:
  - Maximise utilisation of land
  - Minimise nuisance
  - Pedestrian and road safety
  - Manage disasters
- Best achieved through application of a minor/major system approach
- Underground and surface system options. Surface system critical.
- Analysis is complex and iterative therefore computers essential
- Little research and advance in this area since 1987 except for improved software



Thankyou