STORMWATER MANAGEMENT

SOME WHYS AND HOWS

Chris Brooker PrEng

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SPECIALIST ENGINEERS

Introduction

- Why manage stormwater
- Do it right
  - Planning, design, building and maintenance.
- Impacts of urbanisation
- Principles of stormwater management
- Techniques for stormwater management

So Why Manage Stormwater?

To avoid this

or this

or this.

Minimise the total cost!

Do It Right! Planning and Design

Try not to end up with any of these

Do It Right! Building and Maintenance

These can be quite embarrassing

Some Hydrological Effects of Urbanisation

- Increased impervious coverage
- Efficient drainage systems
- Canalisation of water courses
- Soil compaction
- Reduction in the surface area of vegetation cover
- Encroachment into floodways and water courses
- **Hasten runoff**
- **Reduce temporary storage**
- **Reduce infiltration of rainwater into the soil**

Quality Effects of Urbanisation

- Increased point and diffuse pollution sources
- Failure of wastewater drainage systems,
- Poor or non-existent sanitary facilities,
- Poor sanitation practices,
- Littering and poor garbage disposal practices

- **Deterioration of water quality in streams.**

Impacts

- Increased frequency of runoff
- Increased volume and peak discharges
  - Flood and spate flows
- Rapid and extreme variations
  - Flow rates and water temperatures
- Increased sediment runoff and deposition
- Morphological deterioration of water courses
- Deterioration of biological and aesthetic water quality
- Increased debris load in runoff water
- Reduced groundwater recharge

- The urban stream syndrome

Some Consequences

- Increased hazard – drownings increasingly common
- Increased flood risk to existing developments
- Exposure of new developments to flood hazard
- Loss of function or stability of hydraulic structures
  - e.g. undercutting or blocking of bridges
- Threat to dams
  - Sediment build-up and spillway failure
- Blockage and failures in stormwater drainage system.

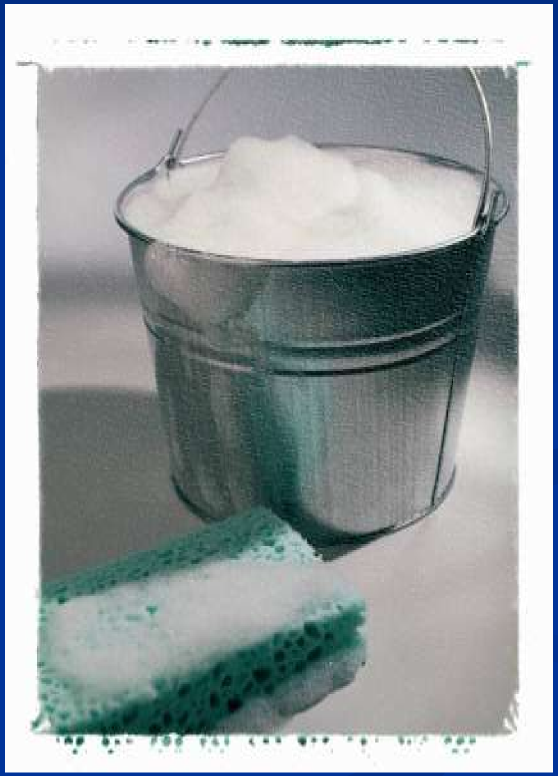
More Consequences

- Loss of recreational amenity of water courses, wetlands and water bodies
  - reduced accessibility (donga formation),
  - aesthetic, and biological deterioration

- Increased public health risks
  - deliberate and inadvertent contact with poor quality water
- Opportunities for antisocial and criminal behaviour
  - reed beds as hiding places for criminals
- **Reduced societal appreciation of water courses and wetlands**
- **Loss of habitat diversity and species diversity**

So what can we do?

- Stick to the principles
- Use SUDS



PRINCIPLES (ASCE)

1. Drainage is a regional phenomenon, it does not respect boundaries
2. Every urban area has two drainage systems whether or not they were specifically designed
3. Runoff routing is a space allocation problem
4. Post development runoff = pre development runoff
5. Do not rely on transferring the problem downstream
6. Urban drainage strategy should be a multipurpose, multimeans effort
7. Storm drainage is a subsystem of the total water resource system
8. System should be designed beginning with the outlet
9. System should receive regular maintenance

SUDS

SQIDS

BMPS

WSUDS

LIDS

SUDS,	Sustainable Urban Drainage Systems
BMPS,	Best Management Practices
WSUDS,	Water Sensitive Urban Designs
LIDS,	Low Impact Drainage Systems
SQIDS,	Stormwater Quality Improvement Devices

WSUDS

- Restore natural processes
  - Infiltration (volume and peak discharge)
  - Evapo-transpiration (volume)
  - Storage (peak discharge)
  - Filtration and sedimentation (quality)
  - Bioremediation (quality)
- Treatment train

  Prevention
  → Source Control
  → Site Control
  → Regional Control
- Address multiple impacts
- Many options

Standards

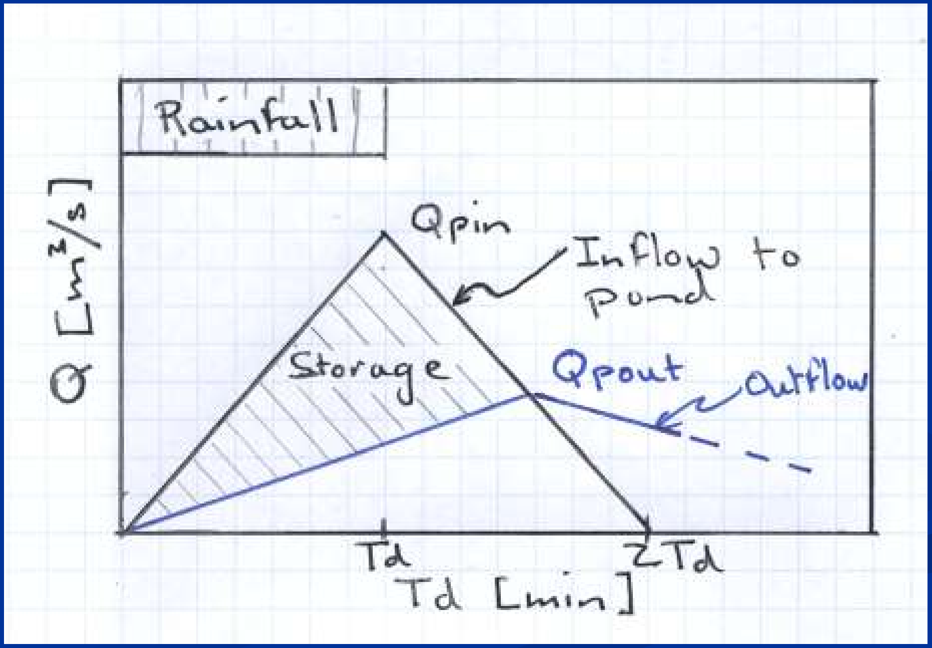
- "Red Book" or Local Authority standards
- Safety standards
  - Velocity and Depth $E_s = h + V^2/2g < 0.5m$
  - Screen inlets
- Local Authority objective eg Q_{post} ☯ Q_{pre}
- Control runoff volume
- Maintain natural groundwater flow
- Maintain or improve runoff water quality
- Provide space for riparian corridor
- Visually and structurally integrate into the built and natural environment
- Implement WSUDS at appropriate scales

Some WSUDS

- Detention Storage
- Rainwater Harvesting
- Roof Storage Flat Roofs and Green Roofs
- Retention basins
- Swales
- Debris Screens and Filters
- Bio-retention, Bio-filtration
- Infiltration basins
- Constructed Wetlands
- Permeable Paving

Detention Storage

- Basis of most municipal SWMP's in SA
- Reduce peak discharge only
- May improve quality by trapping sediment
- Easy to design
- Proven technology
- $Q_{out} = Q_{in} - D_{storage}$



Rainwater Harvesting

- Collection of roof runoff permitted by Water Act
- Rainwater generally potable but:
  - Acid (natural and anthropogenic)
  - Industrial air pollution even remote from source
- Quality depends on catchment
  - Roof runoff generally OK but:
    - Industrial fallout, lead primers, birds etc
  - Catchment contamination a problem
    - Pathogens, fuel spills, sediment

- Yield depends on:
  - Rainfall annual depth, monthly distribution, reliability
  - Catchment runoff (roofs 30% to 90%, ground 15% to 75%)
  - Storage volume (can be calculated using Rippl plot)
  - Demand

Roof Storage: Flat Roofs & Green Roofs

- Flat roofs
  - Detention storage
- Green roofs emulate natural systems
  - Water storage in the soil
  - Hydraulically rough surface
  - Evapo-transpiration
  - Aesthetics
  - Micro-habitats and biodiversity
  - Insulation
- Types defined by accessibility and soil depth
  - Extensive: inaccessible, light, soil 50 mm to 150 mm
  - Semi-intensive: partially accessible, soil 0.1m to 0.2m
  - Intensive: accessible for other uses, soil > 0.15m
  - Elevated landscape: artificial topography, soil > 0.6m

Some Green Roofs

http://www.treehugger.com/galleries/2009/06/green-roofs-are-changing-architecture.php

Retention

- Long term storage
- Infiltration and evapo-transpiration
- Water quality improvement
- Benefits
  - Reduce peak flow and total runoff volume
  - Minimise pollutant flux
  - Stormwater harvesting opportunities
  - Biological diversity
  - Visual diversity

Swales

- Vegetation lined swales
  - Slow flow and increase storage
  - Promote infiltration
  - Trap sediment
  - Enhance visual diversity
  - Improve biological diversity

Debris Screens and Filters

- Debris screens
  - Careful design
  - Regular cleaning required
- Sand Filters
  - Physical filtration removes suspended solids
  - Require pre-treatment
  - Can easily clog
  - Restore by skimming the surface
- Subsurface flow wetlands
  - Physical & biological filtration

Bio-retention and Bio-filtration

- Similar meaning in the literature
- Stormwater stored above and below surface
- Encourage infiltration
- Uptake of nutrients by plants
- Almost any scale
- Can link to drainage system

Infiltration

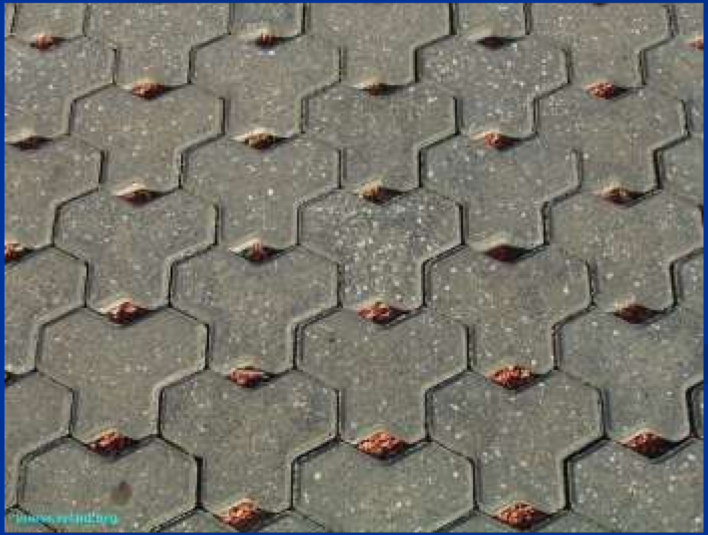
- Reduce runoff volume
- Recharge groundwater
- Enhance visual diversity
- Increase biological diversity
- Any scale domestic to regional
- Require permeable soil
- Be careful – foundation settlement!

Constructed Wetlands

- Emulate natural wetlands
- Easiest if soils impermeable
- Improve water quality
- Reduce runoff volume
- Zoned
  - Sediment trap accessible for maintenance
  - Open water areas
  - Densely vegetated areas
- On line or off channel
- Any scale
  - Rain garden to regional facility

Permeable Paving

- Reduces effective impermeable area
- Reduces peak discharge
- Improves water quality
- Can reduce runoff volume
- Rainwater stored in porous medium under paving
- Outflow:
  - Restricted outlet
  - Infiltration into subgrade
- Careful design
- Requires flat slopes



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