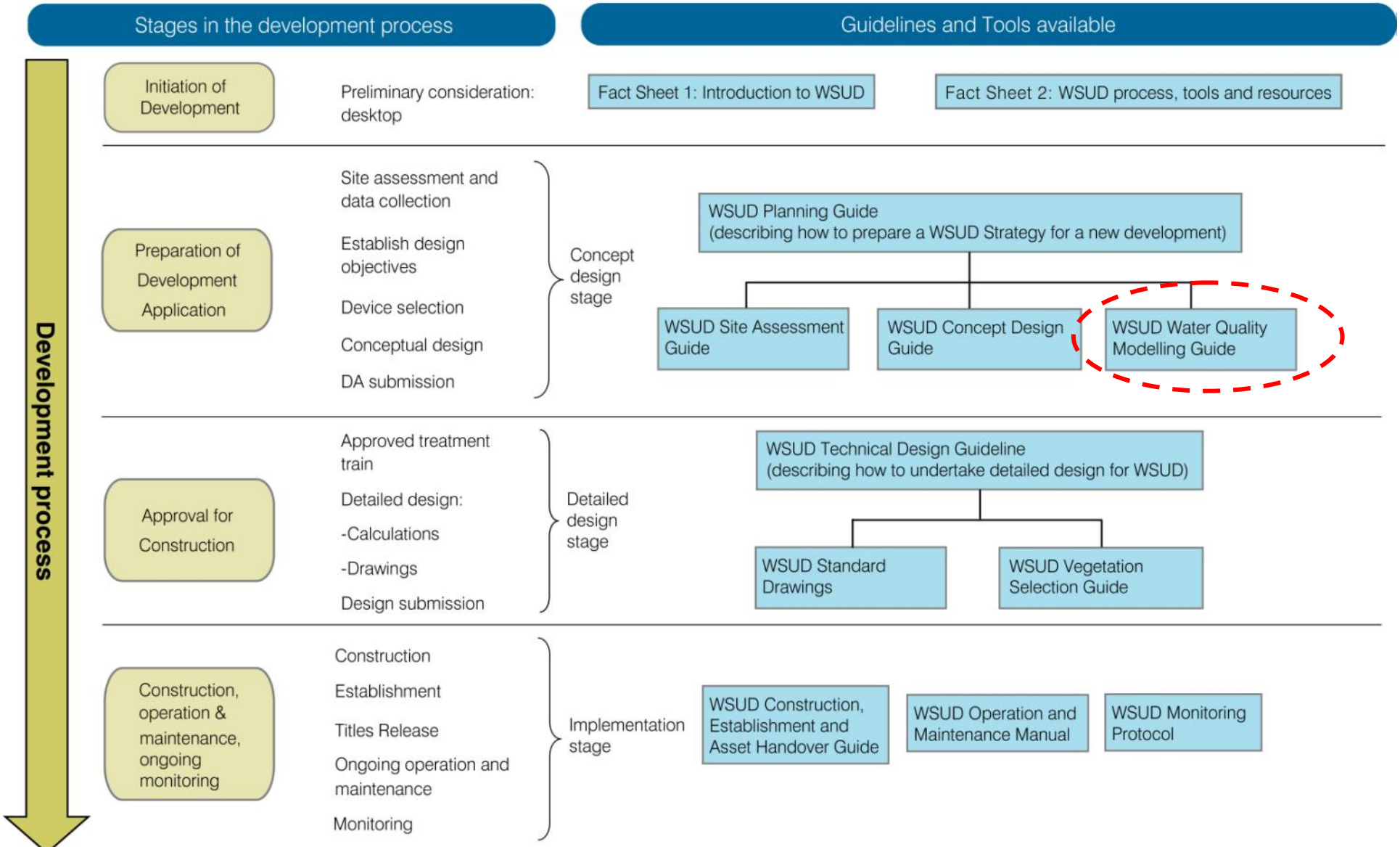

MUSIC Modelling for Darwin

Darwin Harbour WSUD Guidelines and Tools



Need for Stormwater Quality Modelling

1. To predict or determine water quality from a specific catchment (land use)

2. Predict the relative performance of treatment systems

3. Evaluate the performance of treatment systems against specified standards

Benefits of Stormwater Quality Modelling

- Urban catchments include multiple land uses and an extensive drainage network
- Every rainfall event is different
- Stormwater pollutant loads in stormwater are highly non-linear; pollutant loads depend partly on antecedent conditions but are also stochastic in nature
- There are typically a wide range of alternative management options
- Stormwater treatment performance depends on a large number of variables including antecedent rainfall and individual storm patterns

Role of MUSIC

1. MUSIC is a concept design tool that is used for decision support primarily for stormwater management

2. MUSIC assists in the evaluation of concept designs of possible treatment systems

3. MUSIC assists in indicative size and layout of treatment systems

4. MUSIC is NOT a detailed design tool

5. MUSIC does not assist in design of stormwater drainage and has limited application for wastewater systems

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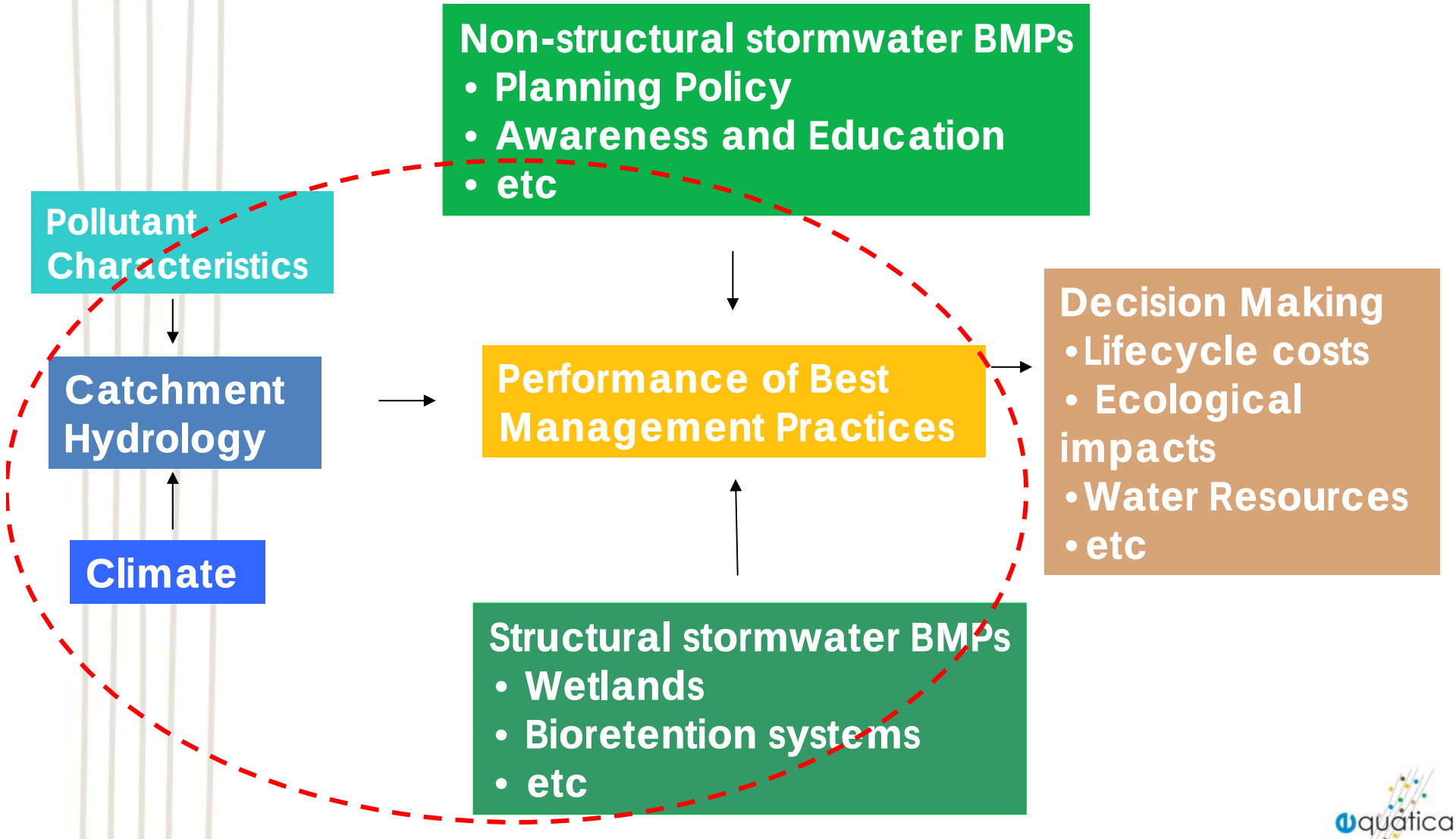
Where does MUSIC Fit?



Modelling Considerations

- **Runoff quality and quantity**
- **Spatial scale**
- **Temporal scale**
- **Data requirements**

What is MUSIC?

MUSIC is a user friendly computer based system that enables users to evaluate the performance and cost of stormwater management options

- flow
- water quality
- lifecycle cost

Can model treatment measures including

- wetlands
- bioretention systems/rain gardens
- infiltration systems
- swales and buffers
- ponds & basins
- stormwater harvesting and reuse (including tanks & to some extent ASR)

What is MUSIC?

- Models urban stormwater flow and quality
- Continuous simulation
- Range of spatial and temporal scales

Music functions through:

- Pollutant Generation Module
- Runoff Generation Module
- Pollutant Removal Module
- Lifecycle costing Module

What is MUSIC Used For ?

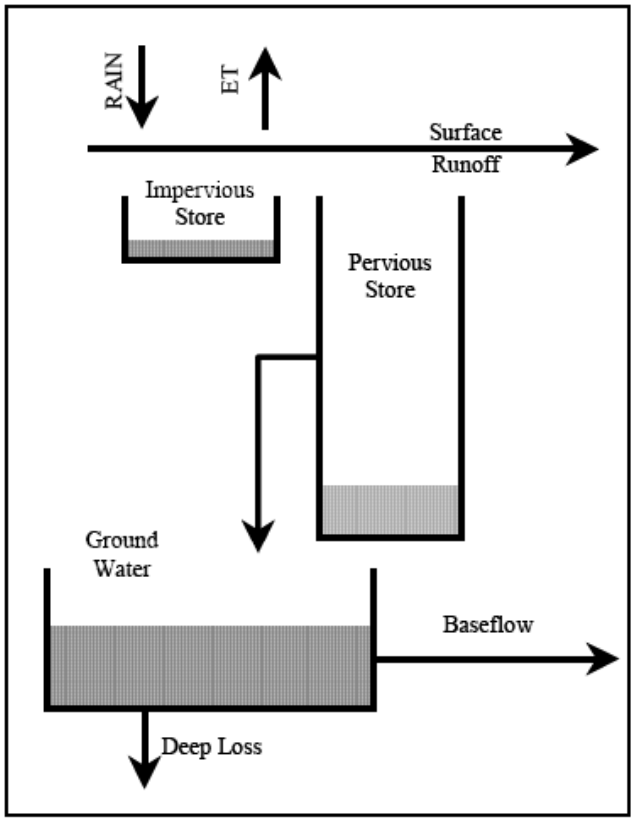
- Stormwater Treatment
- Rainwater Harvesting and Reuse
- Stormwater Harvesting and Reuse
- Catchment Hydrology and Waterway Processes
- Lifecycle Costing
- Catchment Management/Planning

Where to get MUSIC?

Rainfall Runoff Process

MUSIC rainfall runoff model and key parameters

- Rainfall Threshold (mm)
- Soil Capacity (mm)
- Initial Storage (%)
- Field Capacity
- Infiltration Capacity Coefficients
- Initial Depth (mm)
- Daily Recharge Rate (%)
- Daily Baseflow Rate (%)
- Deep Seepage (%)



Runoff Parameters

Parameter	Recommended value
Rainfall Threshold (mm)	1
Soil Capacity (mm)	300
Initial Storage (%)	30
Field Capacity	250
Infiltration Capacity Coefficient a	200
Infiltration Capacity Coefficient b	1
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	5
Deep Seepage (%)	0

Rainfall Runoff Model Notes

- Daily model with disaggregation
- In urban areas runoff dominated by impervious areas
  - Good estimate of catchment impervious important
- Relatively insensitive to pervious areas parameters
- Local Calibration??
- Routing?

Pollutant Generation Process

Stormwater Quality Basics

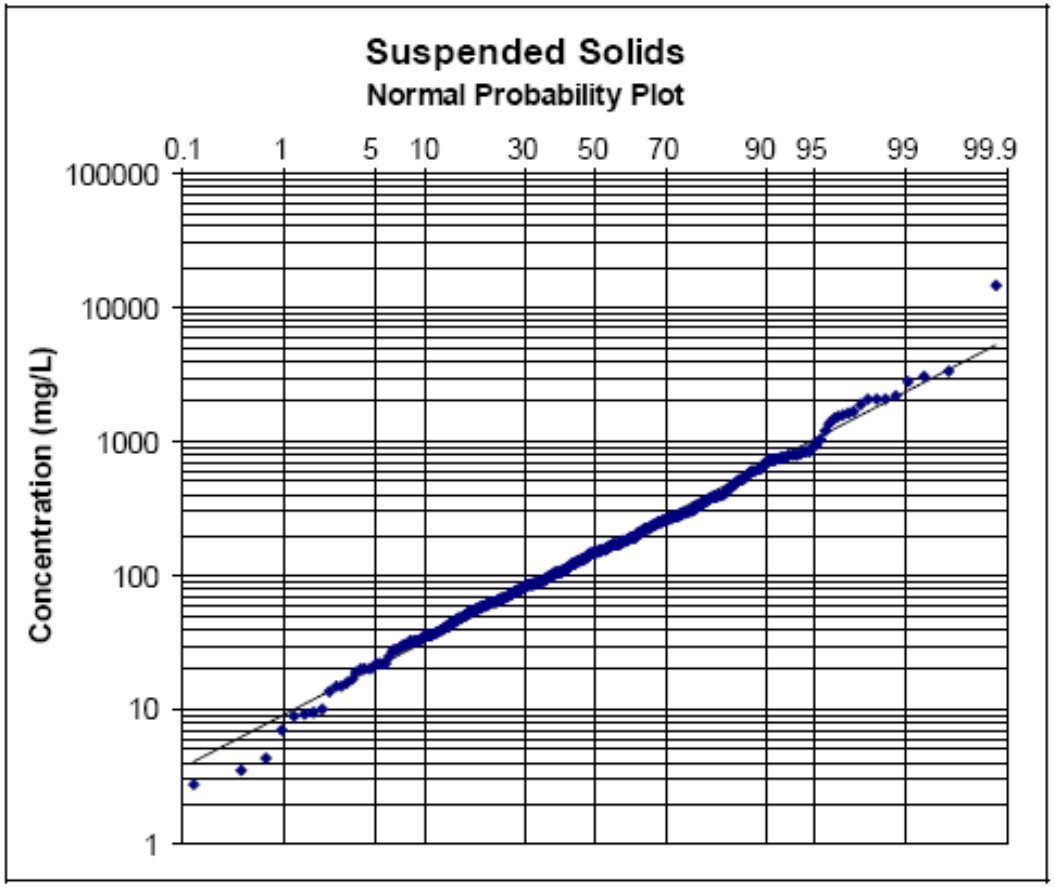


Figure 3.1 Suspended Solids Normal Probability Plot

Stormwater Quality Basics

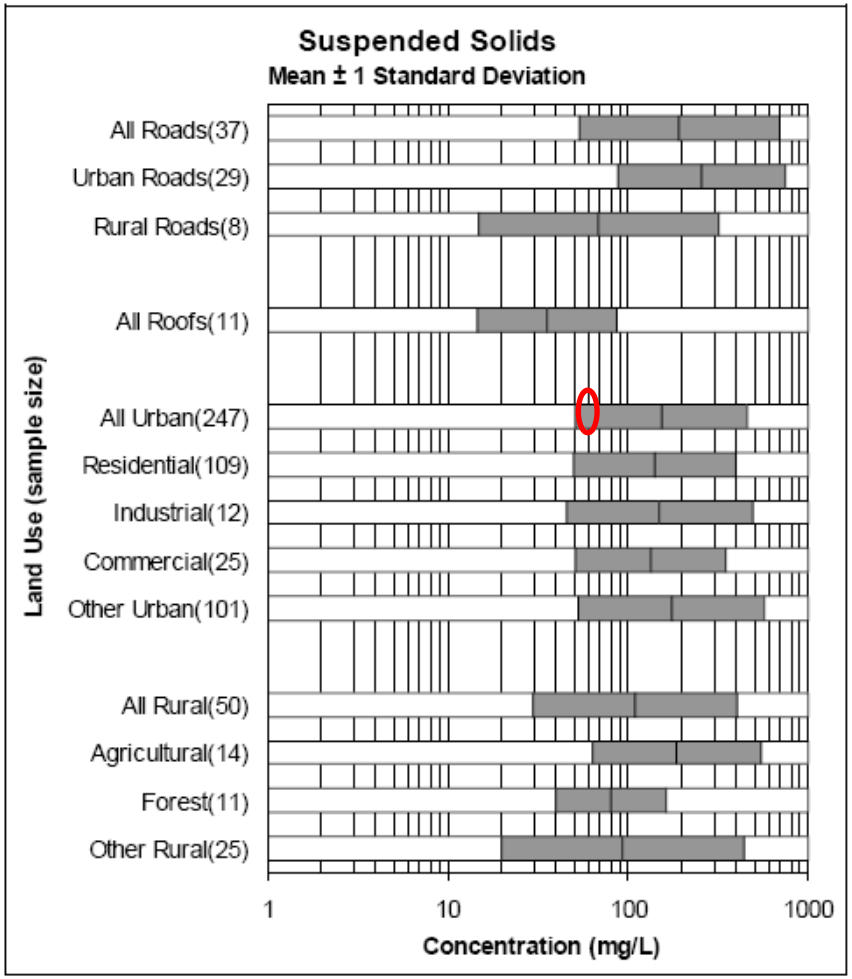


Figure 3.2 Suspended Solids Concentration vs Land Use

Stormwater Quality

- Stormwater quality is stochastic
- Log-normal distribution
- MUSIC creates distributions using means and standard deviation inputs
- Default values have been determined for different land uses

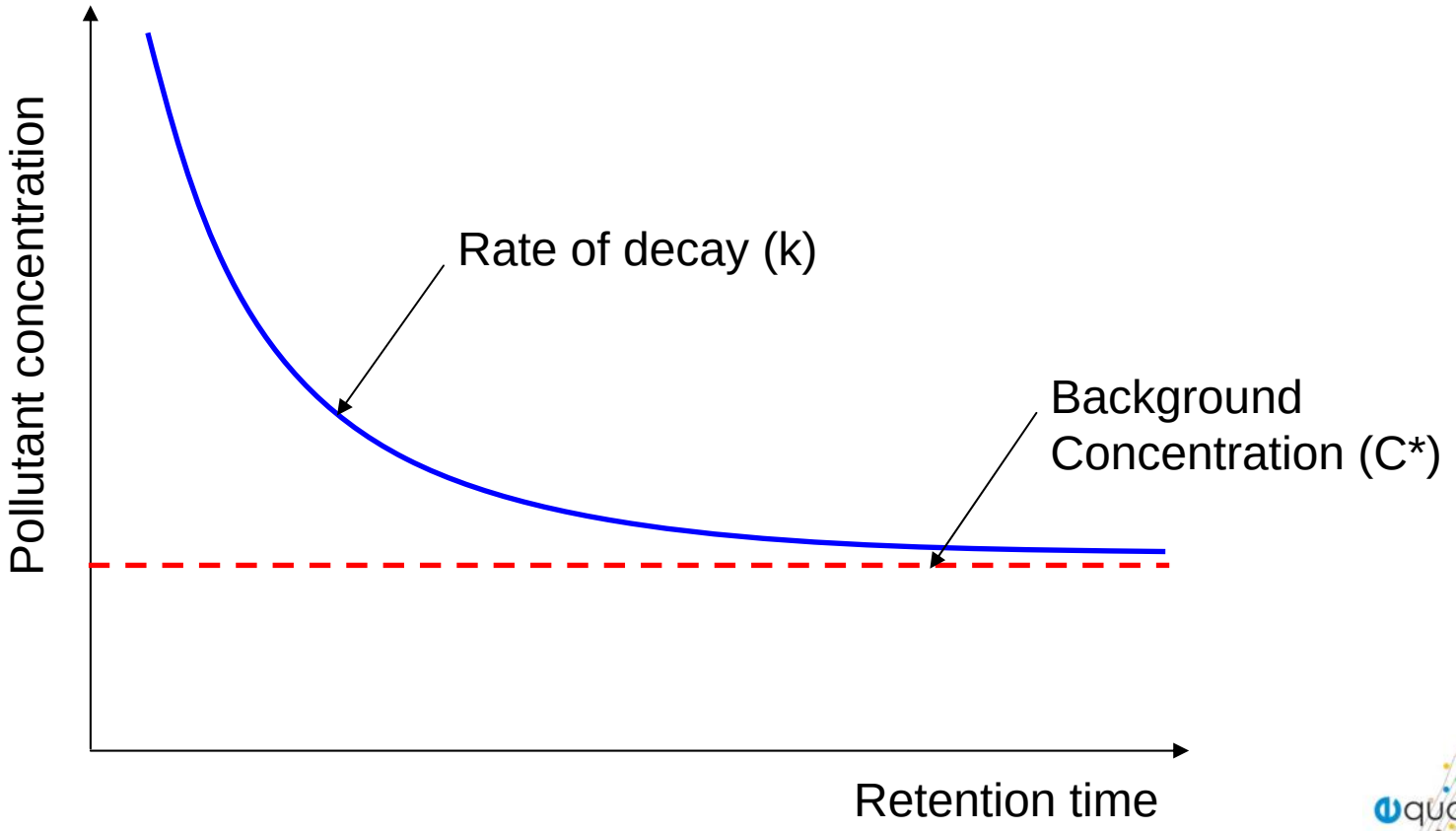
Pollution Generation

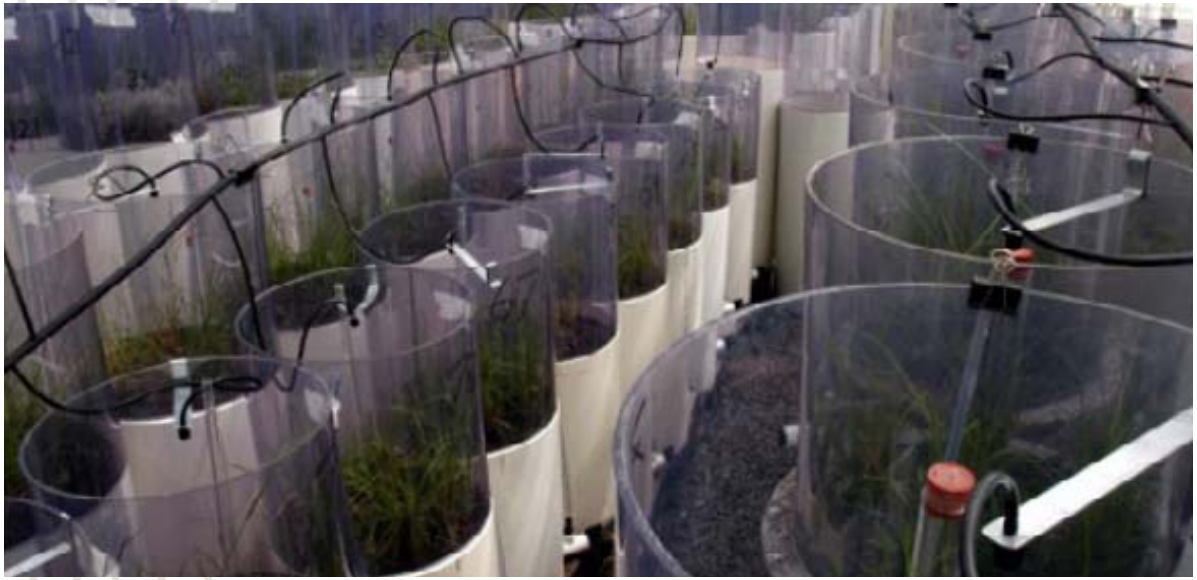
Land-use category		Log10 TSS (mg/L)		Log10 TP (mg/L)		Log10 TN(mg/L)	
		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
Forest	Mean Std Dev	1.90 0.20	0.9 0.13	-1.10 0.22	-1.5 0.13	-0.075 0.24	-0.14 0.13
Agricult-ure	Mean Std Dev	2.30 0.31	1.40 0.13	-0.27 0.30	-0.88 0.13	0.59 0.26	0.074 0.13
Roof Areas	Mean Std Dev	1.55 0.39	1.1 0.17	-0.92 0.29	-0.82 0.19	0.42 0.19	0.32 0.12
Road Reserves	Mean Std Dev	2.38 0.4	1.1 0.17	-0.6 0.5	-0.82 0.19	0.42 0.19	0.32 0.12
General Urban	Mean Std Dev	2.2 0.32	1.1 0.17	-0.45 0.25	-0.82 0.19	0.42 0.19	0.32 0.12

Pollutant Removal Process

Pollutant Removal Model

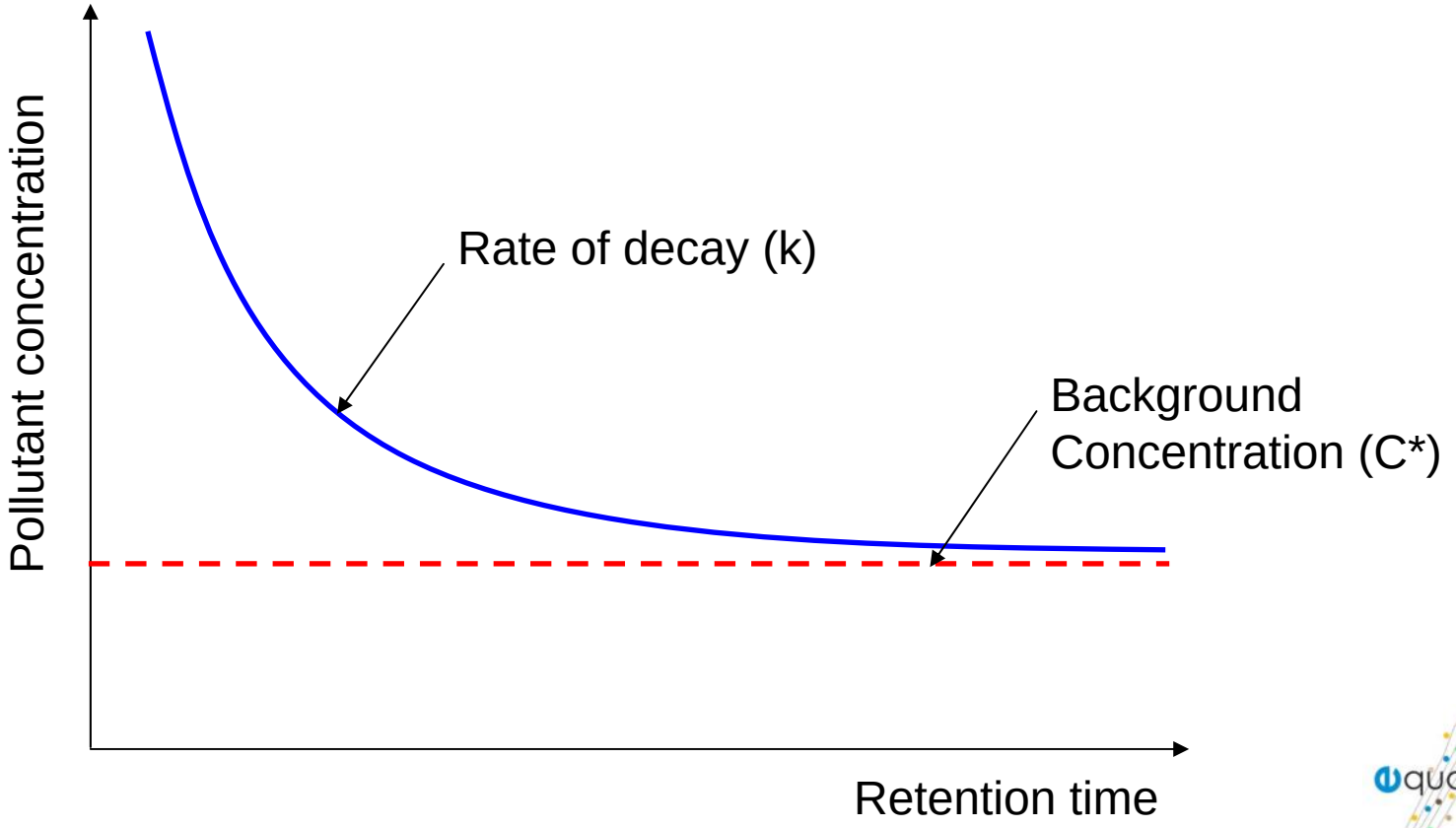
- First order kinetic Model (k-C* Model)
- $(C_{out} - C^*) / (C_{in} - C^*) = e^{-k/q}$





Pollutant Removal Model

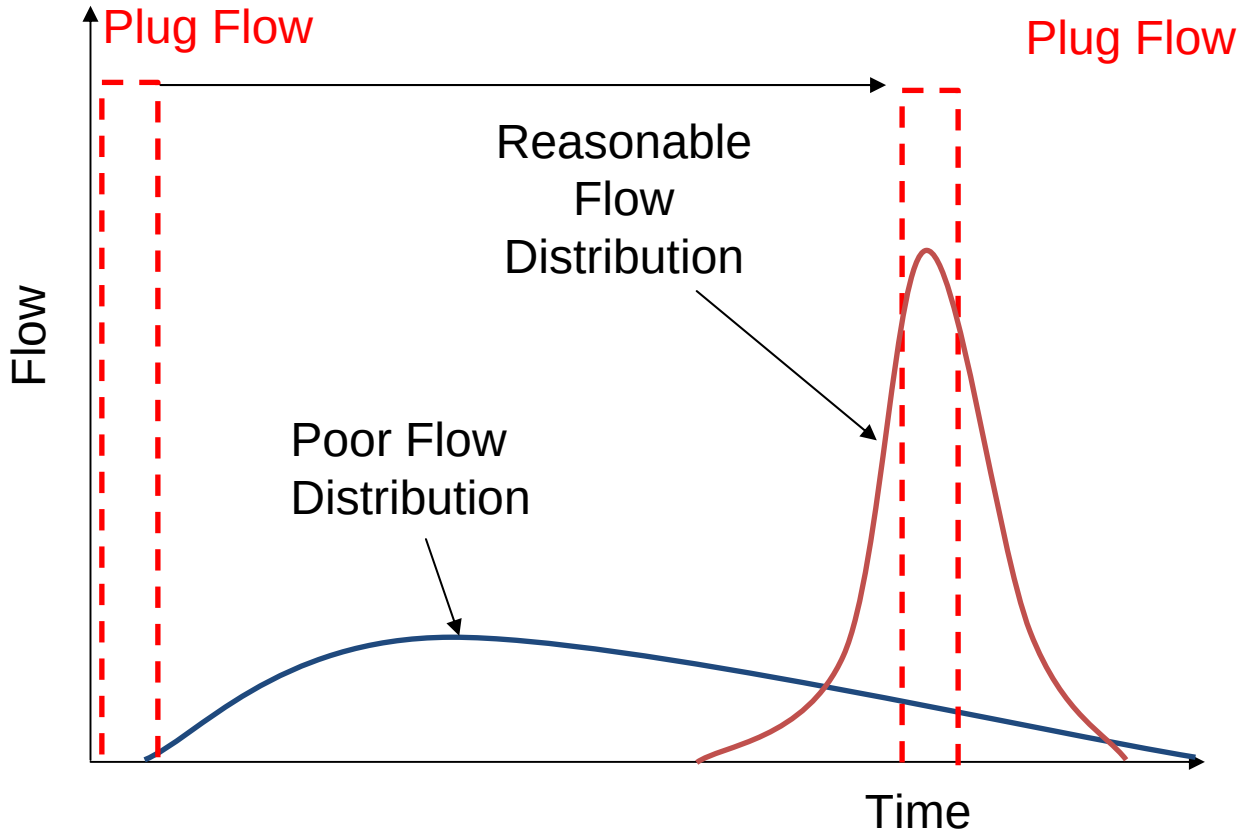
- Dependent on two factors: Areal loading rate and inflow concentration
- $(C_{out} - C^*) / (C_{in} - C^*) = e^{-k/q}$



Continuously Stirred Tank Reactors

- Commonly used in chemical engineering processes
- Assumes that inflow is immediately and completely well mixed with the existing contents

Continuously Stirred Tank Reactors



Continuously Stirred Tank Reactors

- The hydraulic efficiency can be related to the number of CSTRs through this equation
  - Hydraulic Efficiency = $1 - 1/(1- N_{CSTR})$

Life Cycle Costing Module

Lifecycle Costing

- A process to determine the sum of all expenses associated with a product or project including construction, installation, operation, maintenance, discarding and disposal costs
- Identifies all costs over life of system
- Accounts for time value of money
- Discounts costs back to given date (typically today)

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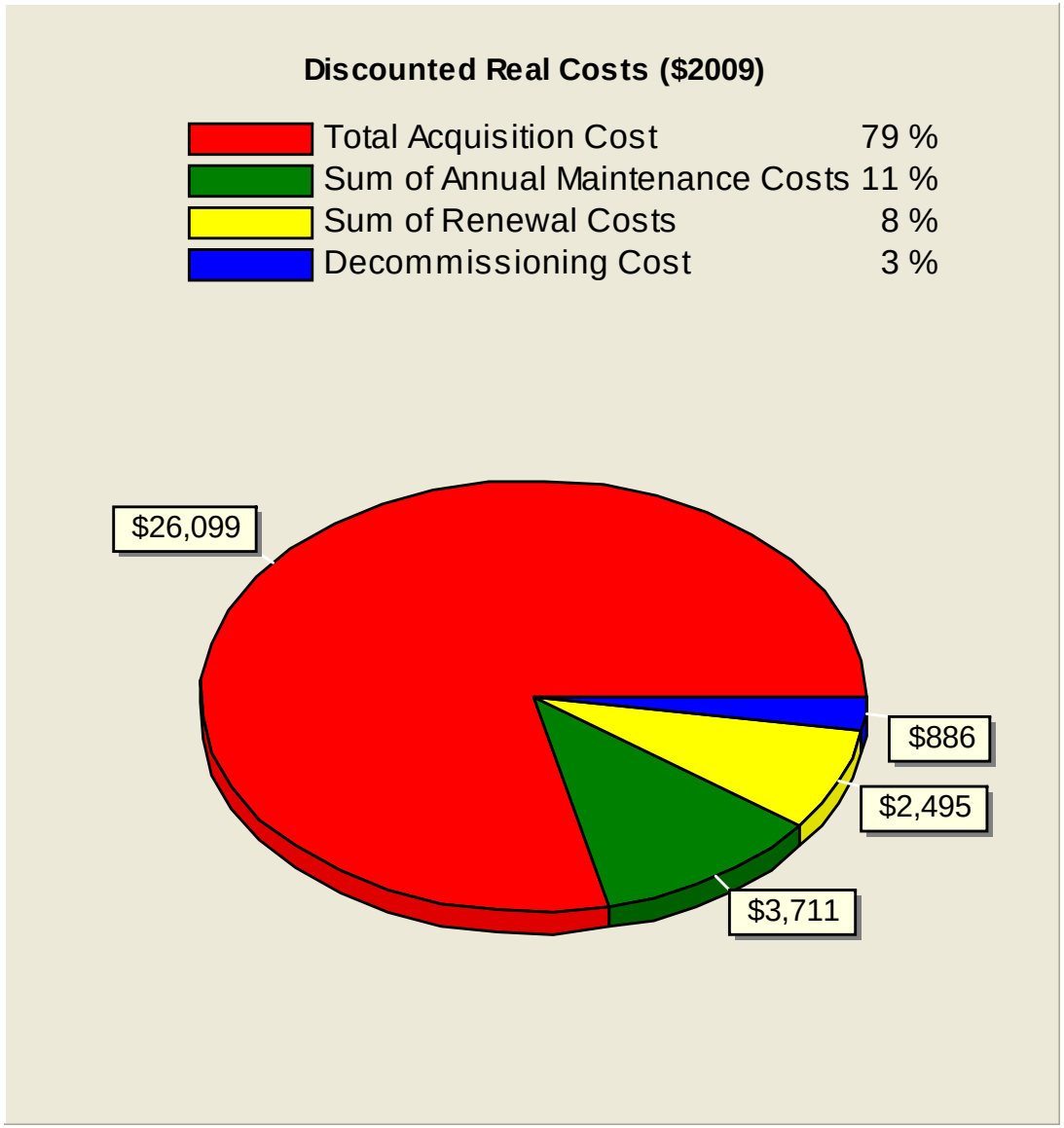
Discounted Real Costs ($2009)
Total Acquisition Cost 79 %
Sum of Annual Maintenance Costs 11 %
Sum of Renewal Costs 8 %
Decommissioning Cost 3 %
$26,099
$886
$2,495
$3,711

Data for LCC Module

- Regression analysis of data collected around Australia
  - 6 states
  - 46 stormwater managers