Monitoring & Evaluation

Photo: Toby Prosser

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Government of Western Australia
Department of Water

Melbourne Water

Why Monitor?

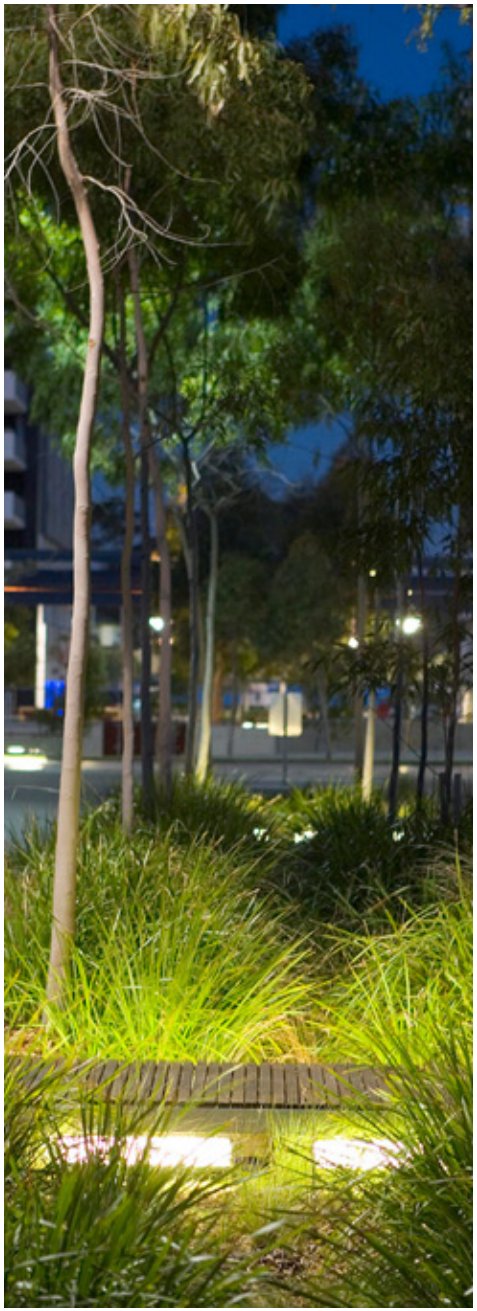
- Demonstrate compliance with legislative requirements or recommended performance targets
  - e.g. “to determine the nitrogen load reduction performance of a biofilter”
- Assess overall and/or long-term performance
- Collect data for model development
- Understand detailed processes
- Improving future design & implementation

Types of Monitoring

Qualitative

Quantitative

- Flow
- Water Quality



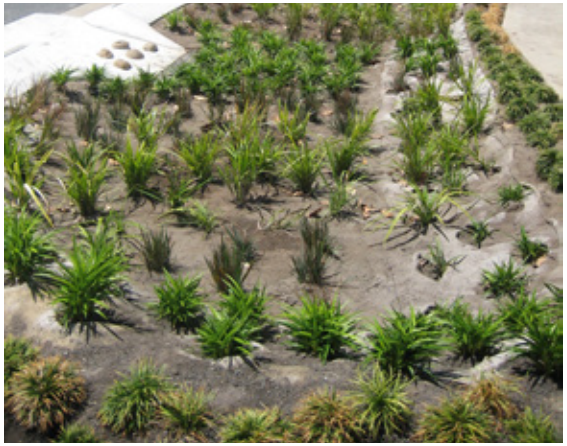
Qualitative Monitoring

Parameter	Indicator of	Possible Cause
Plant health	Too much water	Undersizing
		Water logging
	Too little water	Oversizing
		Inlet level wrong
	Poor flow control	High inflow velocities
		Inadequate high flow bypass
Erosion	Poor flow control	High inflow velocities
		Inadequate high flow bypass
Sediment build-up	Clogging	High sediment loads
		Undersizing
		Inadequate pre-treatment

Qualitative Monitoring

What to look for:



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Steps in designing a quantitative monitoring program

1. Set objectives and applications
2. Select monitoring point(s)
3. Select equipment
4. Identify flow and water quality parameters
5. Determine frequency and duration of the monitoring program
6. **Data storage and analysis**

Setting monitoring program objectives

Why?

- Monitoring quickly becomes resource intensive!!
- Different aims have different data requirements

Objectives that are clear, concise, specific, measurable, realistic, precise, result-oriented

Consequences of having inadequate objectives:

- Basically, wasting a whole lot of time and money!
- Risk of giving a negative result
- Unfortunately, a common problem

Clear objectives are critical!!

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How many samples should I take?

- How much $$$ do you have?
- How certain do you want to be?
  - What’s your objective?

- Sub-daily, daily, weekly, event-based
- Wet vs. dry seasons, summer vs. winter

How do I ensure my data are representative?

Event Mean Concentration (EMC)

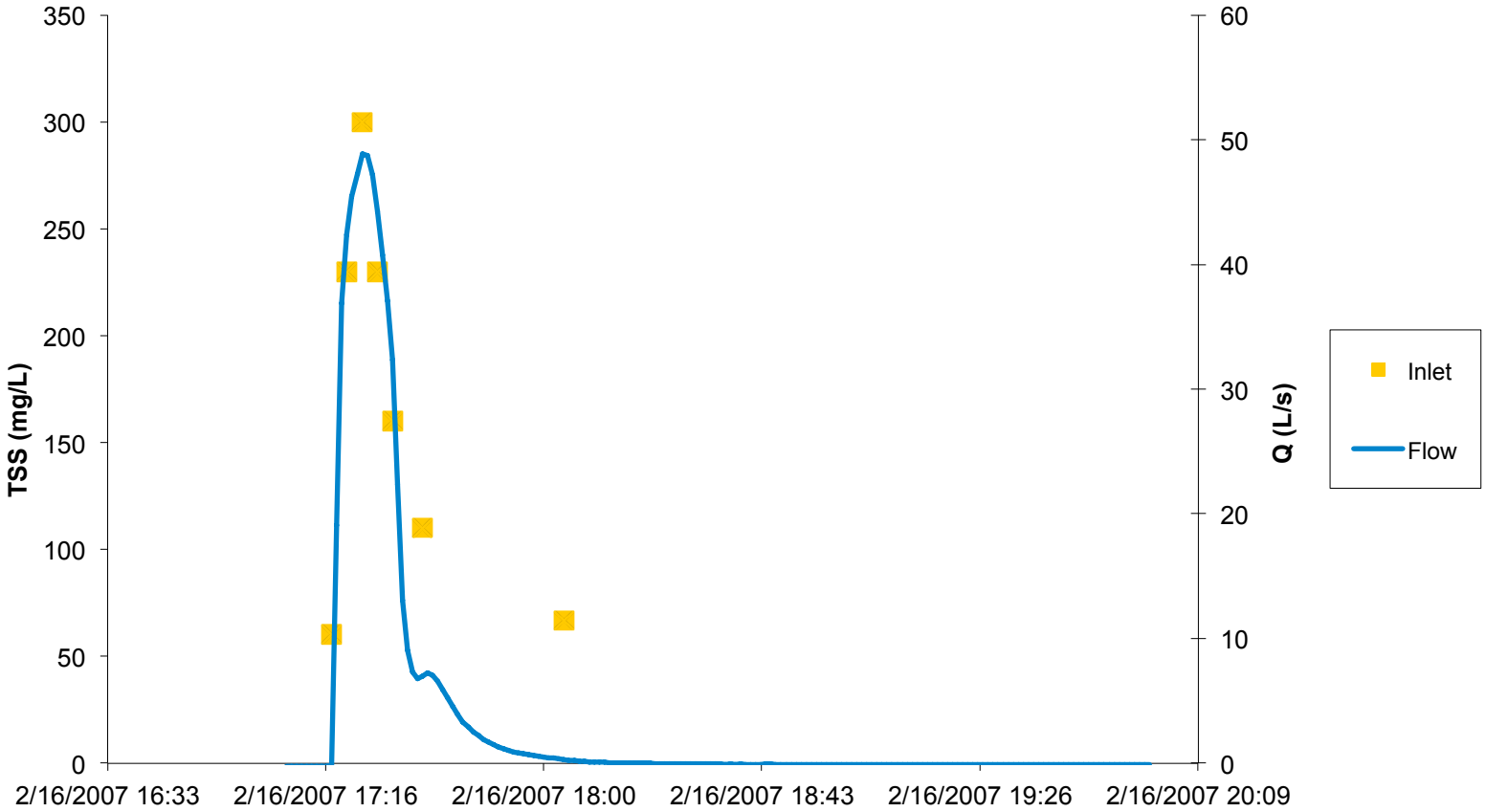
$$EMC = \text{total pollutant loading per event} / \text{total runoff volume per event} = \sum_{i=1}^{n} v_i c_i / v$$

where: v_i = volume at time i (L)

c_i = concentration at time i (mg/L)

v = total volume (L)

How do I ensure my data are representative?



Need to sample the entire hydrograph

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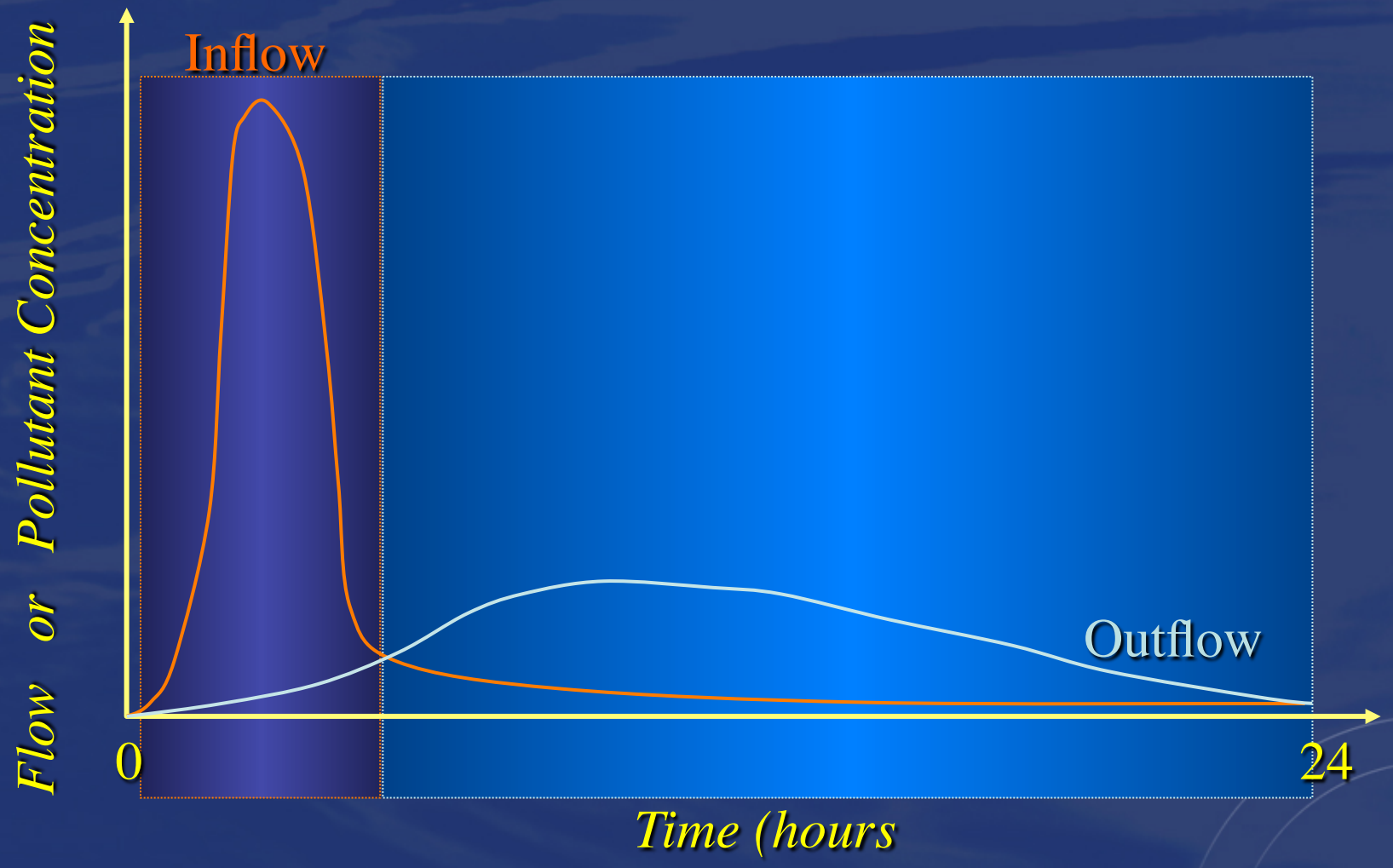
Effect of Storage and timing



How much will it cost?

Infrastructure:

- Approximately $15,000 per sample site, including flow monitoring
- Can be hired on a monthly basis
- Need to pay attention to security (vandalism)
- Needs to be installed and operated by experts!

Decisions about sampling regime:

- Uniform
- Flow-weighted
- Discrete (to determine the range of concentrations experienced by downstream waterway) or composite sample (to quantify loads)
- “time sitting” for species

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How much will it cost?

Laboratory analysis of samples:

- TSS = $10-20
- TP = $25-40 (if done with TN)
- TN = $25-40 (if done with TP)
- Suite of metals = $50-150 ($70 +10n)
- PAHs / TPH = $90-150 / $50-150
- BOD = $20-30
- PSD = $100-180

Example 1 – Monitor expected concentrations

Want to characterise the storm flow concentrations of TSS, TP and TN

<u>For a single sampling point</u>

- 20 events
- **24 samples per event**
- TSS = 20 x 24 x $12 = $5,760
- TP = 20 x 24 x $25 = $12,000
- TN = 20 x 24 x $25 = $12,000
- Autosampler setup = $15,000
- Total cost = $ 44,760

Example 2 – Monitor expected event load (flow-weighted composite)

Want to quantify the storm flow load (so can use composite samples to establish an event mean concentration) of TSS, TP and TN

- 20 events
- 24 samples per event, ***but composited to a single sample***
- TSS = 20 x 1* x $12 = $240
- TP = 20 x 1* x $25 = $500
- TN = 20 x 1* x $25 = $500
- Autosampler setup = $15000
- **Total cost = $ 16240 <u>per monitoring point</u>**

** composited from 24 flow-weighted samples*

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What else could I monitor?

Hydraulic conductivity

- Measure *in situ* using single ring test

OR

- Collect sample for laboratory analysis

OR

- Simply use an Odyssey depth probe

Accumulation of heavy metals

- Occurs primarily in surface layers
- Sampling frequency: ~5 years

=> Higher frequency required for undersized systems or for biofilters in industrial areas

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Benchmarks for performance assessment

Flow

- Runoff volume and frequency relative to pre-development

Water quality

- Load reductions
- Outflow pollutant concentrations

Hydraulic conductivity

- Relative to design value

Accumulation of heavy metals

- Soil quality guidelines (ecological and human health)
- Criteria for prescribed waste

Designing biofilters with quantitative monitoring in mind

Likely monitoring points:

- Inflow
- Outflow
- Overflow
- Water depth (both ponding and in media)
- High flow bypass
- Submerged zone

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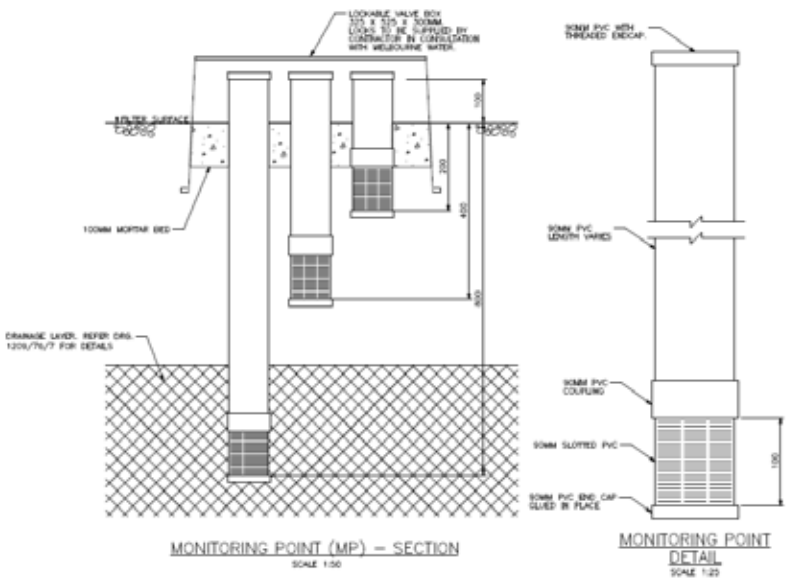
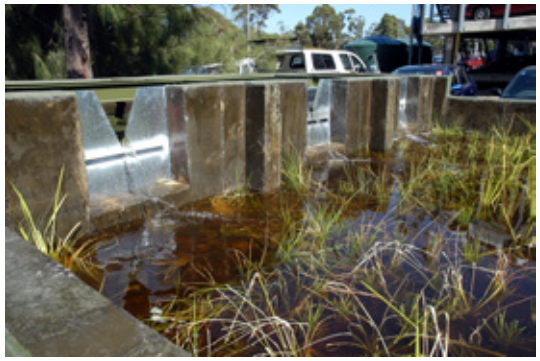
Designing biofilters with quantitative monitoring in mind

Possible Infrastructure:

- Flow – pipes, flumes, weirs
- Water level – monitoring wells
- Perspex wells for endoscopes






Bobcat
weird & couch
yankovic potato

QUESTIONS?