Road Controlling
AUTHORITIES FORUM
Road Controlling Authorities Forum (New Zealand) Incorporated

with assistance from

New Zealand Water and Wastes Association

*presents*

# Managing Stormwater and Road Run-off Tools, Techniques and Devices

nzwwa

New Zealand Water & Wastes Association

Waiora Aotearoa

# Techniques, tool and devices: what works, where, and how?


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Landcare Research
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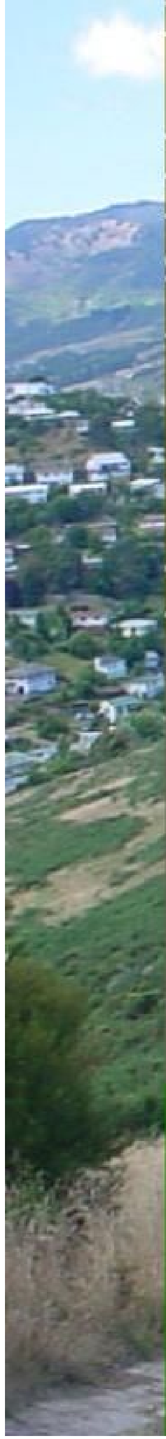
# Bioretention: stripping contaminants from road runoff & mitigating runoff volume

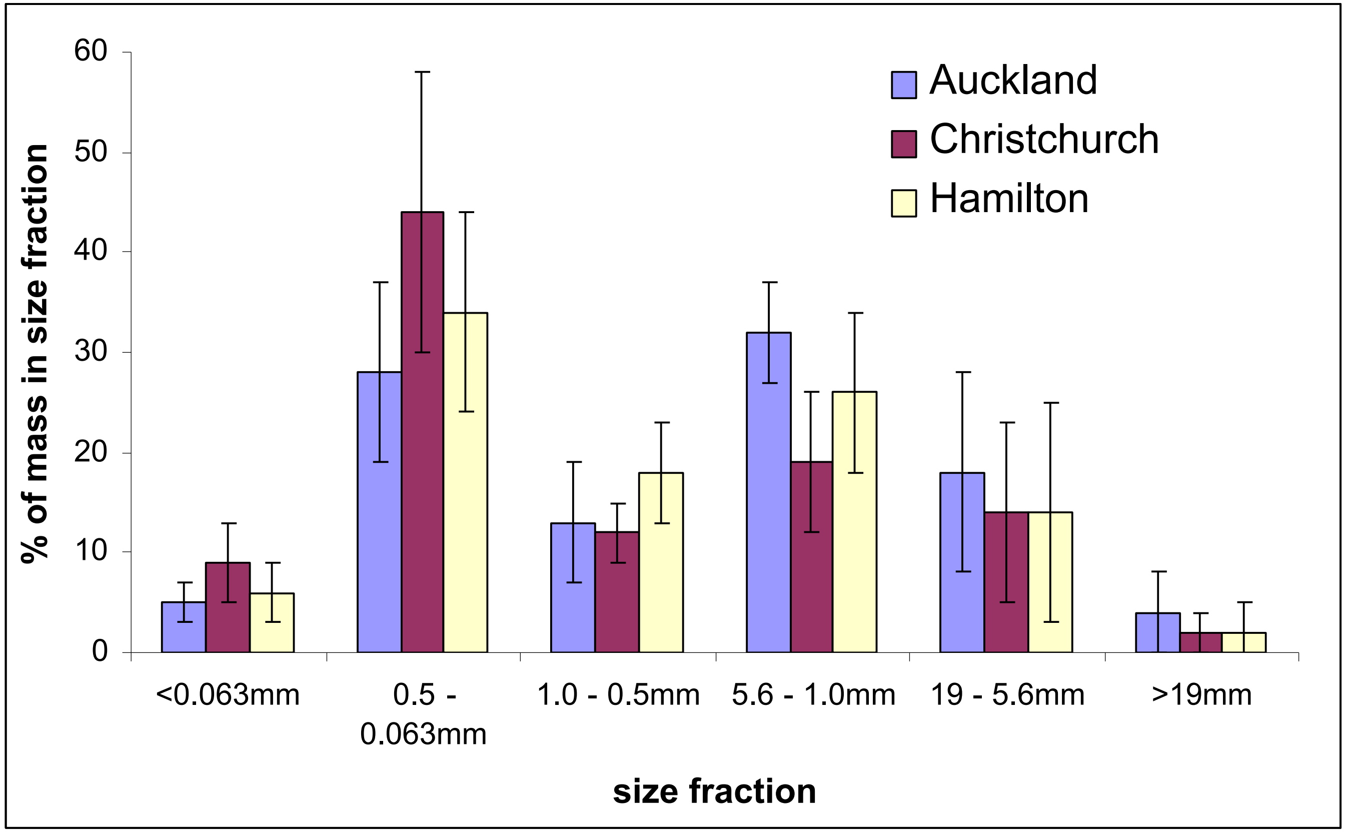


# Outline

- Road runoff sediment & metal loads
- How to reduce pollutant load & volume
- Biofiltration
  - Swales
  - Raingardens
- Case studies: carpark treatment trains
- Implementation issues

# Road runoff: sediment size

- Catchpits & road sweepings have similar particle size, 30 to 50% <0.5 mm
- Total road dust is finer, c.70% <0.5 mm



# Fine particles (<0.25 mm) are usually more toxic (& harder to remove)

| Particle size | Total metal concentration mg/kg | | |
|---|---|---|---|
| | Cu | Zn | Pb |
| 0 - 63 microns (clay) | 189 | 1889 | 319 |
| 63 -125 microns (silt) | 212 | 1628 | 334 |
| 125 - 250 microns | 184 | 1073 | 251 |
| 0.25 – 0.5 mm | 85 | 507 | 193 |
| 0.5 - 1mm | 26 | 268 | 323 |
| 1 - 2 mm | 21 | 226 | 36 |
| Whole sample | 124 | 962 | 249 |

# Zinc is the key contaminant in most urban catchpits & road sweepings

| Standard | Copper mg/kg | Nickel mg/kg | Lead mg/kg | Zinc mg/kg |
|---|---|---|---|---|
| Class A landfill criteria | 100 | 200 | 100 | 200 |
| Class B landfill criteria | 10 | 20 | 10 | 20 |
| Biosolids grade A | 100 | 60 | 300 | 300 |
| Background Soil Median | 27 | 12 | | 63 |
| Range | 1 to 76, | 4 to 320 | 20 | 7 to 97 |
| Catchpits Median | 85 | 22 | 133 | 464 |
| Road sweepings Median | 55 | 24 | 117 | 336 |

# Efficiency of removal depends on particle size & device maintenance

NIWA Study (Timperly et al. 2003)

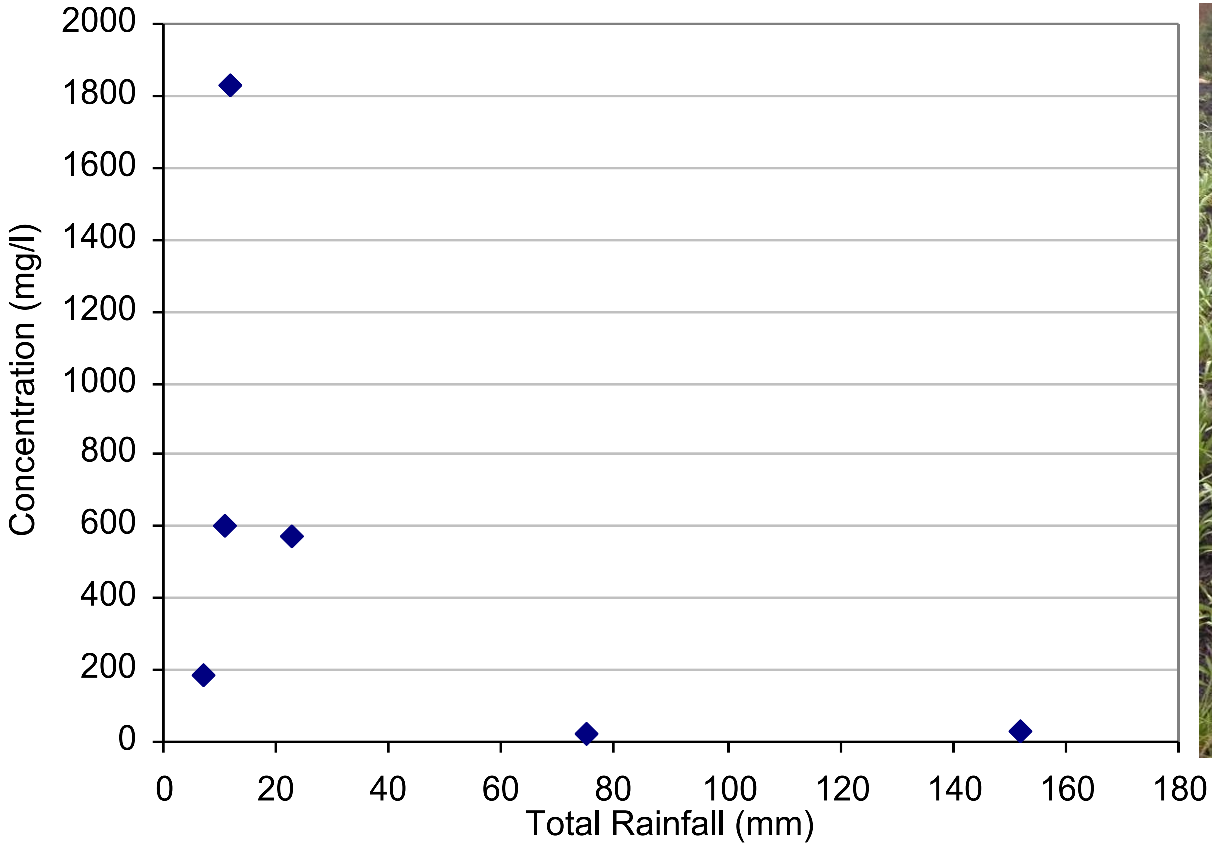

- Clean catchpits retain 65% of 0.1 to 0.5 mm diameter sediment

  BUT

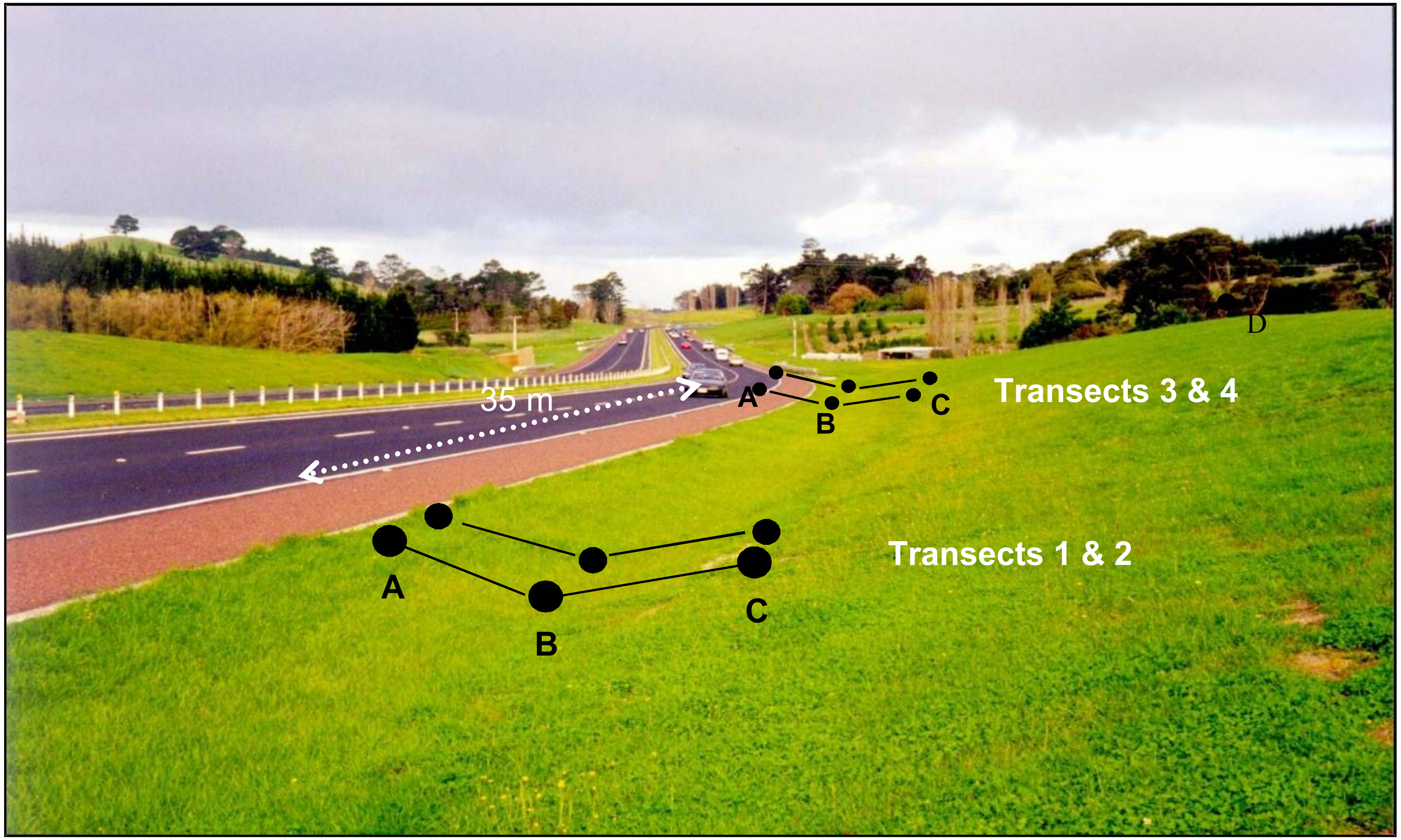
- This reduces to c. 30% for catchpits partially full of sediment

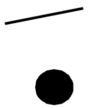
Filtration devices remove smaller particles as long as sediment doesn't block the surface, preventing infiltration

# **GOOD NEWS**: TSS in road runoff often decreases as rainfall increases → benefit in treating small events & first flush




# Silverdale Motorway swale sampling

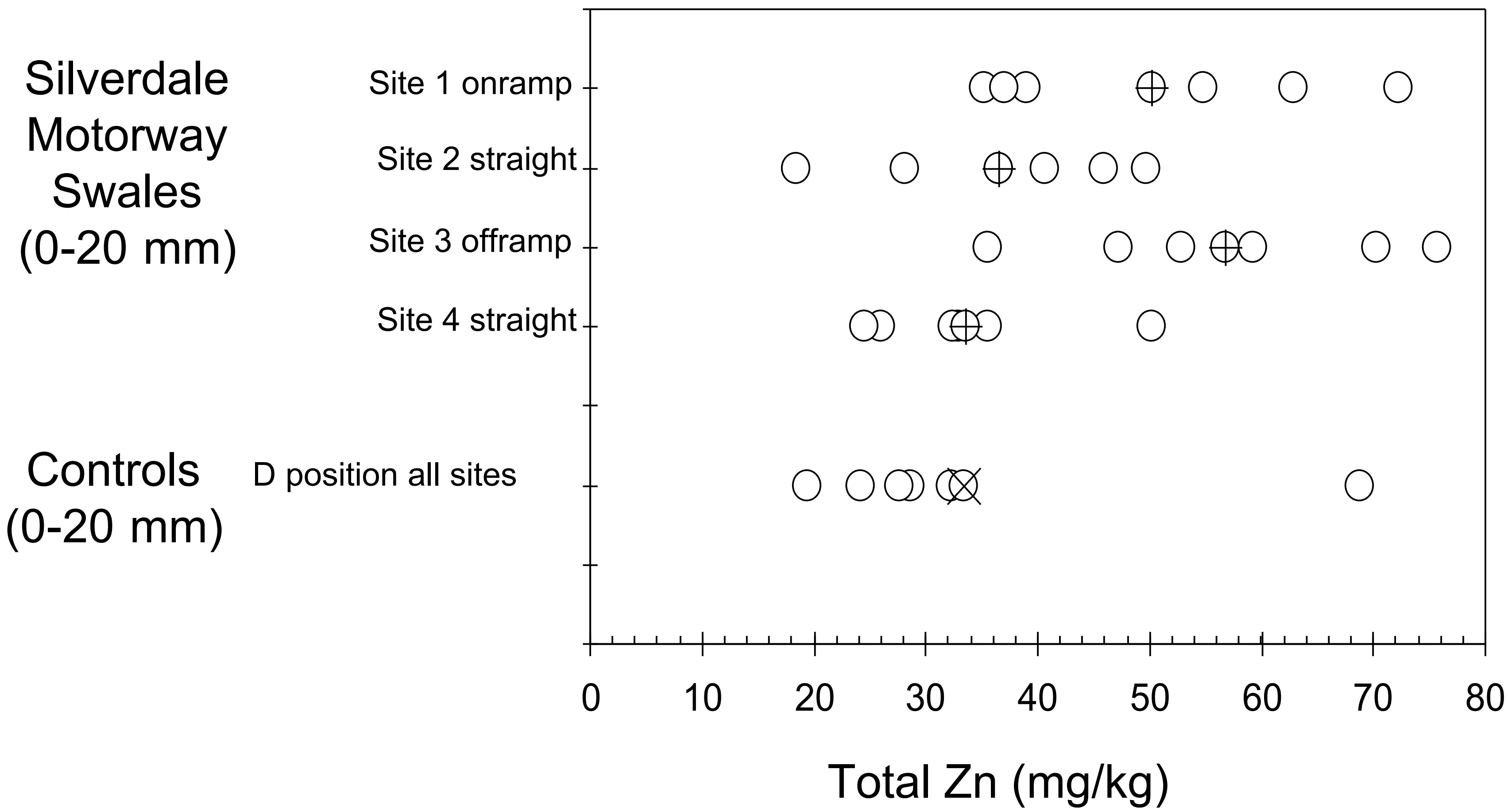


Transect across the swale, 8.7 m from A to C

Sample location for 2 bulked samples 1 m apart

# Hotspots: on-off ramps



# Good news: large improvements possible by treating high risk sites

- Roads >c.10,000 vehicles/day
- Areas with high tyre wear - roundabouts, on/off ramps, heavy braking areas
- Areas prone to spills – roundabouts, near loading areas, stock crossings
- Areas with sensitive receiving environments
  - cold, clean, small streams (hot runoff)
  - estuaries & food gathering waters
  - soft-sided, incised streams (erodible)

# Ways to reduce pollutant loads

- Reduce source area (bioretention requires only 2 to 5% of road area for Auckland)
- Reduce inputs (Zn in tyres, Pb wheel balances)
- Reduce runoff volume (promote infiltration)
- Reduce pollutant concentrations – usually targeting TSS

# Reduce source area

# Reduce source area

# Reduced road widths used for raingardens and slowing traffic in residential areas

# Treating road runoff using biofiltration

Research programme (since c.2002):

- Ability of variety of substrates to remove dissolved metals & achieve permeability
- Started with lab column leaching tests
- Constructed, then monitored field trials
- Surveyed ‘commercial’ installations for implementation & maintenance issues

# Treatment walls & biofiltration

- Physically filter runoff
- Add chemical removal by adsorption… effectively ‘smart’ sand filters
- Plants in biofiltration devices increase removal (espec N), maintain permeability & enhance moisture loss
- Plants can add value by looking great, capturing dust, reducing glare & noise and providing a frangible landing place.

# Biofiltration: permeable paving, swales, raingardens, infiltration areas

# Biofiltration: swales & raingardens

# Bioretention: key features

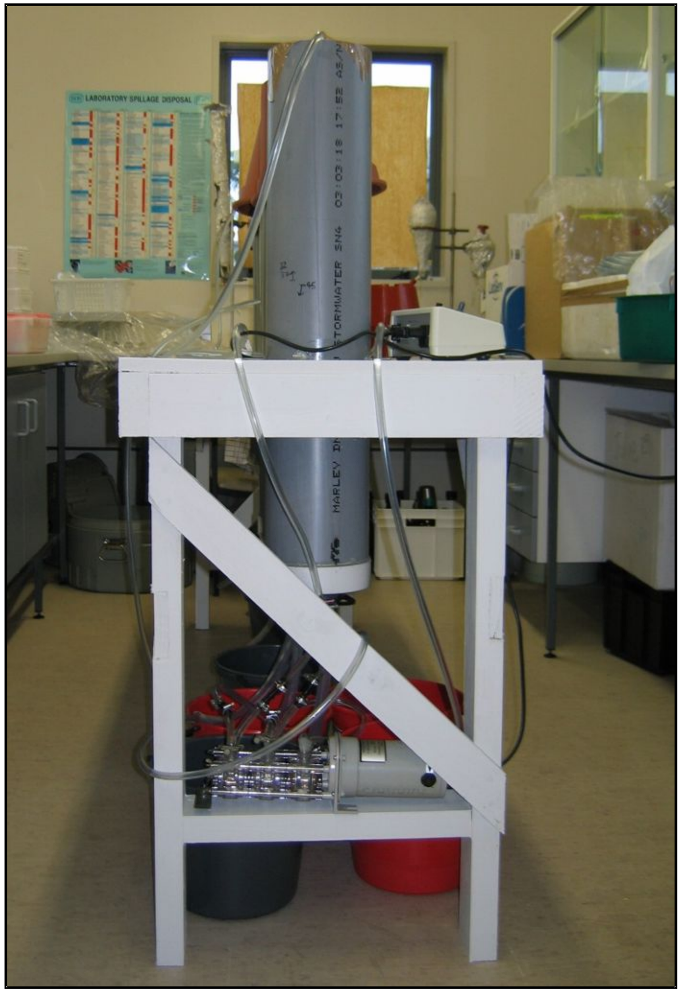
- Moderate to rapid permeability (100 to 500 mm/hour), plants resist clogging
- Remove dissolved metals & PAHs
- Forebay removes coarse TSS
- Detain runoff, lower peak runoff, may reduce runoff volume
- Support plants (moisture, pH, nutrients)

# Bioretention

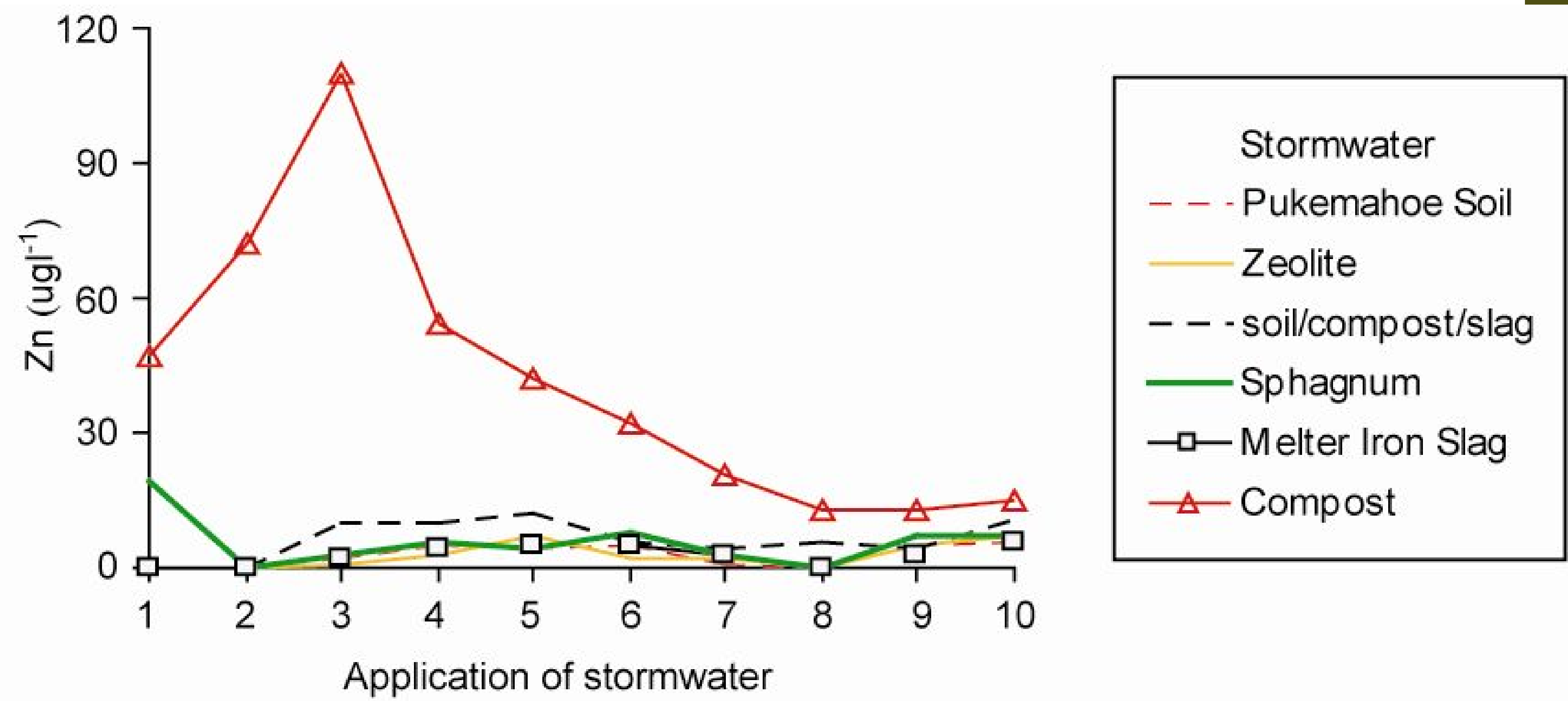
# Retention area used as public space

# Substrates tested

- Organic materials : peat, sphagnum, sawdust, bark, composts, kiln ash
- Inorganic materials: zeolite, steel slag, pumice, scoria, limestone, kiln ash, beach sands
- Natural soils: Granular, amended Ultic, Allophanic, Recent, Pumice



# Typical results: Zinc



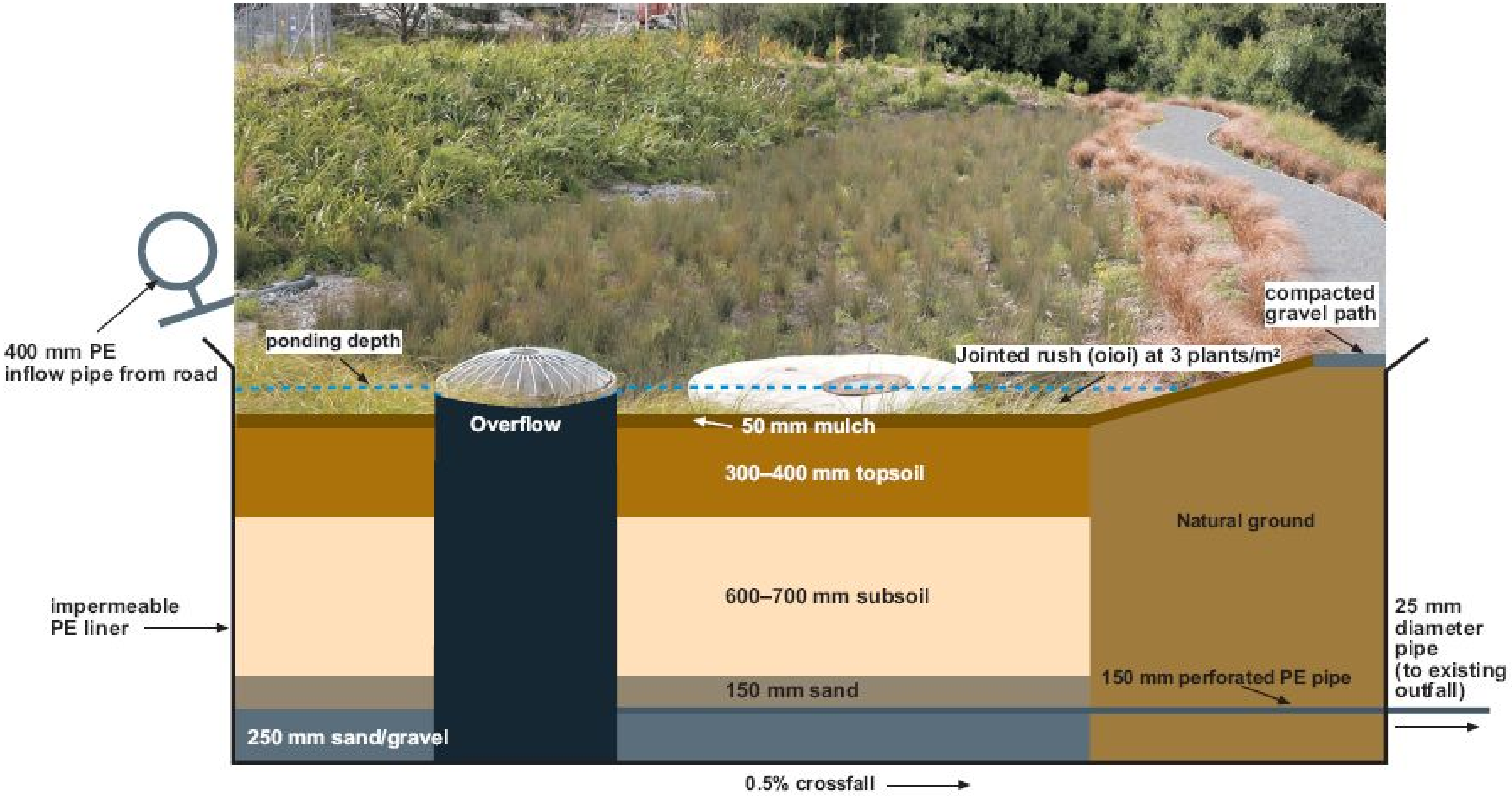
# Conclusions from lab tests

- All media produced leachate with acceptable pH range
- Mixes with wood ash, lime, iron slag, Granular Soil, sphagnum and zeolite reduced Zn to detection levels
- Green compost mixes released Cu and N, especially in the first few irrigations
- Soils should be tested for N and P
- Sand filters can be made smarter by adding some of these materials if permeability is maintained

# Treatment wall conclusions: 4 field sites monitored12 to 39 months

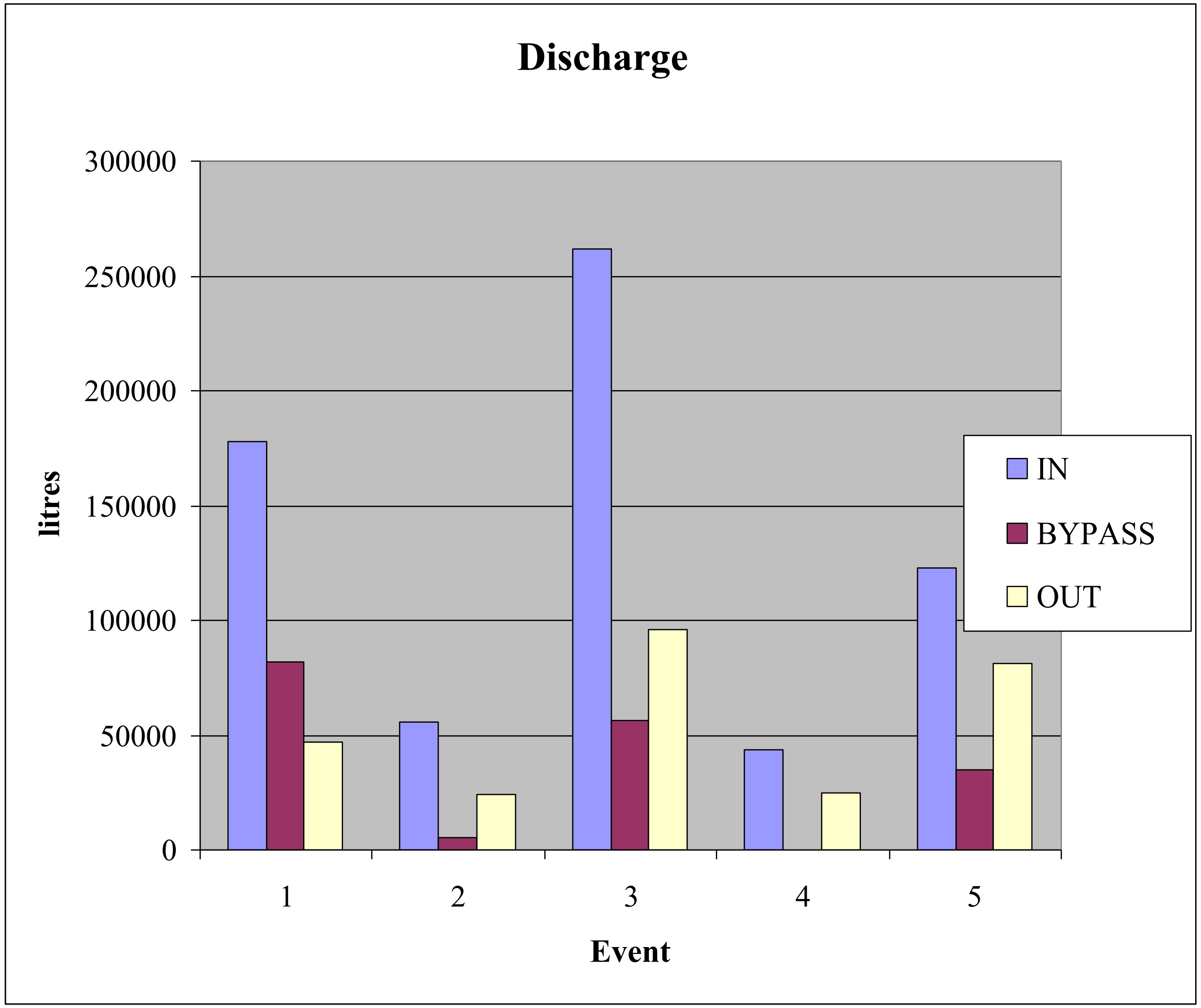
- Wide variation in nature of runoff (TSS, pH, nutrients and metal concentrations)
- Zinc the most mobile contaminant
- Truck spills at Cambridge & Tauranga mitigated (TSS, pH and P)
- Effectiveness requires regular removal sediment to maintain permeability
- Effectiveness higher than sand filters with longer time to ‘breakthrough‘

# Bioretention field trial

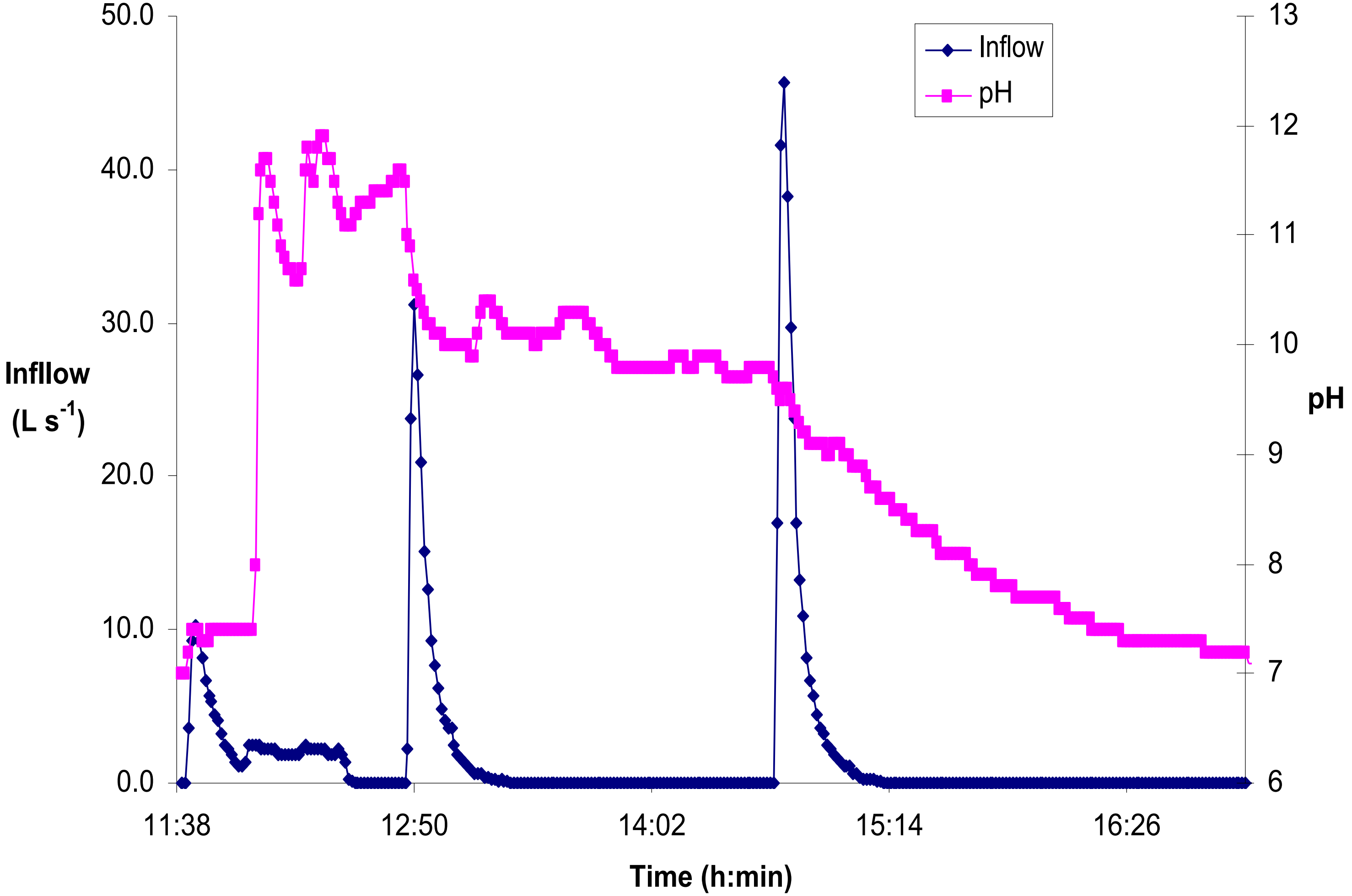


# Getting runoff for trials in dry areas: our latest stormwater machinery

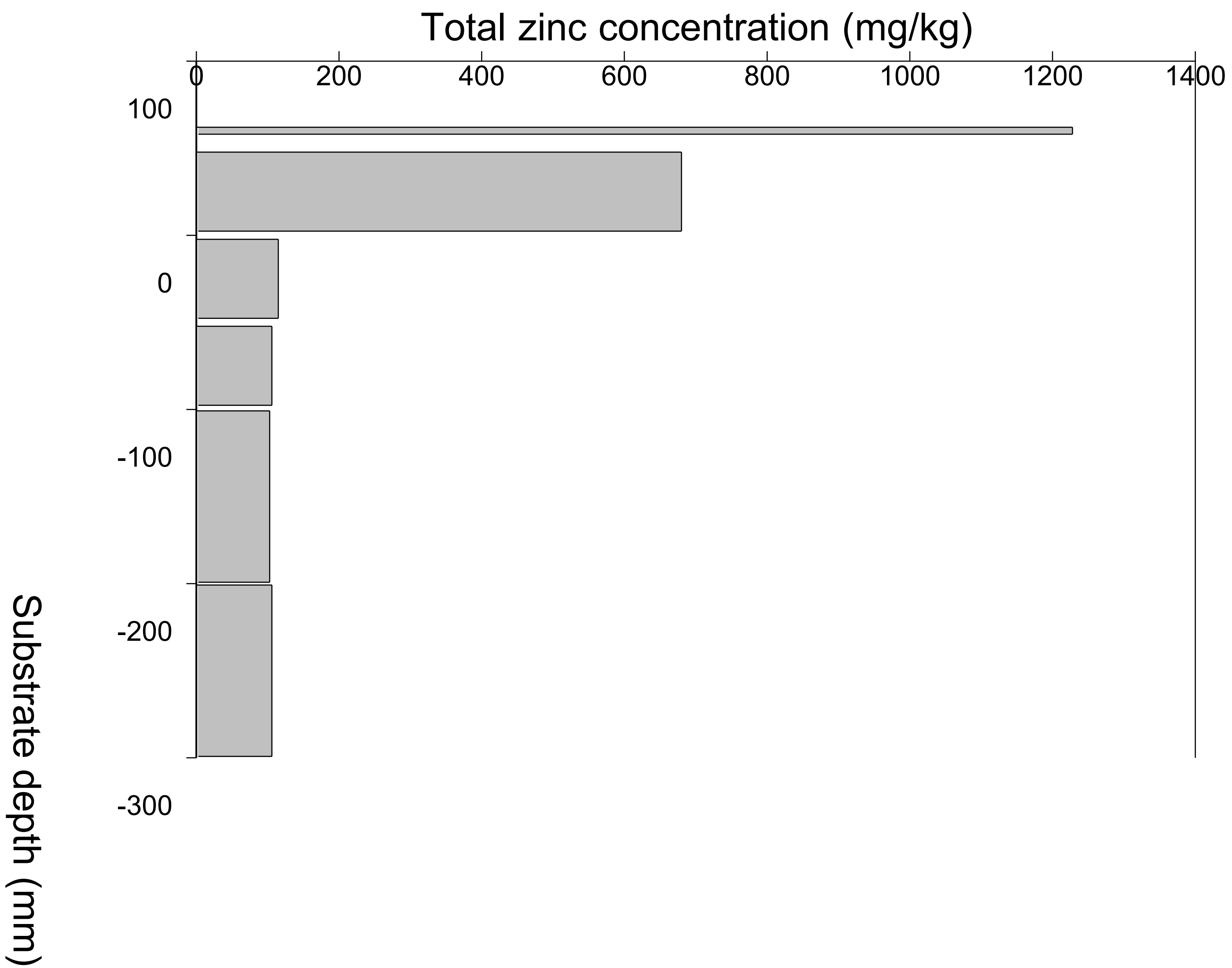
# Volume discharged is reduced for small events & dry antecedant conditions



# Bioretention buffers small rainfalls & shock loading



# Bioretention devices accumulate contaminants – these need landfilling



# Design issues

- Pretreatment is needed for sites with high TSS (>300 mg/l)
- Incorporate features to exclude vehicles & people (rocks, drops, curbs, plant choice)
- Underdrains need protection from sediment blocking via a filter layer of sand
- Include in package cost of supervision during construction, especially for retrofits

# Implementation issues

- Complete bioretention after earthworks or protect from sediment during earthworks
- Maintaining inflow and recommended permeability is critical to performance
- Select non-floating mulches or protect grates
- Frequent weeding in the first 6 to 12 months critical if no mulch is used

# Implementation issues

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# Case study: Green Carparks

- Trees provide shade & intercept rainfall
- Swales & raingardens slow water moving into drains
- Allow rooting under low-load areas (footpaths)

# Case study: Bioretention for free!

- Sheet runoff into vegetated road verges
- Raise mowing height to >100 mm, or avoid mowing completely
- Minimise or avoid herbicide strip

# Conclusions

Bioretention devices are ideal for treating frequent, low volume runoff from hotspots

These devices consistently & significantly lower pollutants in dirty runoff as long as permeability and exchange capacity are adequate

Bioretention devices are lower maintenance options as plants help maintain permeability, also remove N

Good bioretention contractors are scarce – must monitor construction to guarantee performance