PICP & Biofilters

21-30 May 2019

Setting the scene

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7700 Rondebosch
SOUTH AFRICA

This seminar is sponsored by the Water Research Commission (WRC) of South Africa (Project No. K5/2413)

Seminar programme

1. Welcome and introductions
2. Setting the scene – Neil Armitage
3. PICP in the USA – Ryan Winston
4. Discussion
5. Tea and coffee
6. Bioretention in the USA – Ryan Winston
7. Discussion
8. Closure

CPD

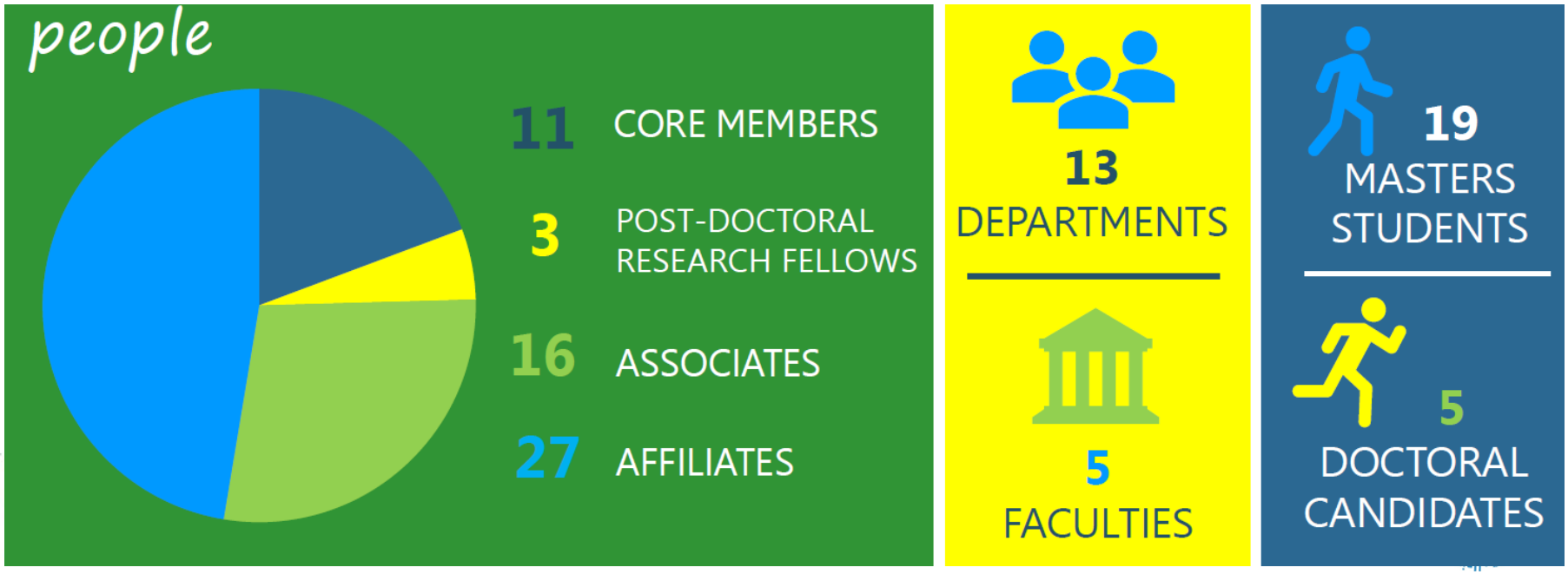
If you want CPD points for this seminar (dumb question?!) you need to:

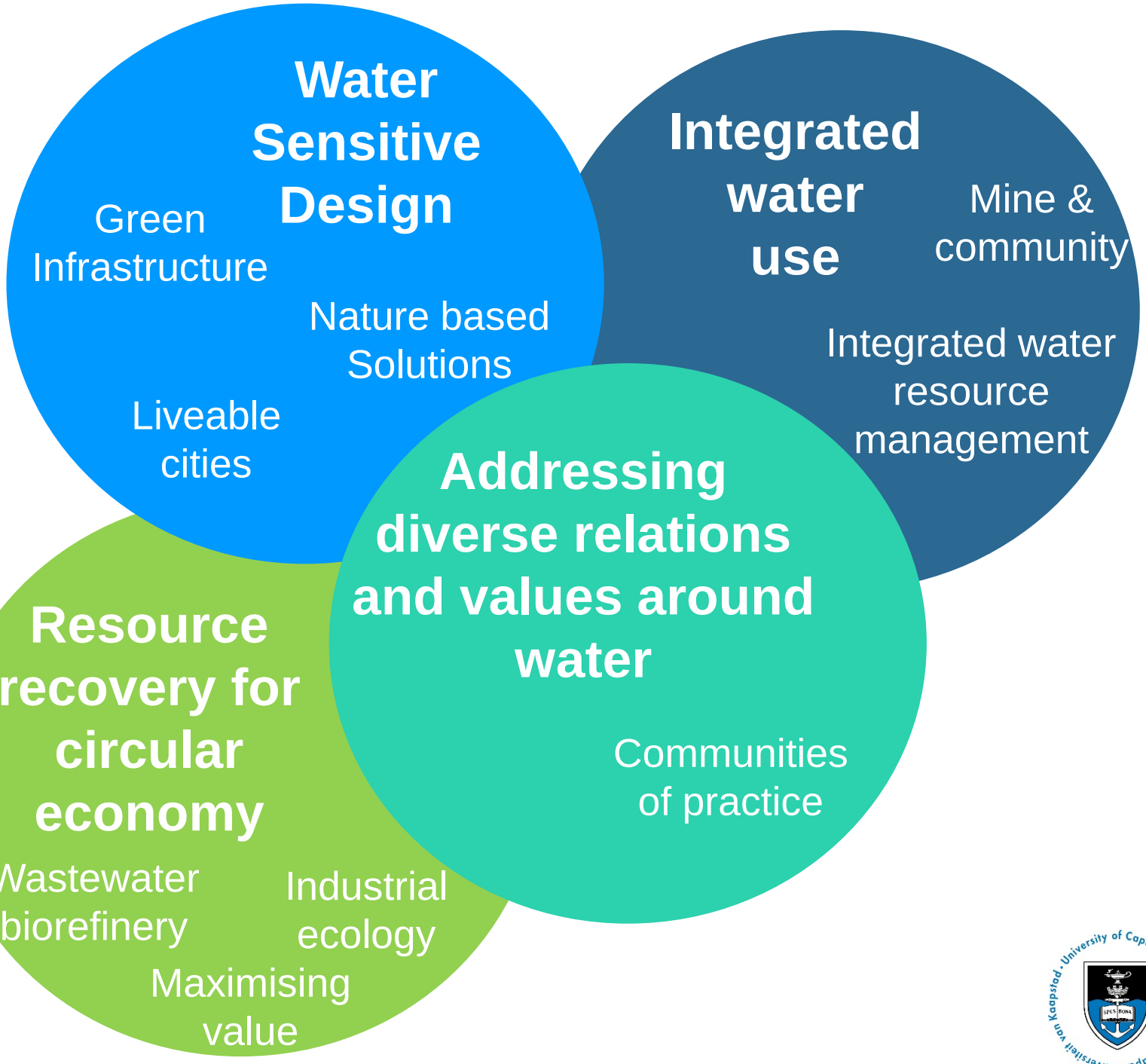
1. Sign the attendance register
2. Send an email to Kim Liu, LXXBOD001@myuct.ac.za requesting a certificate
3. CPD Code = UCTPICP01

Future Water

‘Exploring and enabling regenerative water futures which transform human settlements into liveable and sustainable ecologies’

Research into the improvement of water management to address issues of water scarcity in human settlements




Water Sensitive Design
Green Infrastructure
Nature based Solutions
Liveable cities
Integrated water use
Mine & community
Integrated water resource management
Addressing diverse relations and values around water
Communities of practice
Resource recovery for circular economy
Wastewater biorefinery
Industrial ecology
Maximising value

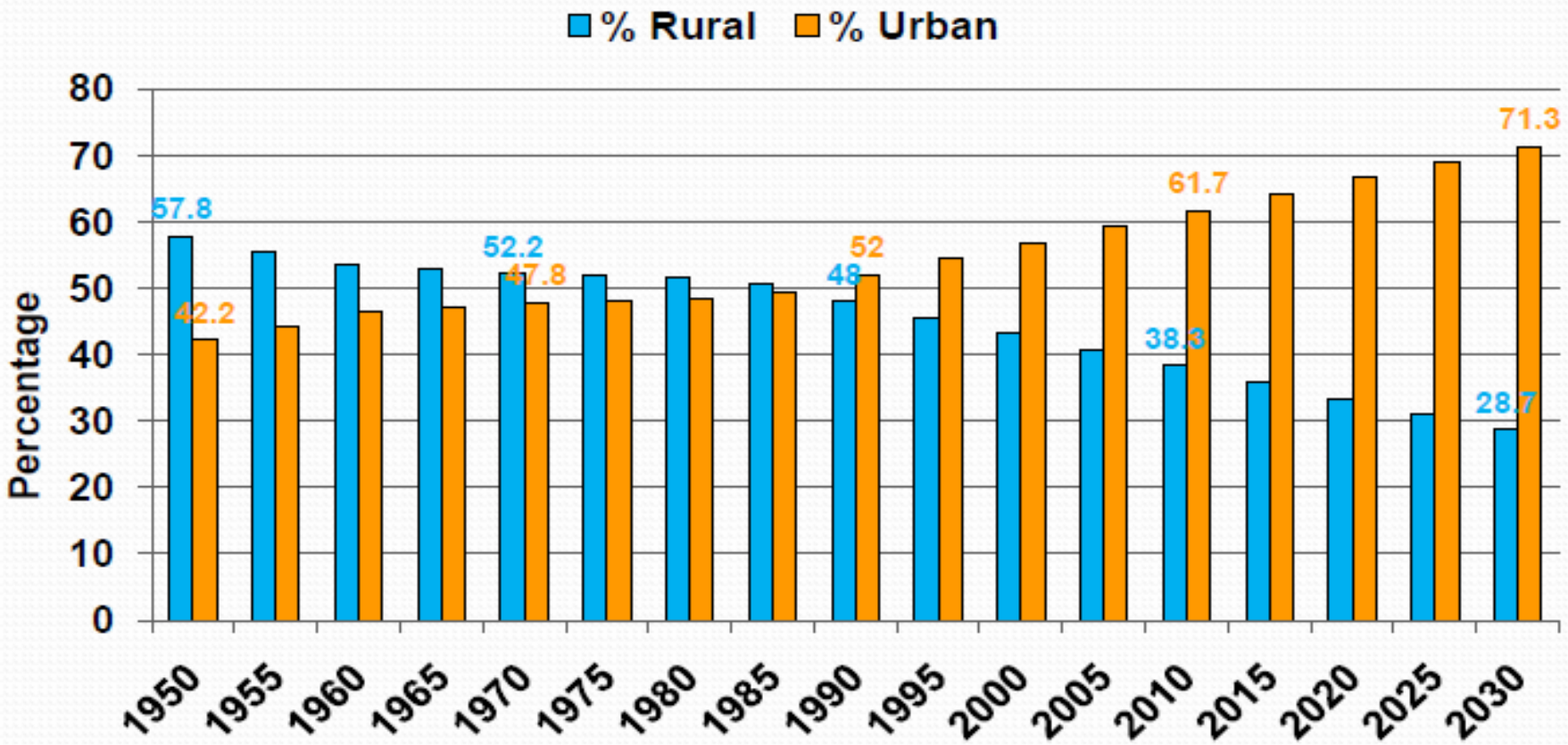
South African population growth 5

The total population in South Africa was estimated at 57.7 million people in 2018, according to the latest census figures. Looking back, in the year of 1960, South Africa had a population of 17.5 million people.

Historical Data API

https://tradingeconomics.com/south-africa/population

The future is urban



Source: Haldenwang, 2010

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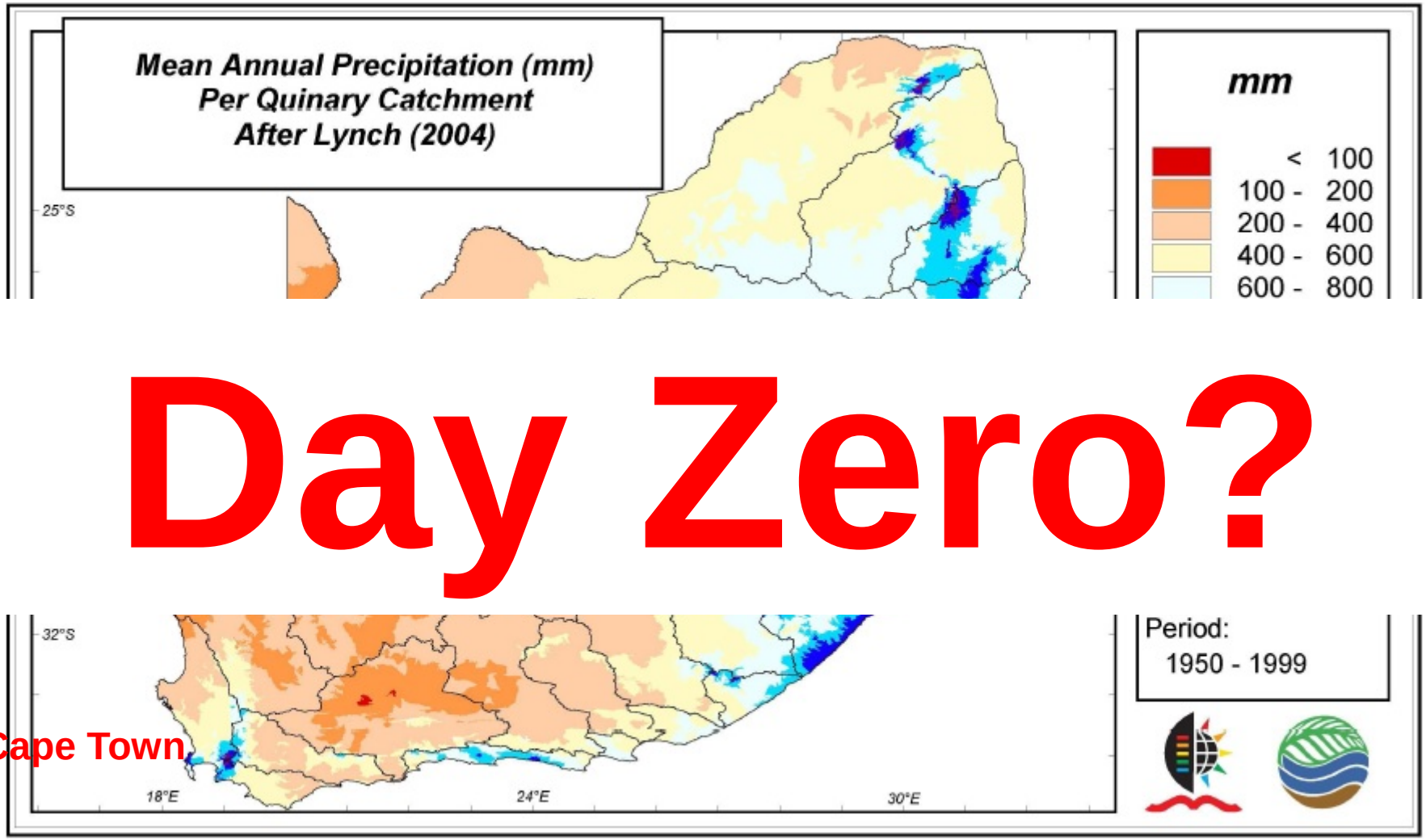
Rainfall in RSA



Day Zero?

South Africa is a semi-arid country

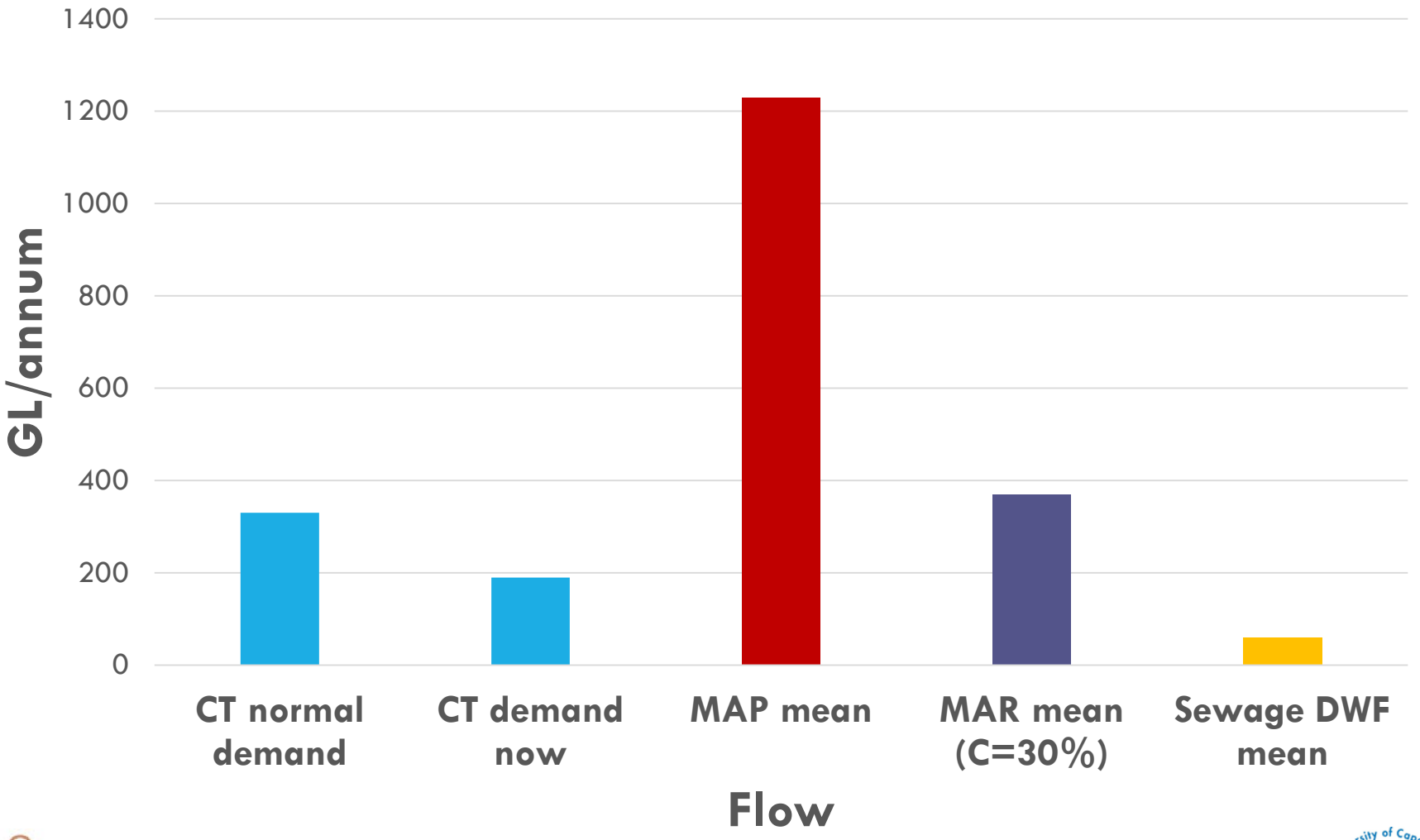
Schulze, 2011

‘Future proofing’ cities (Wong, 2012)

- Resilient (coping capacity)
- Liveable (comfort capacity)
- Sustainable (carrying capacity)
- Blue-green corridors as integral elements of city’s drainage infrastructure for flood conveyance and amenity
- Stormwater as a resource

Water Sensitive Cities (WSC) keep water in the town / city

Typical annual flow volumes in CT



1 GL = 1000 ML = 1 million kL (cubic metres)

The stormwater problem

Picture: Hanno Langenhoven

https://www.news24.com/Video/SouthAfrica/News/watch-durban-beach-buried-in-garbage-after-heavy-rains-20190311

The stormwater problem

24 April 2019: The torrential rain and flooded rivers in Durban washed tonnes of plastic and other rubbish into Durban Harbour.

https://www.newframe.com/durban-floods-profiting-plastic/

Highway pollution (RSA)

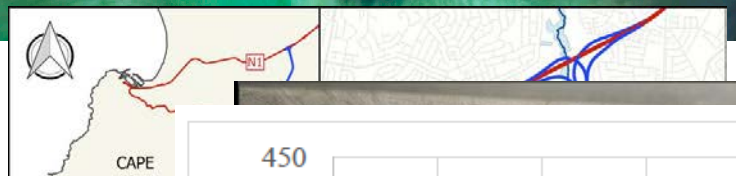
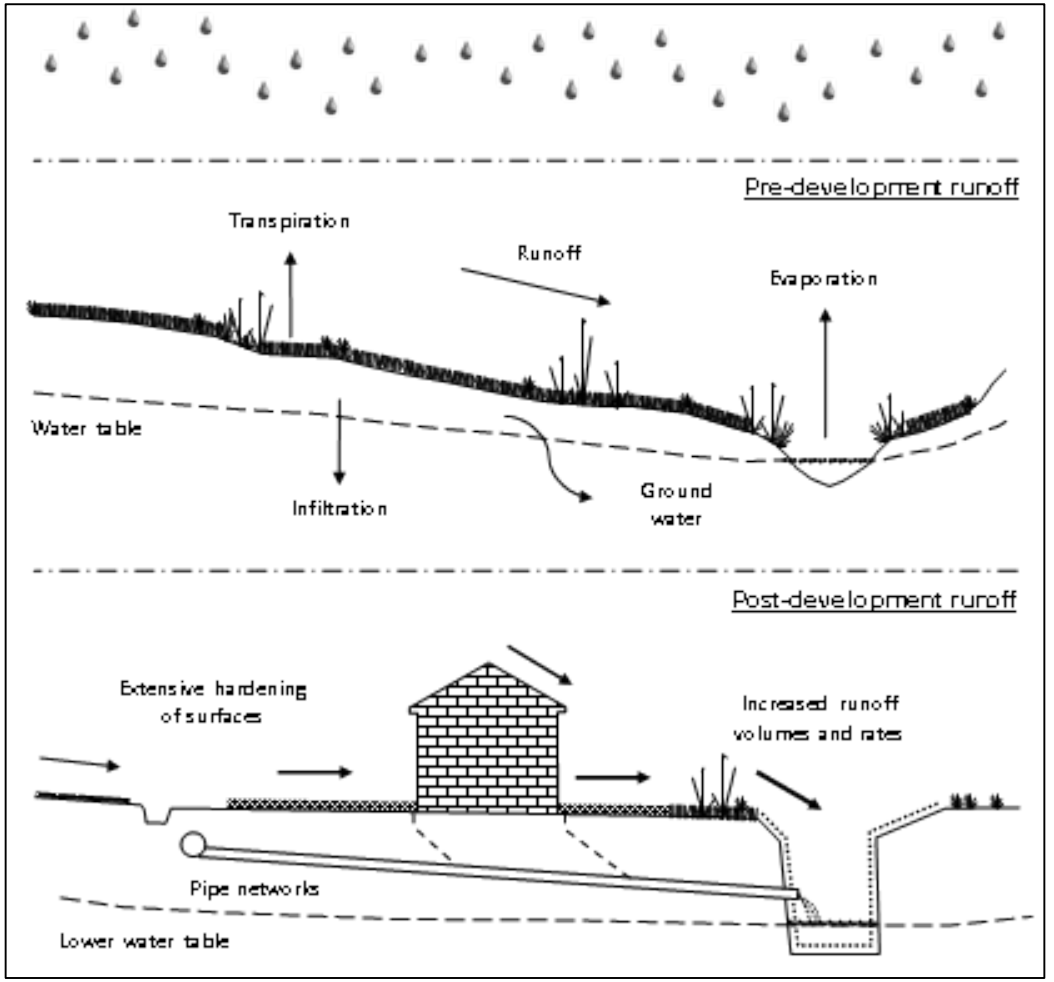


Table 4-10: Runoff contaminant concentrations compared to the DWS water quality guidelines

		Runoff	Aquatic ecosystem water quality guidelines	
	Units	Mean	Target Water Quality Range	Acute Effect Value
Total Aluminium	µg/l	9478.3	5	100
Total Arsenic	µg/l	5.8	10	130
Total Cadmium	µg/l	0.0	0.25	6
Total Chromium	µg/l	49.9	12	340
Total Copper	µg/l	143.1	0.8	4.6
Total Lead	µg/l	79.7	0.5	7
Total Manganese	µg/l	245.6	180	1300
Total Nitrogen	mg/l	19.2	0.5	10
Total Phosphorus	µg/l	2660.2	0.5	250
Total Zinc	µg/l	698.4	2	36
Total Suspended Solids	mg/l	145.7	100	-

Pre- and post development flows



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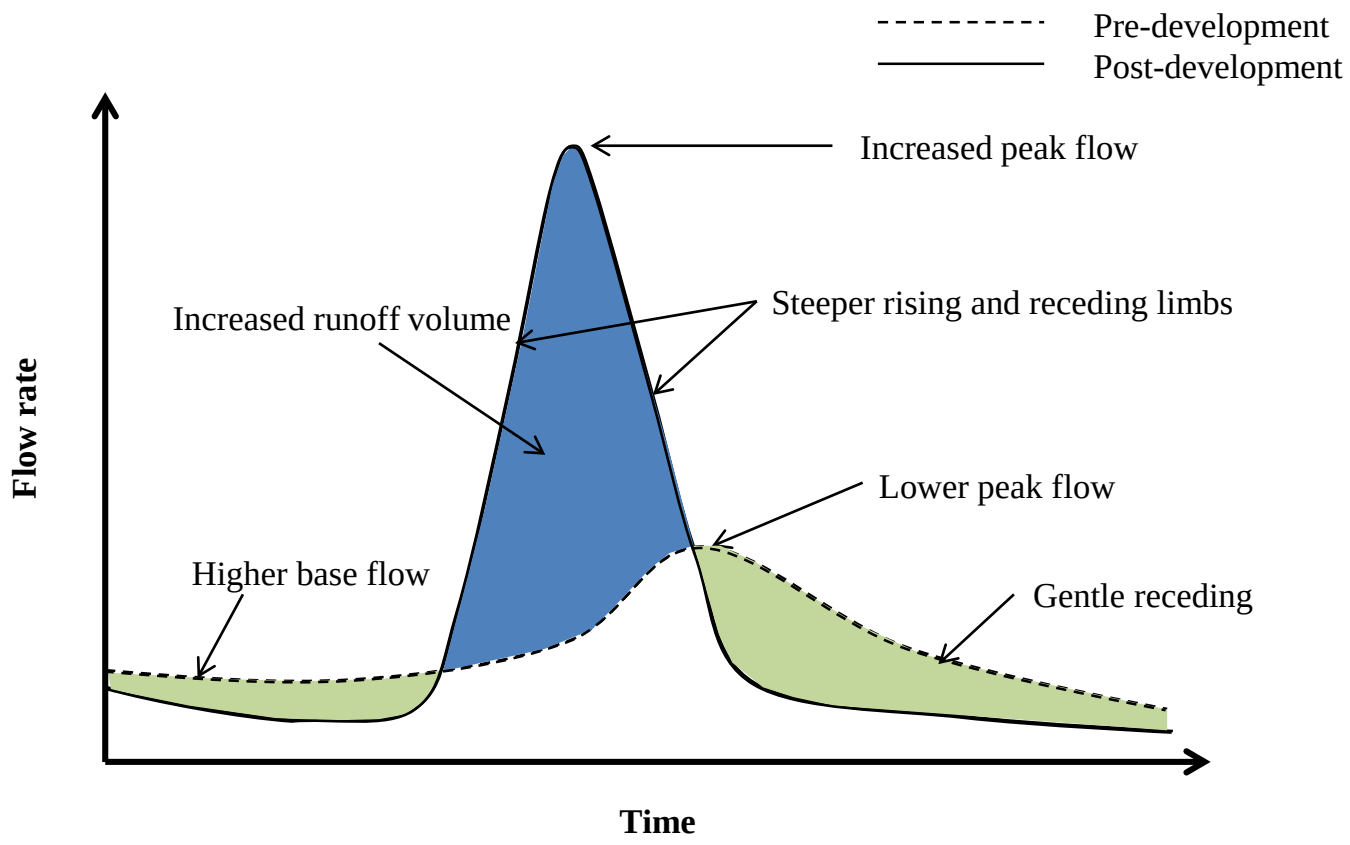
Impact of conventional drainage



Conventional drainage systems

Conventional drainage systems are designed to minimise inconvenience and reduce flood risk by removing rainwater to the nearest receiving water as rapidly and efficiently as possible – often with the use of concrete pipes and channels. Unfortunately, they also:

- Raise flood peaks
- Increase flood volume
- Pollute receiving waters
- Destroy amenity and biodiversity

Conventional Drainage Systems

- Sewerage concept initially developed by Victorian engineers in the 19th Century (with great success – it doubled life expectancy in London!)
- 'Improved' through separation into 'foul' and 'stormwater' streams in the 20th Century under the mistaken impression that the latter is essentially clean water and doesn't need to be treated (reduced flows to WWTW).
- Now, in the 21st Century, it is clear they have

Failed!!!

Sustainable Drainage Systems (SuDS) 17

‘Sustainable Drainage Systems (SuDS)’ (sometimes called ‘Low Impact Development’, LID) attempt to mimic the pre-development situation both with regard to runoff quality, runoff quantity, and amenity and biodiversity by, *inter alia*,

- treating the stormwater as close to its source as possible, and
- using a “treatment train” to successively treat potential increased post-development pollution and flow rates.”

‘Soft’ engineering – minimise concrete conduits

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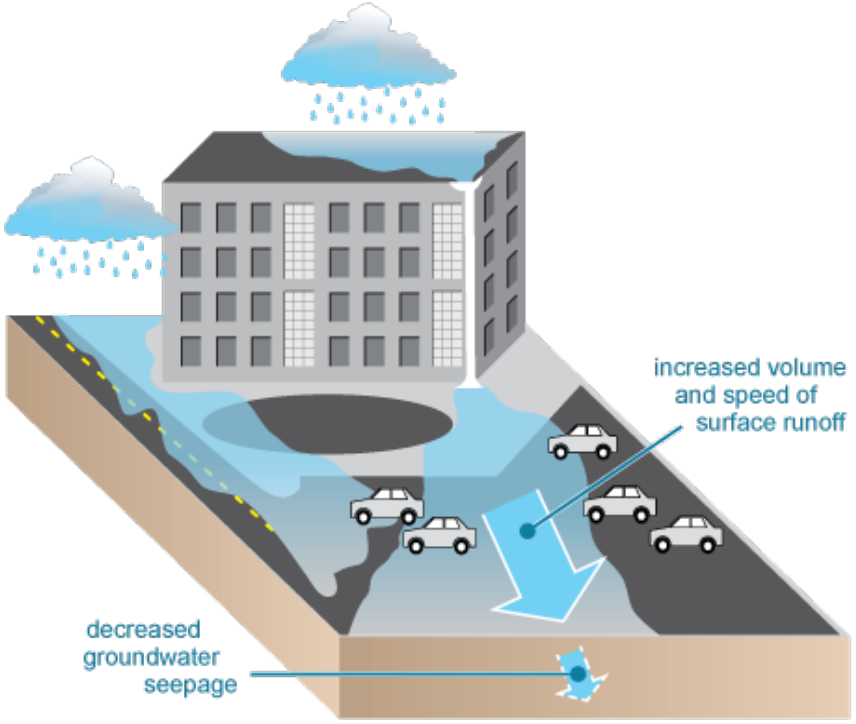
Conventional vs. SuDS

Impervious surfaces



Impervious 'hard' surfaces (roofs, roads, large areas of pavement, and asphalt parking lots) increase the volume and speed of stormwater runoff. This swift surge of water erodes streambeds, reduces groundwater infiltration, and delivers many pollutants and sediment to downstream waters.

Pervious surfaces

Pervious 'soft' surfaces (green roofs, rain gardens, grass paver parking lots, and infiltration trenches) decrease volume and speed of stormwater runoff. The slowed water seeps into the ground, recharges the water table, and filters out many pollutants and sediment before they arrive in downstream waters.

Conceptual diagram illustrating impervious and pervious surfaces. Impervious surfaces are hard and increase stormwater runoff, causing pollutant and sediment delivery in downstream waters. Pervious surfaces are soft and decrease stromwater runoff, which filters out pollutants and sediments before they arrive in downstream waters.

Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Chesapeake and Atlantic Coastal Bays Trust Fund, 2013. Stormwater Management: Reducing Water Quantity and Improving Water Quality. IAN press, newsletter publication.

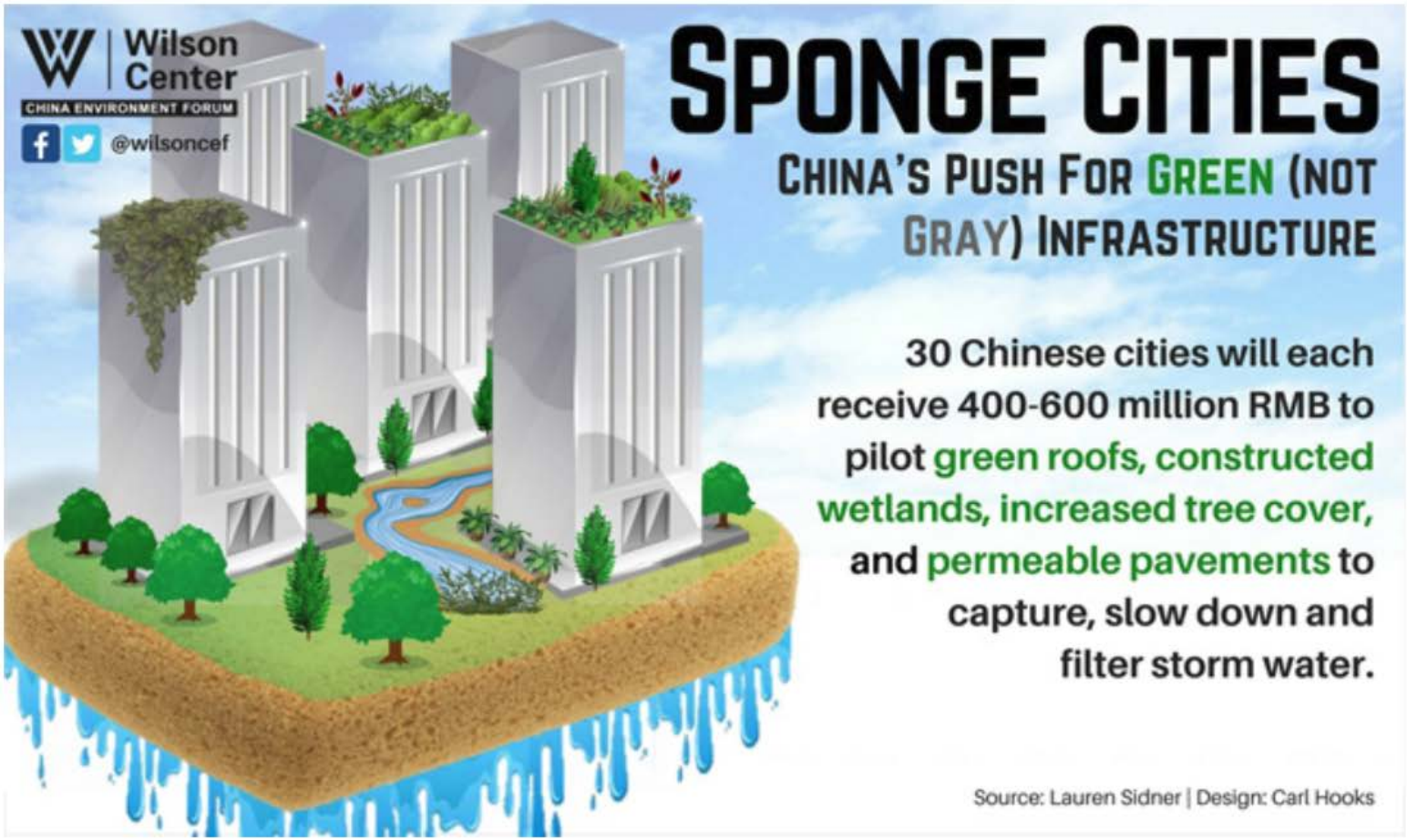

SINGAPORE
103°40'E
103°50'E
104°E
1°30'N
1°20'N
MALAYSIA
MALAYSIA
MALAYSIA
Johor Strait
Sembawang
Woodlands
Sungei Sembawang
SIMPANG
Lim Chu Kang
Mandai
Mandai
Pungol Barat I.
Pungol Timor I.
Ubin Island
Tekong Island
North Eastern Islands
Kranji Reservoir
Murai Reservoir
Singapore Zoo
Seletar Reservoir
Punggol
Sengkang
Changi
Western Water Catchment
Choa Chu Kang
Upper Peirce Reservoir
Hougang
Pasir Ris Town Park
Poyan Reservoir
Bukit Batok
SERANGOON
Bishan
Bishan Park
Paya Lebar
Jurong West
Bukit Batok Nature Park
MacRitchie Reservoir
Bedok Reservoir
Changi Intnl. Airport
Jurang Lake Park
Singapore Science Centre
Toy Payoh
Tampines
Jurong East
Singapore Botanical Gardens
Little India
Singapore
Bedok
Changi Bay
Jurang Bird Park
Pandan Reservoir
Queens Town
ORCHARD
RACHOR
Marine Parade
National Museum
West Coast Park
RIVER VALLEY
Singapore Flyer
TUAS
Boat Quay and Clarke Quay
Marina Bay Sands
SINGAPORE
Jurong I.
Underwater Worlds
Brani I.
Universal Studios Singapore
Sentosa I.
Palau Busing
Bucom I.
Western Is.
St. Joan I.
Sudong I.
Semakau I.
Sebarok I.
Singapore Strait
Pawai I.
Senang I.
INDONESIA
0
5 Km
0
2 Miles
LEGEND
Country Boundary
Major Road
Other Road
River
Sea Port
Airport
Point of Interest
Park
Lake
Copyright © 2013 www.mapsofworld.com
(Updated on 25th January, 2013)

From this...

To this!

From harbour to freshwater reservoir

Sponge Cities



Acknowledgment: The Woodrow Wilson International Center for Scholars is the living, national memorial to President Wilson established by the United States Congress in 1968

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http://waterbucket.ca/rm/2017/08/20/sponge-city-solutions-for-chinas-thirsty-and-flooded-cities/ *(accessed 5/10/18)*

Greening the city

Rainwater harvesting

‘Sponge’ gardens

Raingarden between flats (AUS)

Permeable pavements (RSA)

Promoting infiltration in the CBD (USA)

Bioretention cells (USA)

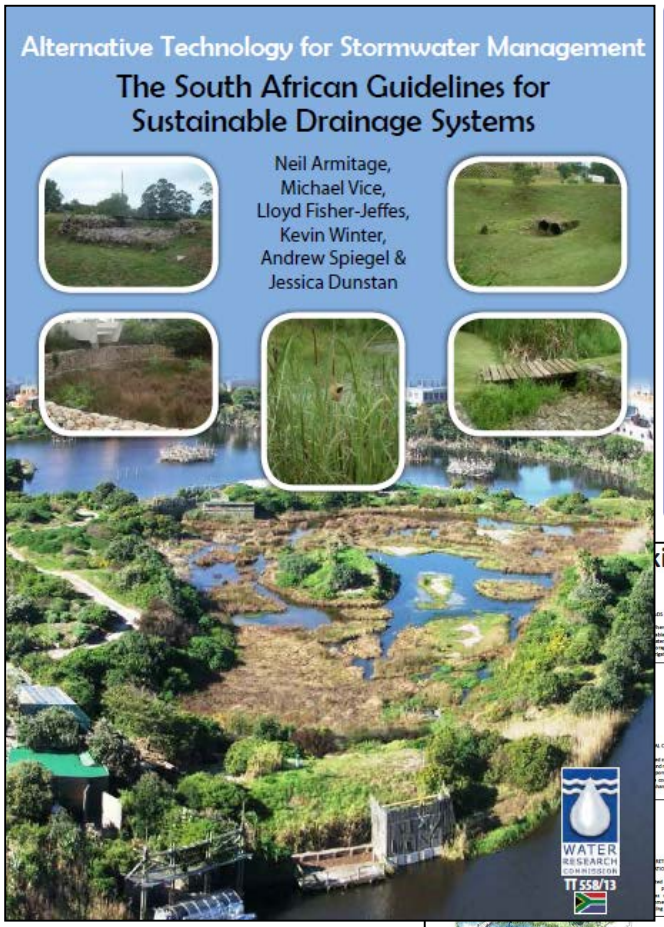
Bio-swale (AUS)

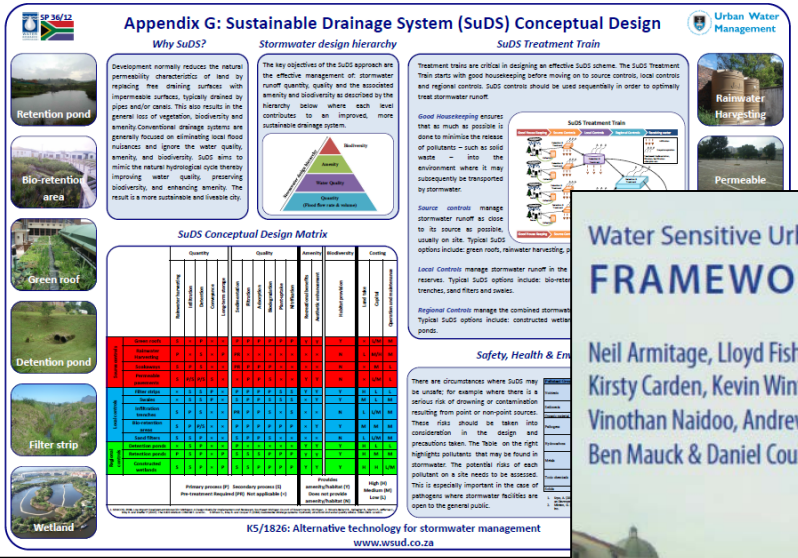
Retention pond (AUS)

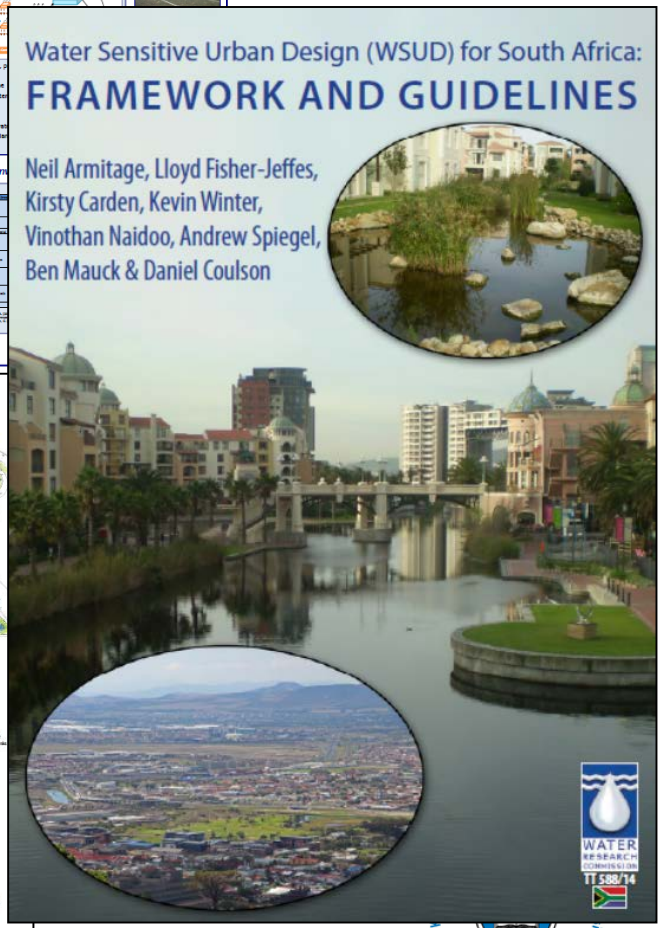
Wetlands (USA)

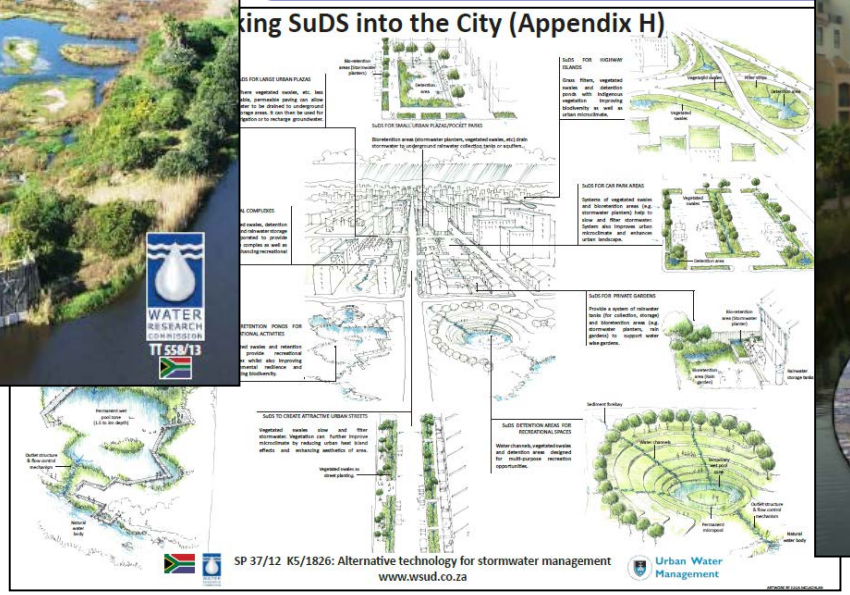
Wetlands in the City (AUS)

South African guidelines









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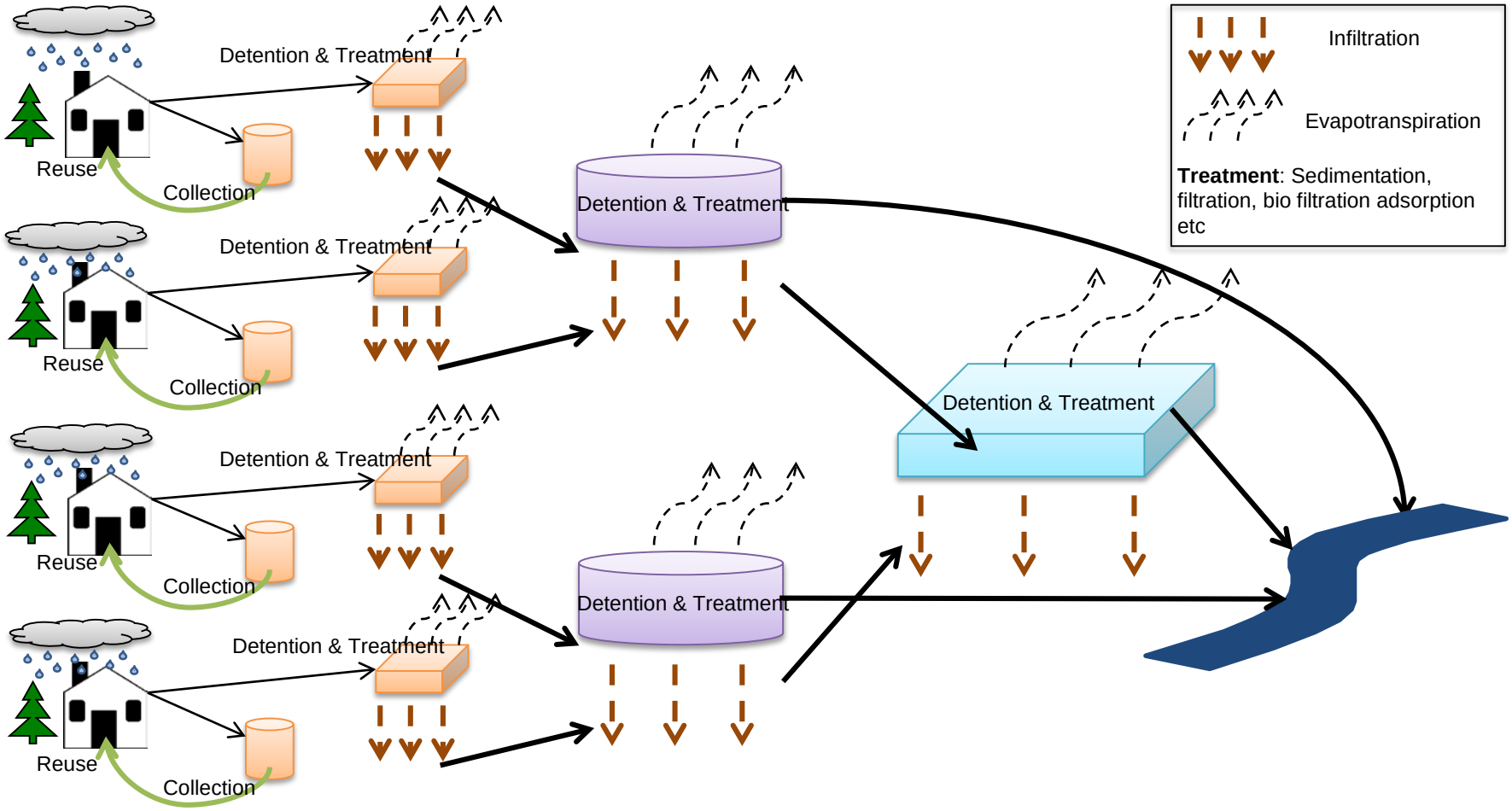
SuDS Treatment Train

Good House Keeping | Source Controls | Local Controls | Regional Controls | Receiving water



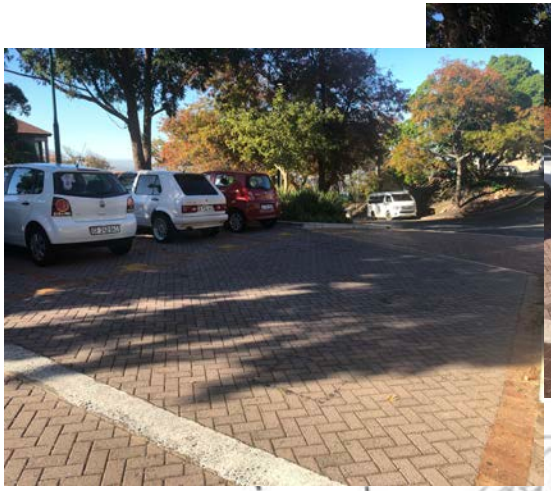
Good House Keeping | Source Controls | Local Controls | Regional Controls | Receiving water

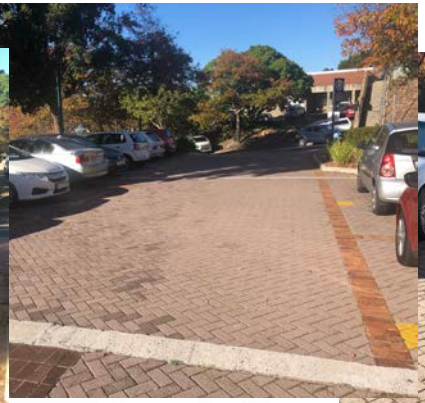
The NEB Parking Area (2019)

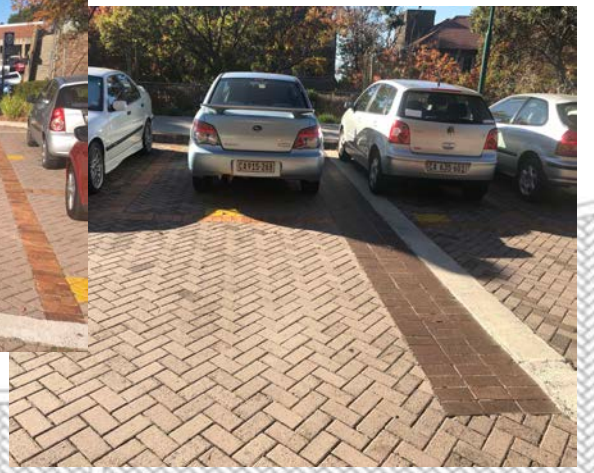
Source: Kim Liu

The NEB Parking Area (2013)

The NEB Parking Area (2019)

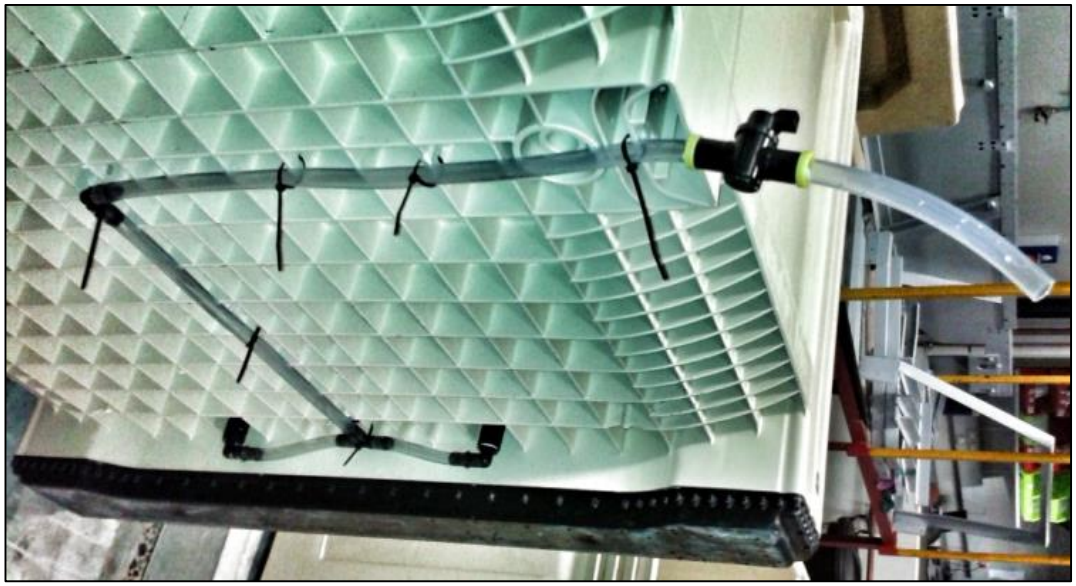






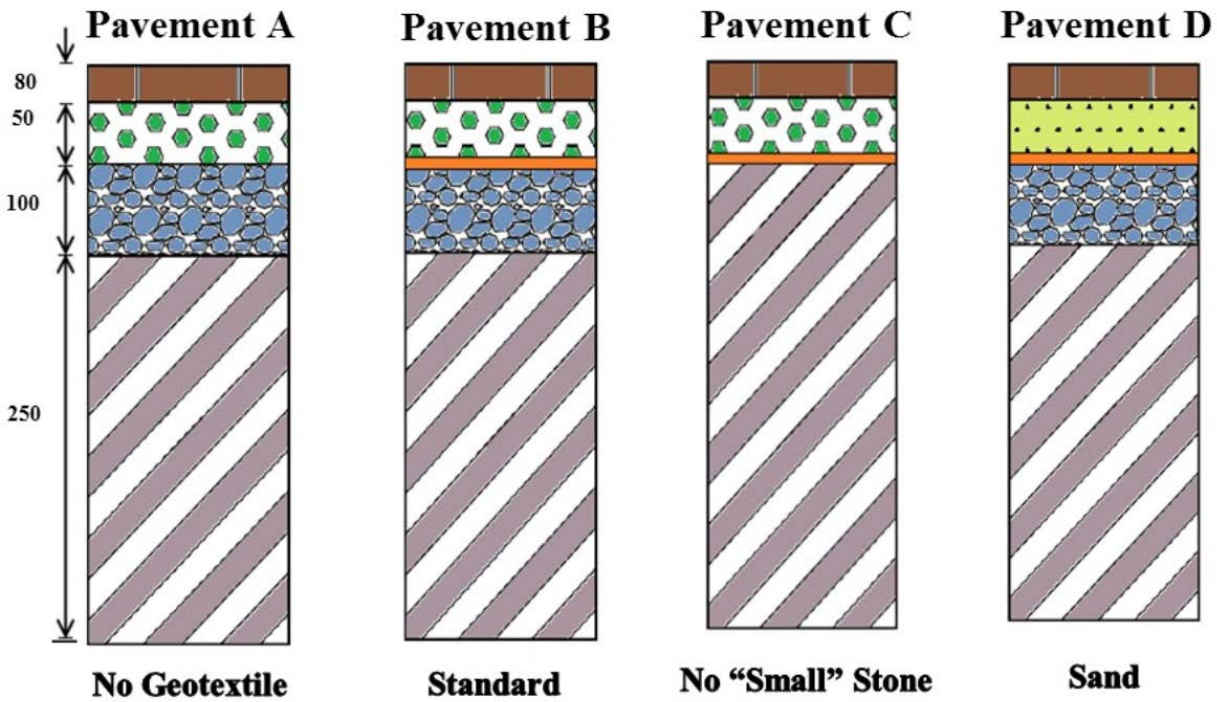
Source: Kim Liu

Lab tests on NEB-type paving (2015)



Source: Ben Biggs

Lab tests on NEB-type paving (2015) 41

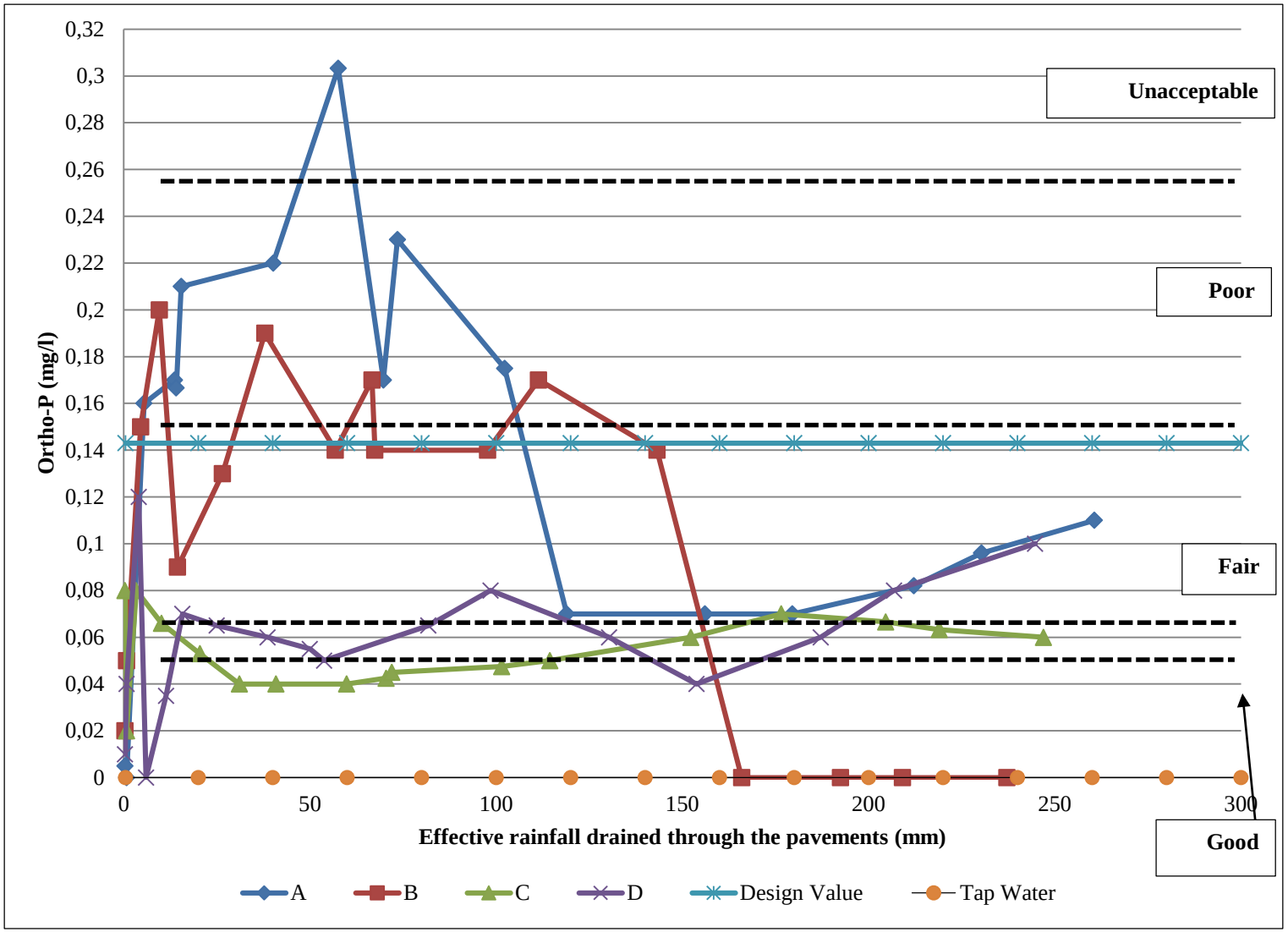


Source: Ben Biggs

Lab tests on NEB-type paving (2016) 42

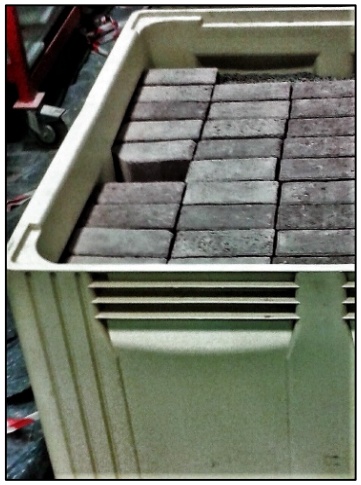
Source: Ben Biggs

Lab tests on NEB-type paving (2016) 43



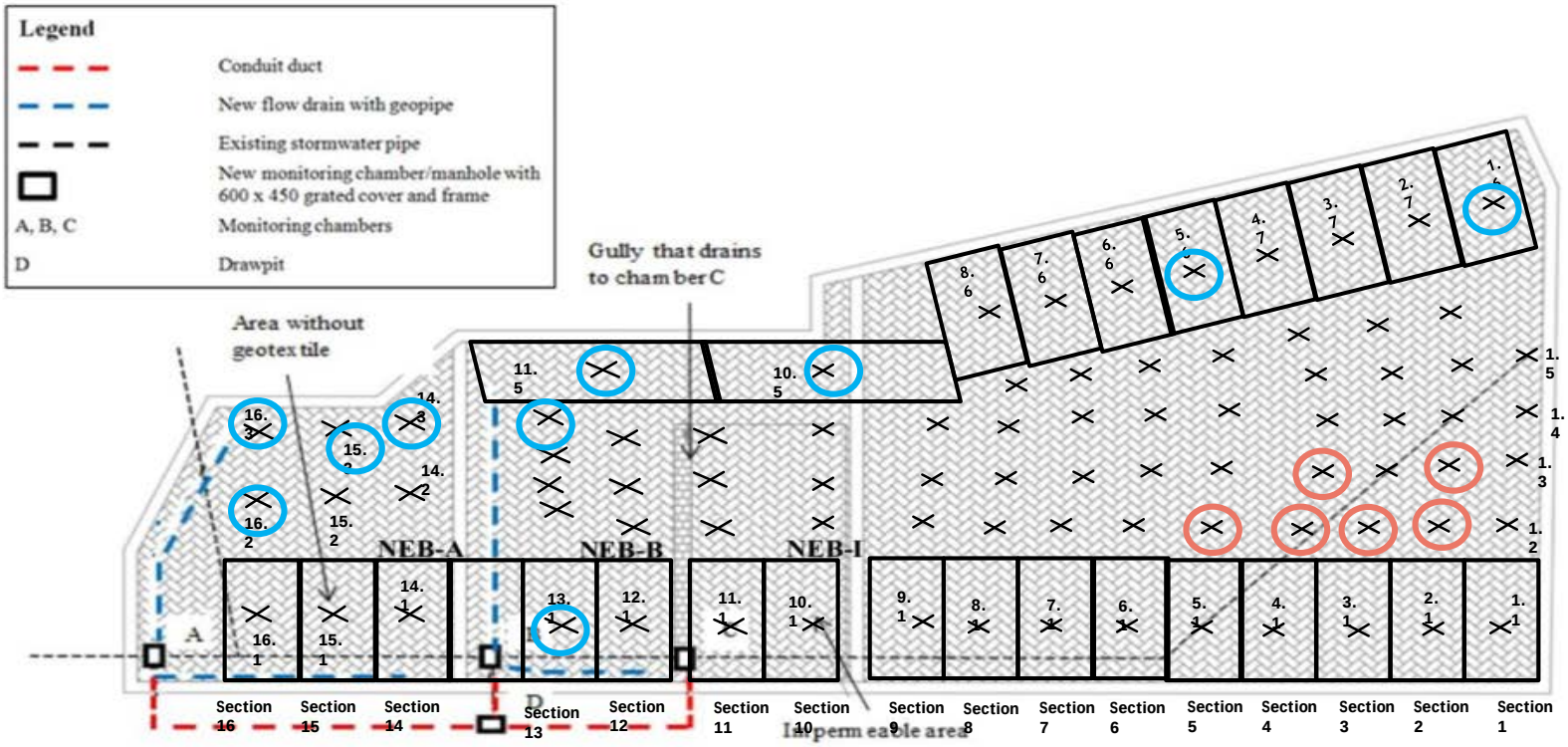
Source: Ben Biggs

Lab tests on NEB-type paving (2016) 44



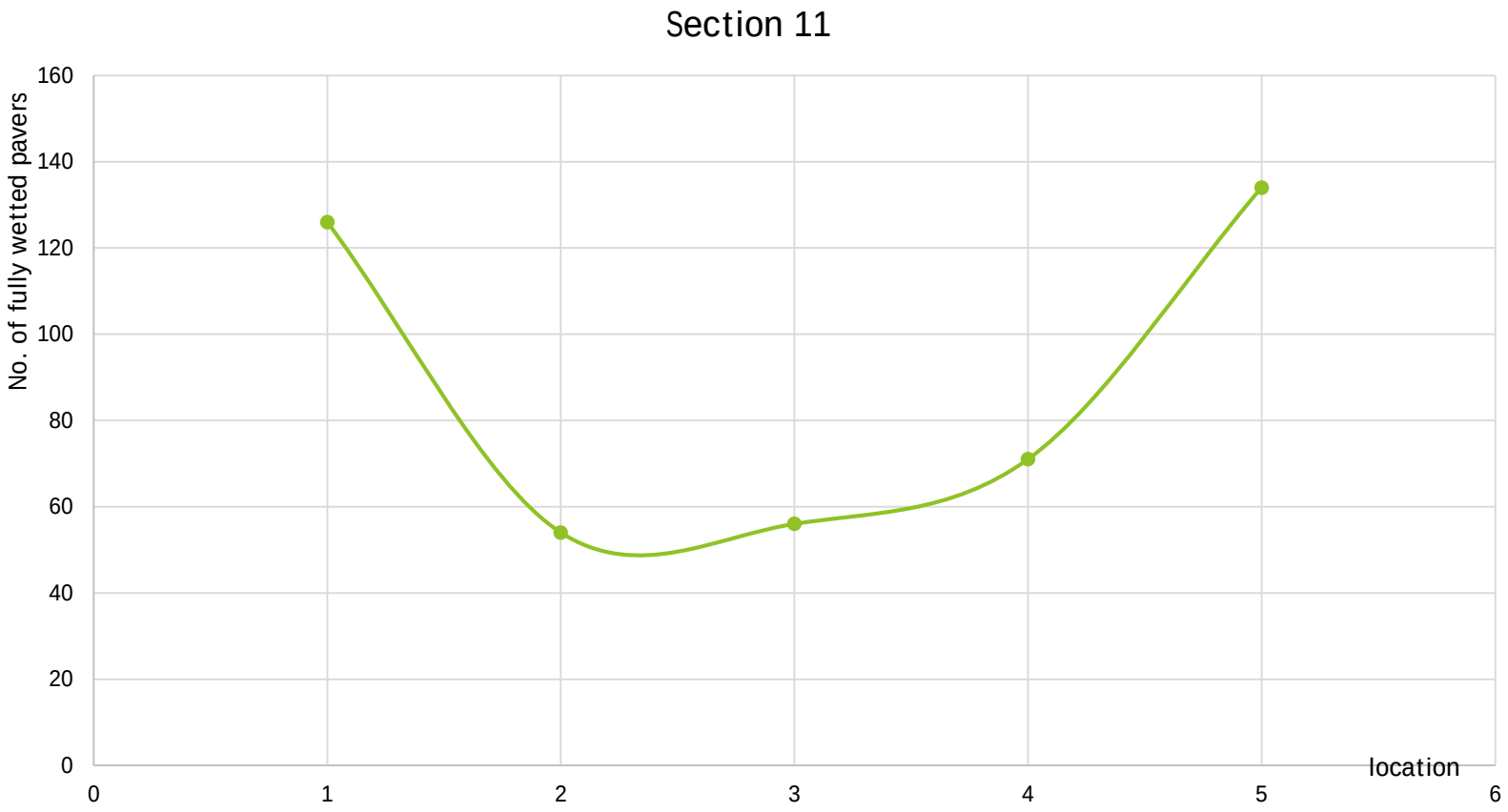
Source: Ben Biggs

Testing Locations



Source: Kim Liu

Infiltration tests on NEB paving (2019)



NB. High values indicate blockage i.e. blocked on the edges but relatively unblocked in the centre of this pavement

Source: Kim Liu

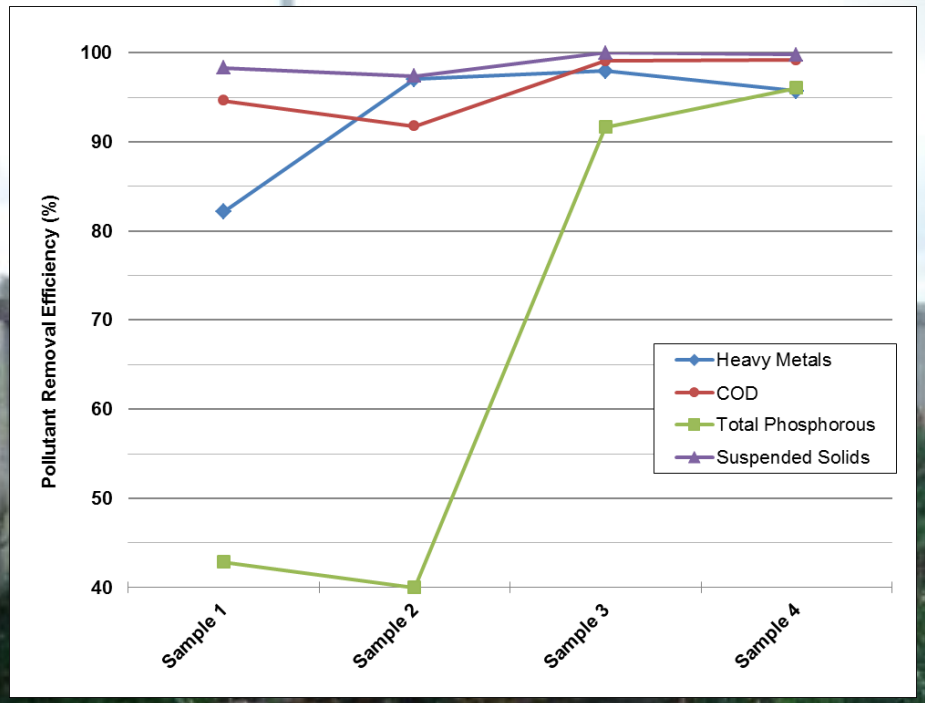
PICP research findings to-date

- Problems with the materials – particularly stone
- Problems with the construction methods – particularly environmental control
- Problems with maintenance – usually none / ineffective, leading to blockage
- Likely not meeting expected water quality objectives
- Perhaps some common designs not appropriate for South African conditions?

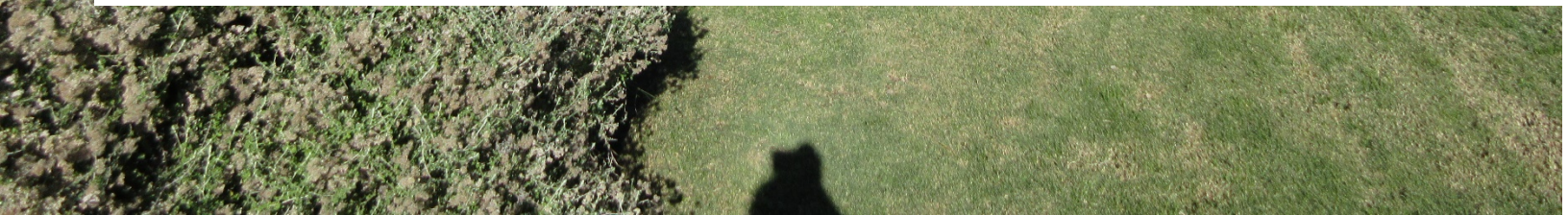
PICP Working Group

- PICP Working Group formed to assist with the drawing up of suitable SA guidelines / standards for the design, construction and maintenance of PICP
- If you would like to join please email me at: Neil.Armitage@uct.ac.za

Bio-swale in Kraaifontein



Bio-retention cell in Tokai



A better alternative?

Thank you

http://www.futurewater.uct.ac.za/

Two interesting TEDx talks:

- Tony Wong on Envisaging a Water Sensitive Future for our Cities and Towns - https://www.youtube.com/watch?v=6KFqEmcLXk8
- Brad Lancaster on Planting the Rain to grow abundance - https://www.youtube.com/watch?v=I2xDZlpInik