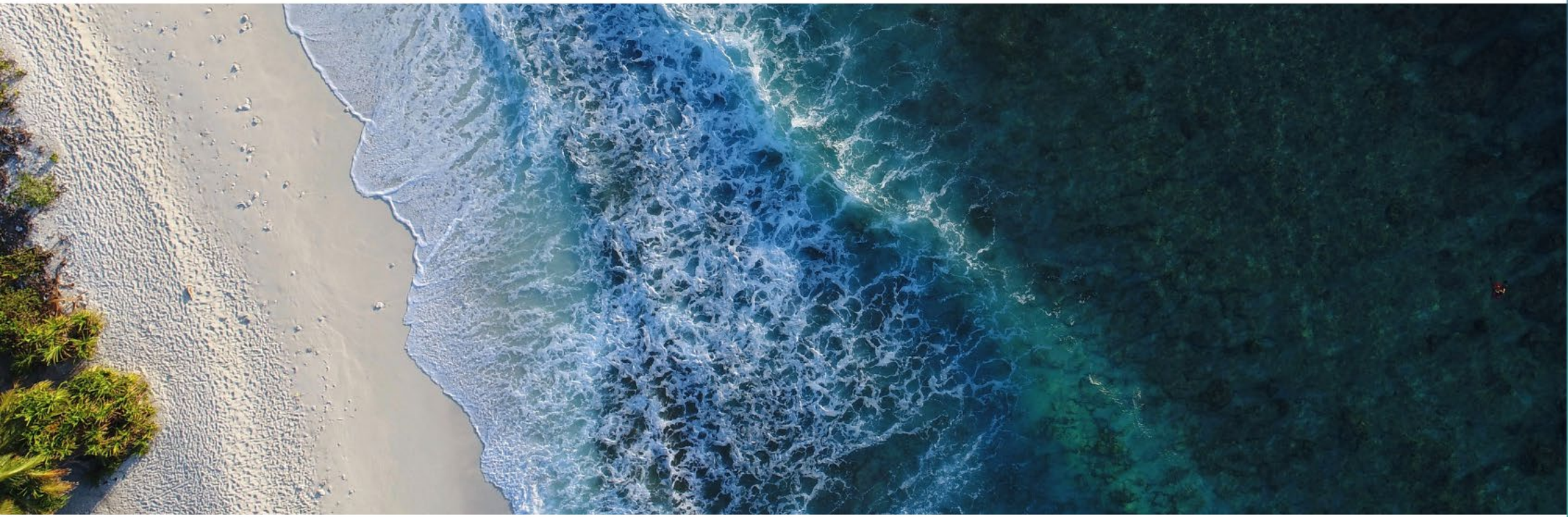
Stormwater Fundamentals Series – Impacts of traditional urban stormwater management

Presented by Brad Dalrymple

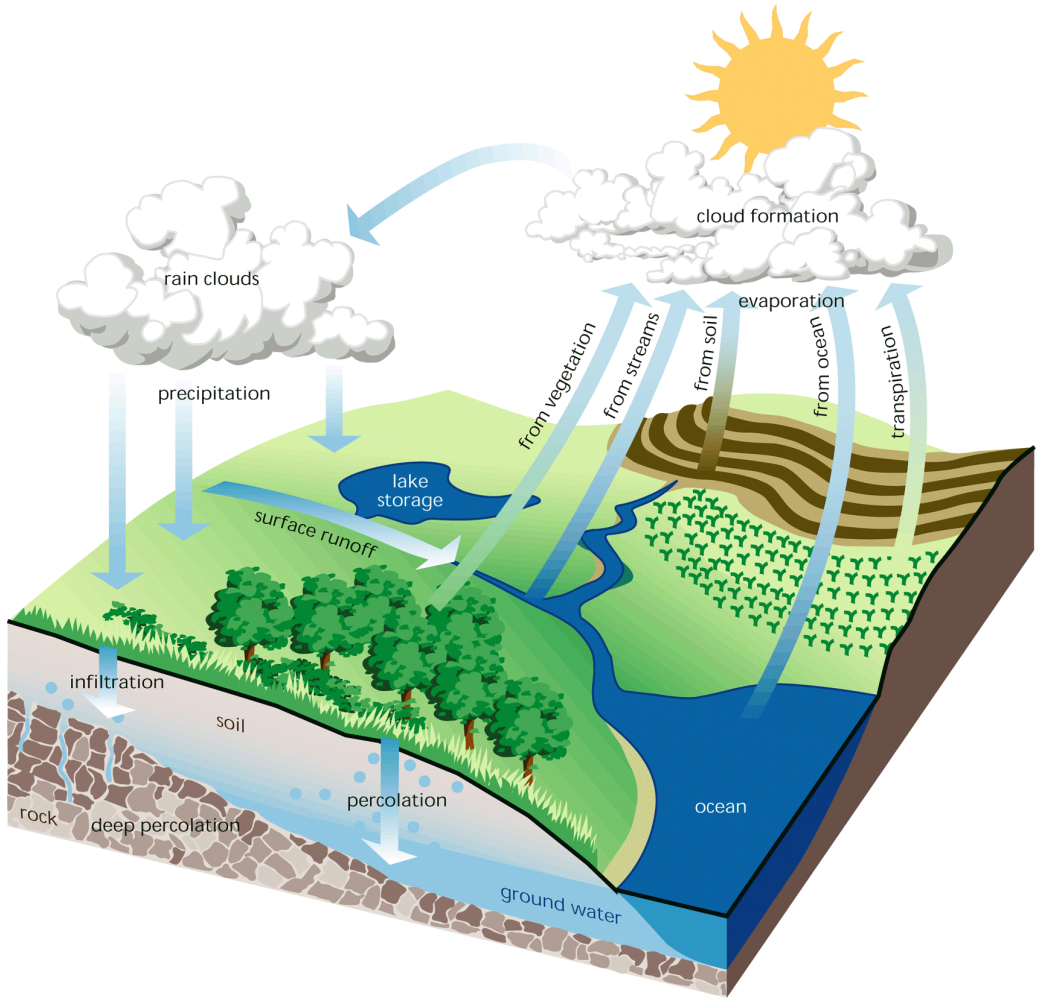
1 May 2024



Agenda

- Key catchment changes associated with urbanisation
- Associated changes to stormwater quantity and quality, & impacts to waterway health
- Types, sources & impacts of ‘common’ stormwater pollutants
- Emerging contaminants

The hydrological cycle



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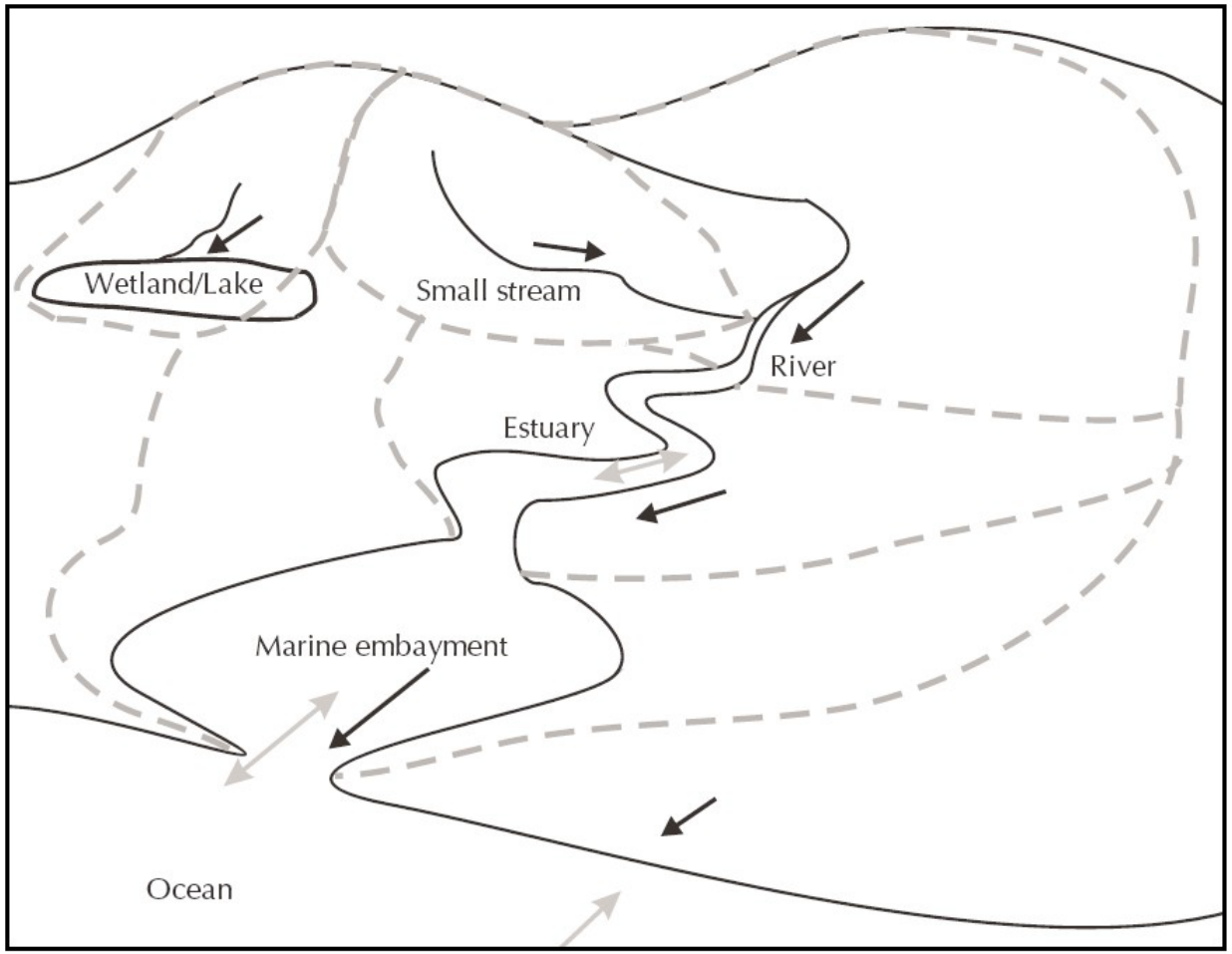
Catchments & waterways



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Southern Moreton Bay water quality simulation

Source: BMT WBM (2005)

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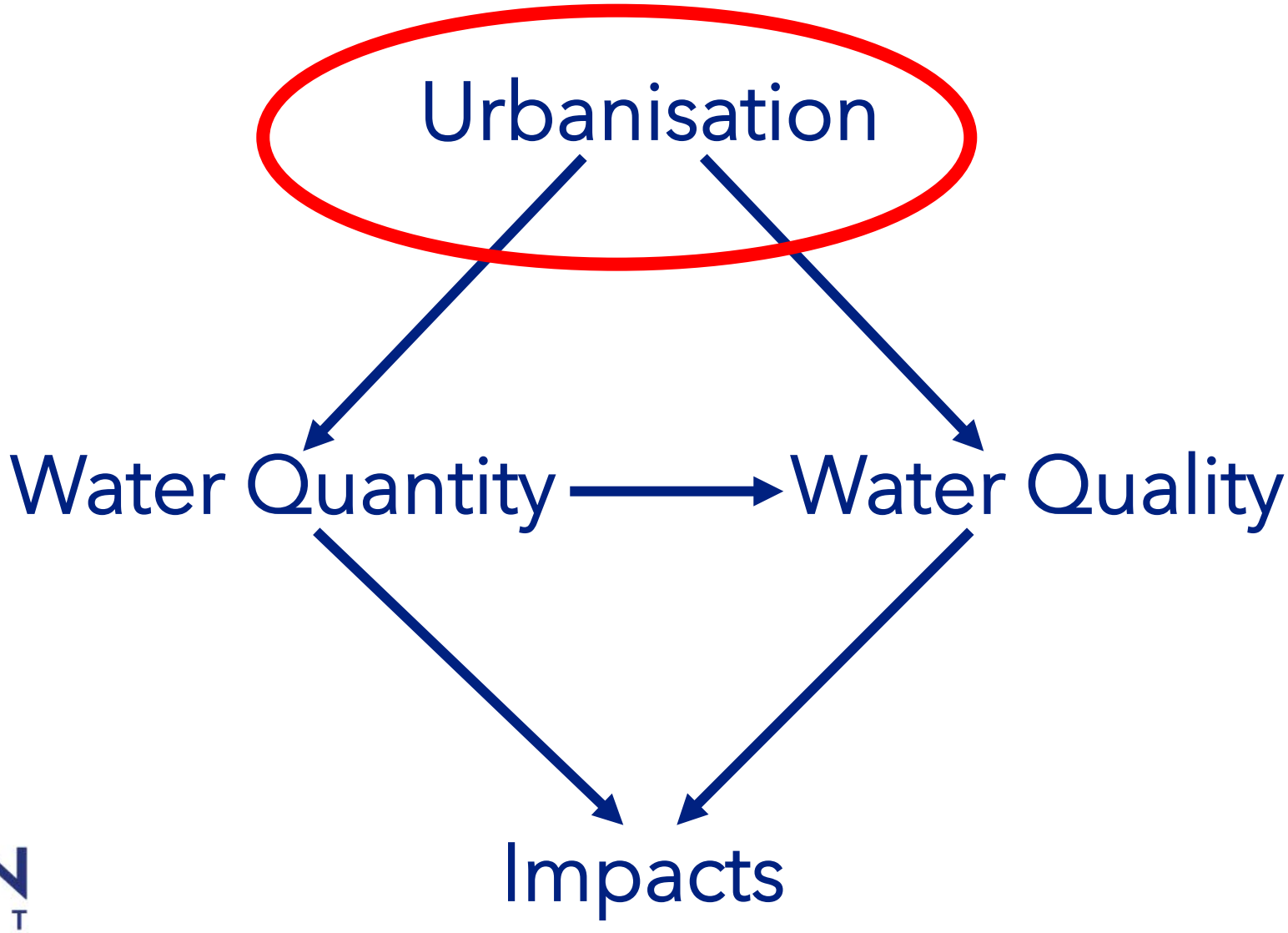

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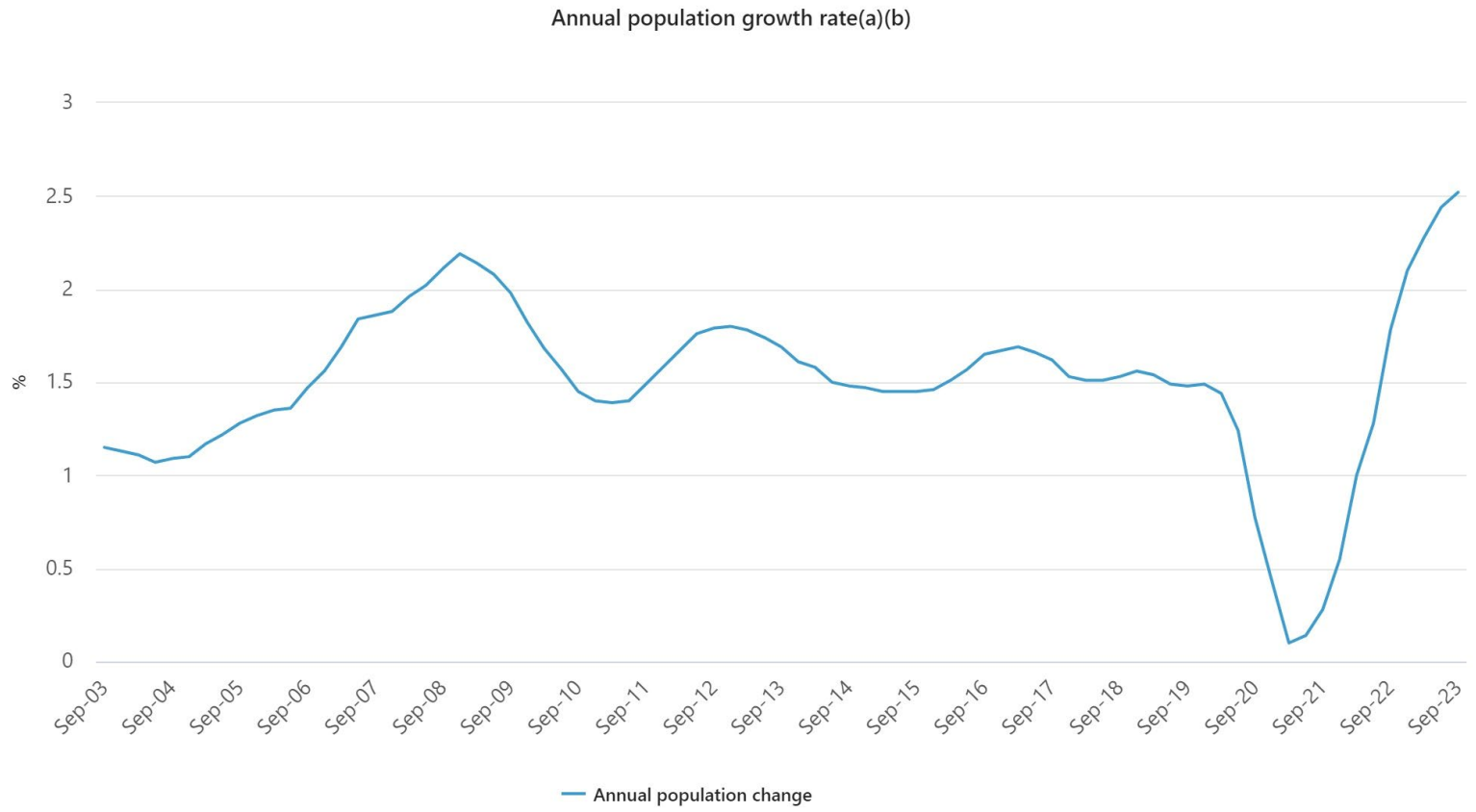
Population growth in Australia



Source: Australian Bureau of Statistics, National, state and territory population September 2023

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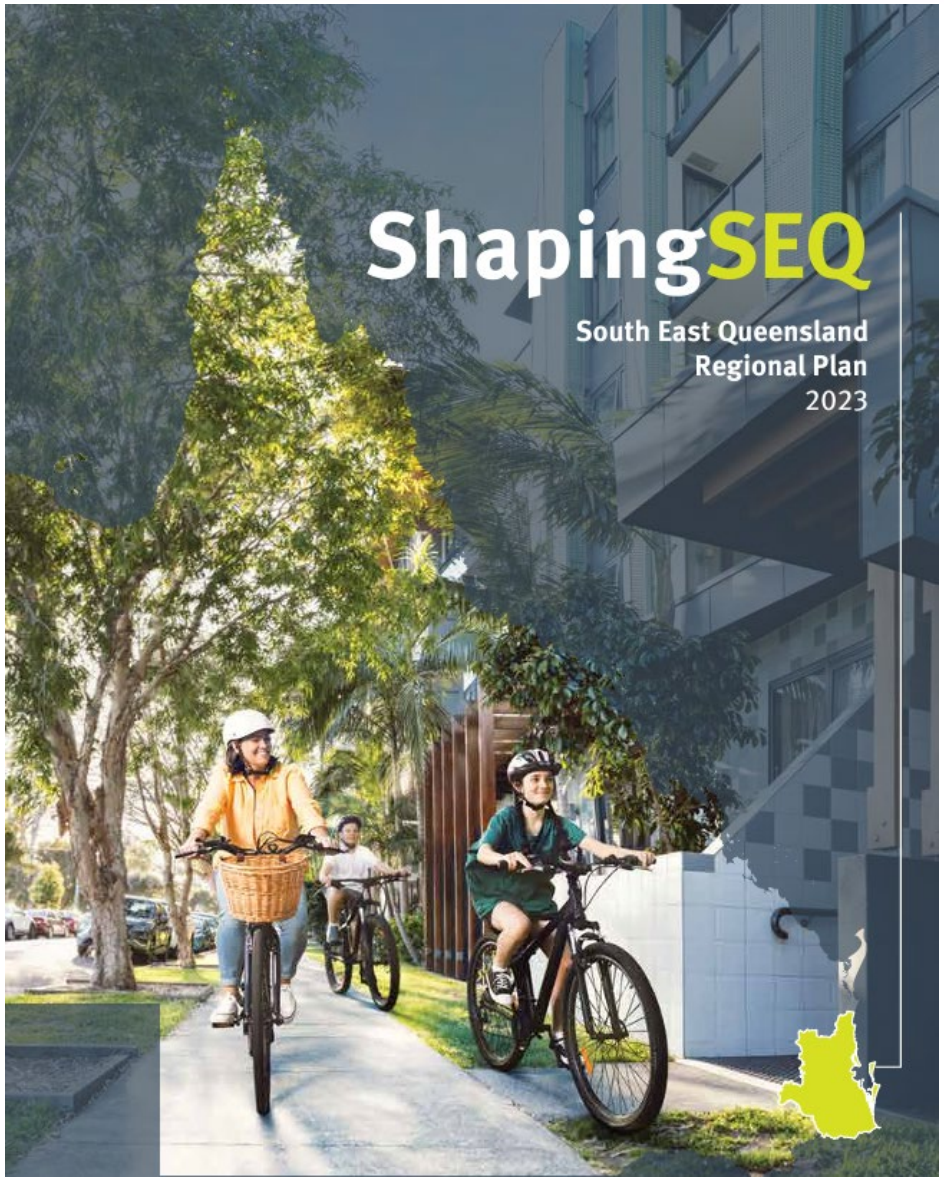
- SEQ Regional Plan 2023:
  - *"By 2046, our population is expected to be about six million. That's an additional 2.2 million people requiring almost 900,000 new homes…"*



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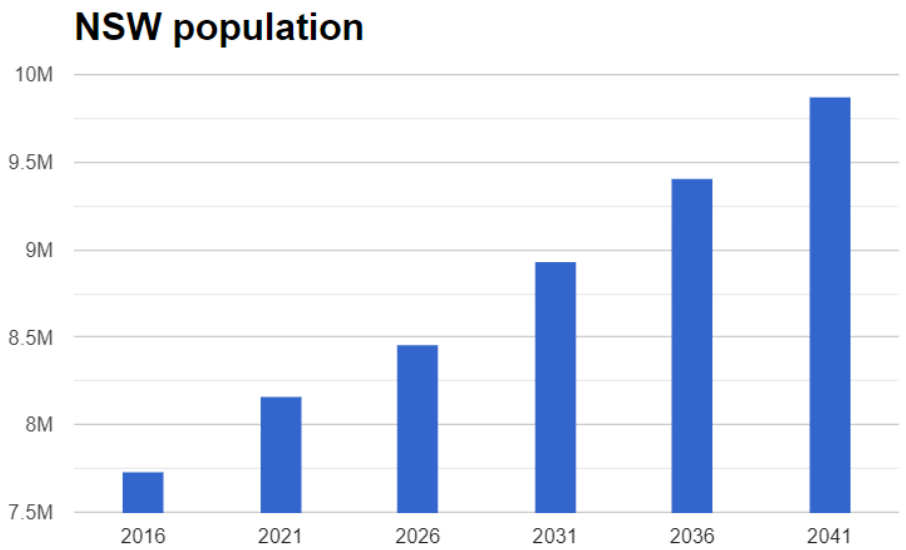
Planning



- The 2022 NSW Population Projections show:
  - NSW is expected to grow on average by over 85,000 people each year until 2041.
  - Based on recent trends regional NSW's population will increase by 570,000 to 3.7 million in 2041.
  - Greater Sydney's population will grow to approximately 6.1 million by 2041 – over a million more people than currently live in the region.

Source: https://www.planning.nsw.gov.au/research-and-demography/population-projections

What are the key catchment changes with urbanisation ?

Key catchment changes

- Vegetation loss
- Increased imperviousness
- Increased hydraulic efficiency
- Pollution

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Impervious areas

- Roofs
- Roads
- Driveways
- Footpaths/ bikeways
- etc.

- Overseas studies have shown that up to 70% of the impervious areas of an urban catchment is transport-related, ie roads, driveways, and car-parks

(Schueler 1987, cited in Wong et al 2000)

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Hydrological impacts of increased imperviousness (& vegetation loss)

- Reduced rainfall/ runoff interception
- Reduced infiltration
- Runoff transported much quicker/ intensely into waterways

- Brodie (2005) found that runoff from impervious areas would begin after no more than 2mm of rainfall as opposed to between 15 and 25mm that was required before runoff would occur over pervious surfaces in the same area.

Me hugging a tree in Amazon ~ 2003

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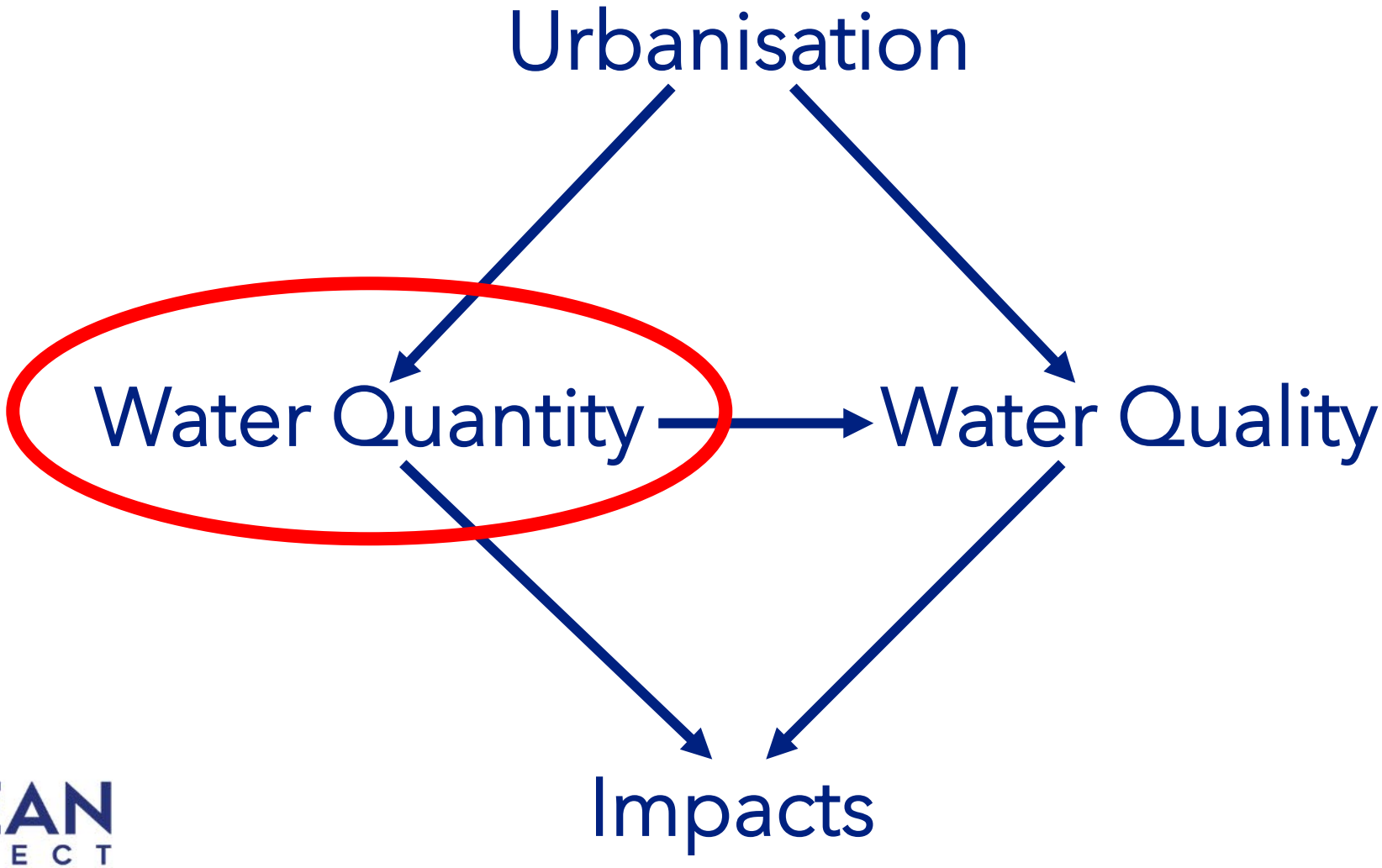

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Traditional
stormwater
management

Traditional Stormwater Management

- Focused largely (if not entirely) on safely & economically conveying stormwater runoff from urban areas to receiving waterways
- Flood protection

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Traditional Stormwater Management (in Australia)

- ‘Separate’ stormwater & wastewater

Me in a cellar/ basement in West Yorkshire, UK ~ 2002

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Traditional Stormwater Management (in Australia)

- Kerb-side channels & inlet pits
- Pipes
- Channels ('natural' or artificial)
- Overland flow paths (e.g. streets, drainage areas)
- Detention basins

Hydrological impacts (again)

- Reduced rainfall/ runoff interception
- Reduced infiltration
- Runoff transported much quicker/ intensely into waterways

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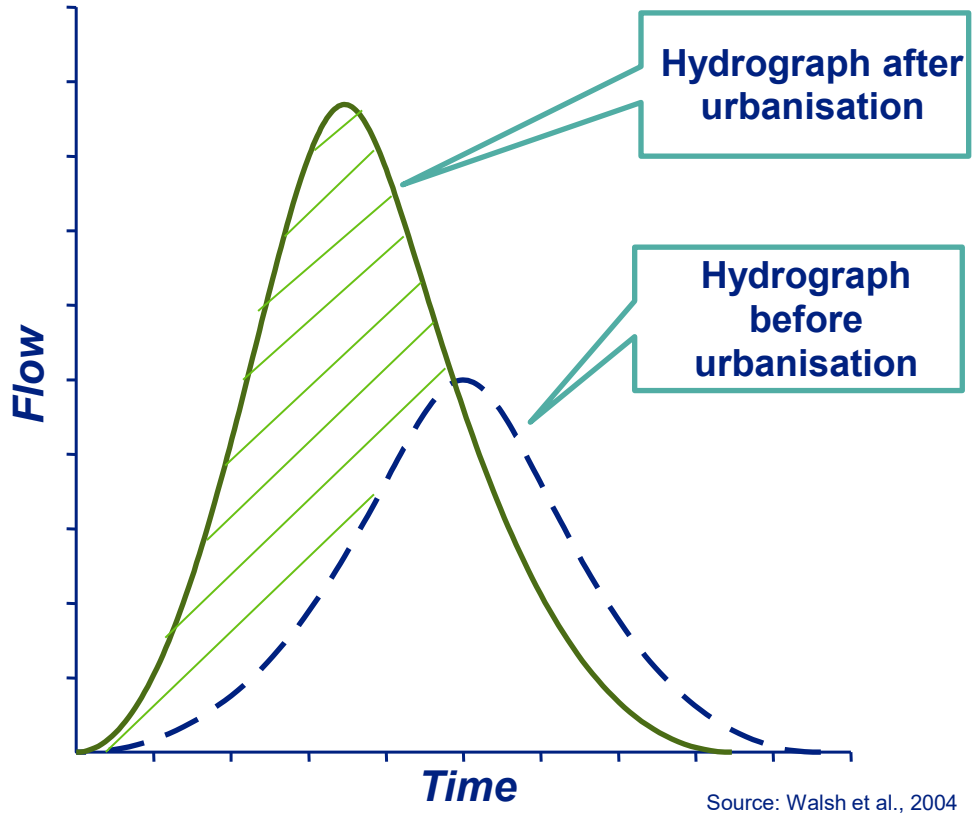
Hydrological change



Source: Walsh et al., 2004

- Decreased time to peak flow-rate
- Increased runoff peak FLOW-RATE
- Increased runoff VOLUME

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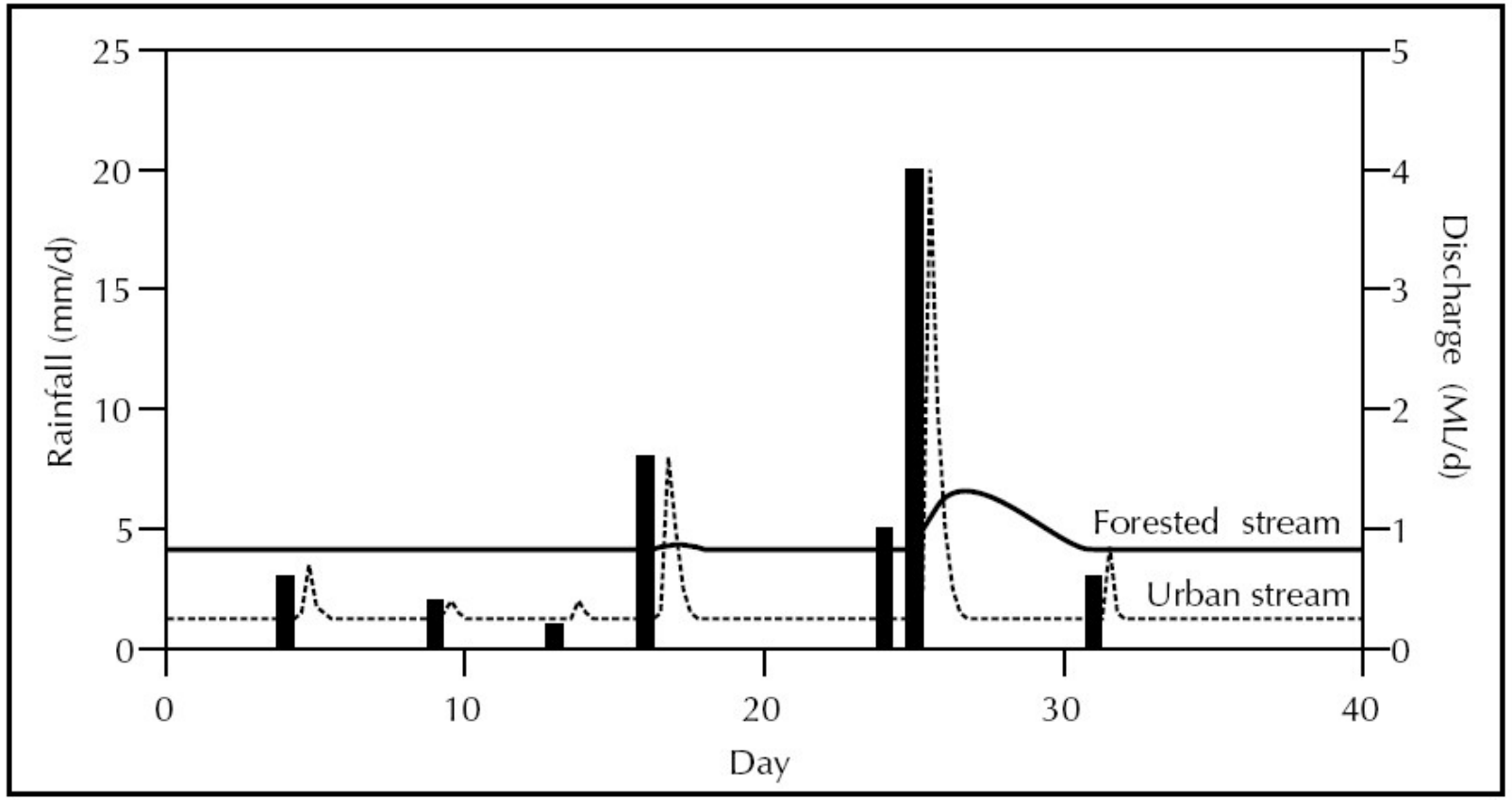
Hydrological change



Schematic diagram showing flow response to rainfall (bars) in two hypothetical streams with a catchment of 1 km^2: one draining a forested catchment (solid line) and one draining an urbanized catchment with conventional stormwater drainage systems (dashed line).

- Decreased time to peak flow-rate
- Increased runoff peak FLOW-RATE
- Increased runoff VOLUME
- Increased runoff FREQUENCY

- Smaller more frequent rainfall events that may have previously infiltrated in an undeveloped (e.g. forested) catchment generate runoff

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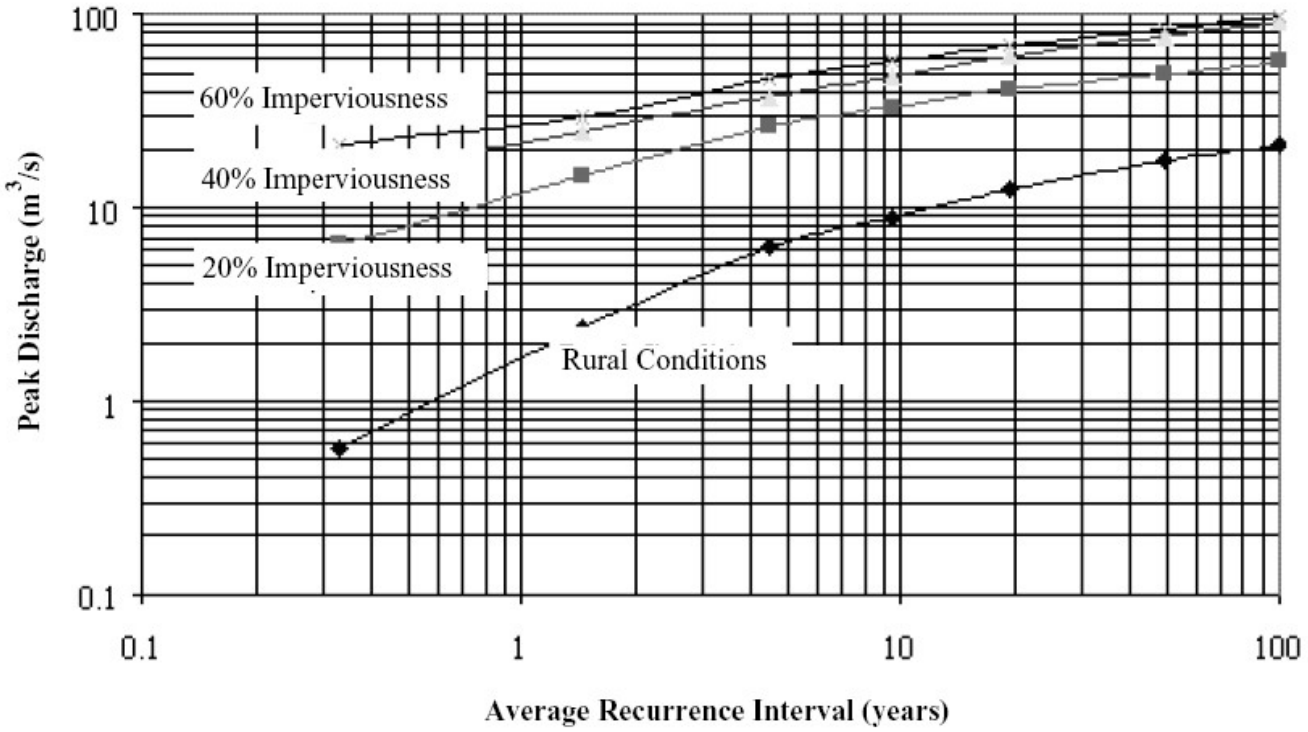
(Source: Walsh et al, 2004).

Peak flow & imperviousness



(Source: Wong et al, 2000)

- Peak discharge from an urbanised catchment can be as much as 35 times that generated from a rural catchment
- Difference most pronounced for FREQUENT (small) rainfall events

Source: Walsh et al., 2004

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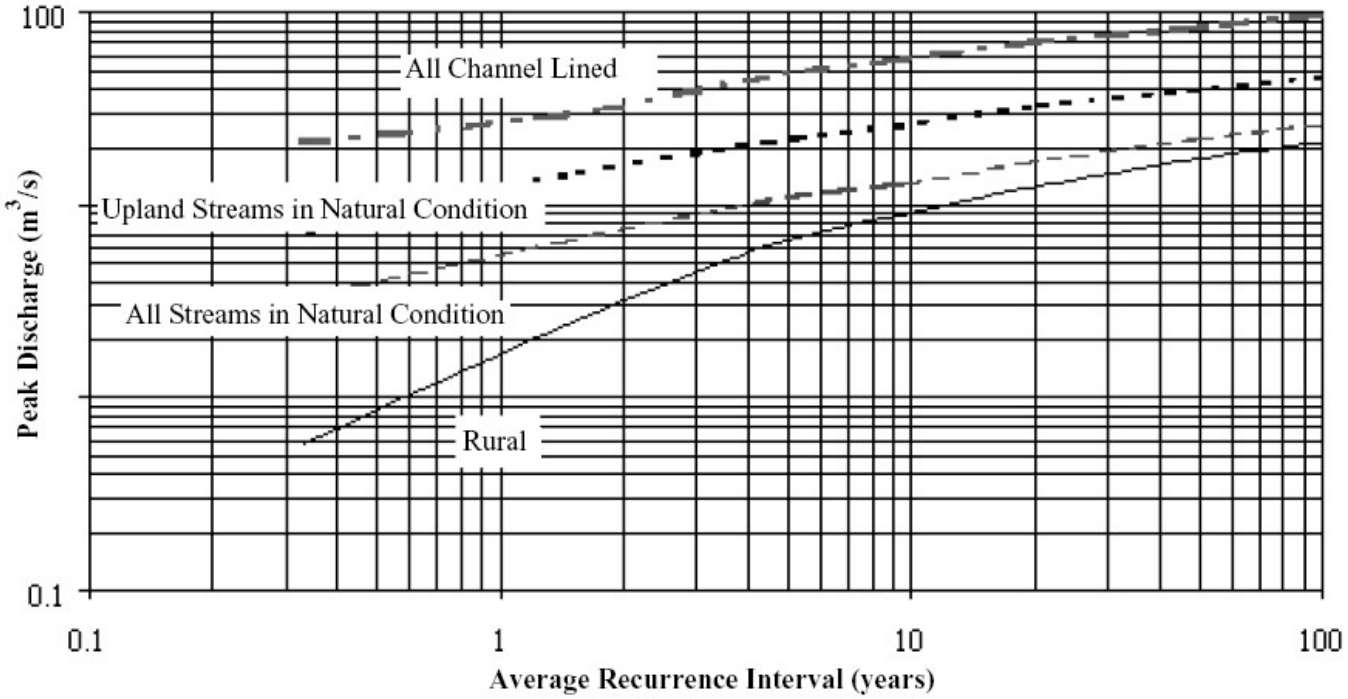
Peak flow & hydraulic efficiency



(Source: Wong et al, 2000)

- Increased hydraulic efficiency can account for up to 95% of the increase in peak discharge in an urbanised catchment

(Source: Wong et al, 2000)

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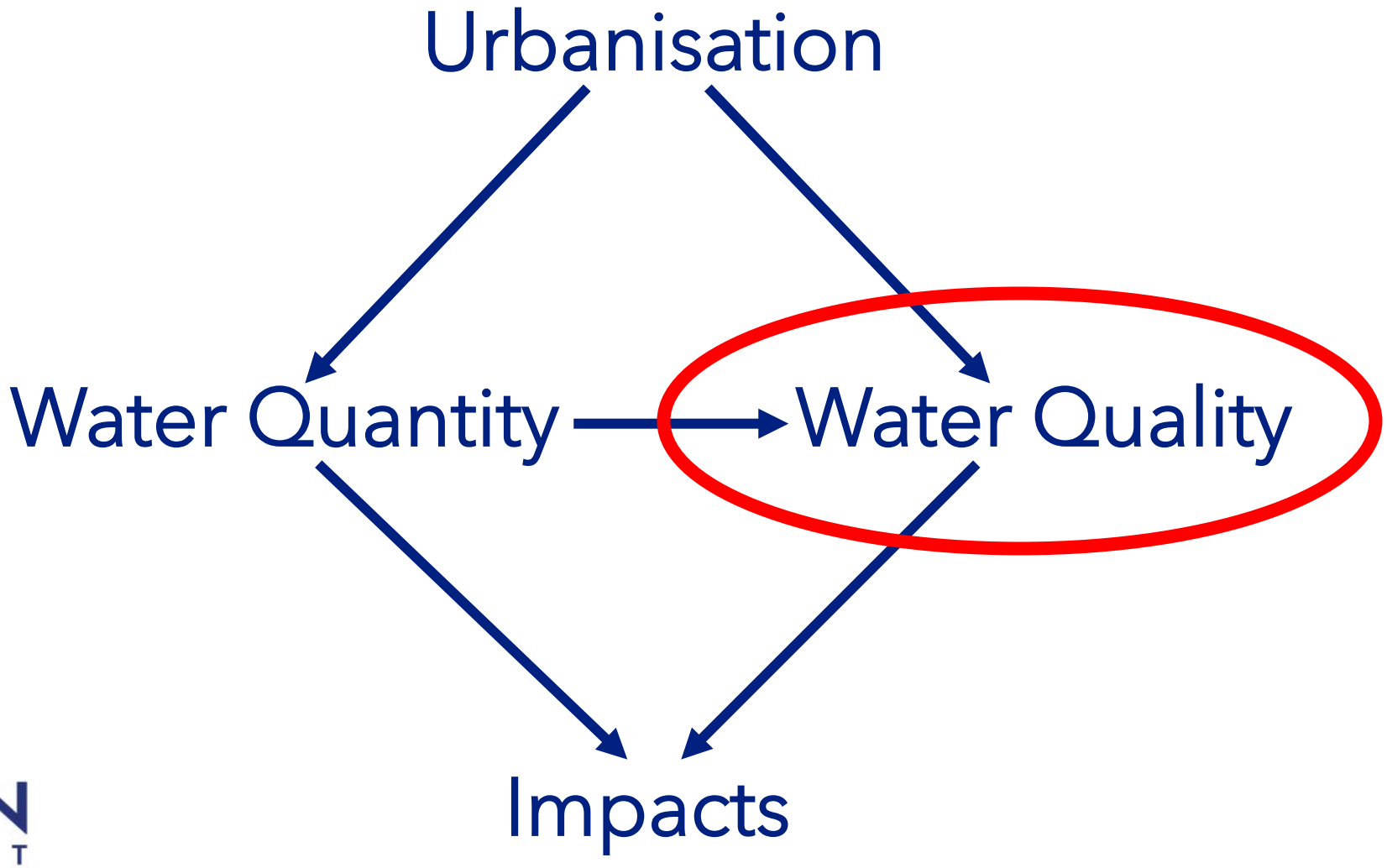

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How does stormwater become polluted ?

Build-up

- Accumulation of pollutants surfaces
- Via:
  - Dry deposition or fallout (the settling of fine particles from the atmosphere)
  - Accumulation of pollutants (e.g. fine particles, gross pollutants) from local sources
  - Redistribution of surface pollutants by wind & traffic
- Depends on:
  - Rate of deposition
  - Any removal by redistribution, decomposition, street sweeping/ wash-off

Wash-off:

- Removal of accumulated pollutants by rainfall & runoff
- Via:
  - Rain-drop impact & flowing water loosens particles, which become suspended in water and conveyed downstream
  - Pollutants washed out from the atmosphere by rainfall

(Source: Chiew et al, 1997)

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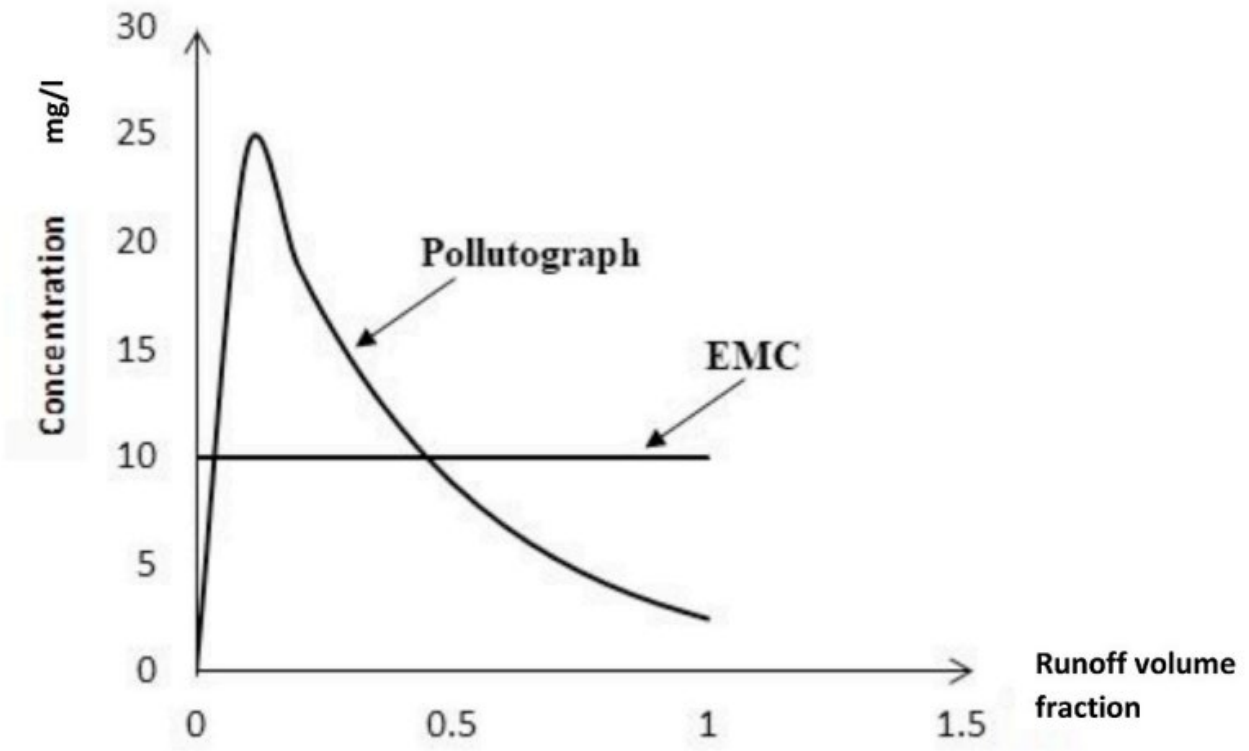

Fig. 1. Pollutogrpah and the EMC of a typical storm runoff event.

(Source: Perera et al, 2021)

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Forested catchments

- Majority of contaminants (that fall from the air, eroded from rocks or derived from plants/ animals) are taken up by processes within the forest or soil
- Potential contaminants are usually retained or removed by terrestrial processes in the catchment
- Water flowing in streams is usually of high quality
  - very low levels of contaminants with high levels of dissolved oxygen

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Urbanisation

- Increases the amount of many contaminants in the catchment; and
- Introduces a large number of potentially toxic contaminants that are not found at all in undeveloped catchments

Source: UniNSW (2024)

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Key pollutants in urban stormwater ?

- Sediments
- Nutrients
- Heavy metals
- Bacteria
- Litter

❖ …. ‘emerging’ contaminants ?

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Sediments

- ‘Sediments’ = soil & other fine particles
- Type:
  - Inorganic/ organic particulates
- Key sources:
  - Erosion
  - Land degradation

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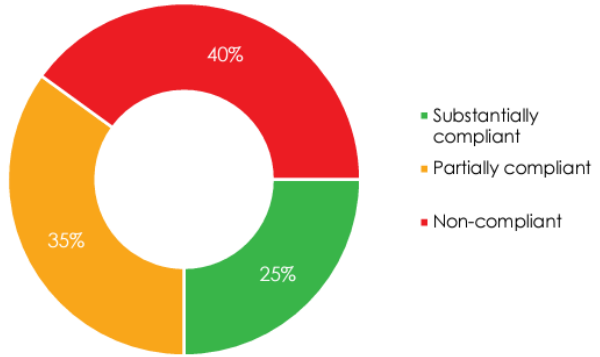
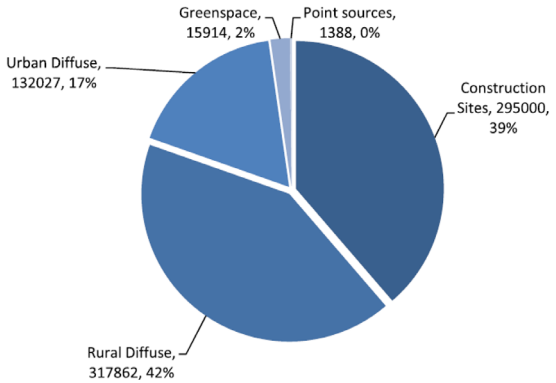
A “low hanging fruit” for healthier rivers

Enforce erosion & sediment control practices on construction sites

Examples of non-compliant building and development sites.



Overall ESC compliance rating for 135 building sites in seven LGAs



Estimated annual contributions of sediment to receiving waters in SEQ

Figures are in tonnes/ year and percentage contribution from that land use/ activity Source: Hoban (2012)

The sediment plume from the 2022 SEQ floods entering southern Moreton Bay (Sentinel-2 imagery from European Space Agency).

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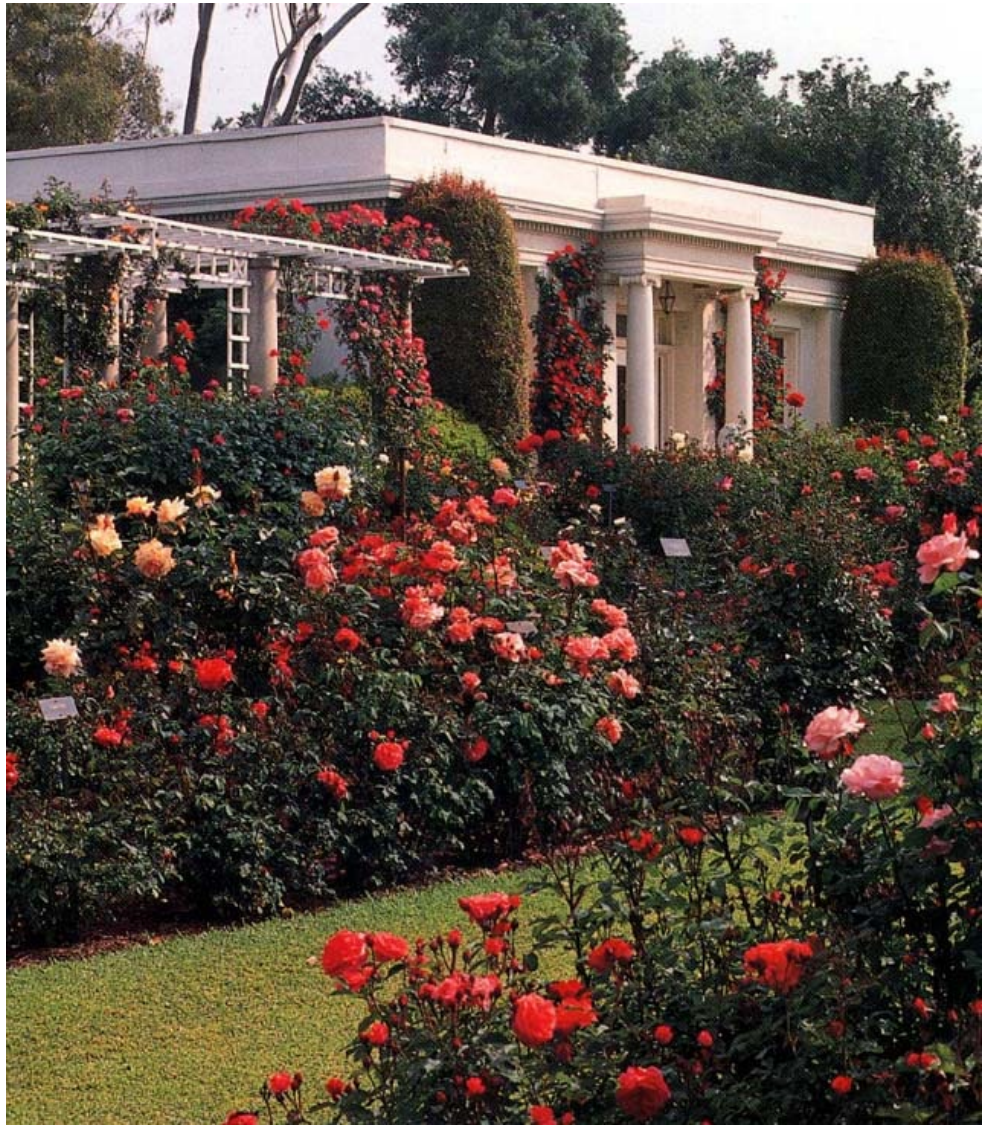
Healthy Land & Water (2022), *Review of Erosion and Sediment Control in South East Queensland*, Brisbane, Queensland, Healthy Land & Water.

Nutrients

- Type:
  - Mainly nitrogen (N) & phosphorus (P)
- Key sources:
  - Erosion/ land degradation
  - Roads
  - Sewer overflows
  - Industrial discharges
  - Animal waste
  - Fertilisers
  - Domestic detergents
  - Septic tank seepage
  - Rainfall



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Heavy metals

- Type:
  - Cd, Cr, Ni, Pb, Zn
- Key sources:
  - Roads
    - Vehicle emissions
    - Wear from vehicle components (eg. tyres, brakes)
  - Road/ pavement degradation
  - Roofs
  - Erosion/ land degradation
  - Atmospheric deposition (e.g. air pollution)
  - etc.

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Bacteria

- Type:
  - Faecal coliforms, pathogens
- Key sources:
  - Animals (domestic pets & birds)
  - Sewer/ septic overflows/ leakage

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Gross pollutants

- Type:
  - Litter, vegetation
  - Anything bigger than ~ 5mm
- Key sources:
  - Humans
  - Vegetation

~15,000 cigarette butts collected by small group of volunteers on Gold Coast, December 2023

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CARTON PICK HEADER Label
NO SUGAR
Coca-Cola


DO NOT
OVERTAKE
TURNING VEHICLE
CL·05·CT

What is being captured?

8 Gully pit baskets in Western Sydney

~2720m^2 urban road catchment

5 months (2019)

850 bits of plastic, including:

- 228 cigarette butts
- 88 plastic drink lids
- 44 cans
- 22 plastic cups
- 21 plastic straws

130kg of sediment

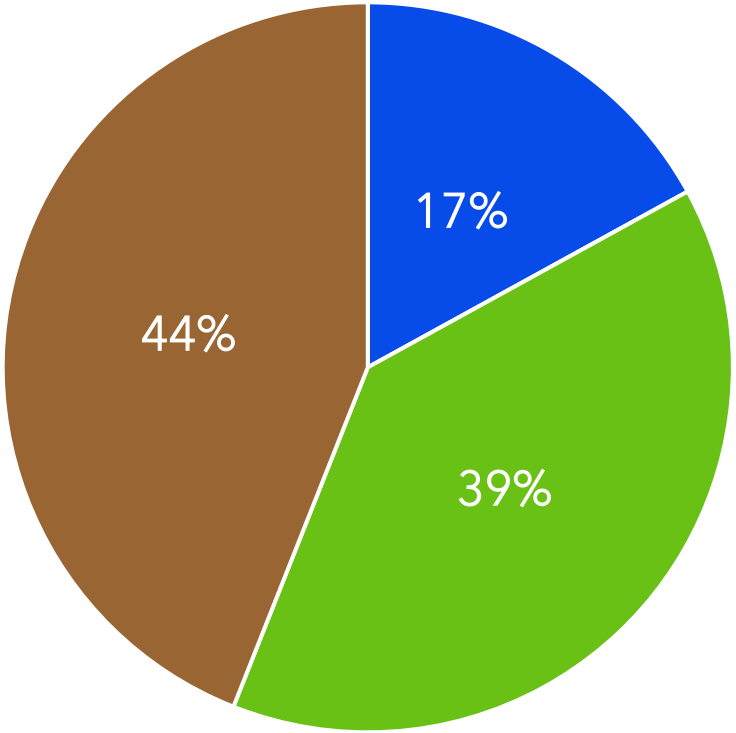
What is being captured in GPTs ?

158 GPTs
in a NSW LGA

1,044 GPT cleans

35 months
(2014-2016)

1,693m^3 removed



- Litter
- Organics
- Sediment

% by volume

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Source: Brad Dalrymple et al 2017


Before
After




7

music BY eWater

- Models the generation, transport & treatment of:
  - Total Suspended Solids
  - Total Nitrogen
  - Total Phosphorus
  - Gross Pollutants

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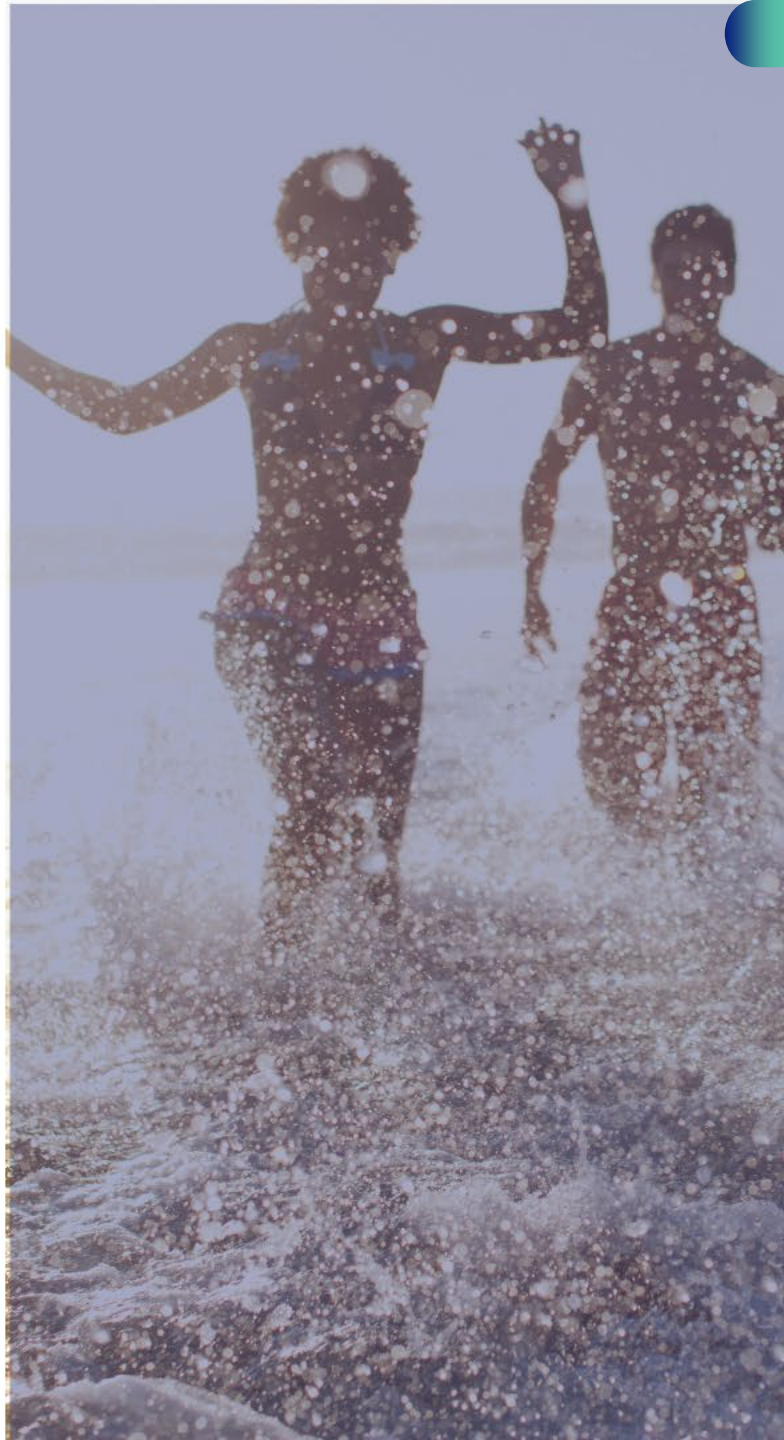


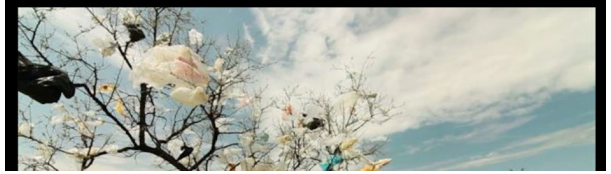

‘Emerging
contaminants’

Microplastics

ENVIRONMENT | PLANET OR PLASTIC?

In a first, microplastics found in human poop

As microplastics permeate remote places and species around the globe, people are no exception.



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Randomized Controlled Trial > Lancet. 2020 Jul 18;396(10245):167-176.
doi: 10.1016/S0140-6736(20)30539-0.

Urgent endoscopic retrograde cholangiopancreatography with sphincterotomy versus conservative treatment in predicted severe acute gallstone pancreatitis (APEC): a multicentre randomised controlled trial

Nicolien J Schepers [1], Nora D L Hallensleben [2], Marc G Besselink [3], Marie-Paule G F Anten [4], Thomas L Bollen [5], David W da Costa [5], Foke van Delft [6], Sven M van Dijk [7], Hendrik M van Dullemen [8], Marcel G W Dijkgraaf [9], Casper H J van Eijck [10], G Willemien Erkelens [11], Nicole S Erler [12], Paul Fockens [6], Erwin J M van Geenen [13], Janneke van Grinsven [3], Robbert A Hollemans [7], Jeanin E van Hooft [6], Rene W M van der Hulst [14], Jeroen M Jansen [15], Frank J G M Kubben [16], Sjoerd D Kuiken [15], Robert J F Laheij [17], Rutger Quispel [18], Rogier J J de Ridder [19], Marno C M Rijk [20], Tessa E H Römkens [21], Carola H M Ruigrok [18], Erik J Schoon [22], Matthijs P Schwartz [23], Xavier J N M Smeets [13], B W Marcel Spanier [24], Adriaan C I T L Tan [25], Willem J Thijs [26], Robin Timmer [27], Niels G Venneman [28], Robert C Verdonk [27], Frank P Vleggaar [29], Wim van de Vrie [30], Ben J Witteman [31], Hjalmar C van Santvoort [32], Olaf J Bakker [7], Marco J Bruno [33], Dutch Pancreatitis Study Group

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Microplastics detected in placentas, infant feces, breastmilk, and infant formula

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By Dr. Liji Thomas, MD — Sep 21 2022

Reviewed by Benedette Cuffori, M.Sc.

Due to the exponential increase in the manufacturing, use, and disposal of plastics, the pollution of these products continues to overwhelm ecosystems throughout the world. Following their release into the environment, these places eventually degrade into microplastics (MPs) that can cause significant harm to organisms.

A new *Science of the Total Environment* journal paper reports the presence of this unknown and potentially life-threatening class of contaminants in uterine and infant tissues, breastmilk, and infant formula.

ELSEVIER

Science of The Total Environment
Volume 854, 1 January 2023, 158699

Detection of various microplastics in placentas, meconium, infant feces, breastmilk and infant formula: A pilot prospective study

Shaojie Liu [a, 1], Jialin Guo [c, 1], Xinyuan Liu [a, 1], Ruoru Yang [a], Hangwei Wang [a], Yongyun Sun [a], Bo Chen [a, b], Ruihua Dong [a, b]

ELSEVIER

Science of The Total Environment
Volume 807, Part 2, 10 February 2022, 150817

Microglial phagocytosis of polystyrene microplastics results in immune alteration and apoptosis *in vitro* and *in vivo*

Wookbong Kwon [a, b, 1], Daehwan Kim [a, b, 1], Hee-Yeon Kim [b, c], Sang Won Jeong [a], Se-Guen Lee [a], Hyun-Chul Kim [a], Young-Jae Lee [a], Mi Kyung Kwon [a], Jun-Seong Hwang [a], Jee Eun Han [c], Jin-Kyu Park [c], Sung-Jun Lee [a], Seong-Kyoon Choi [a, b]

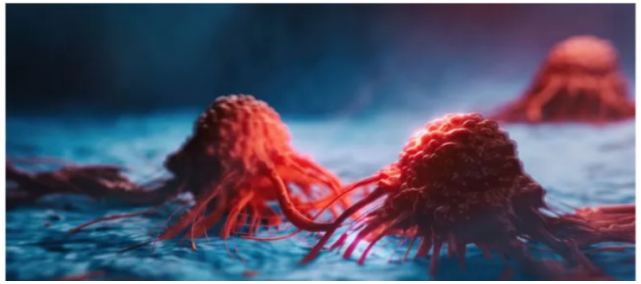
Health > Viruses, Infections & Disease > Cancer

'Very concerning': Microplastics can accumulate in cancer cells and may help them spread, study hints

News By Sneha Khedkar published March 22, 2024

An early lab-dish study in cancer cells suggests microplastics can persist through cell division and may contribute to cancer spread, when they're in tumors.

Comments (0)



ELSEVIER

Chemosphere
Volume 353, April 2024, 141463

Microplastics role in cell migration and distribution during cancer cell division

Ekaterina Brynzak-Schreiber [a], Elisabeth Schögl [a b], Carolin Bapp [a], Klaudia Cseh [c], Verena Kopatz [d e f g], Michael A. Jakupec [c], Andreas Weber [b], Tobias Lange [h i j], José L. Toca-Herrera [b], Giorgia del Favero [k l], Wolfgang Wadsak [e m], Lukas Kenner [d e g n o], Verena Pichler [a e]

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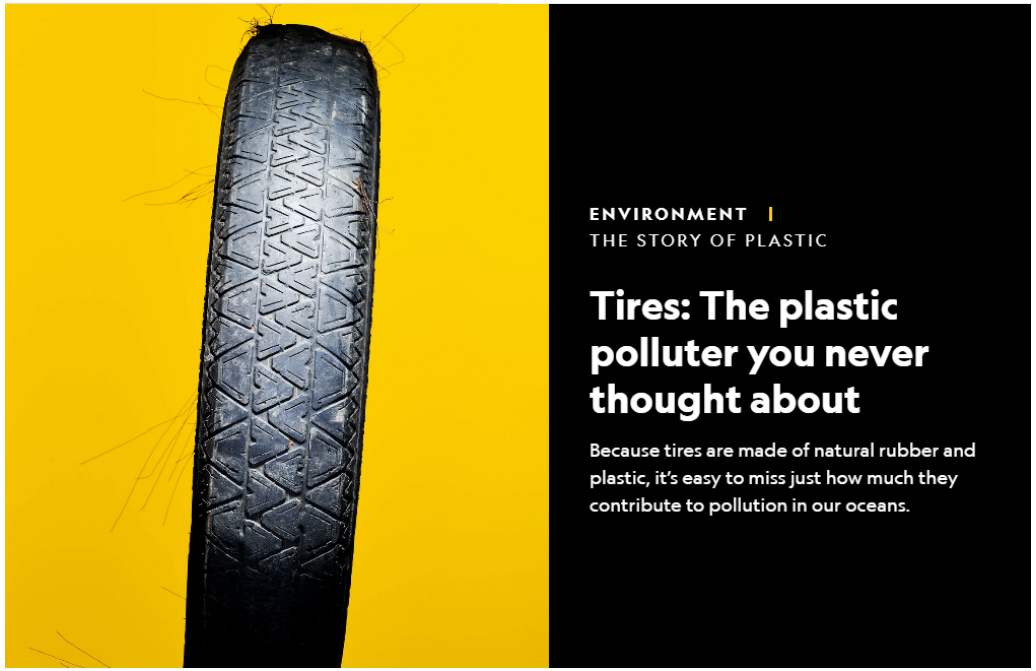
Microplastics – Vehicle tyre wear & tear

NATIONAL GEOGRAPHIC



ENVIRONMENT |
THE STORY OF PLASTIC

Tires: The plastic polluter you never thought about

Because tires are made of natural rubber and plastic, it's easy to miss just how much they contribute to pollution in our oceans.

IUCN

Primary Microplastics in the Oceans:

a Global Evaluation of Sources

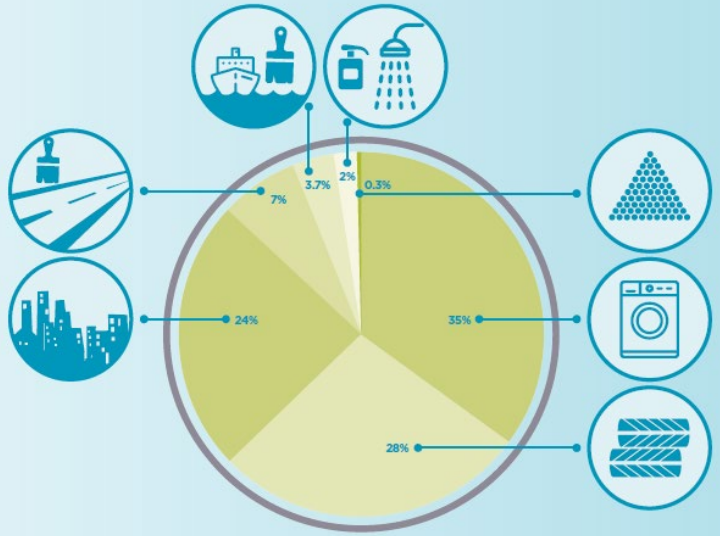
Authors: Julien Boucher, Damien Friot

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

MAVA ea SVENSKA POSTKOD LOTTERIET GALLIFREY FOUNDATION

GLOBAL RELEASES OF PRIMARY MICROPLASTICS TO THE WORLD OCEANS

BY SOURCE (IN %).



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Environmental Science & Technology

pubs.acs.org/est

Article

Concentrations of Tire Additive Chemicals and Tire Road Wear Particles in an Australian Urban Tributary

Cassandra Rauert,* Nathan Charlton, Elvis D. Okoffo, Ryan S. Stanton, Alon R. Agua, Michael C. Pirrung, and Kevin V. Thomas

Cite This: *Environ. Sci. Technol.* 2022, 56, 2421–2431

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ECOTOXICOLOGY

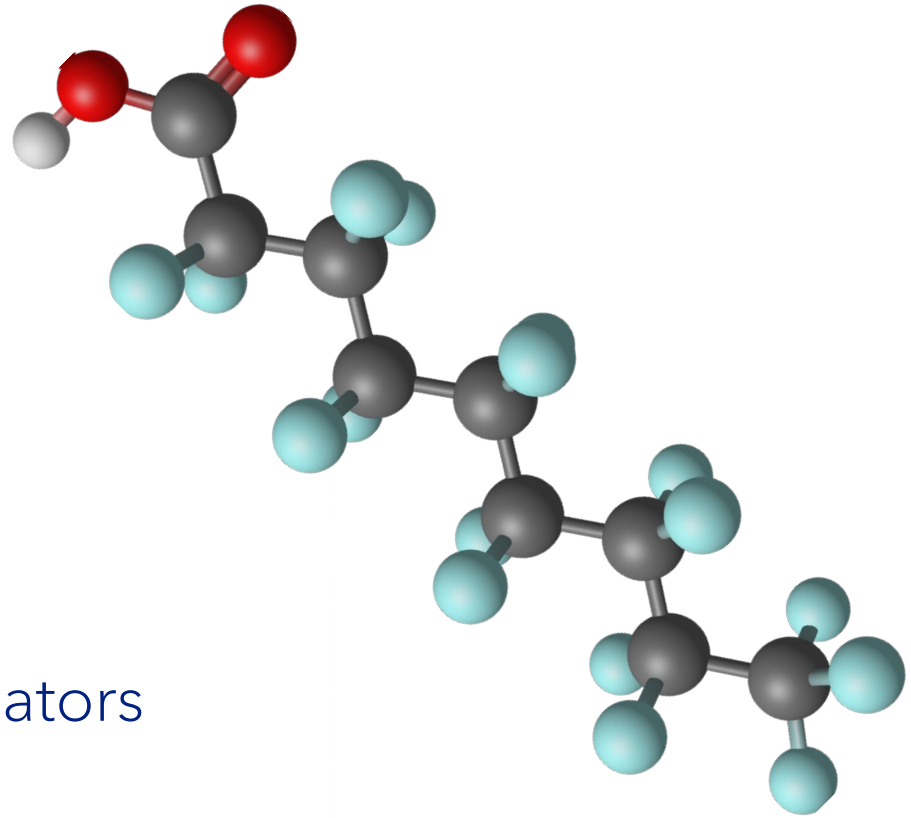
A ubiquitous tire rubber–derived chemical induces acute mortality in coho salmon

Zhenyu Tian[1,2], Haoqi Zhao[3], Katherine T. Peter[1,2], Melissa Gonzalez[1,2], Jill Wetzel[4], Christopher Wu[1,2], Ximin Hu[3], Jasmine Prat[4], Emma Mudrock[4], Rachel Hettinger[1,2], Allan E. Cortina[1,2], Rajshree Ghosh Biswas[5], Flávio Vinicius Crizóstomo Kock[5], Ronald Soong[5], Amy Jenne[5], Bowen Du[6], Fan Hou[3], Huan He[3], Rachel Lundeen[1,2], Alicia Gilbreath[7], Rebecca Sutton[7], Nathaniel L. Scholz[8], Jay W. Davis[9], Michael C. Dodd[3], Andre Simpson[5], Jenifer K. McIntyre[4], Edward P. Kolodziej[1,2,3]*

In U.S. Pacific Northwest coho salmon (*Oncorhynchus kisutch*), stormwater exposure annually causes unexplained acute mortality when adult salmon migrate to urban creeks to reproduce. By investigating this phenomenon, we identified a highly toxic quinone transformation product of *N*-(1,3-dimethylbutyl)-*N*′-phenyl-p-phenylenediamine (6PPD), a globally ubiquitous tire rubber antioxidant. Retrospective analysis of representative roadway runoff and stormwater-affected creeks of the U.S. West Coast indicated widespread occurrence of 6PPD-quinone (<0.3 to 19 micrograms

Per & poly-fluoroalkyl substances (PFAS)

- Manufactured ‘forever chemicals’
- Produced since 1940’s
- Used in various products
- Persistent
- Toxic
- Bio-accumulative
- Everywhere
- High priority for environmental regulators



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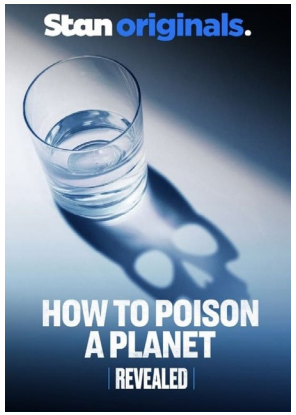
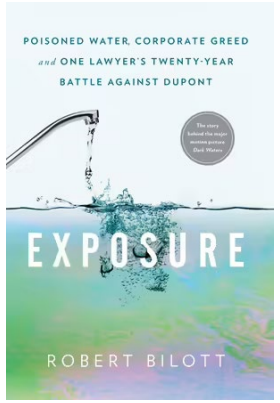
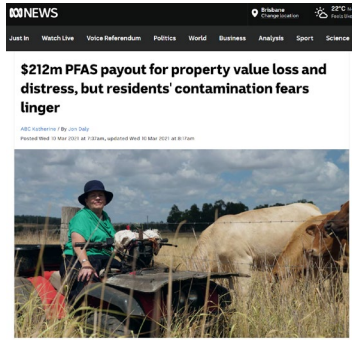
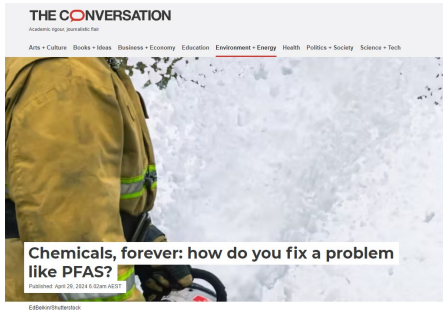
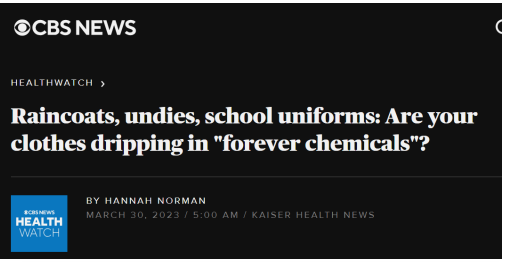
PFAS in the media (& courts)

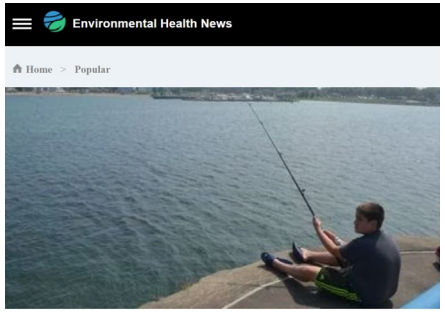


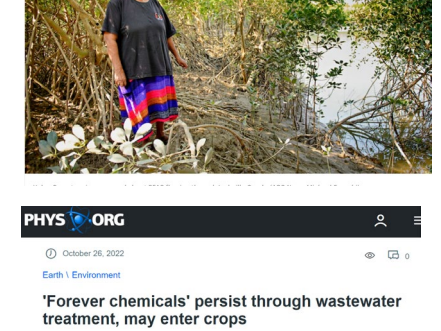


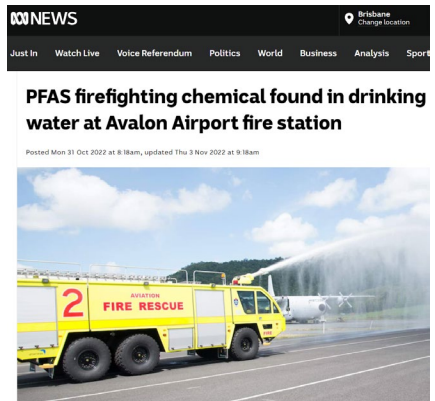


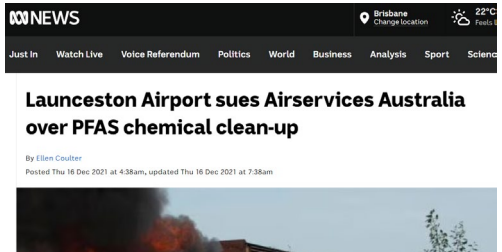












Australian Government
Defence

PFAS INVESTIGATION AND MANAGEMENT PROGRAM

SERVICE
COURAGE
RESPECT
INTEGRITY
EXCELLENCE

PFAS INVESTIGATION AND MANAGEMENT PROGRAM SNAPSHOT - JULY 2022

Program financials (AUD)

As of July 22

Spent to Date (Since 2016)
$580 million

FY22/23 budget allocation
$117.5 million

Site statistics

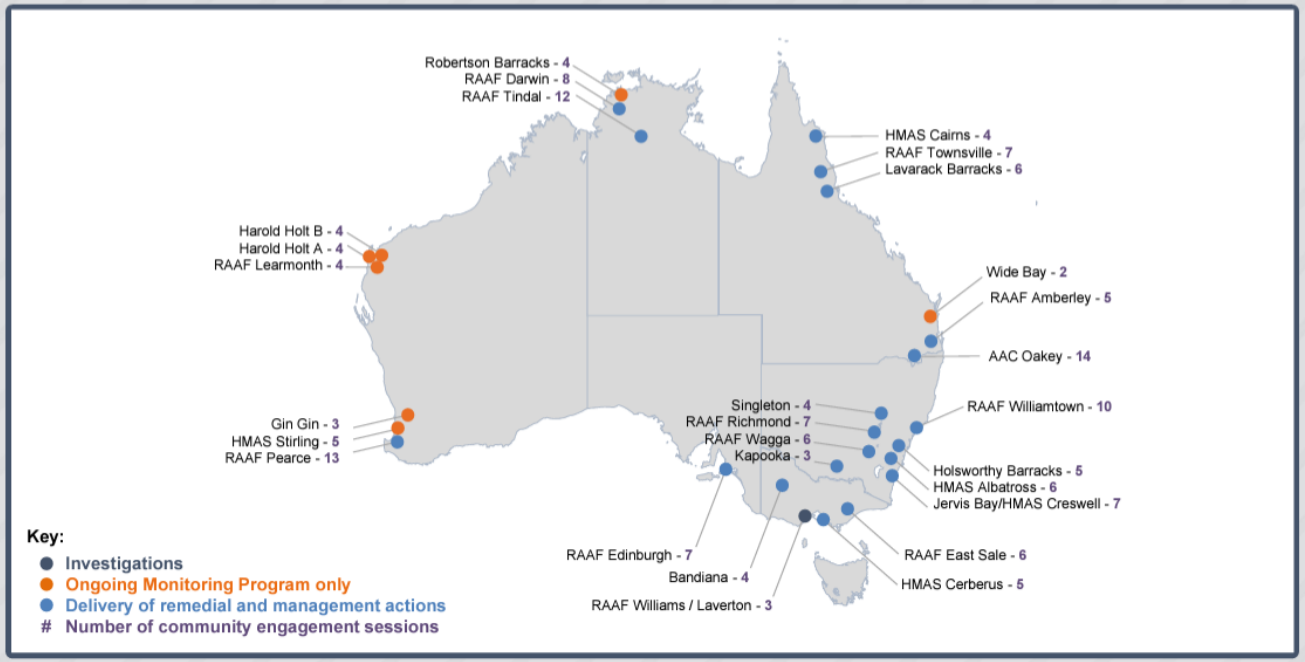
- PFAS environmental investigations are complete at 27 of 28 sites in Defence's PFAS investigation and management program.
- The 27 sites have now transitioned to remediation and/or management.
- The investigation at RAAF Williams (Laverton) is expected to conclude during the second half of 2022.

Program uncertainties

- Emerging science that may inform the risk profile of current levels of contamination.
- Emerging policy and regulatory frameworks and guidance.
- Rate of development of technology and options improving the efficiency and effectiveness of remedial actions.
- Unseasonal or extreme weather events may delay the conduct of remedial works or impact the effectiveness of works or technology trials underway.

Community & stakeholder concerns / risks

- Results from Defence's Ongoing Monitoring Program may demonstrate changes in PFAS contamination levels or locations, and leading to additional Defence responses.
- Remedial activities may not deliver timely changes to PFAS contamination profiles, or remediate to the extent desired.
- Uncertainty over the human health and ecological impacts of PFAS exposure.
- Delivery of town water infrastructure to the West Bullsbrook community.
- Concern over the impact of PFAS contamination on property values.



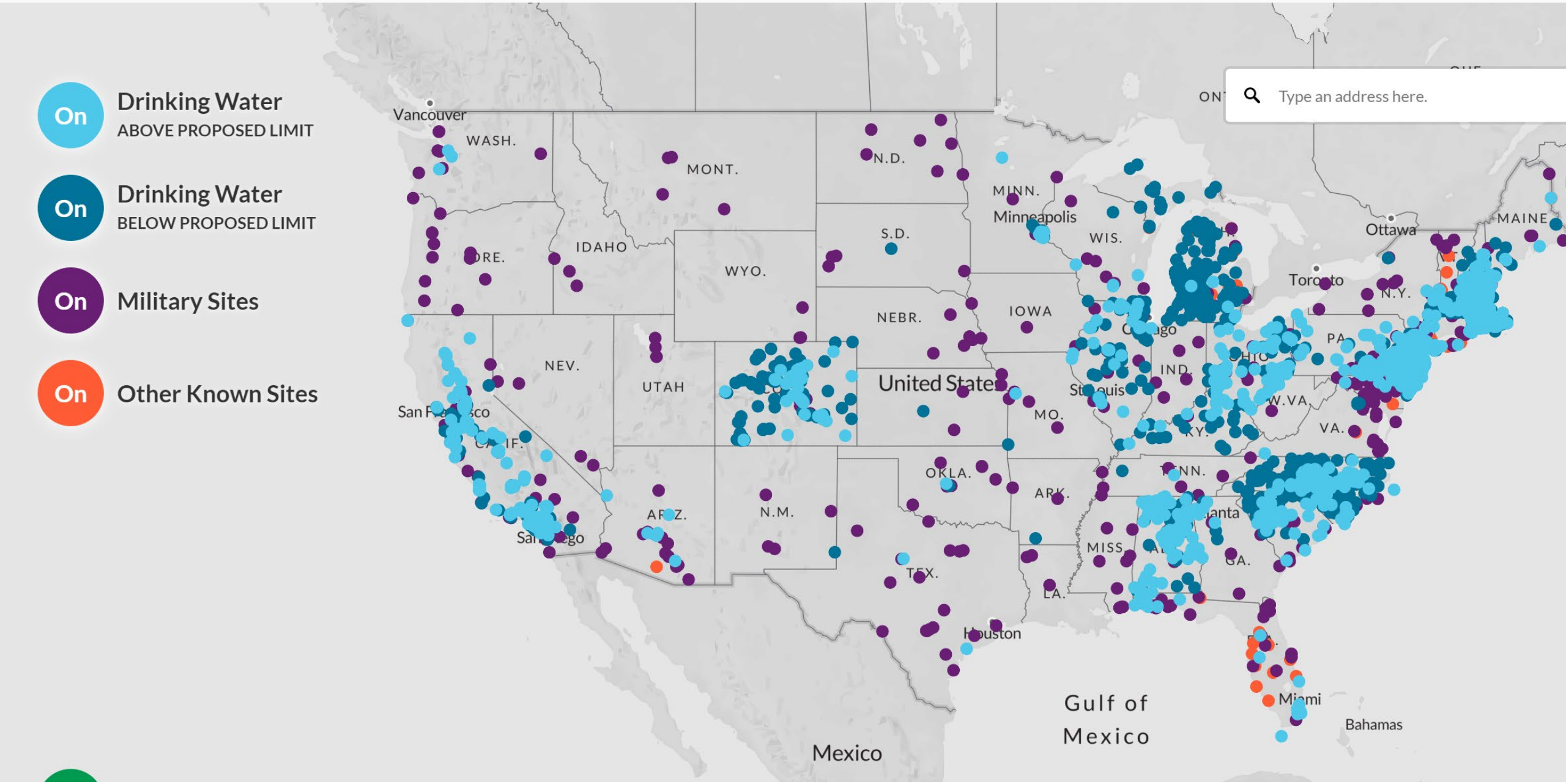
Remedial actions

- Treated over 8 billion litres of water.
- Treated and/or removed over 54,000 tonnes of contaminated soil.
- Provided 115 rainwater tanks to 80 properties in affected areas.
- Connected 378 properties to town water.
- Provided funding of approximately $24 million for 13 research activities in support of PFAS investigation and remediation activities.
- Remediation using water treatment plants are currently operating at Edinburgh (1), Tindal (2), Katherine (1), Williamtown (2), and Oakey (1). Resin media regeneration facilities are operating at both Williamtown and Tindal.
- Remediation works targeting soil and other materials have taken place or commenced at RAAF Base Williamtown, Army Aviation Centre Oakey, RAAF Base Edinburgh, HMAS Cerberus, RAAF Base Tindal, RAAF Base Pearce, and RAAF Base Townsville.
- Works are due to begin at RAAF Base Richmond, HMAS Creswell, and RAAF Base Darwin in the second half of 2022.

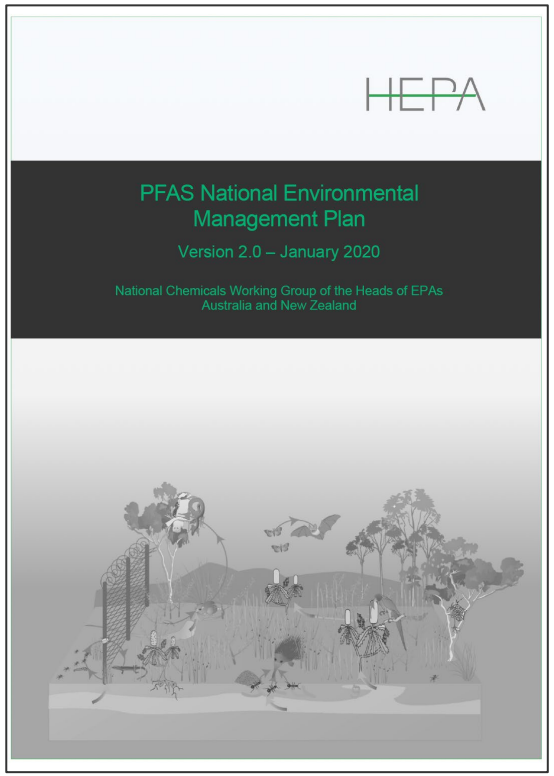
Our goal: To support affected communities and Defence capability by managing PFAS contamination on and around Defence bases, using the best science and practicable remedial approaches.

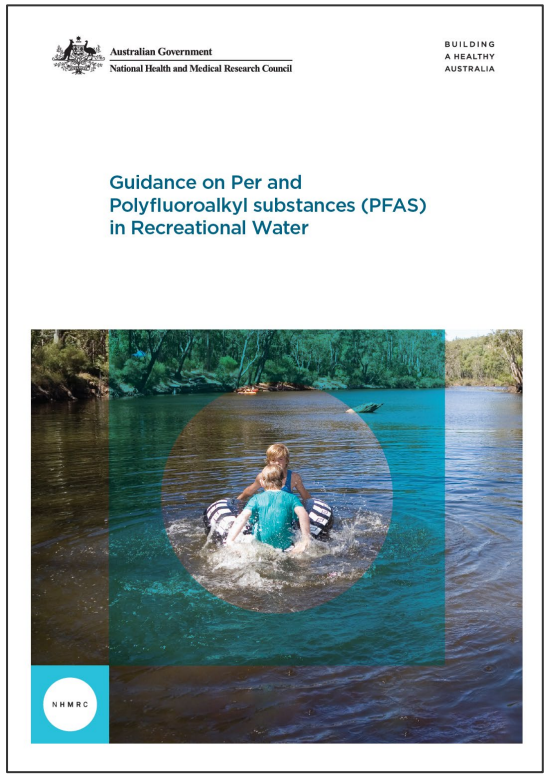
https://www.ewg.org/interactive-maps/pfas_contamination/map/

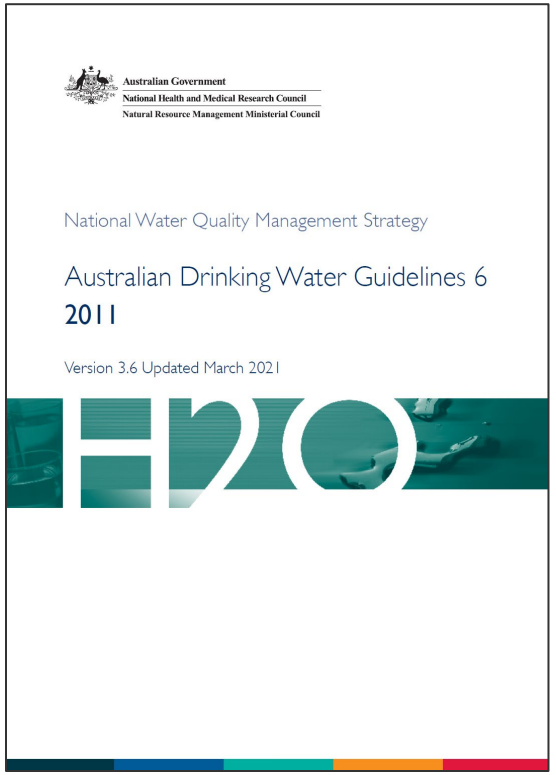
PFAS Contamination in the U.S. (June 8, 2022)

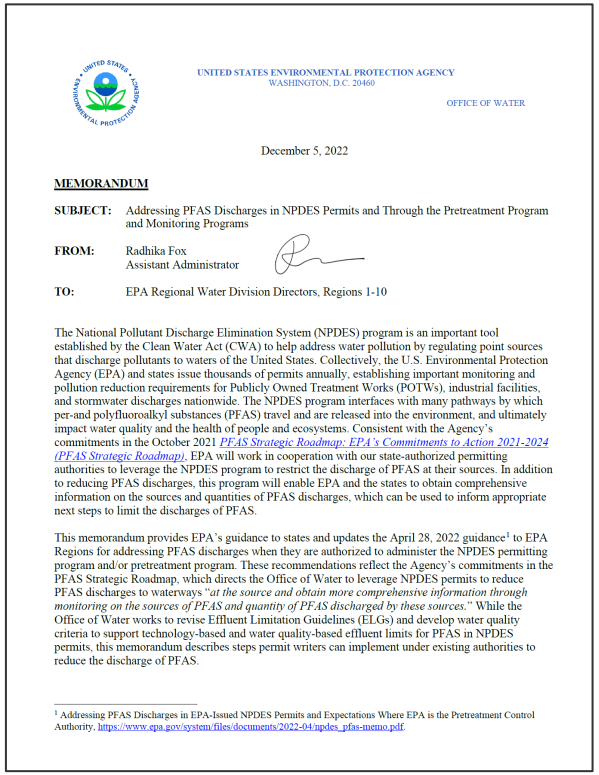


PFAS Guidelines & Regulations









UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF WATER

December 5, 2022

MEMORANDUM

SUBJECT: Addressing PFAS Discharges in NPDES Permits and Through the Pretreatment Program and Monitoring Programs

FROM: Radhika Fox
Assistant Administrator

TO: EPA Regional Water Division Directors, Regions 1-10

The National Pollutant Discharge Elimination System (NPDES) program is an important tool established by the Clean Water Act (CWA) to help address water pollution by regulating point sources that discharge pollutants to waters of the United States. Collectively, the U.S. Environmental Protection Agency (EPA) and states issue thousands of permits annually, establishing important monitoring and pollution reduction requirements for Publicly Owned Treatment Works (POTWs), industrial facilities, and stormwater discharges nationwide. The NPDES program interfaces with many pathways by which per-and polyfluoroalkyl substances (PFAS) travel and are released into the environment, and ultimately impact water quality and the health of people and ecosystems. Consistent with the Agency's commitments in the October 2021 *PFAS Strategic Roadmap: EPA's Commitments to Action 2021-2024 (PFAS Strategic Roadmap)*, EPA will work in cooperation with our state-authorized permitting authorities to leverage the NPDES program to restrict the discharge of PFAS at their sources. In addition to reducing PFAS discharges, this program will enable EPA and the states to obtain comprehensive information on the sources and quantities of PFAS discharges, which can be used to inform appropriate next steps to limit the discharges of PFAS.

This memorandum provides EPA's guidance to states and updates the April 28, 2022 guidance[1] to EPA Regions for addressing PFAS discharges when they are authorized to administer the NPDES permitting program and/or pretreatment program. These recommendations reflect the Agency's commitments in the PFAS Strategic Roadmap, which directs the Office of Water to leverage NPDES permits to reduce PFAS discharges to waterways "*at the source and obtain more comprehensive information through monitoring on the sources of PFAS and quantity of PFAS discharged by these sources.*" While the Office of Water works to revise Effluent Limitation Guidelines (ELGs) and develop water quality criteria to support technology-based and water quality-based effluent limits for PFAS in NPDES permits, this memorandum describes steps permit writers can implement under existing authorities to reduce the discharge of PFAS.

[1] Addressing PFAS Discharges in EPA-Issued NPDES Permits and Expectations Where EPA is the Pretreatment Control Authority, https://www.epa.gov/system/files/documents/2022-04/npdes_pfas-memo.pdf.

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Increased pollutant loads in catchment

+

Increased flows from catchment to waterways

Increased pollutant loads to waterways

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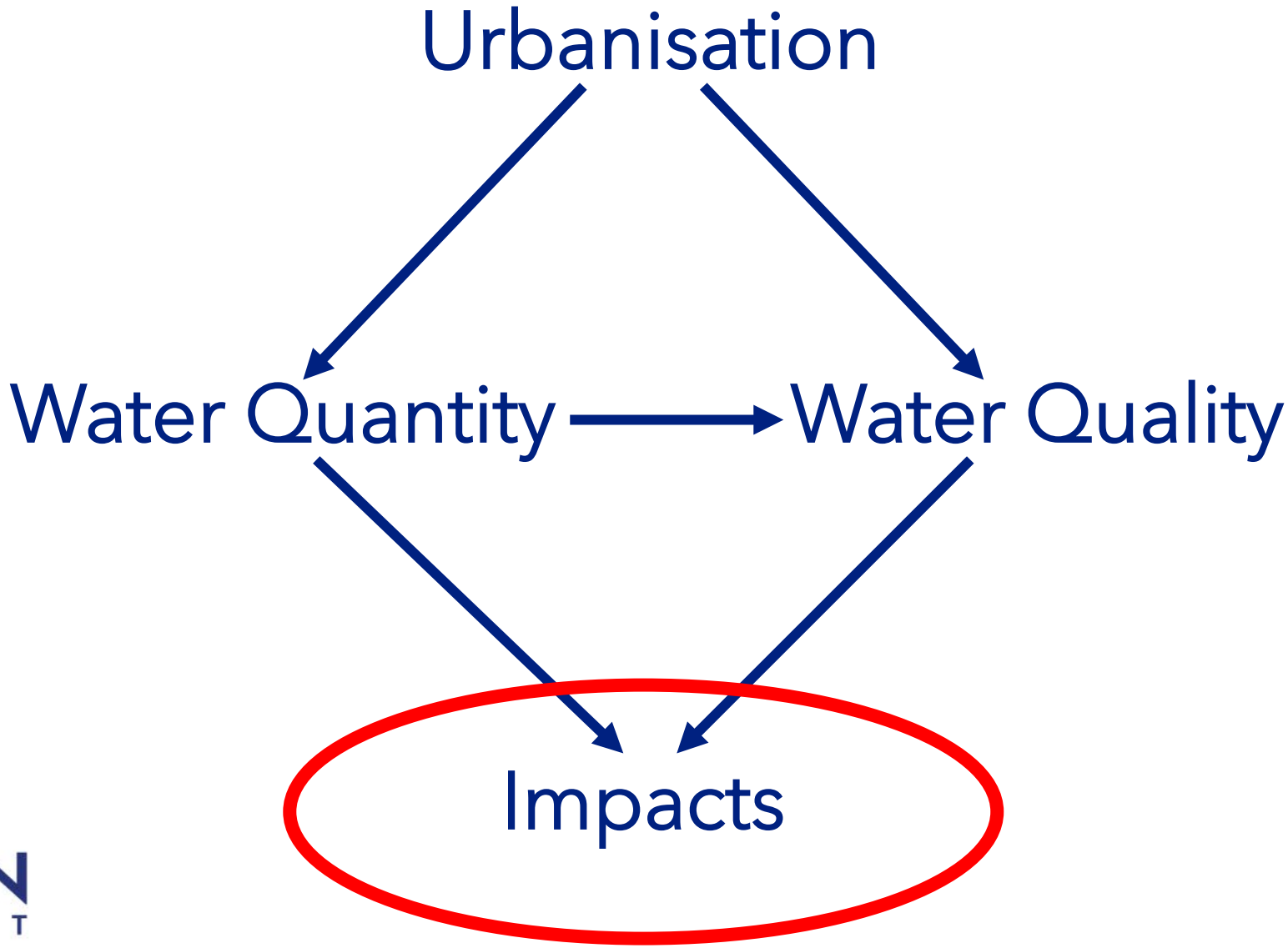
The impacts



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Impacts

- Flooding
- Channel form
- Water quality
- Ecological change

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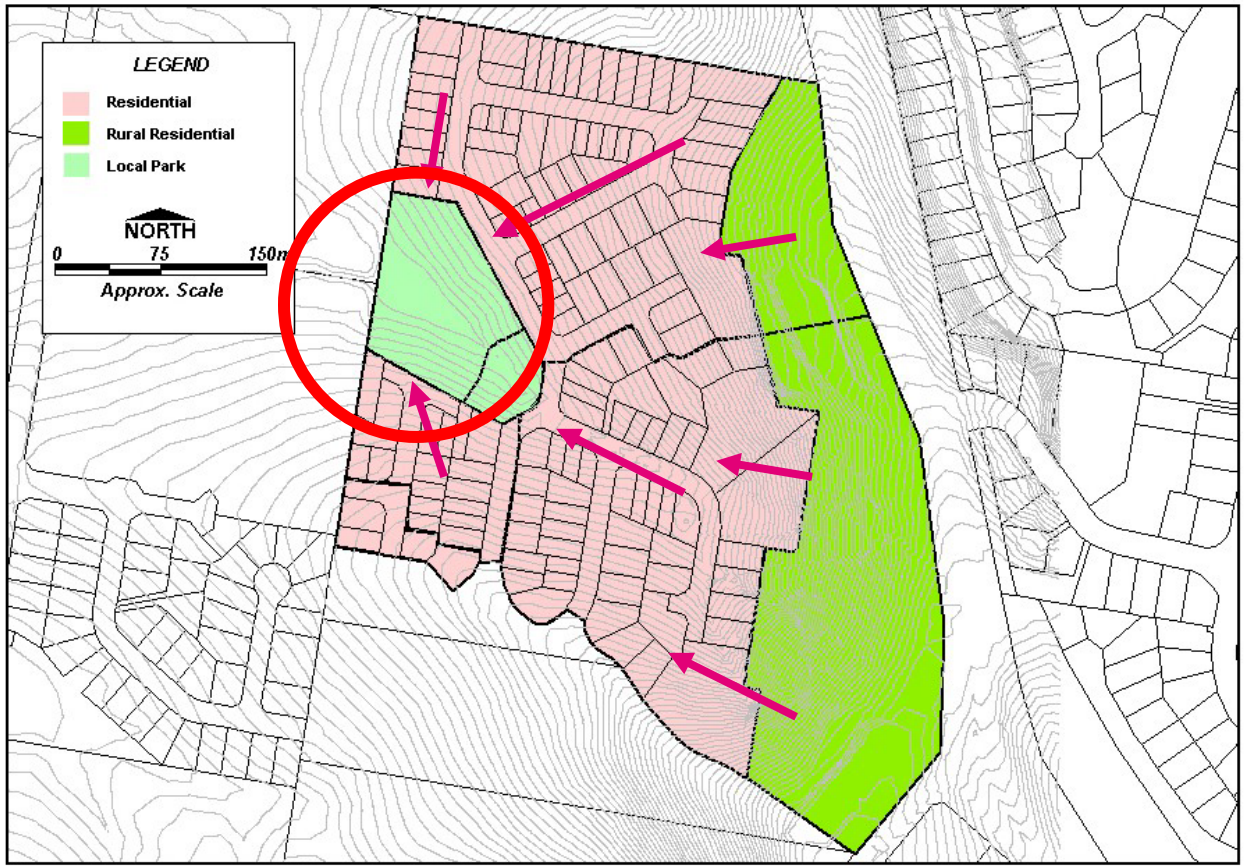
Flooding impacts

Flooding

- No-worsening' of peak flows for large/ infrequent (eg. Q5-100) rainfall events typically required for new urban development
- Some sort of 'detention' typically required

❖ Typically 'end-of-pipe' treatment focused on large (Q5-Q100) rainfall events



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Channel form impacts

Channel form

- Channel Form'
  - Shape of channel meanders
  - Width/ depth
  - Composition of sediment/ rocks in stream bed

- Stream channels adjust their width/ depth in response to long-term changes in:
  - Sediment supply
  - Size & frequency of flow

  (unless constrained by unerosive bed-rock)

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Channel form

- Urbanisation:
  - Increased peak flow rate, volume & frequency of stormwater flows
  - Increased sediment supply

- Stormwater management policies in recent past aimed at 'no-worsening' in peak flow-rates for large/ infrequent events
  - No/ little consideration of frequency or duration of small/ frequent flows

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Channel form

- Impacts of urbanisation:
  - Increased channel erosion, incision
  - Wider/ deeper channels
  - Reduced effects of riparian vegetation

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Channel form

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Channel form

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Benefits of riparian vegetation

- Moderation of water temperature
- Shading
- Reduced in-stream plant production
- Supply of organic matter (eg. leaves) to provide energy to the stream food web
- Supply of woody debris to create stream habitat
- Interception of sediments & other contaminants from the adjacent catchment
- Uptake and transformation of nitrate from shallow groundwater

(Source: Walsh et al, 2004)

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Channel form

- Likely that the most important effect of urban stormwater on channel form is the increased frequency of smaller floods (that approach or exceed bank-full flow-rates)

Management implications ?

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Water quality impacts

Dugongs *in Moreton Bay*

Scientific name: *Dugong dugon*

Dugongs, or 'seacows' as they are sometimes known, are tubby, vegetarian, marine mammals found in the warm, tropical, coastal waters of Australia. The coastal waters of South East Queensland are the southern limit of their distribution along the east Australian coastline.

Once common, this shy creature is now listed as a vulnerable species and, sadly, the population is continuing to decline. As few as 400 to 600 dugongs remain in Moreton Bay. The Moreton Bay Marine Park is the only place in the world where large numbers of these magnificent creatures can be found near a major city.

The dugong can grow up to 3 metres in length, weigh over 400 kilograms and can live for 70 years!

They are usually found in shallow waters protected from large waves and storms and surface only to breathe. Unlike other aquatic mammals such as dolphins and whales, dugongs cannot hold their breath under water for very long. Dugongs are often slow and graceful movers. They swim using their whale-like, fluked tail while their front flippers are used for balance and turning.

They have one offspring at a time, and mothers wait about three years before having another calf. A calf will stay with its mother for 18 months or more. The mother and her offspring communicate with each other by producing soft "chirps".

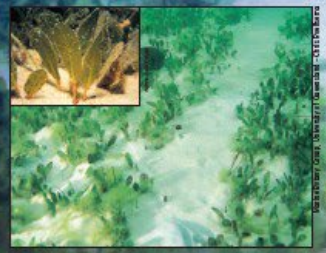
Dugongs are almost entirely dependent on seagrass as a food source. They can eat up to 30 kilograms of seagrass in a day! You can tell where they've been because they often leave clear trails in the seagrass bed.

The fate of these gentle creatures depends on us!

- The dugong survives solely on seagrasses and may become extinct if the seagrass dies off. See page 4 and 5 to find out how you can help look after seagrass.
- Boaties can help protect dugongs by going slow over seagrass meadows. There are five designated 'turtle and dugong go slow areas' within the Moreton Bay Marine Park (for locations contact Moreton Bay District Office 3821 9000). A deep boat propeller strike is almost certain to cause death or severe injury to a dugong.
- Remember to take all your rubbish with you. Dugongs can become tangled in plastic, old nets, fishing line and rope when it is thoughtlessly discarded in the sea.
- Keep local stormwater drains free of rubbish, garden waste, soil and any chemical pollutants. Water that goes down the stormwater drain is not treated and flows to the nearest creek or river. This water eventually makes its way into the ocean or bay.

Dugongs live in Moreton Bay

The Moreton Bay Marine Park is home to dugongs or 'seacows'. The local population of these shy, vegetarian marine mammals is continuing to decline. As few as 400 to 600 dugongs remain in Moreton Bay.



Their favorite food is seagrass

Dugongs are almost entirely dependent on seagrass as a food source. Dugongs eat entire seagrass plants, including below-ground roots and rhizomes, and often leave distinct grazing trails. Above you can see a dugong grazing path through the seagrass bed.

Seagrass needs light to grow

Like all plants, seagrass needs sunlight to grow. For the light to reach the seagrass, the water needs to be clear. Above you can see some healthy seagrass beds in clear, shallow water in Moreton Bay.

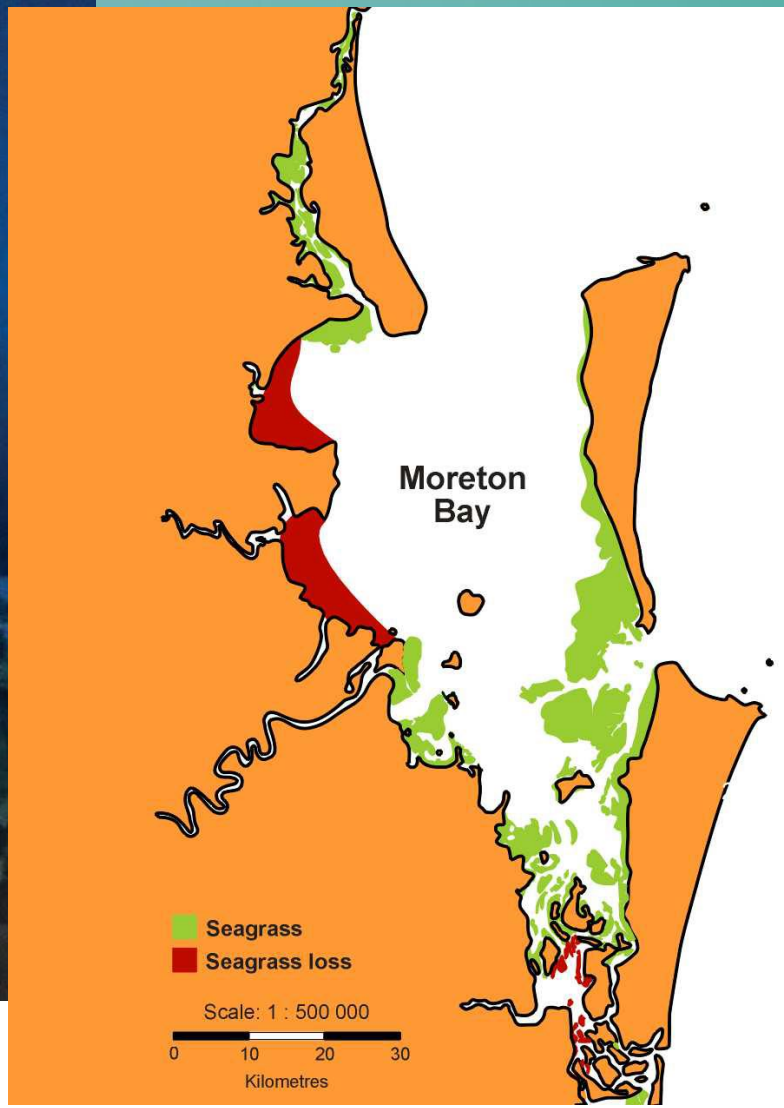
Murky water kills the seagrass

In parts of Moreton Bay and throughout coastal South East Queensland the water is frequently brown and murky because there is too much sediment (soil) in the water. This sediment prevents sunlight reaching the seagrass, often causing seagrass beds to die.

Save the seagrass – Save the Dugong!

A good width of native trees, shrubs and grasses along creek and river banks reduces sediment run-off. Get involved – join your local catchment group and plant some trees! Also, check out pages 4 & 5 for every day things that you can do to help reduce other threats to seagrass, such as stormwater pollution. Look after seagrass and help our dugongs in Moreton Bay!

Dugong photograph courtesy of the Great Barrier Reef Marine Park Authority



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Sediment

- Increased turbidity
  - Reduced light penetration
  - Reduced aquatic growth/ biodiversity
  - Reduced aesthetics
  - Smothering aquatic habitat
  - Reduced drainage/ channel capacity
- Contaminants attached to sediment
  - Nutrients
  - Toxins
  - ‘Oxygen depleting substances’ (eg. organic matter)
  - etc

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Nutrients

- Eutrophication
  - Excess nutrients promote the growth of one species of aquatic plant (eg. algae), to the exclusion of others
  - Reduced light penetration
  - Reduced oxygen due to algal death (& decomposition), plant respiration at night & reduced atmospheric exchange

(Source: National Geographic, July 2006)

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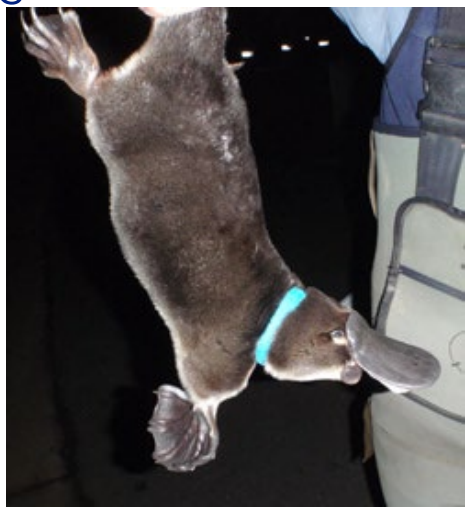
WARNING
BLUE-GREEN ALGAE ALERT
Blue-green algae has been detected in these waters
Contact can be harmful
Regular water testing and treatment is underway. For further information please call 1800 819 912 or visit www.derm.qld.gov.au
Do not drink, swim/wade, fish or allow pets near water.
These waters are being tested regularly.


WARNING
HARMFUL ALGAE MAY BE PRESENT IN THIS WATER
CONTACT MAY CAUSE SERIOUS HARM TO
HUMANS AND ANIMALS
FOR MORE INFORMATION CALL
THE ALGAL INFORMATION LINE


RIVERSTONE RISE

Water quality impacts (cont'd)

- Heavy metals:
  - toxic impacts (chronic & acute)
- Bacteria:
  - disease, death
- Litter:
  - Reduction in flow capacity of stormwater drainage
  - Physical impact on aquatic habitats & species
  - Contaminated with other pollutants
  - 'Plasticosis'
  - etc



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Water quality impacts

- Toxicity
- Reduced oxygen levels
- Disease/ stress
- Reduced aesthetics
- Blockage of drainage systems

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Ecological impacts

Ecological impacts

- Changes to flow, channel form & water quality due to urbanisation & conventional stormwater drainage have severe & predictable consequences for stream ecosystems
- 'Urban Stream Syndrome' used to describe sick state of streams in urban areas around the world

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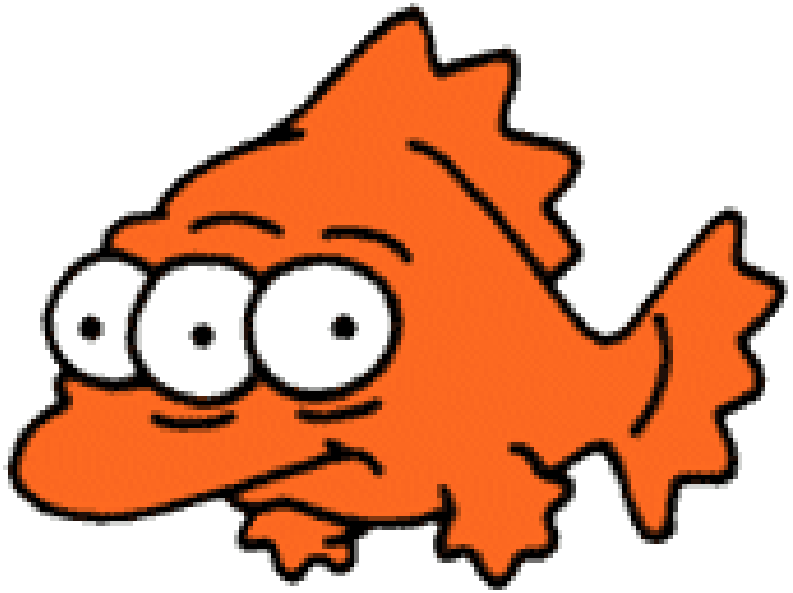
‘Urban stream syndrome’ symptoms

- Hydrology
  - Decreased low flow volume
  - Increased frequency & magnitude of peak flow
  - Decreased groundwater recharge & lower water table
- Channel Form
  - Increased channel erosion/ incision
- Water Quality
  - Increased contaminant loads & concentrations
- Ecology/ Biodiversity
  - Decreased biodiversity
  - Habitat simplification
  - Decreased nutrient retention & altered patterns of nutrient energy cycling



(Source: Walsh et al, 2004)

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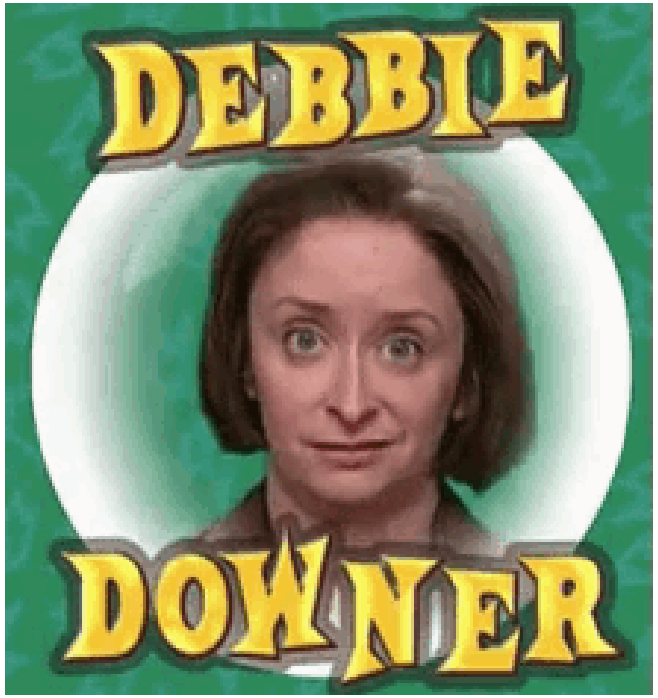

Source: www.tenor.com


What can we do ?

The next ‘Stormwater Fundamentals’ session …

- Water Sensitive Urban Design
- Wednesday 22nd May 2024, 12:30pm AEST
- Info & register at www.oceanprotect.com.au/webinars

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www.oceanprotect.com.au

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THANK YOU

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