

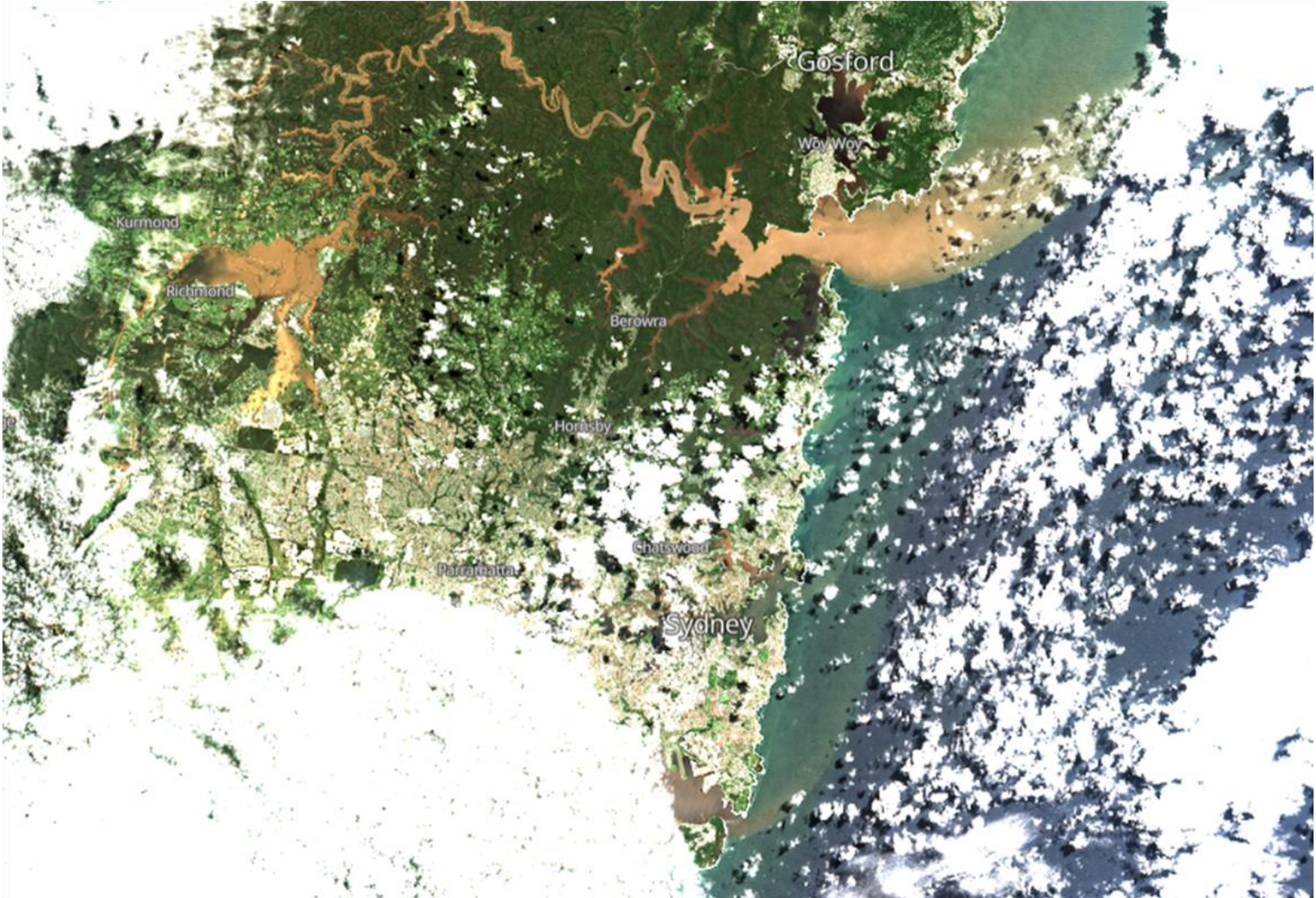


Sydney  
**WATER**

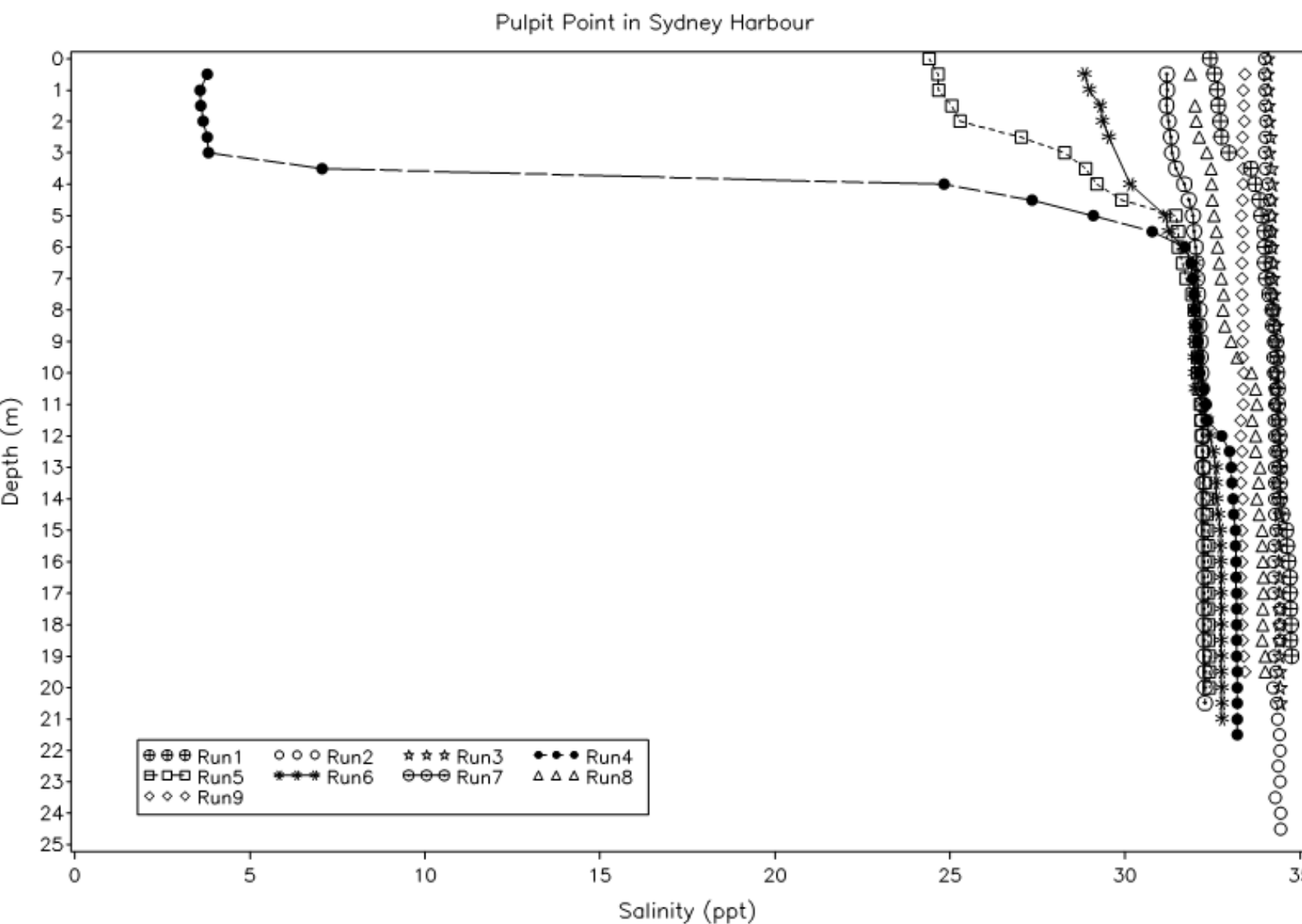
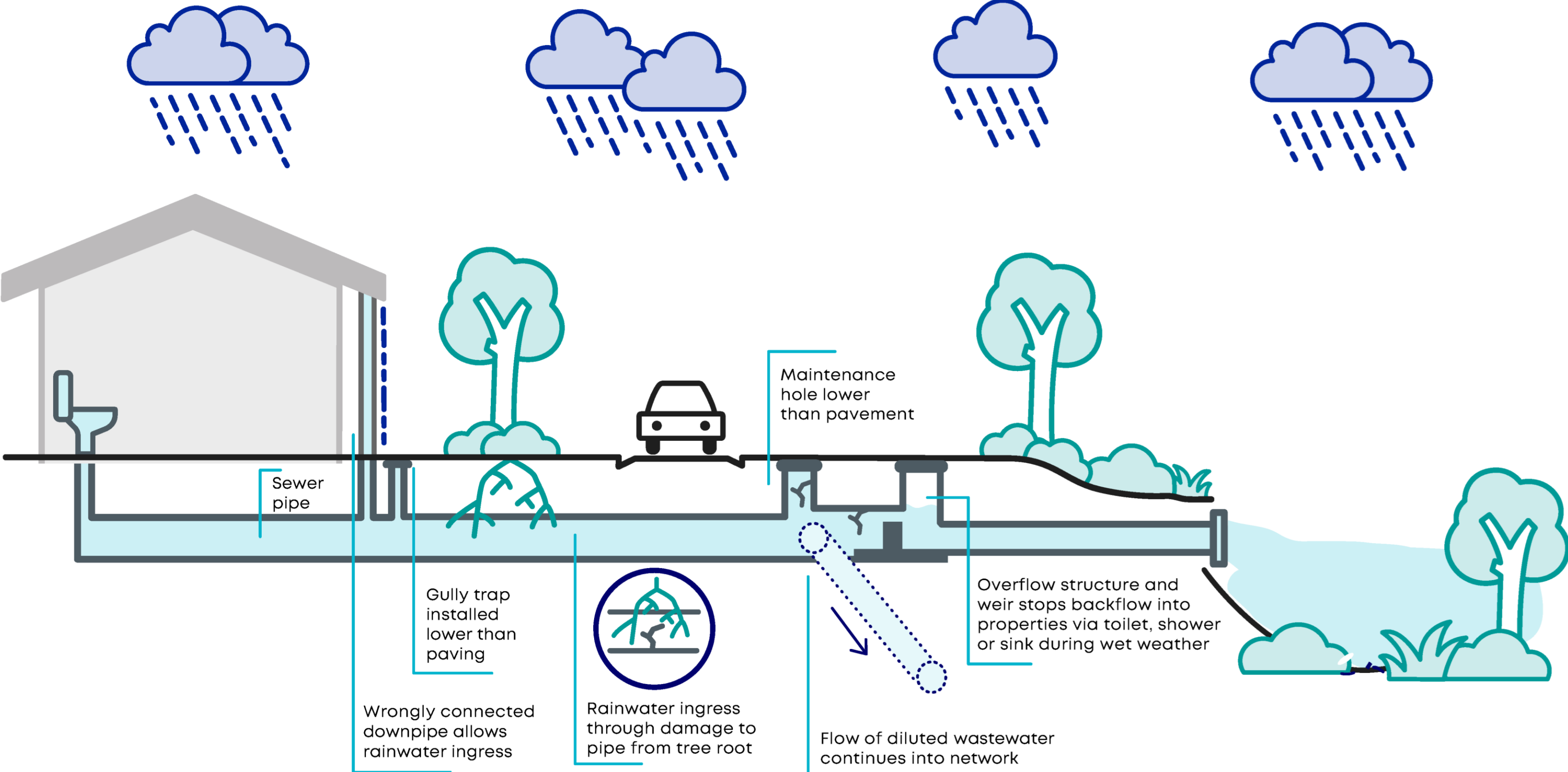
**Conceptual models of risk posed from wet-weather overflows to both human health and of adverse ecological effects in urban receiving waterways**

# Wet-weather overflow monitoring program initial questions

- Is there a driver to contain entire wastewater system?
- or is a focus on source control to reduce wet weather overflows from the wastewater system suitable?
- Source control aim to restore 3 times average dry-weather flow capacity by reducing inflow and infiltration – 27,000km



<https://www.weatherzone.com.au/news/sydneys-floodwaters-visible-from-the-edge-of-space/536604>



# Collaboration and governance

- Guide, adapt and assure the program **across 22 workshops**
- Ensure robust outcomes that could withstand scrutiny from the EPA and scientific community, and provide confidence to Board and other stakeholders
- **17 journal publications, 1 under review**

## Expert Peer Panel

- Doctor Graeme Batley AM (2016 - 2024)
- Associate Professor Gavin Birch (2016 - 2024)
- Professor Melanie Bishop (2016 - 2024)
- Professor Angus Webb (2016 - 2024)
- Associate Professor Susan Petterson (2016 - 2022)
- Professor Anne Roiko (2022 - 2024)

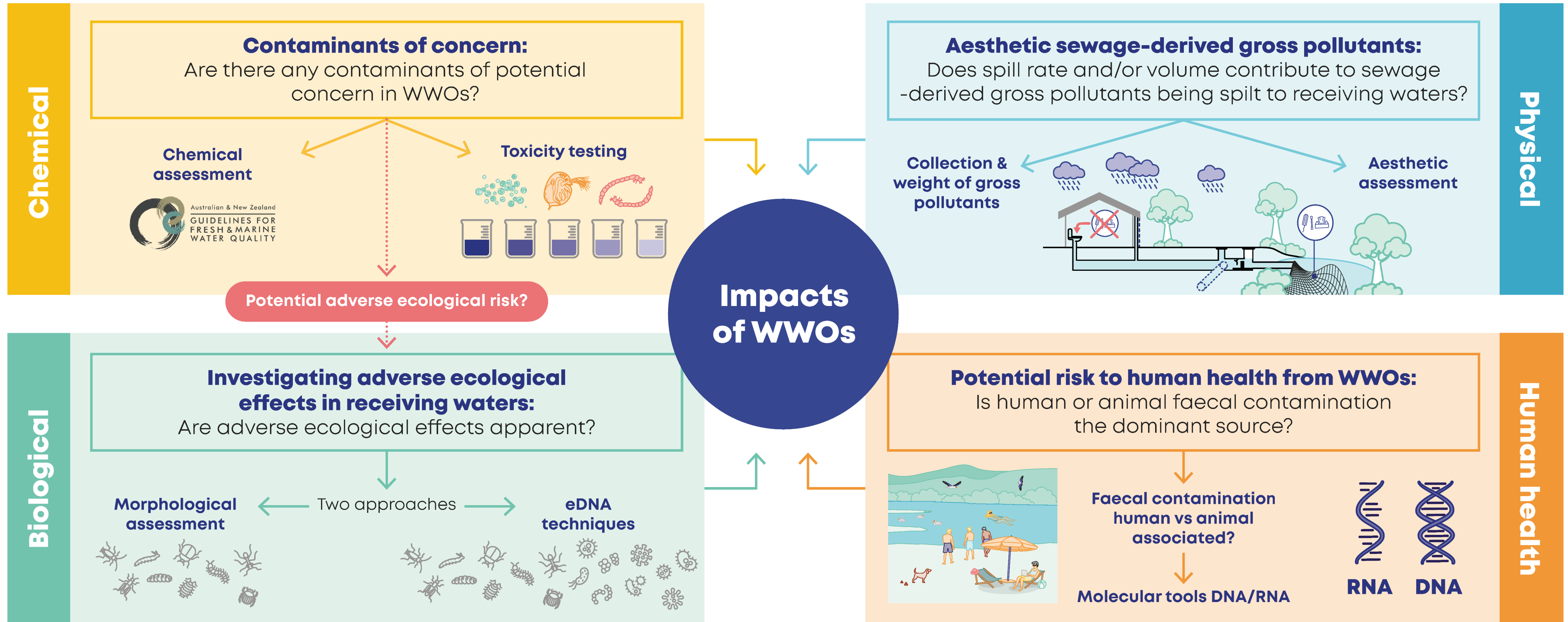
## Our key research collaborators



**Learnings informed a revised risk prioritisation methodology for management**

# Key research questions

Developed with peer-review panel as were conceptual models



## Aesthetic sewage-derived gross pollutants:

Does spill rate and/or volume contribute to sewage-derived gross pollutants being spilt to receiving waters?

Collection & weight of gross pollutants

Aesthetic assessment

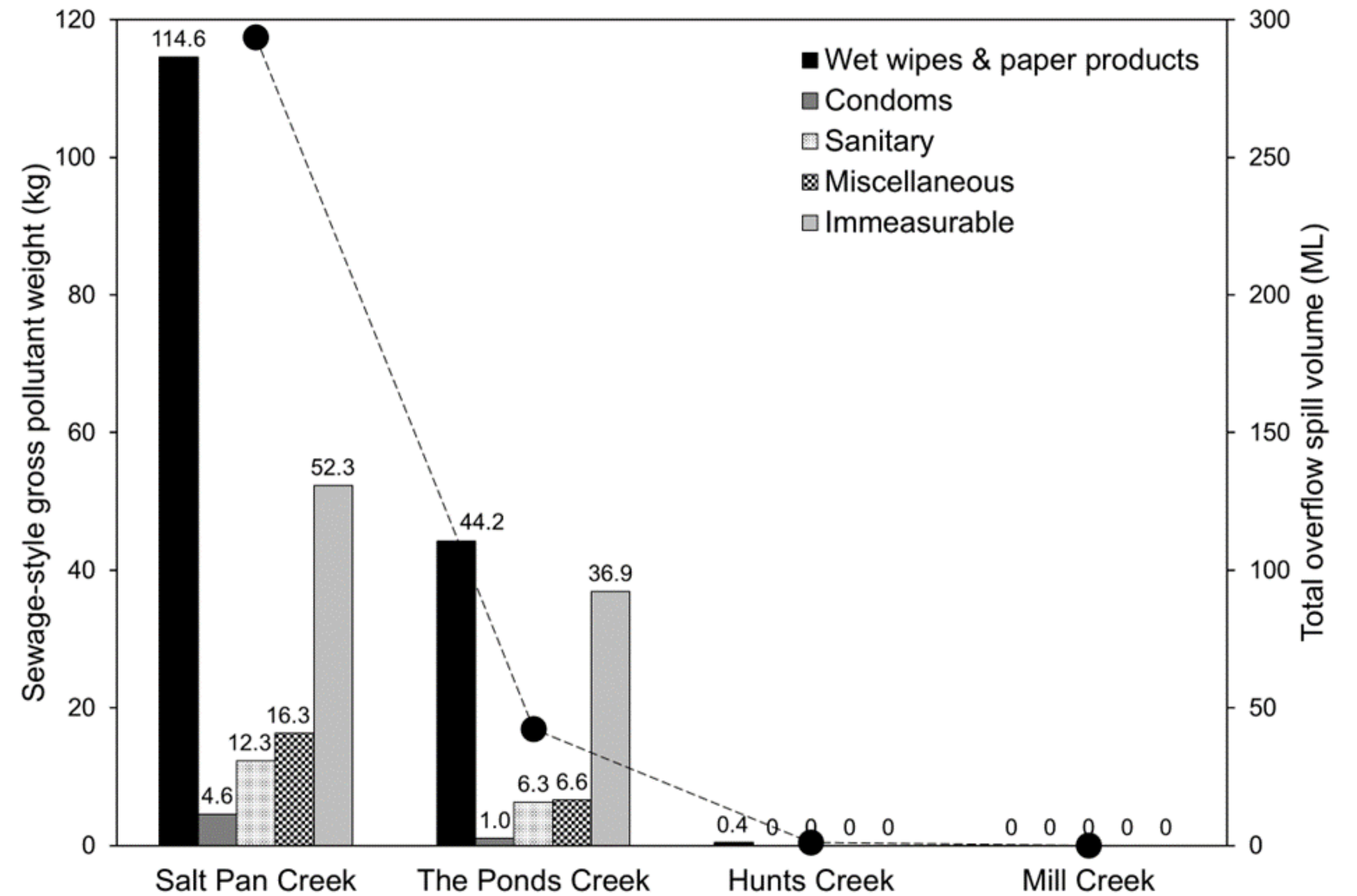


Physical

Understanding from study of three categories of ERS with differing spill rates & volumes

# Summary of sewage-style gross pollutants by category

Collected from four overflow netted ERSs



Individual category weights (kg) by ERS location are shown at top of each bar. Black dot indicates total overflow spill volume (ML)

# Conceptual model of WWOM

## Aesthetic sewage-derived gross pollutants:

Does spill rate and/or volume contribute to sewage-derived gross pollutants being spilt to receiving waters?

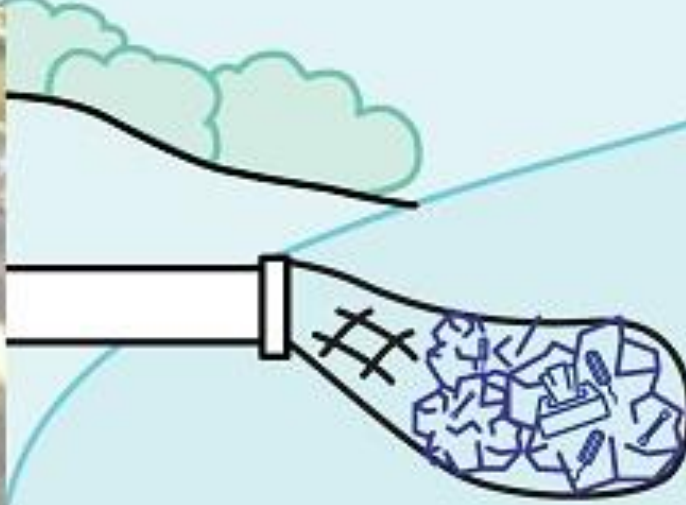
### Spill rate

Wet weather overflows spilling **<100 L/s**

Minimal gross pollutants are discharged

Wet weather overflows spilling **>150 L/s**

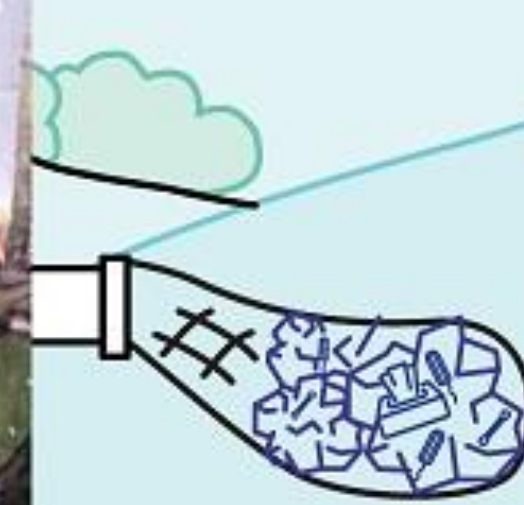
Larger volumes of gross pollutants discharged



### Volume – for the same outlet pipe size

Lesser volumes are spilt from **gravity overflows** (>150 L/s).

Greater volumes are spilt from **siphonic overflows** (>1000 L/s)



**Chemical**

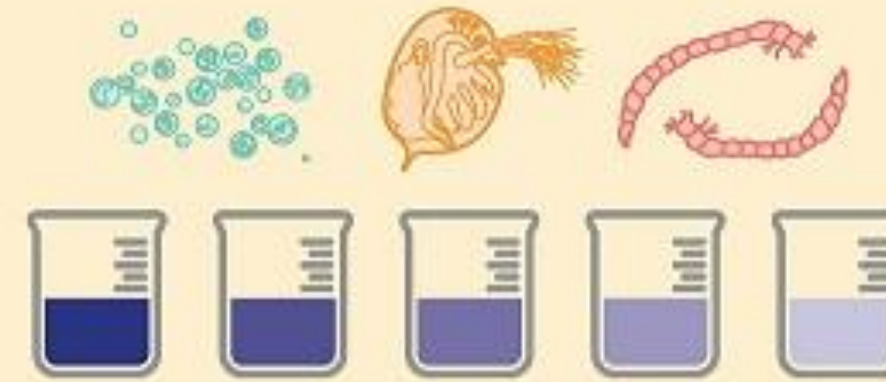
**Contaminants of concern:**

Are there any contaminants of potential concern in WWOs?

**Chemical assessment**



**Toxicity testing**



Potential adverse ecological risk?

**Biological**

**Investigating adverse ecological effects in receiving waters:**

Are adverse ecological effects apparent?

**Morphological assessment**



Two approaches

**eDNA techniques**



# Conceptual model of WWOM

## Contaminants of concern:

Are there any contaminants of potential concern in WWOs?

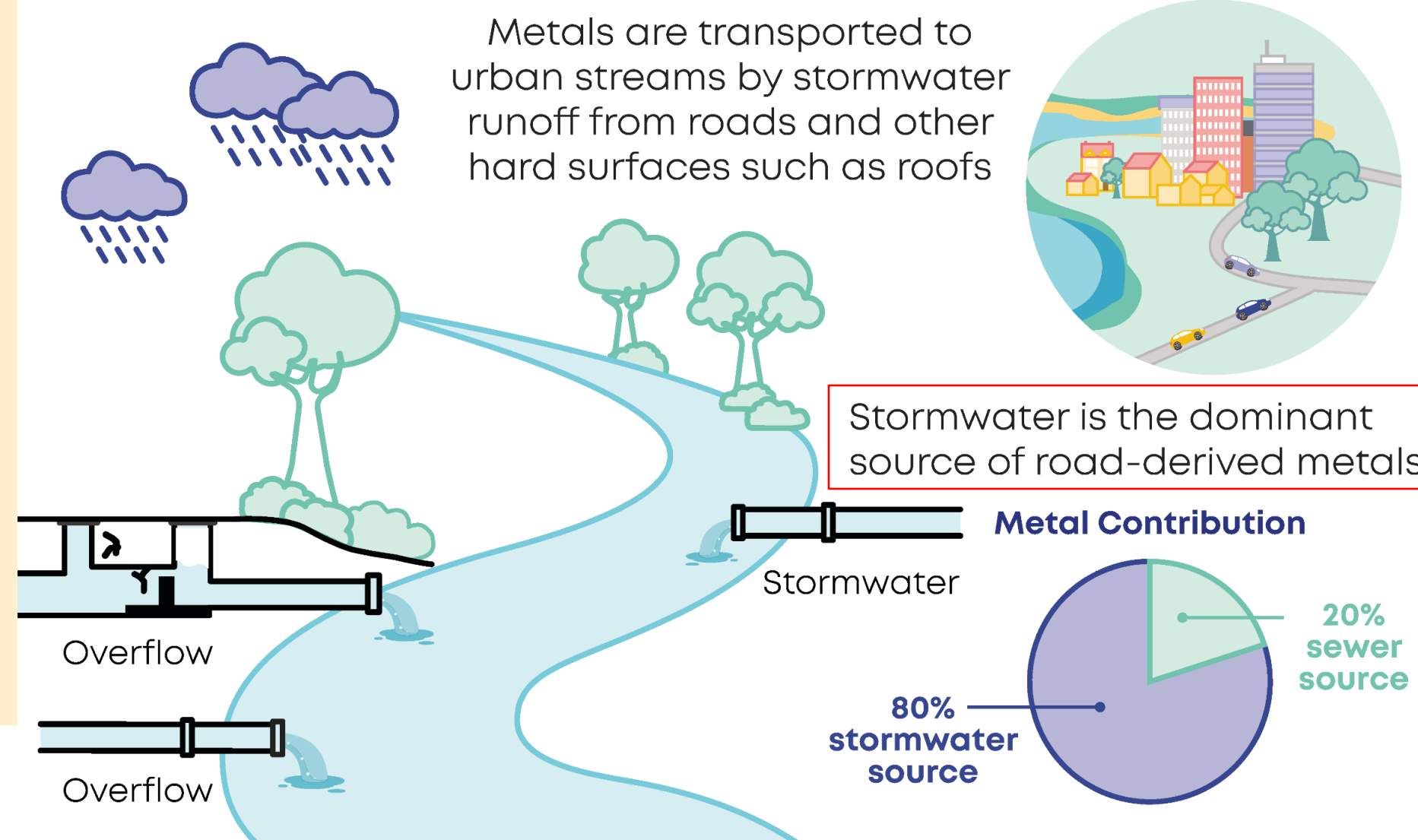
### Chemical assessment



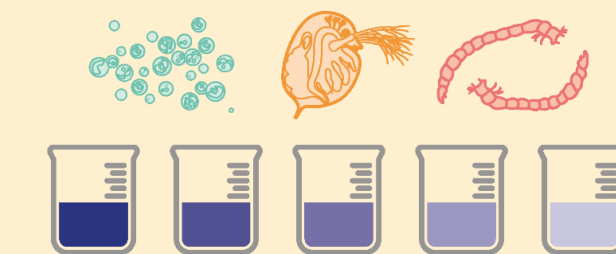
Australian & New Zealand  
GUIDELINES FOR  
FRESH & MARINE  
WATER QUALITY

#### Findings:

- 18 organic contaminants below level of potential concern
- High carbon concentrations within influent ameliorated bioavailable metal concentrations within the sewer system
- Only ammonia could be categorised as a contaminant of potential concern in 1 of 5 sites tested (Vineyard Creek)



### Toxicity testing



#### Findings:

- Toxicity identification and evaluation (TIE) determined that ammonia and metals (Cu & Zn) were contaminants of potential concern
- Ammonia concentration best represented toxicity outcomes with risk of adverse ecological effect reduced with dilution
- 6 hour and 24 hour toxicity testing durations better mimicked wet weather overflow durations than multi-day chronic toxicity tests

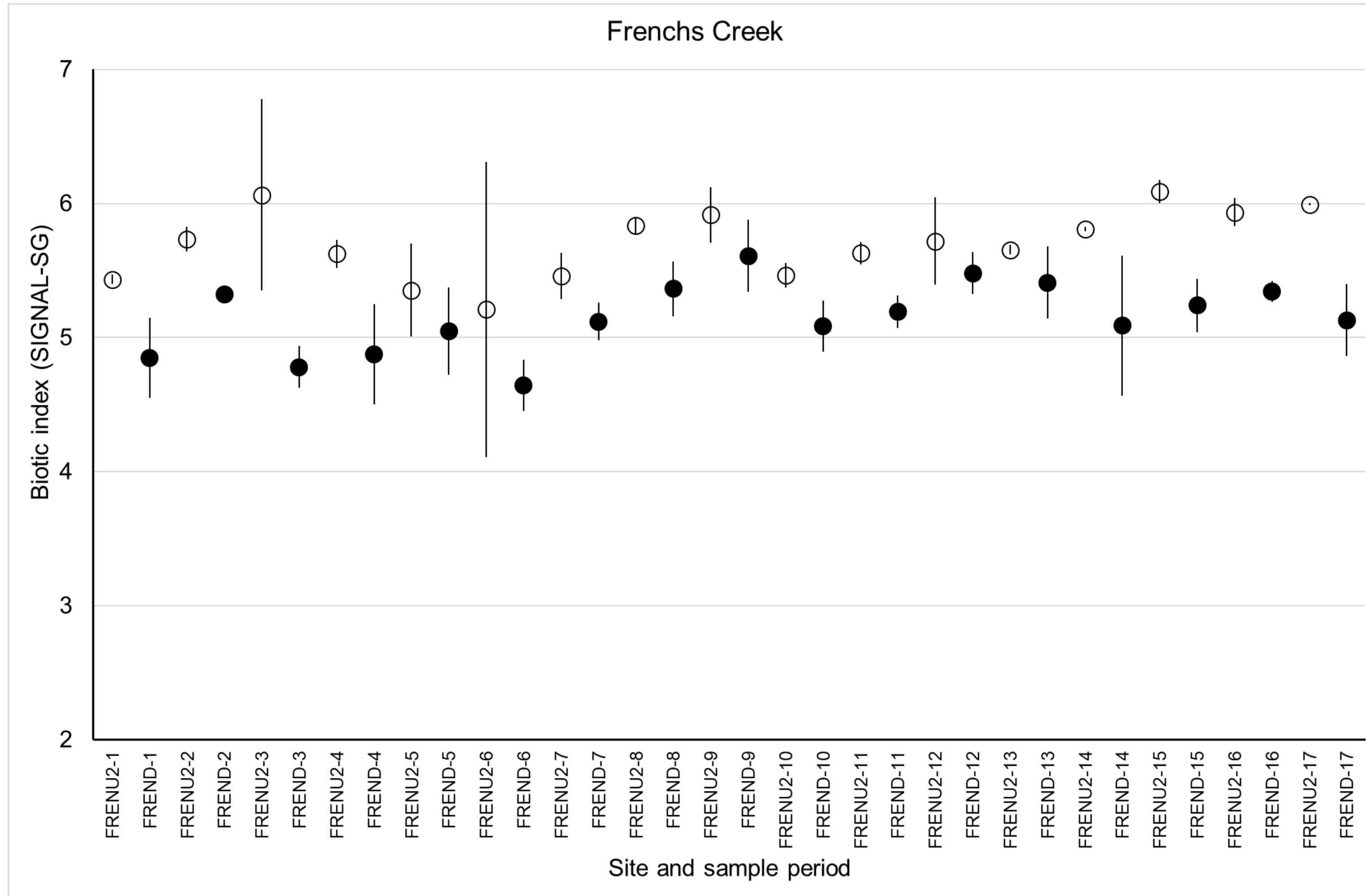
### Outcomes

- Ammonia is a contaminant of potential concern where there is limited capacity for dilution of spill volumes from wet weather overflows in receiving waters
  - There is the potential of adverse ecological effects where wet weather overflow dilutions are < 1 in 2

Stormwater loading of Cu, Pb and Zn 79-87% from residential properties and roads (Davis and Birch, 2009); Bickford et al. (1999) 85% loading from stormwater for Cu, Zn, and Ag

Metal sensitive taxa already absent from urban streams (Iwasaki et al., 2018)

# Low dilution stream setting



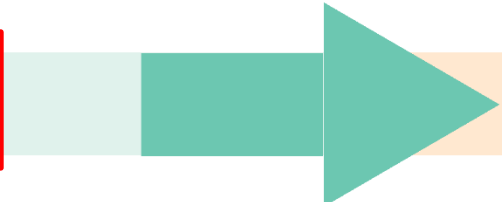
**Ecological control chart** of freshwater macroinvertebrates from morphological (microscopic) assessment  
 open circles - upstream mean SIGNAL-SG scores  
 filled in dots - downstream mean SIGNAL-SG scores

# Conceptual model of WWOM

## Investigating adverse ecological effects in receiving waters:

Are adverse ecological effects apparent?

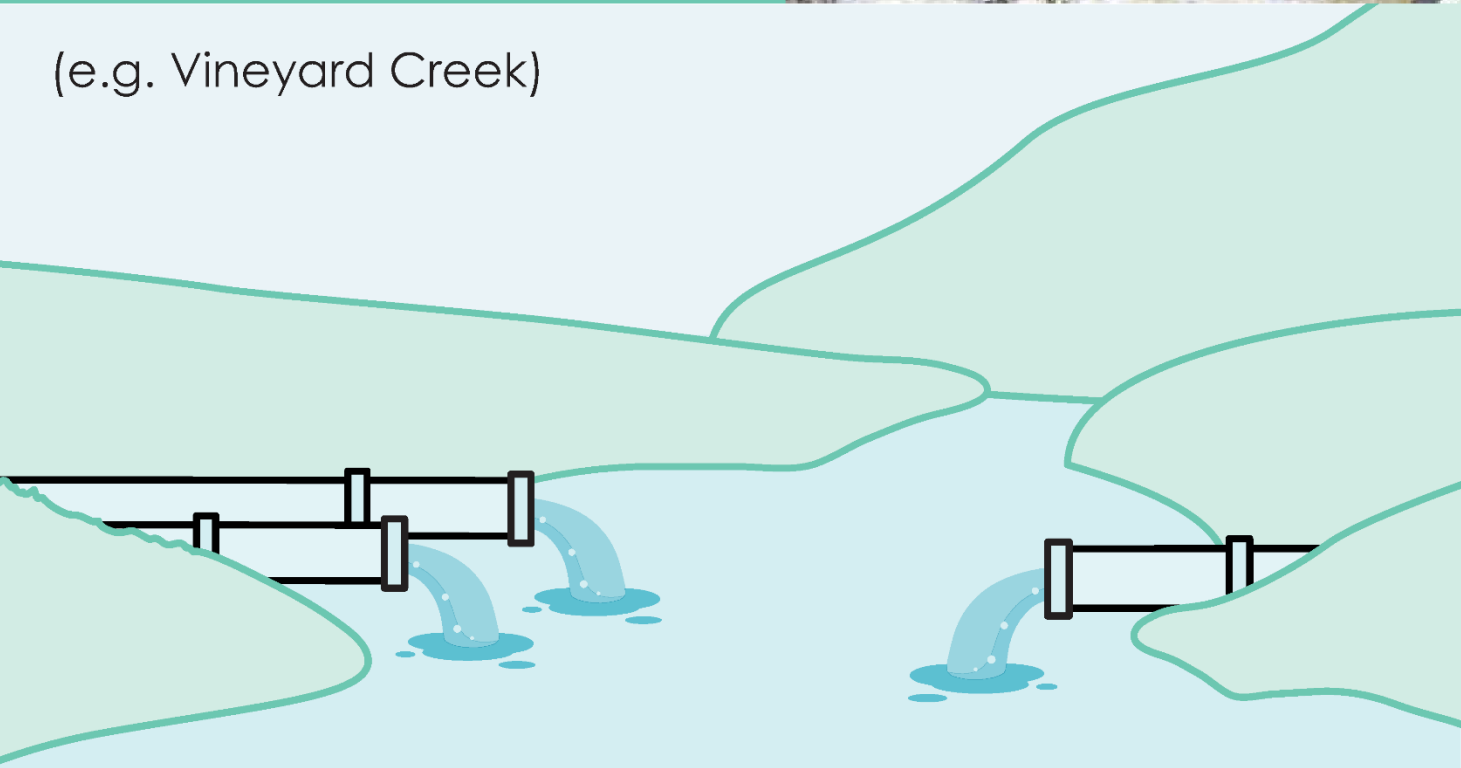

In 22% of urban stream sites ongoing impacts were observed



Dilutions required to remove toxicity of > 1 in 2 not met

Examples of three urban stream conditions where there is limited capacity for dilution of spill volumes from wet weather overflows

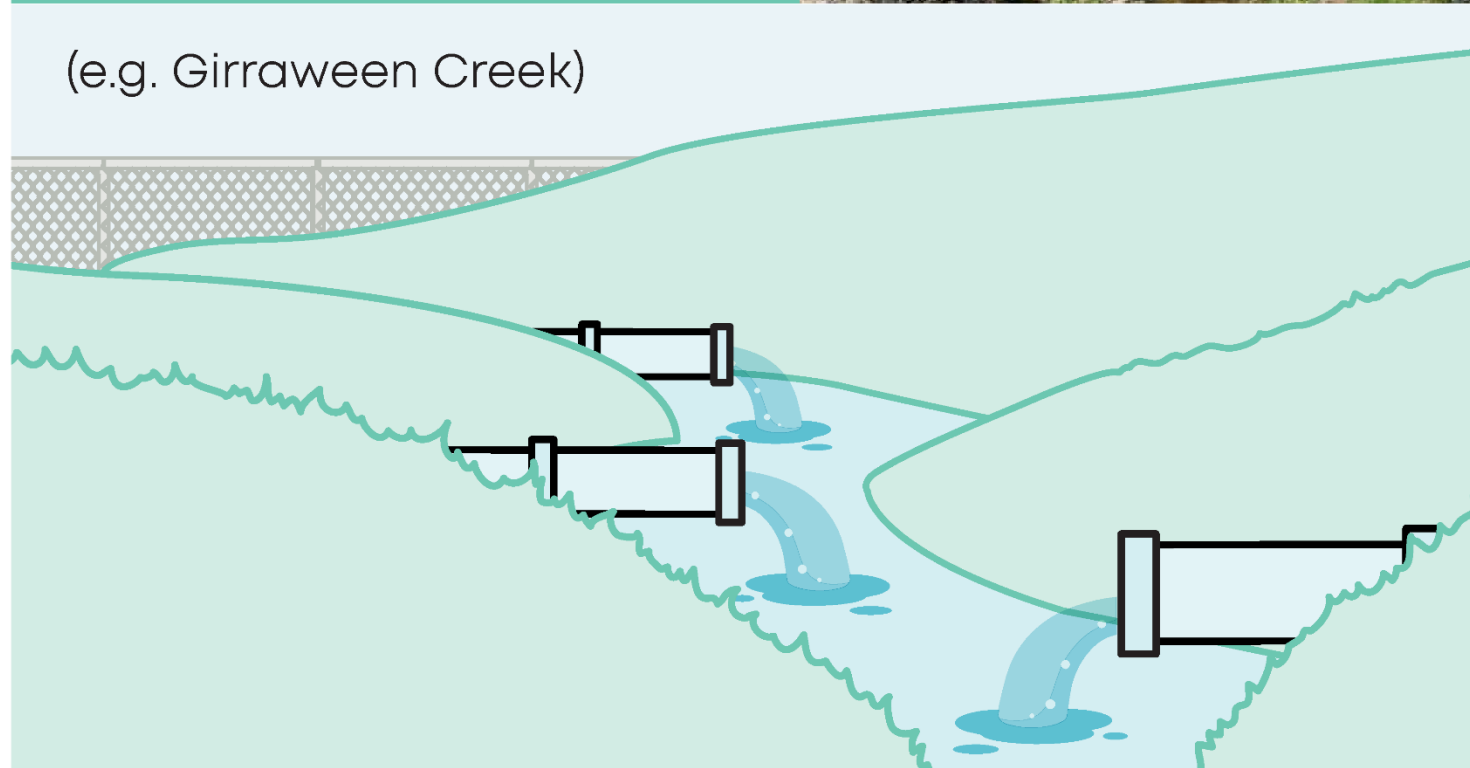

**Scenario 1:**  
Too many ERSs spilling to the same point in a stream  
(e.g. Vineyard Creek)



**Scenario 2:**  
Oversized ERS spilling to a very small urban stream reach  
(e.g. Kittys Creek)



**Scenario 3:**  
Too many oversized ERSs spilling to a small urban stream reach  
(e.g. Girraween Creek)



## Potential risk to human health from WWOs:

Is human or animal faecal contamination the dominant source?



Faecal contamination  
human vs animal  
associated?

Molecular tools DNA/RNA



**RNA**



**DNA**

**Human health**

Same approach as for COVID-19 single molecular targets

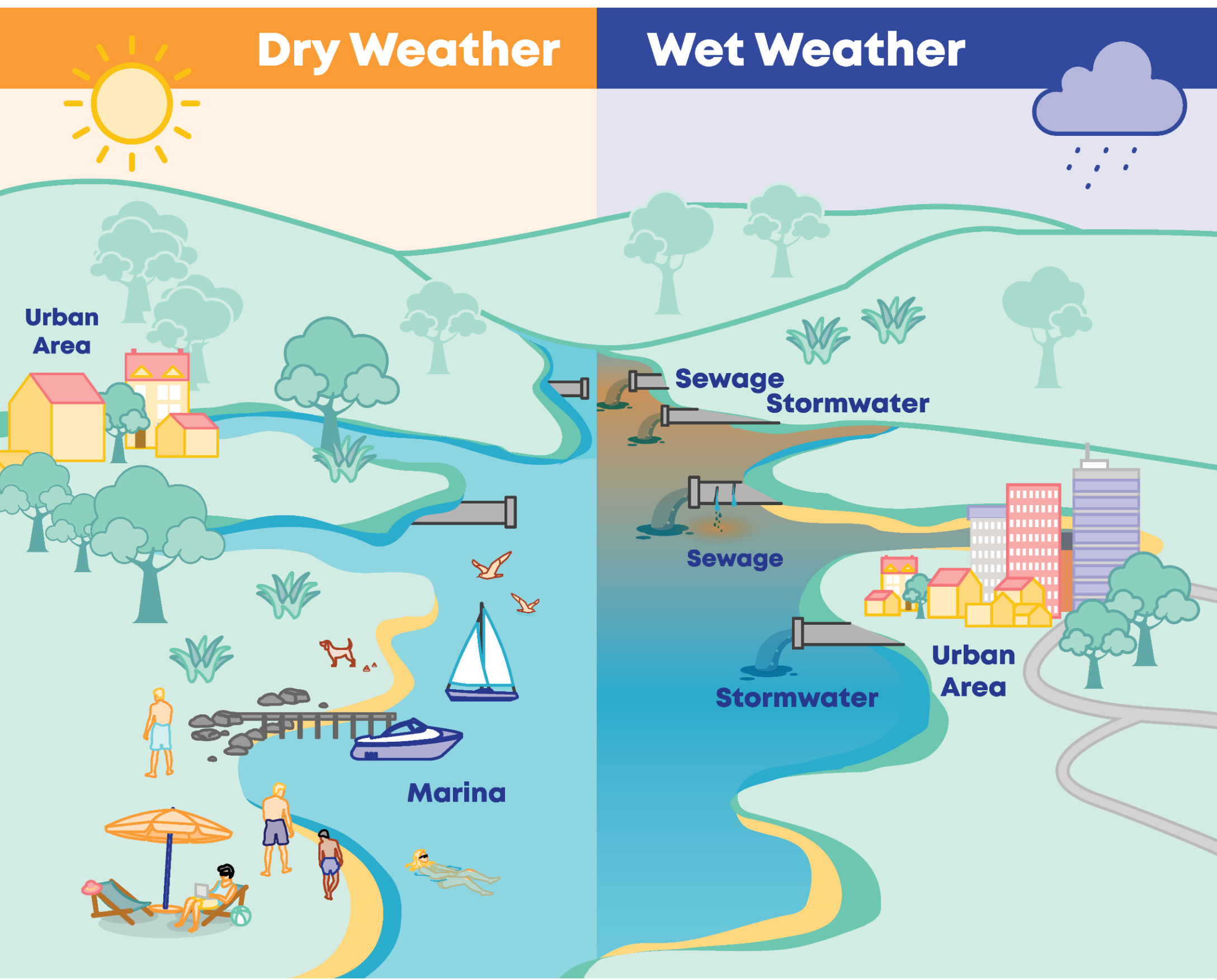
# Conceptual model – Human health

Site specific Risk Based Thresholds (RBTs) have been calculated for four molecular marker genes and are aligned to gastrointestinal human health risk from Day 0 to Day 10

Being able to sample after a storm event supports safe monitoring within human resource limitations

## Potential risk to human health from WWOs:

Is human or animal faecal contamination the dominant source?



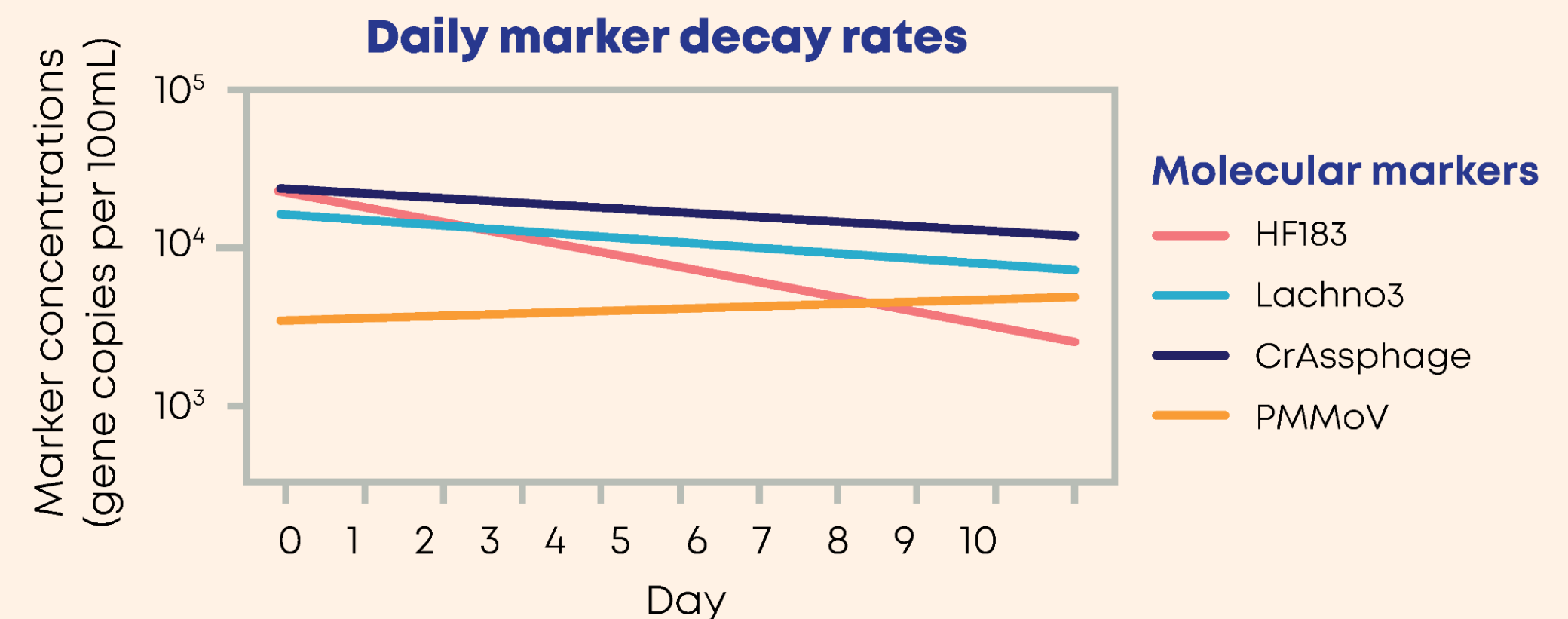
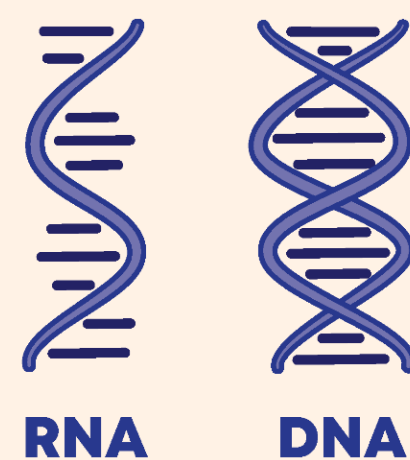
During wet weather, the major faecal contamination comes from humans through WWOs, with minor contributions from animals such as birds and dogs. In contrast, during dry weather, human faecal sources are not detected unless there are network faults (leaks).

The qPCR detection of human faecal-associated marker genes provides an effective method to detect sewage contamination.

The decay rate of human faecal matter in receiving waters is largely dependent on sunlight and the turbidity of the receiving waters.

Different markers have different decay rates.

The presence of human faecal-associated molecular markers (DNA & RNA) reflects human health risk



# Findings supported by


## Implemented management in United Kingdom

The Storm Overflows Discharge Reduction Plan (Defra, 2023) applies 99<sup>th</sup> percentile standards for **ammonia** and dissolved oxygen downstream of storm overflows for identification and measurement of **local adverse ecological effects**

UK targets:

- **Risk of adverse ecological effects:** *Water companies only permitted to discharge ...where they can demonstrate that there is no local adverse ecological effect*
- **Potential risk to human health:** *must reduce harmful pathogens from storm overflows discharging near designated bathing waters, by either: reducing the frequency of discharges; or applying disinfection to meet Environment Agency spill standards by 2035*

**Sydney Water's source control approach aligns with these targets**



[Sydney Water Wet Weather Overflow Monitoring program 2016 to 2024 Synthesis Report](#) can be accessed via this link

**Thank you**

Sydney  
**WATER**

