next water
12-13 February 2019
Melbourne

Water Research AUSTRALIA

Integrated modelling to compare health risks associated with alternative approaches to managing sewer overflows

Dr. Anne Roiko

Associate Professor of Environmental Health

School of Medicine & Cities Research Institute, Griffith University

The team

- A/Prof. Anne Roiko (Griffith Uni - Cities Research Institute)
- A/Prof. Susan Petterson (Griffith Uni & Water & Health)
- Miss Sonya Kozak (Griffith Uni - Cities Research Institute)
- Mr. Tony McAlister (Director, Water Technology, Griffith Uni - Cities Research Institute)
- Mr. Ian Jennison (Qld Urban Utilities - Senior Sewerage Master Planner Planning Group)
- Mr. Sam Bagraith (Qld Urban Utilities Leader Network Master Planning Group)

Drivers

- We want improved customer, environmental and public health performance from our sewerage systems at the lowest community cost
- How can we plan for/design our sewerage infrastructure going forward to achieve those outcomes?

As opposed to designing sewerage infrastructure to “rules – based” engineering guidelines that are assumed to safeguard public and environmental health

Management Paradigm Options

Business as Usual **VS** **Effects-Based Planning**

- Rules-based compliance
- Upgrade “hard” sewerage Infrastructure
- Often expensive
- Effective?

- Evidence-based
- Invest in alternative options such as offset approaches including vegetated waterways and wetlands.
- Best return for investment
- Effective?

Research Objective:

To compare the human health risk profiles of wet weather sewer overflows under different management scenarios

Part 1: Contamination of downstream recreational waterways

Part 2: Manhole sewer overflows in a residential area

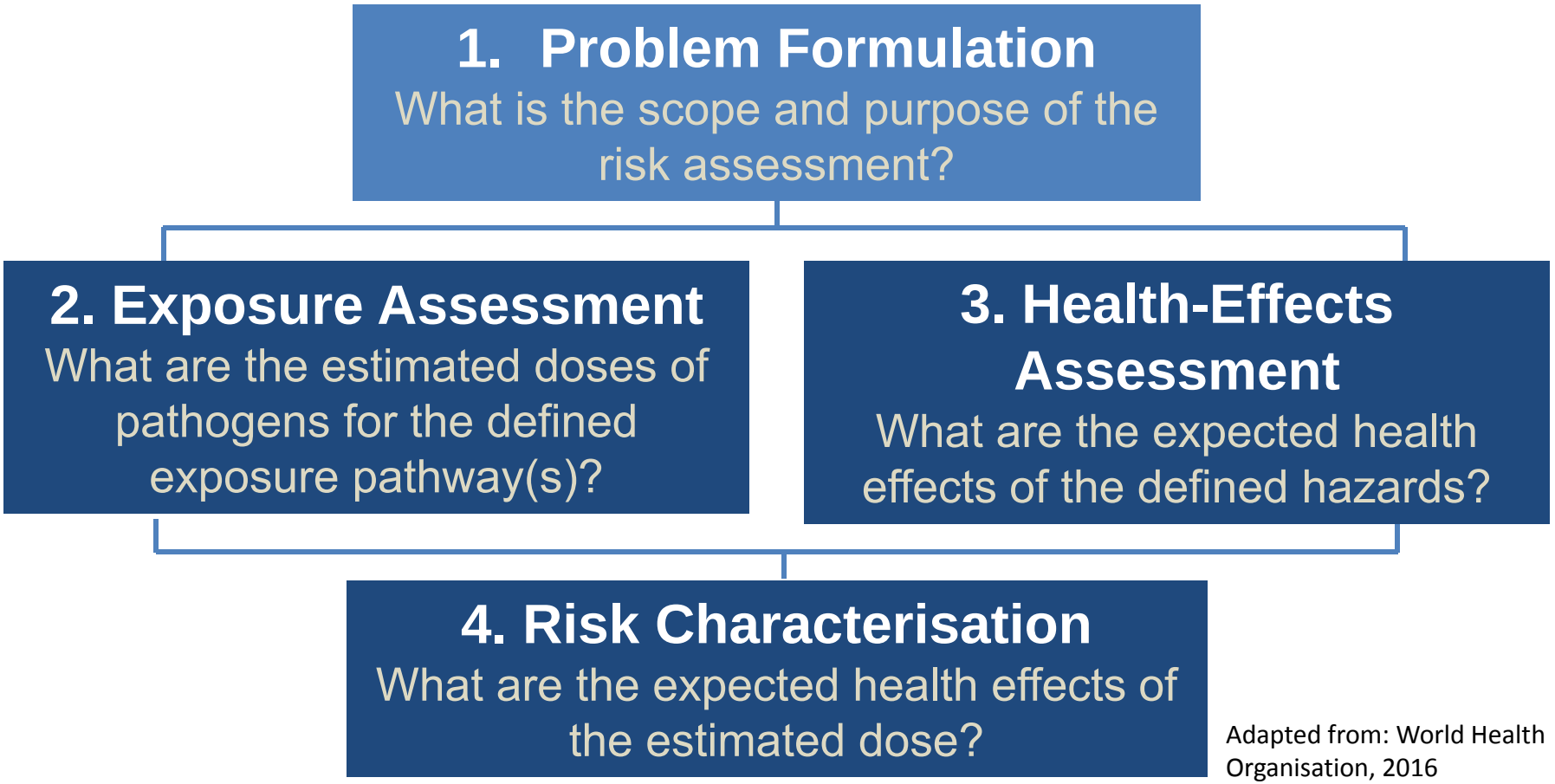
- NB. Part of broader set of work packages

Approach

- Combined modelling approach to evaluate options
- Hydrodynamic modelling
  - Sewer system (Infoworks ICM SE)
  - Catchment (Source Catchments)
  - Receiving water quality (Tuflow FV with AED)

- Quantitative Microbial Risk Assessment modelling

Quantitative Microbial Risk Assessment (QMRA)



Adapted from: World Health Organisation, 2016

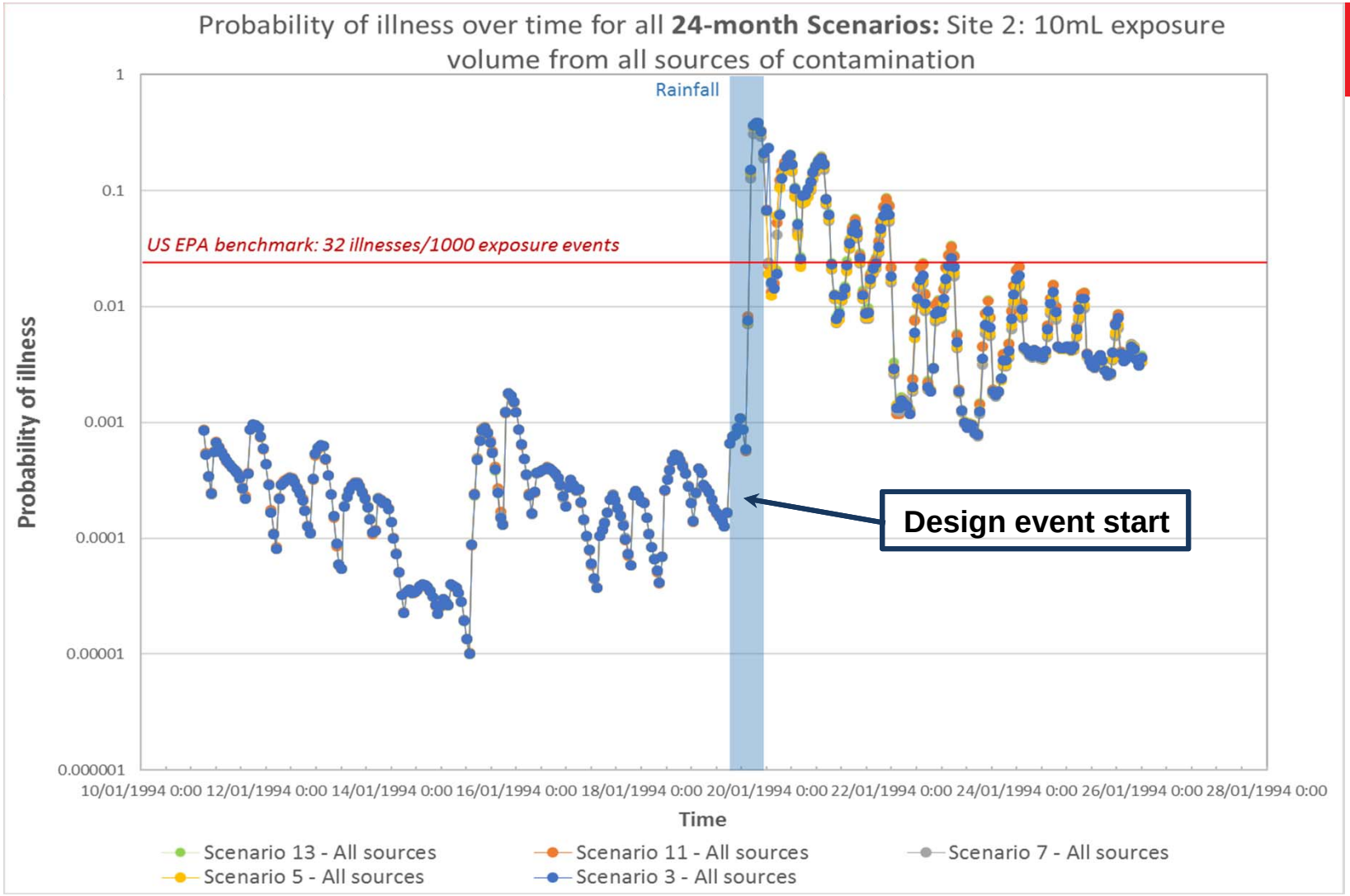
Recreational Exposures

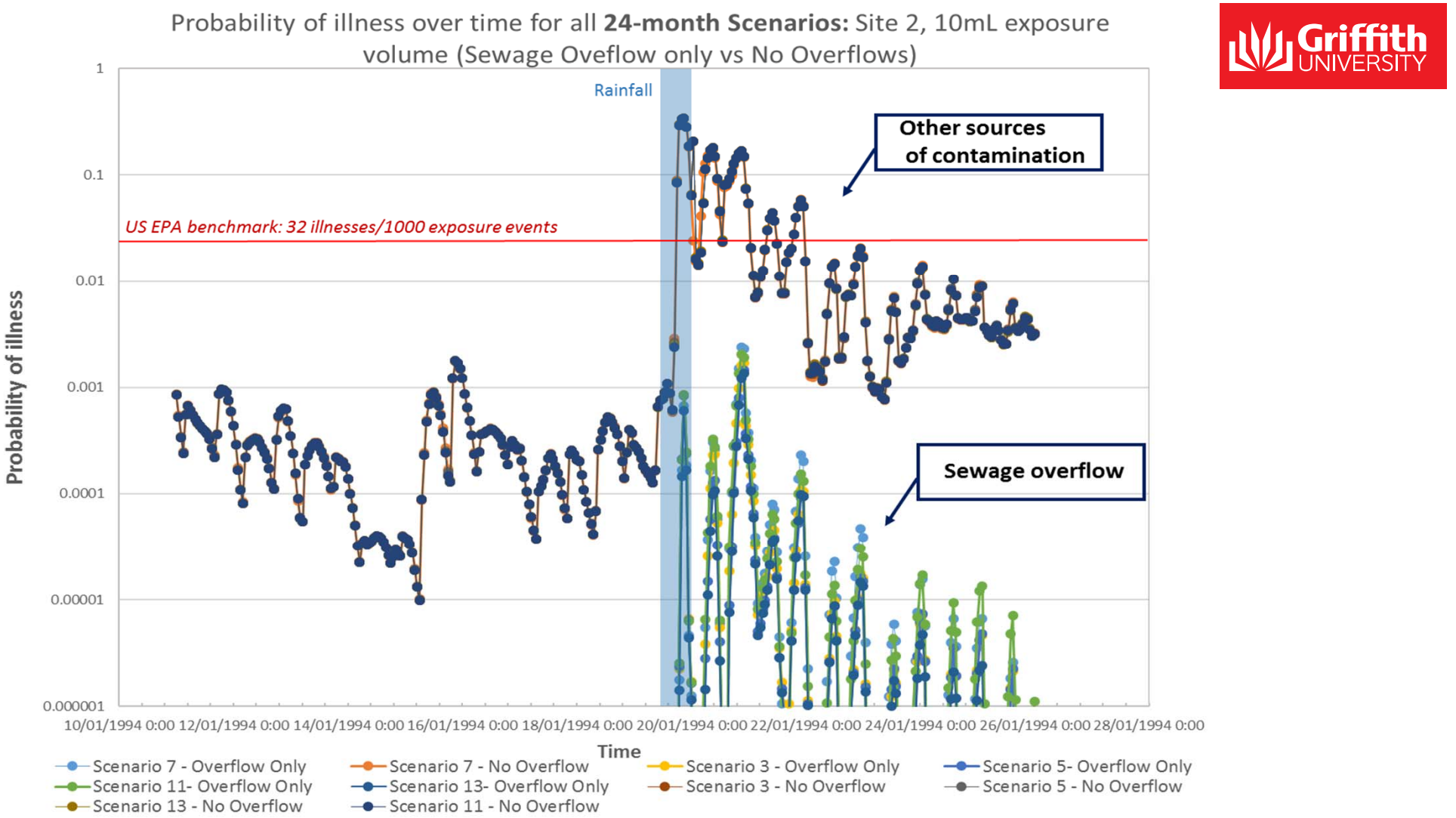
- Input data:
  - Time-series of modelled pathogen concentrations following 12 and 24-month design storms for different design options (13 scenarios overall)
  - Adenovirus, *Campylobacter jejuni, Cryptosporidium* spp.
  - Estimated exposure volumes per site

Risk Characterisation

- Output data: Time-series of *risk of illness* per exposure event

How did these risk profiles <u>compare</u> under different management options?


Probability of illness over time for all 24-month Scenarios: Site 2: 10mL exposure volume from all sources of contamination
Rainfall
US EPA benchmark: 32 illnesses/1000 exposure events
Design event start
Probability of illness
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
10/01/1994 0:00
12/01/1994 0:00
14/01/1994 0:00
16/01/1994 0:00
18/01/1994 0:00
20/01/1994 0:00
22/01/1994 0:00
24/01/1994 0:00
26/01/1994 0:00
28/01/1994 0:00
Time
Scenario 13 - All sources
Scenario 11 - All sources
Scenario 7 - All sources
Scenario 5 - All sources
Scenario 3 - All sources


Probability of illness over time for all 24-month Scenarios: Site 2, 10mL exposure volume (Sewage Oveflow only vs No Overflows)
Rainfall
Other sources of contamination
US EPA benchmark: 32 illnesses/1000 exposure events
Sewage overflow
Probability of illness
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
10/01/1994 0:00
12/01/1994 0:00
14/01/1994 0:00
16/01/1994 0:00
18/01/1994 0:00
20/01/1994 0:00
22/01/1994 0:00
24/01/1994 0:00
26/01/1994 0:00
28/01/1994 0:00
Time
Scenario 7 - Overflow Only
Scenario 7 - No Overflow
Scenario 3 - Overflow Only
Scenario 5- Overflow Only
Scenario 11- Overflow Only
Scenario 13- Overflow Only
Scenario 3 - No Overflow
Scenario 5 - No Overflow
Scenario 13 - No Overflow
Scenario 11 - No Overflow

Residential manhole overflows

Volume of 24 month events:

- Baseline: 5045m^3
- BAU: 23m^3
- EBP: 35m^3

18 → 1 manholes overflowing

Take home messages

1. All sewerage management options modelled ended up with similar public health risk profiles for both recreational water use and residential MH overflows.
2. Modelled recreational health risks were driven by sources other than the modelled sewage overflows
3. EBP offers an opportunity to investigate and deliver more cost-effective, beneficial outcomes in design of sewerage systems

Role of Collaboration in this research

- Critical from start to finish

Collaboration between researchers, water utilities and consultants facilitated the conception and modelling of management scenarios that wouldn't have been possible otherwise

- Collaboration → effective scoping of the issue ensured the right question was answered
- Effective collaboration built on trust and transparency → relationships
- Interdisciplinary collaboration → more robust research design and allowed small but important flaws to be picked up in a timely manner.

Research Impact

- QMRA component: very small cost of the overall project that identified many interesting points
  - Screening-level QMRA answered the critical management question re: EBP potential
  - Relative contribution of contaminant sources on health risk estimates

- This research starts to provide the evidence to support a shift towards evidence-based design and management of our sewerage systems

How research findings ~~will~~ could be implemented to ensure the impact is achieved?

- Good evidence and intention ≠ implementation e.g., recycled water debate
- Findings have and will continue to be incorporated into communication/engagement strategies with stakeholders

‘Next’ Slide

What opportunities does this research generate for the water sector? (beyond its immediate uptake)

- Combined modelling strategy can be used to deal with other urban water issues
- Supports a fundamental paradigm shift in urban catchment and wastewater management
  - Enables outcomes-based investment
- Highlights utility of screening level QMRA at early stages of water infrastructure planning

THANK YOU

Griffith UNIVERSITY