THE UNIVERSITY of ADELAIDE

Environment Institute

Smart Stormwater Storage

Opportunities to use smart stormwater technology to reduce flood infrastructure costs and provide more water for urban greening

Assoc. Prof Mark Thyer & Prof Holger Maier

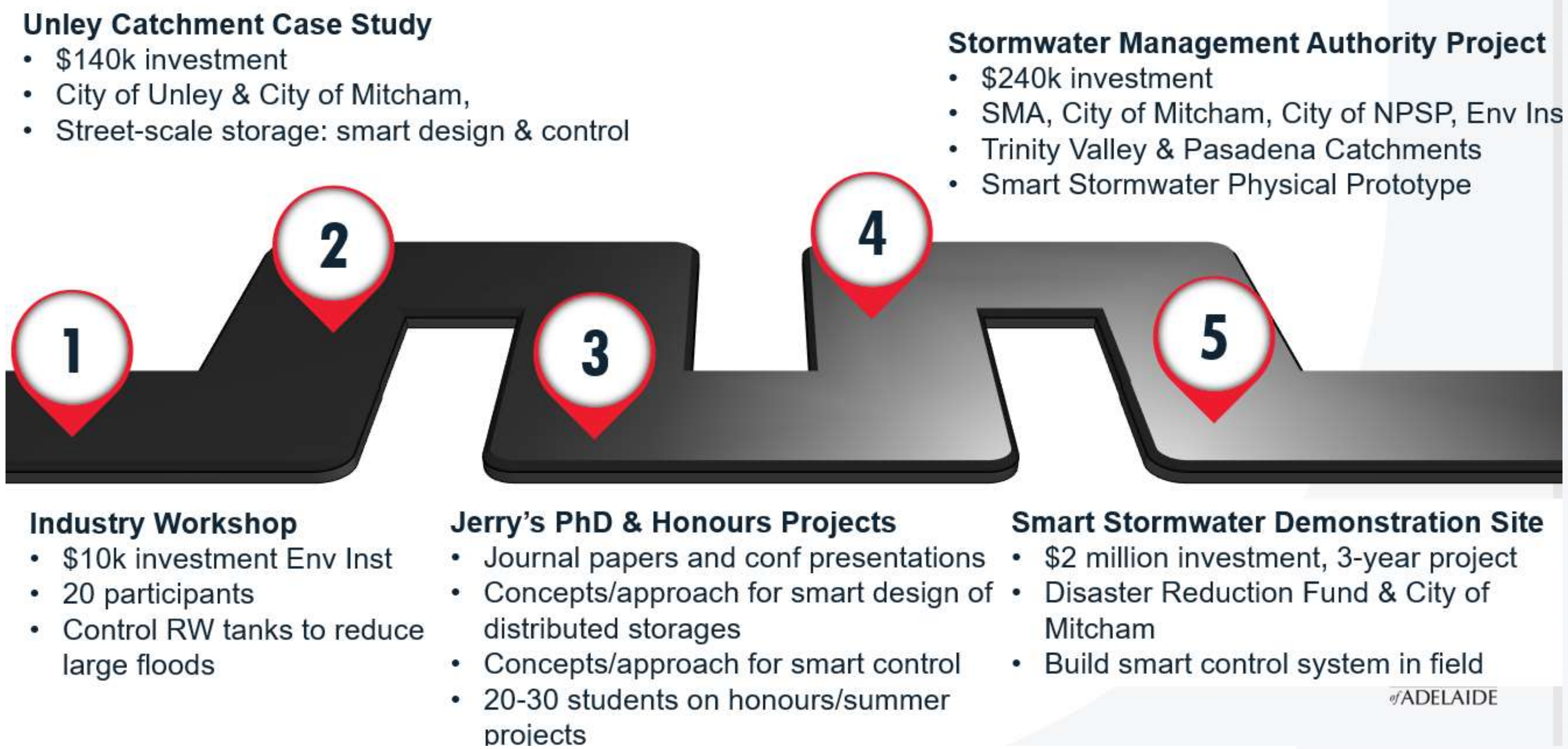
Government of South Australia
Stormwater Management Authority

CITY OF MITCHAM

City of Norwood Payneham & St Peters

make history.

Smart Stormwater: Learnings from Journey



1. **Building pathway to move from research to practical implementation**
2. **Guidance from progressive industry leaders has been fundamental for shaping the direction of this journey**
3. **Exciting: Smart Stormwater has the potential to be a game changer, SA could be a leader in this area.**

THE UNIVERSITY of ADELAIDE

Smart Stormwater Storage Concepts:

What is the motivation?

What are they?

How do they work?

THE UNIVERSITY of ADELAIDE

Stormwater Systems are Stressed

Climate Change

Urbanisation

Densification

Traditional Solutions Might Not Work

Expensive

Infeasible

Disruptive

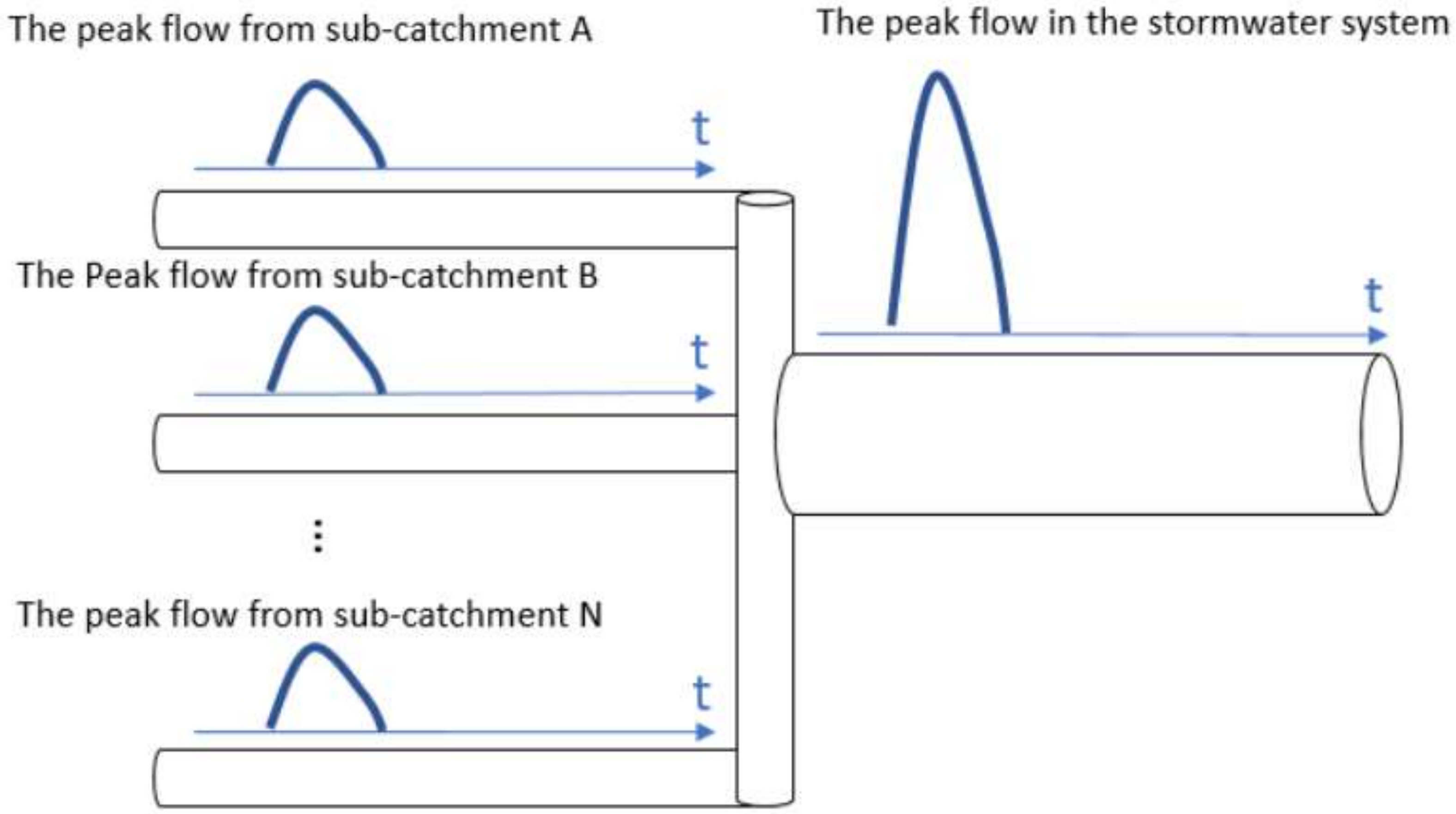
Not Adaptive

Not Resilient

IS THERE AN ALERNATIVE?

THE UNIVERSITY of ADELAIDE

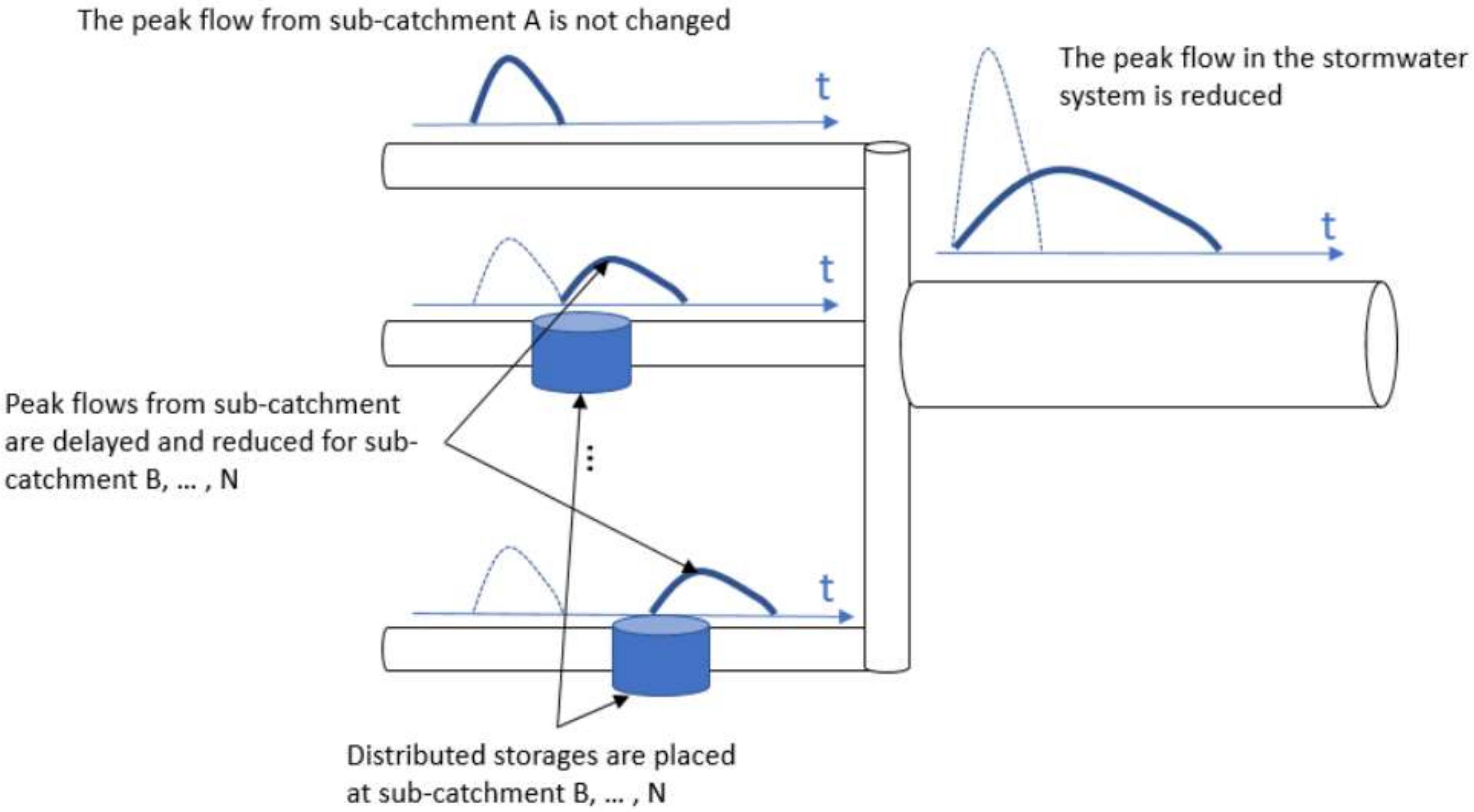
Smart Design and Smart Control of Stormwater Storages can Reduce Peak Flows through “Social Distancing” of Coincident Hydrographs



Flows from different sub-catchments are generally uncontrolled, resulting in coincident hydrographs

Smart Design of Distributed Storages

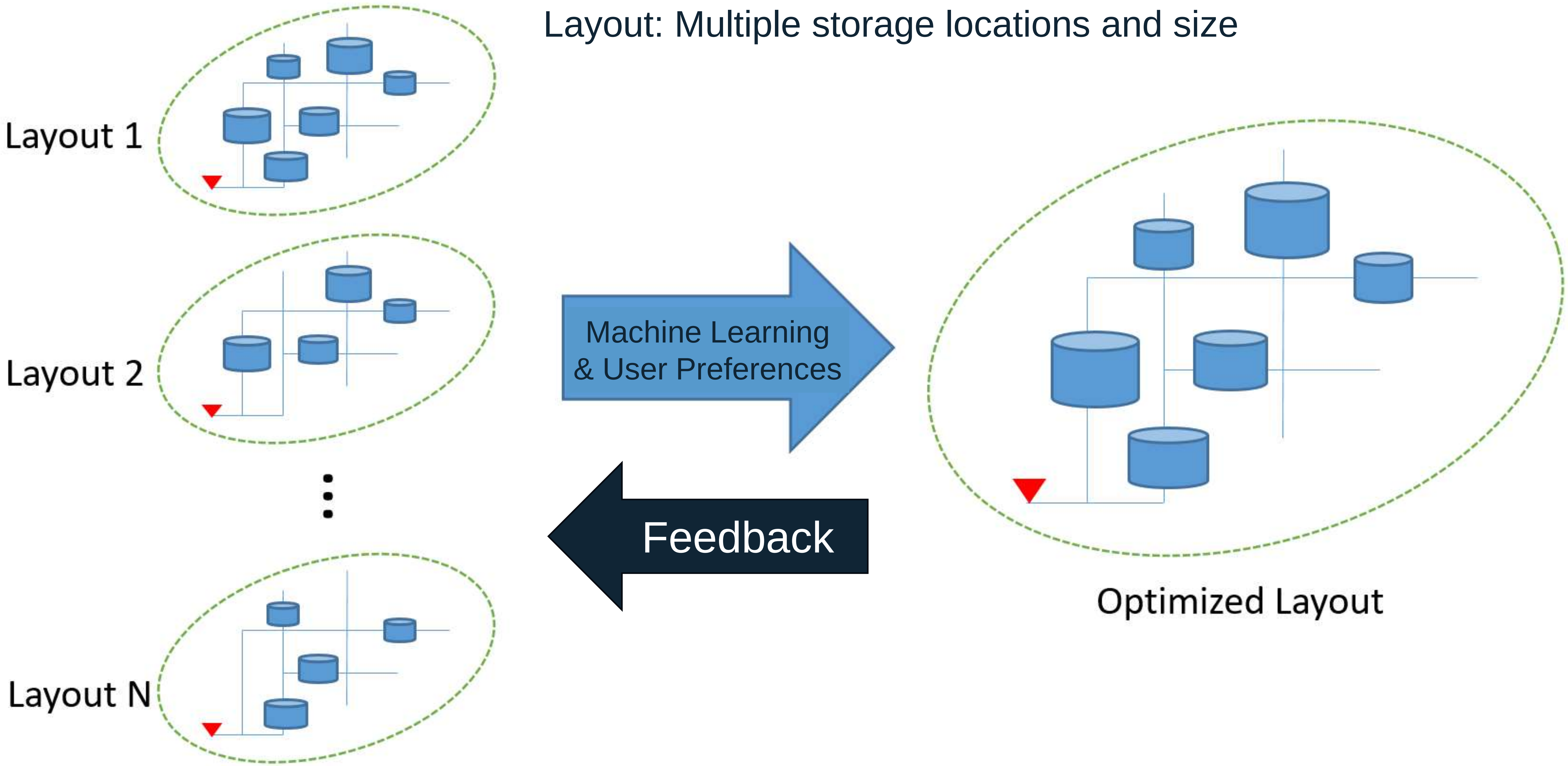
- Use distributed storages to “offset” upstream hydrographs, reducing coincident peaks
- Low-tech solution, low level of disruption



THE UNIVERSITY of ADELAIDE

Smart Design of Distributed Storages

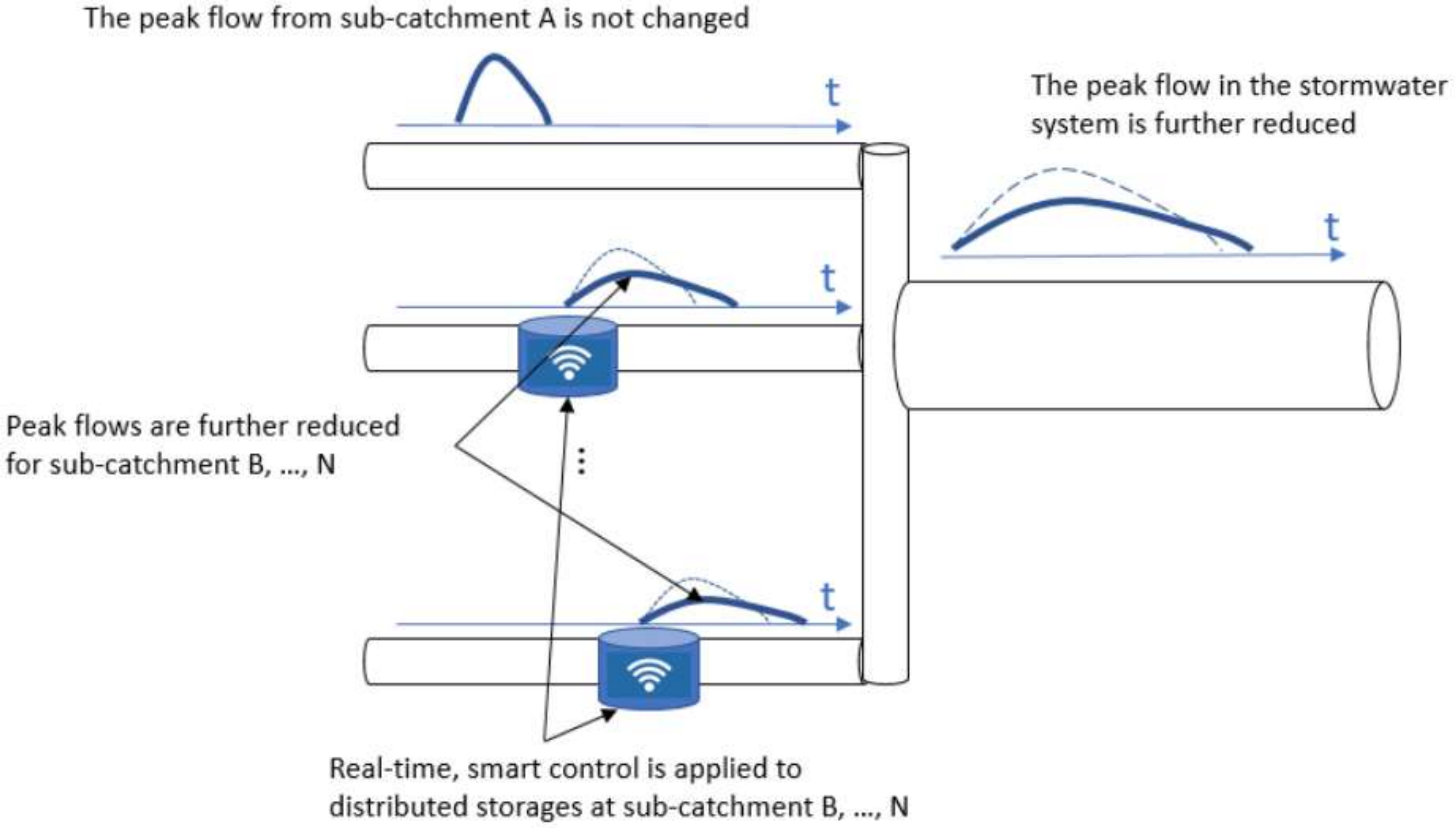
- Challenge: There are thousands of potential layouts for distributed storages – which one works?
- Solution: Utilise machine learning optimisation to determine “optimal” layout that achieves objectives taking account user preferences



THE UNIVERSITY of ADELAIDE

Smart Control of Distributed Storages

- Use opening and closing of storage orifice "during storm" to "offset" upstream hydrographs in sub-catchments, reducing coincident peaks



- Can be retrofitted to distributed storages
- Provides opportunities for adaptation and resilience (e.g. climate change)
- Provides opportunities for co-benefits (e.g. urban greening, water quality improvement)

THE UNIVERSITY of ADELAIDE

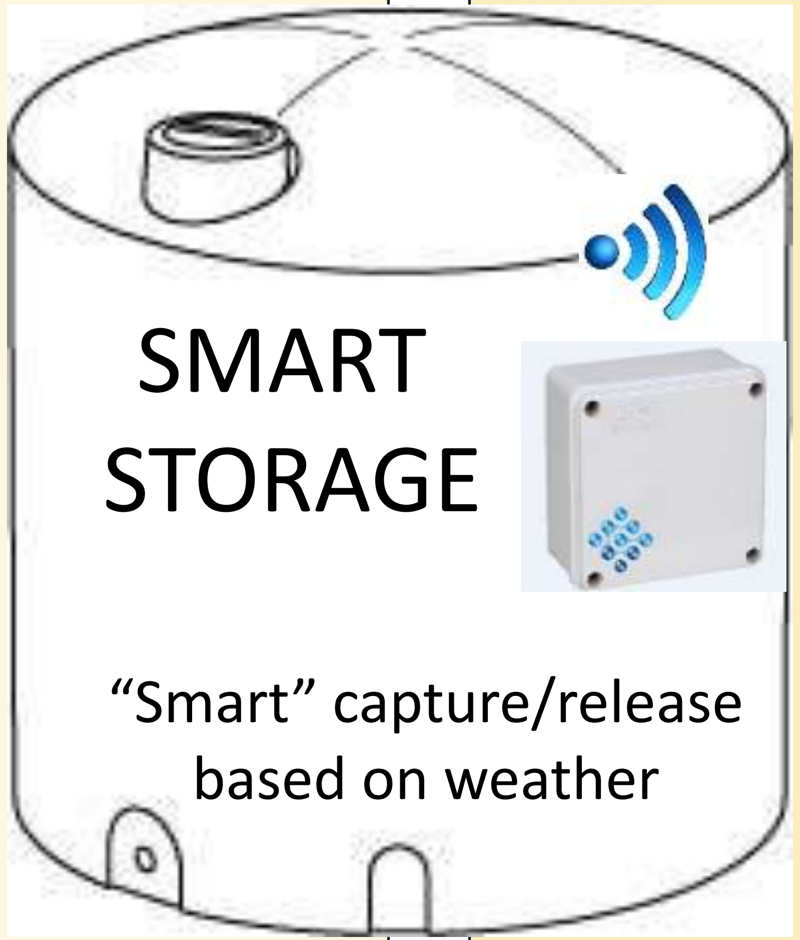
Multiple Benefits of Smart Control of Stormwater Systems

STORMWATER

SUMMER

WATER SUPPLY

Capture **smaller** storms
& provide water for urban greening
=> Reduce deadly impact of heatwaves



SMART STORAGE

"Smart" capture/release based on weather

WINTER

RELEASE

Release water before & during **larger** storms
=> Reduce flood peaks

Provide multiple benefits:
Reduce flood infrastructure costs &
Deliver water for cooler, greener cities

Quantifying Benefits of Smart Stormwater Storage through Case Studies:
Trinity Valley Catchment

THE UNIVERSITY *of* ADELAIDE

Quantifying Benefits of Smart Stormwater Storages: Trinity Valley Catchment

City of Norwood Payneham & St Peters

Challenge: Historical Flooding at Henry & Laura St

Traditional Soln: Major Pipe Upgrade

- Costly: $6.6 million
- Undesirable: Removal of local trees
- Difficult to construct: Limited space
- Potentially infeasible: Due to pipe surcharging

- **Opportunity:** Identify storage layouts on Clifton/Dover Streets that provide no overland flow on both Henry and Laura Street

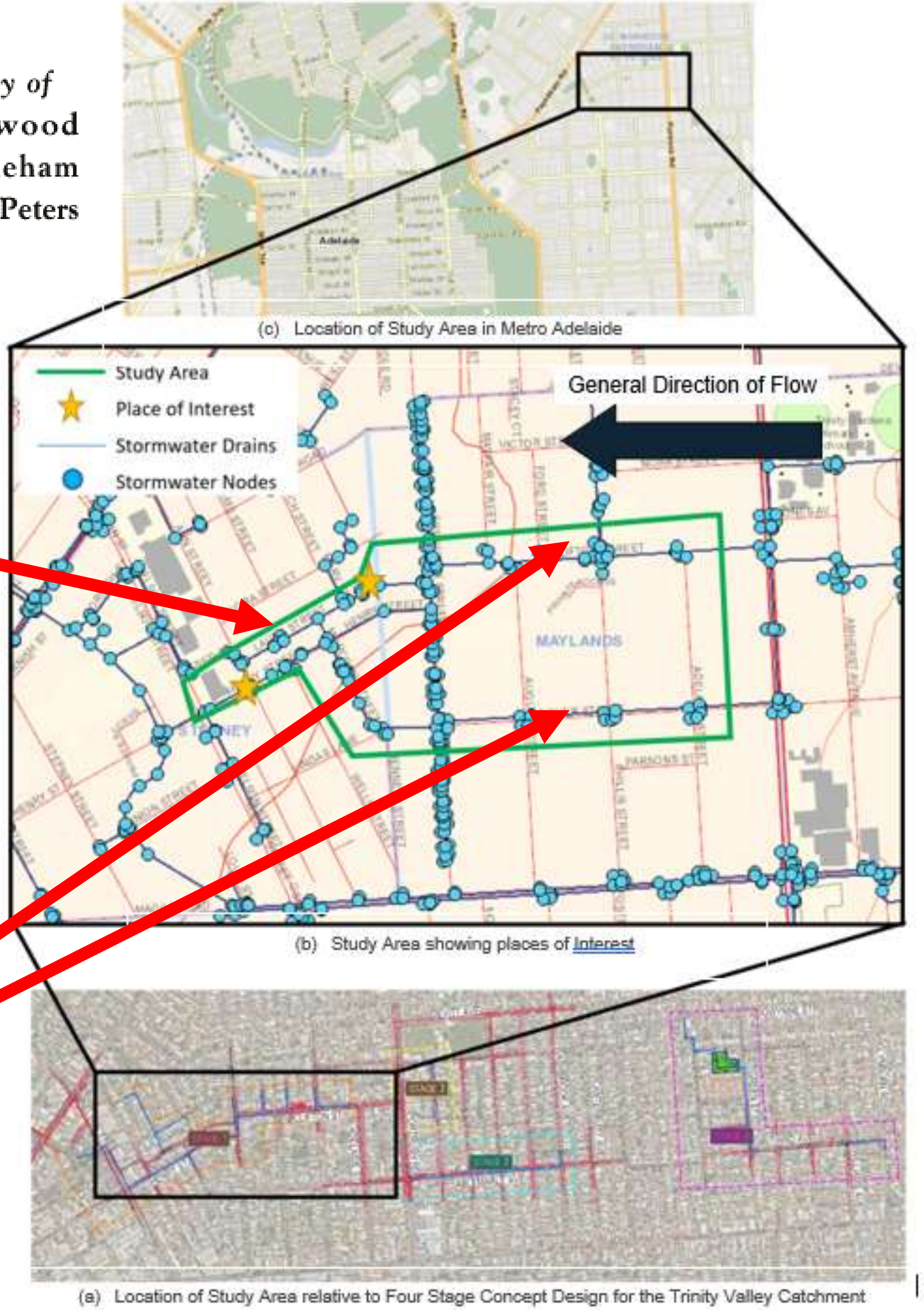


Figure 2.1. Map showing indicative study area for stormwater storages and the places of interest for the Trinity Valley Catchment.

Smart Design of Distributed Storages: Outcomes

- **Oportunity:** Identify storage layouts on Clifton/Dover Streets that provide no overland flow on both Henry and Laura Street

- **Smart Design:** Used multi-objective optimisation to evaluate over 700,000 layouts
- **Numerous constraints:** Size of Storage, Width of Streets, Services, Existing Pipes

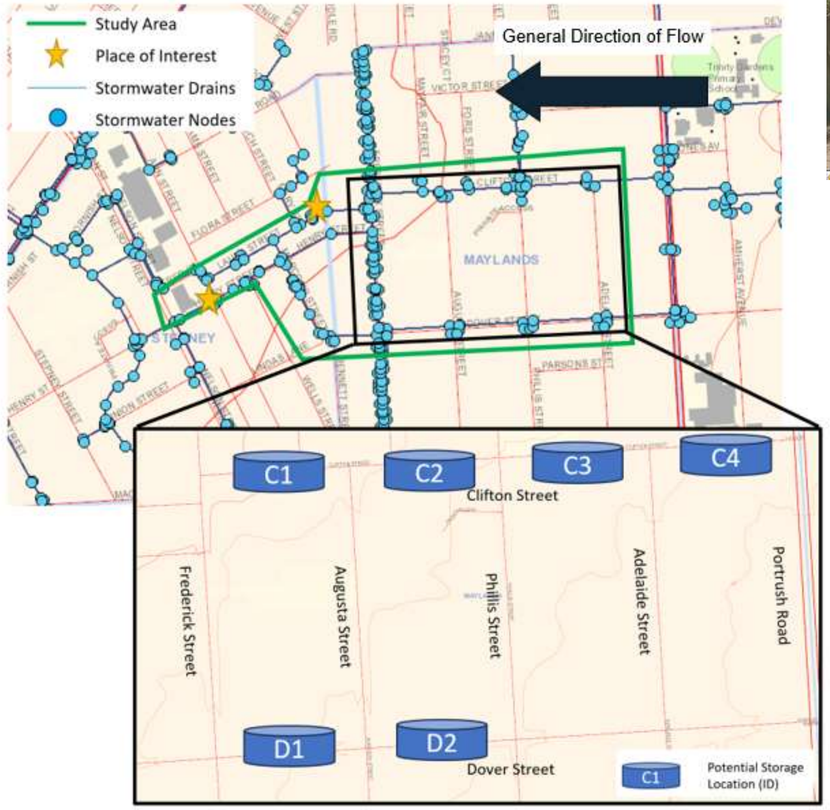
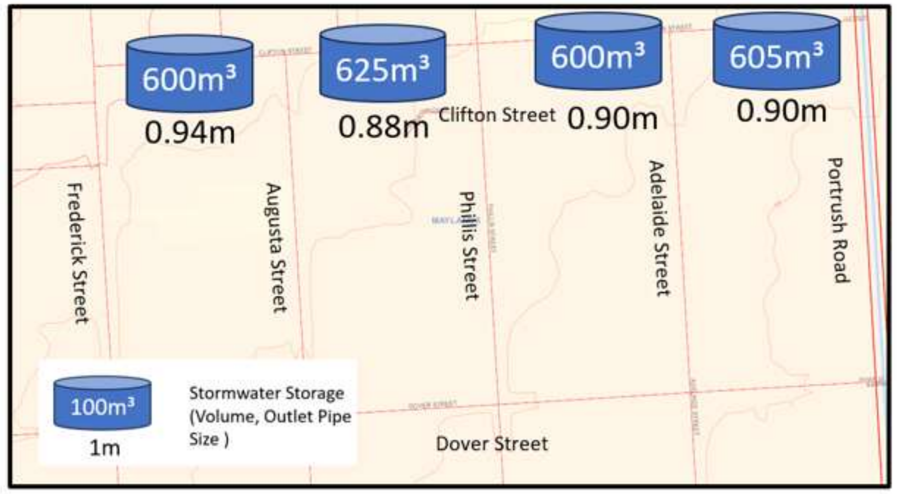


Figure 3.2 Map showing the potential storage locations within the study area

Six potential storage locations

Attributes	Pipe Upgrade	Distributed Storage
Size	Increase in size to existing pipes	No increase in pipes 2400 m^3 storage
Relative Cost	$6.6 million	$2 million* (66% less)
Feasibility	Difficult due to space limitations, tree removal	Easier as located in wide streets

Machine Learning & User Preferences



Potential Conceptual Design Option

THE UNIVERSITY of ADELAIDE

Quantifying Benefits of Smart Stormwater Storage through Case Studies:

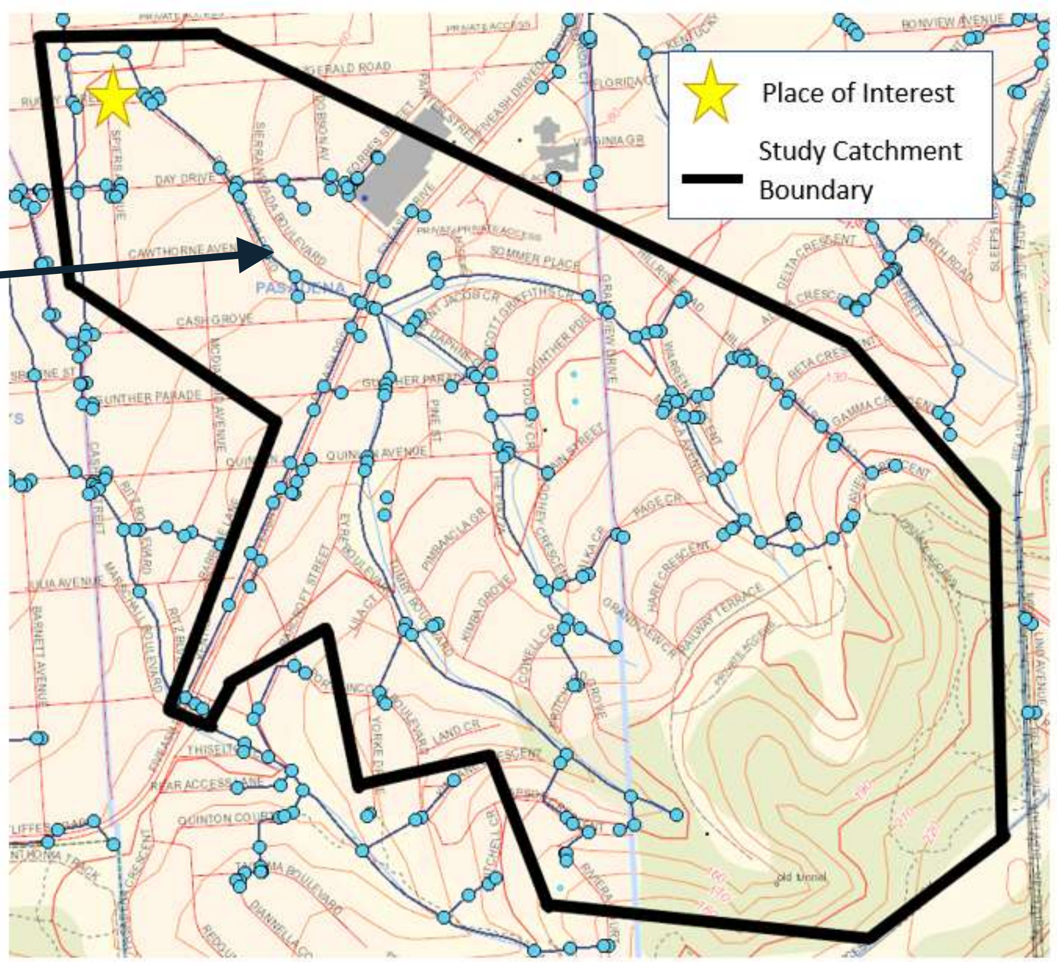
Pasadena Catchment

THE UNIVERSITY of ADELAIDE

Quantifying Benefits of Smart Stormwater Storages: Pasadena Catchment

Problem: Reduce peak flow by 16% to ensure no overland flow at place of interest

CITY OF MITCHAM



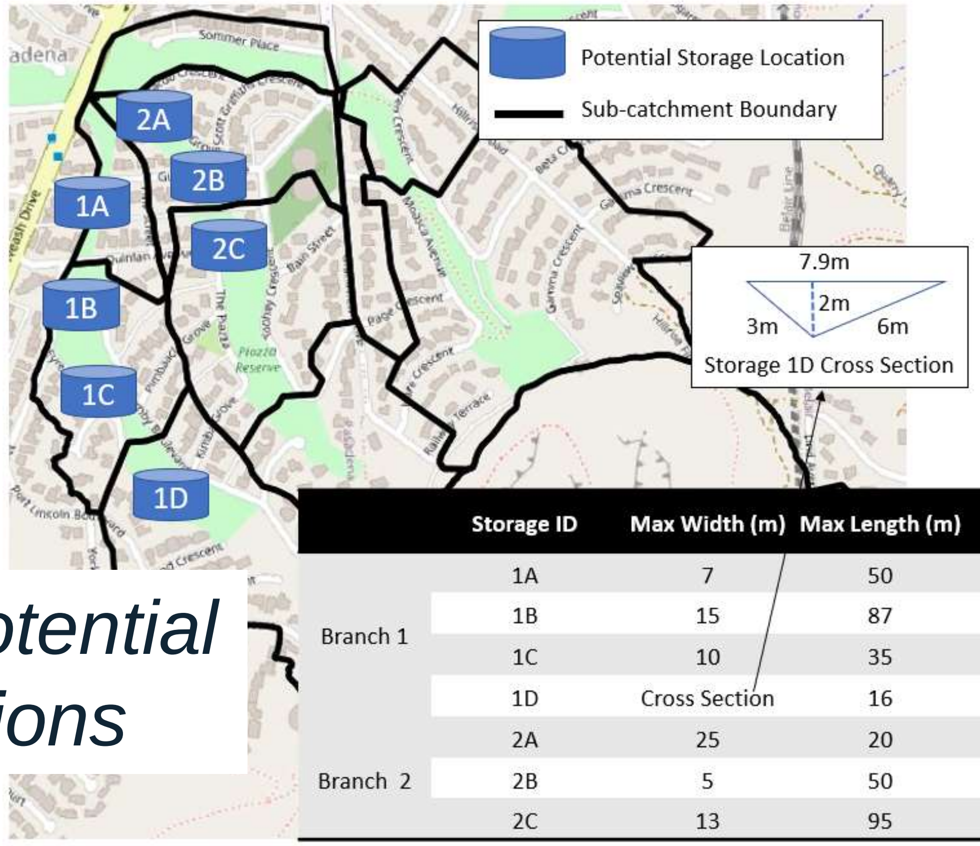
Evaluated Range of Options

- Traditional Single End of System Storage
- Smart Design of Distributed Storages
- Smart Control of Distributed Storages

THE UNIVERSITY of ADELAIDE

Smart Design of Distributed Storages: Outcomes

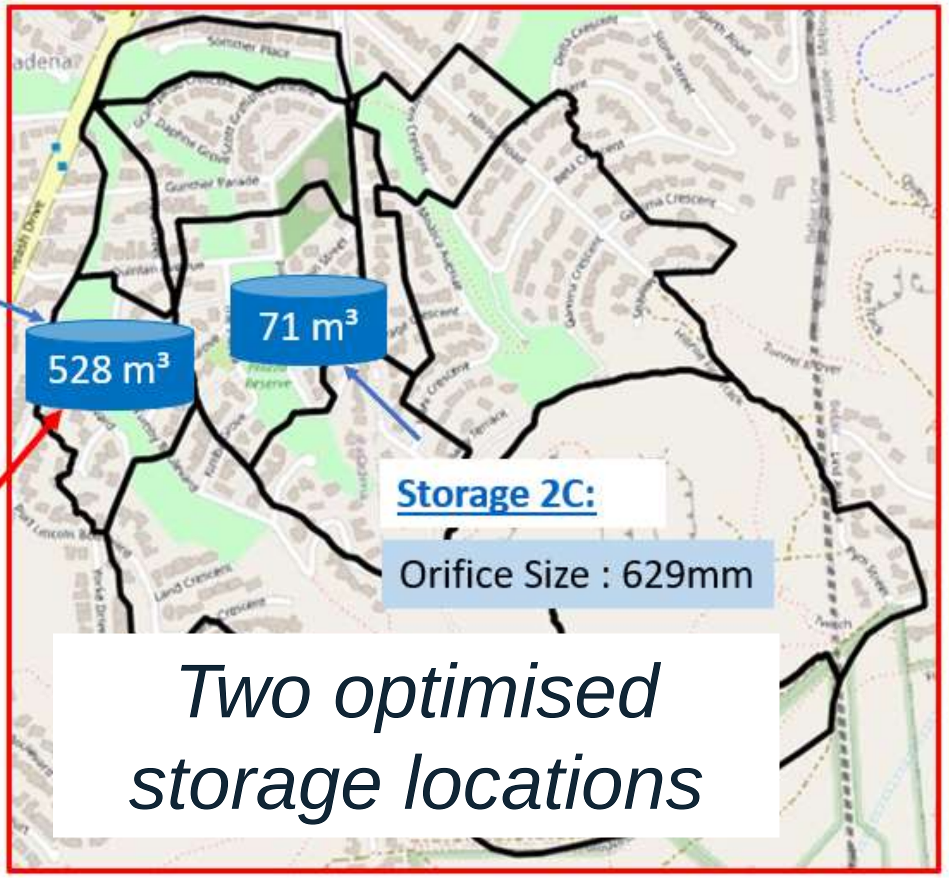
- Identify optimised layout of storages by evaluating over 700,000 combinations



	Storage ID	Max Width (m)	Max Length (m)	Preference
Branch 1	1A	7	50	Rank 3
	1B	15	87	Rank 2
	1C	10	35	Rank 3
	1D	Cross Section	16	Rank 1
Branch 2	2A	25	20	Rank 3
	2B	5	50	Rank 3
	2C	13	95	Rank 2

Eight potential locations

Machine Learning & User Preferences



Two optimised storage locations

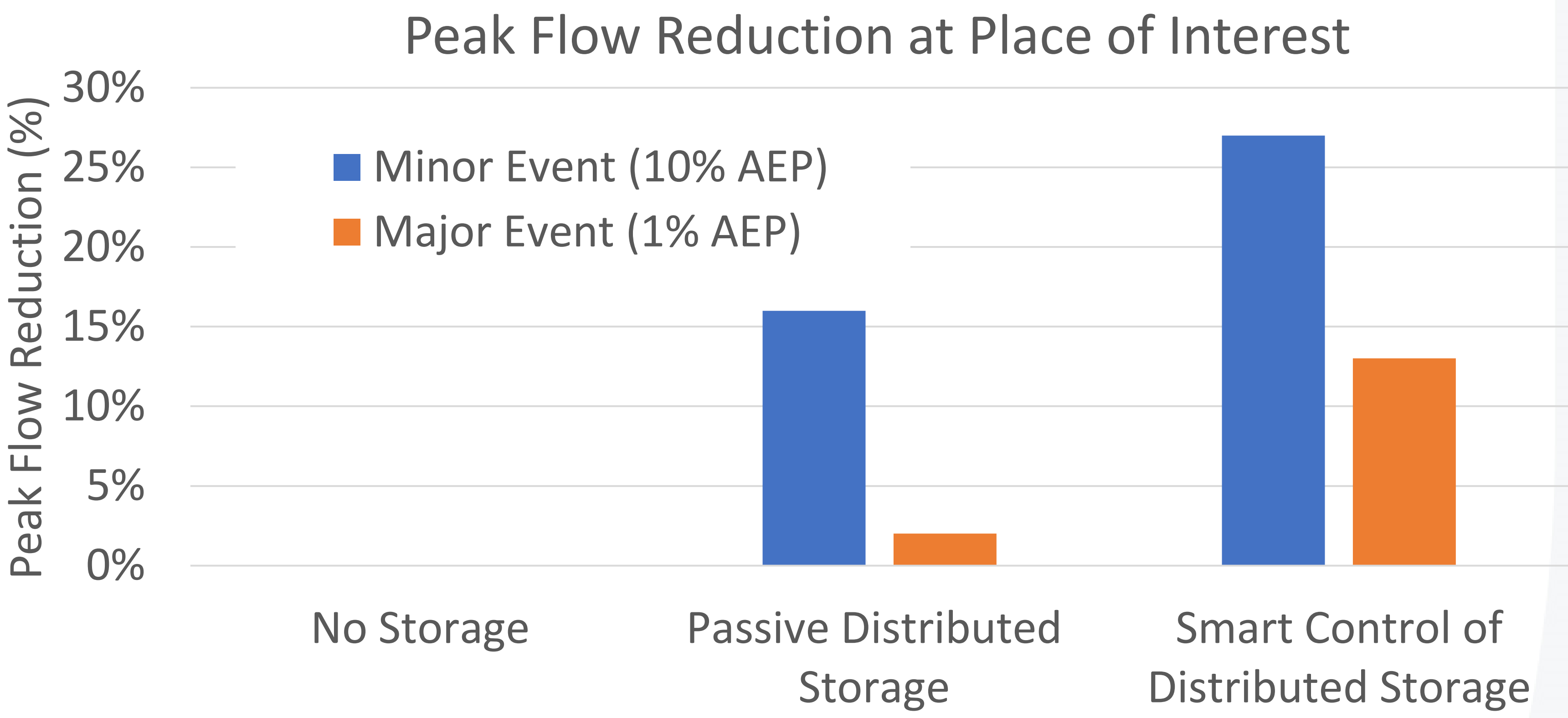
All options achieved objective of 16% peak flow reduction

Attributes	End of System Storage	Distributed Storage
Storage Size	1500 m^3	600 m^3 (60% less)
Relative Cost	(baseline)	60% less
Feasibility	Difficult due to space limitations	Easier as located in reserves

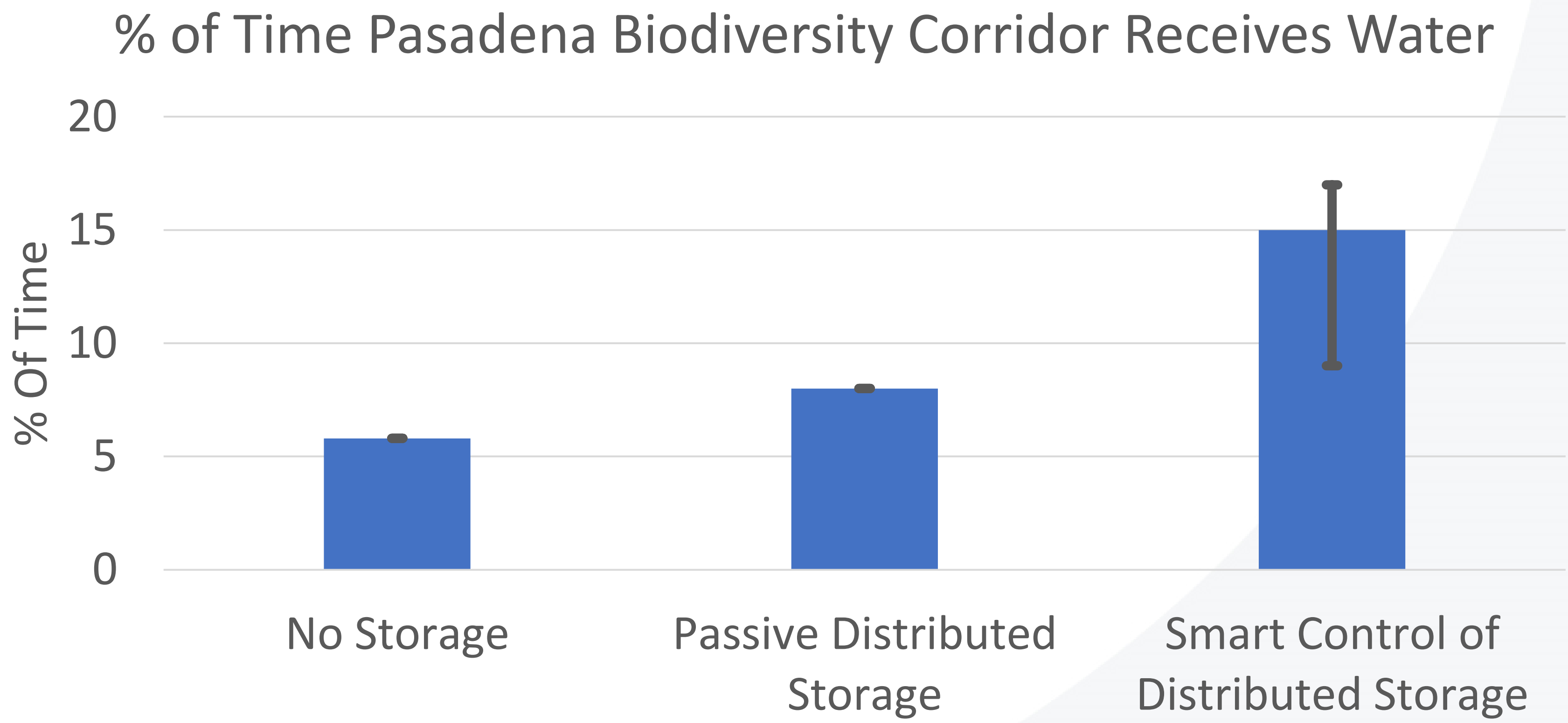
- Distributed Storages: Save Space, Cost Less & Increases Feasibility

Smart Control of Distributed Storages: Outcomes

- Significant Reduction in Peak Flows for both Minor & Major Events



- Significant Increase in Water Re-Use Benefits for Pasadena Biodiversity Corridor



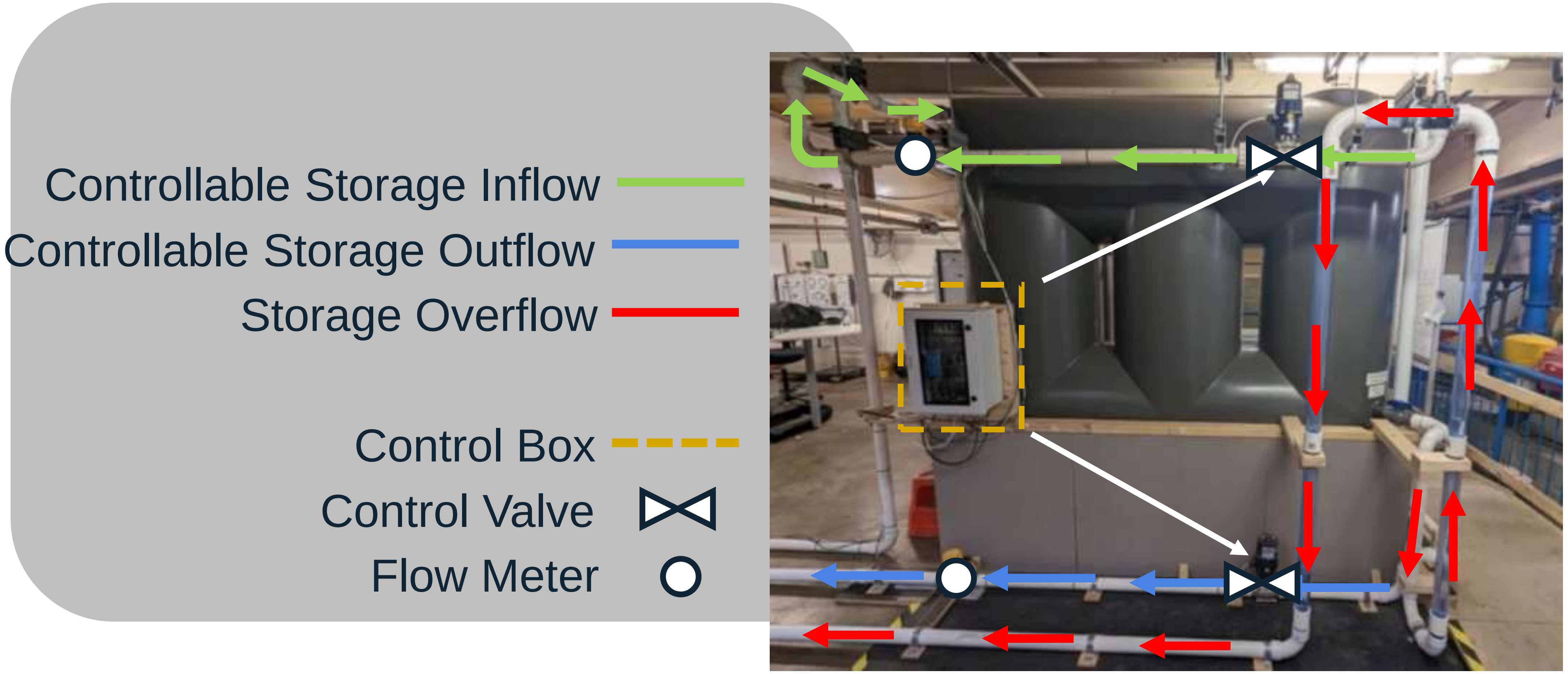
THE UNIVERSITY of ADELAIDE

Quantifying Benefits of Smart Stormwater Storage through Case Studies:

Smart Stormwater Physical Prototype

THE UNIVERSITY of ADELAIDE

Smart Stormwater Physical Prototype

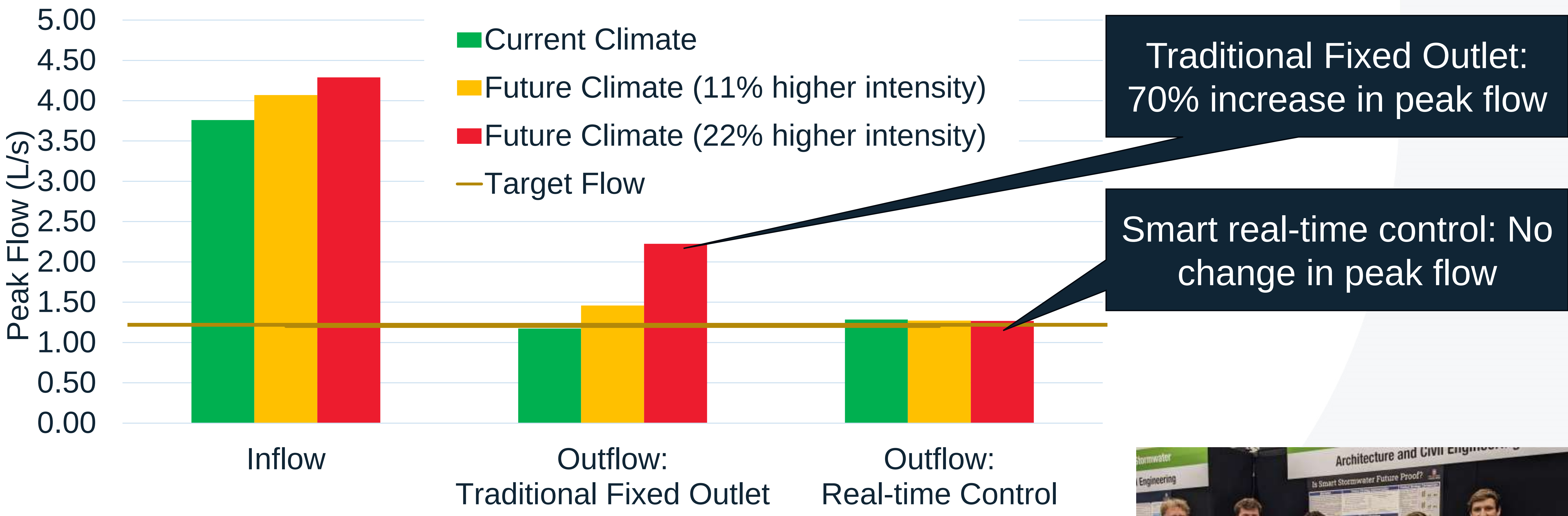


- Generate inflows equivalent to typical lot of 160 m^2
- Generate range ARR design storms (intensity/temporal patterns)
- 2kL storage, 50 mm outlet, fully controllable
- Test range of control strategies (fixed outlet, real-time control)
- Floodplain to show impacts
- Important step towards field trials

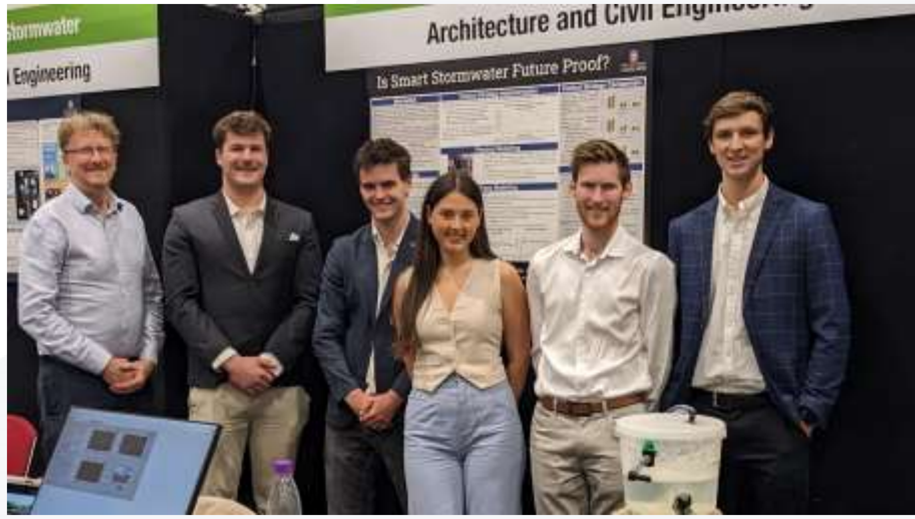
Physical Prototype Outcomes: Impact of Future Climates on Peak flows

Traditional Fixed Outlet vs Smart Real-Time Control

- Current Climate: ARR Design Storms, 30 min duration, AEP 10%, Avg of 3 temporal patterns



- Potential for real-time control to adapt to future climate changes
- Reduce the need for expensive flood infrastructure upgrades



Physical Prototype Outcomes: Outreach Activity

Learning Outcomes:

1. Motivation/Understanding of Flooding & Stormwater Management
2. Compare Traditional/WSUD/Smart Management Strategies
3. Designing Best Practise of Stormwater Management System

Adapted for different audiences:
Middle School/High School Students
Undergraduate/Masters Students
Industry Professionals

Step 1: Introductory Video
Step 2: Hands-on Design Activity

THE UNIVERSITY *of* ADELAIDE

Hands-on Design Activity: The Flood is Coming!

Case studies show smart stormwater saves space, costs less, increases feasibility, adapts to climate change, provides more water for urban greening

Smart Design of Stormwater Storages

- Saves Space: 45% to 60% less
- Costs Less: 30% to 60% reduction
- Increases Feasibility: Easier as smaller storages fit into existing space
- Technology is available now
- Takes longer at design stage, pays for itself with construction savings

Smart Control of Stormwater Storages

- Further Peak Flow Reductions: Additional 10%-20%
- Significant Water Re-Use Benefits
- Potential to Adapt to Future Climate Change: Reduce 70% increase to zero
- Physical Prototype developed for Testing and Outreach

Future: Smart Stormwater "Demonstration" Site:

- $2.1 million funding from Federal Government's Disaster Reduction Fund
- Collaboration between City of Mitcham and University of Adelaide

Future: What are the opportunities for use of Smart Stormwater in SA

THE UNIVERSITY of ADELAIDE