Can we design Stormwater Harvesting for our Waterways?

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Melbourne Water

Presentation overview

Aims

1. Share the **latest research**

2. Application of this research with a **case study**

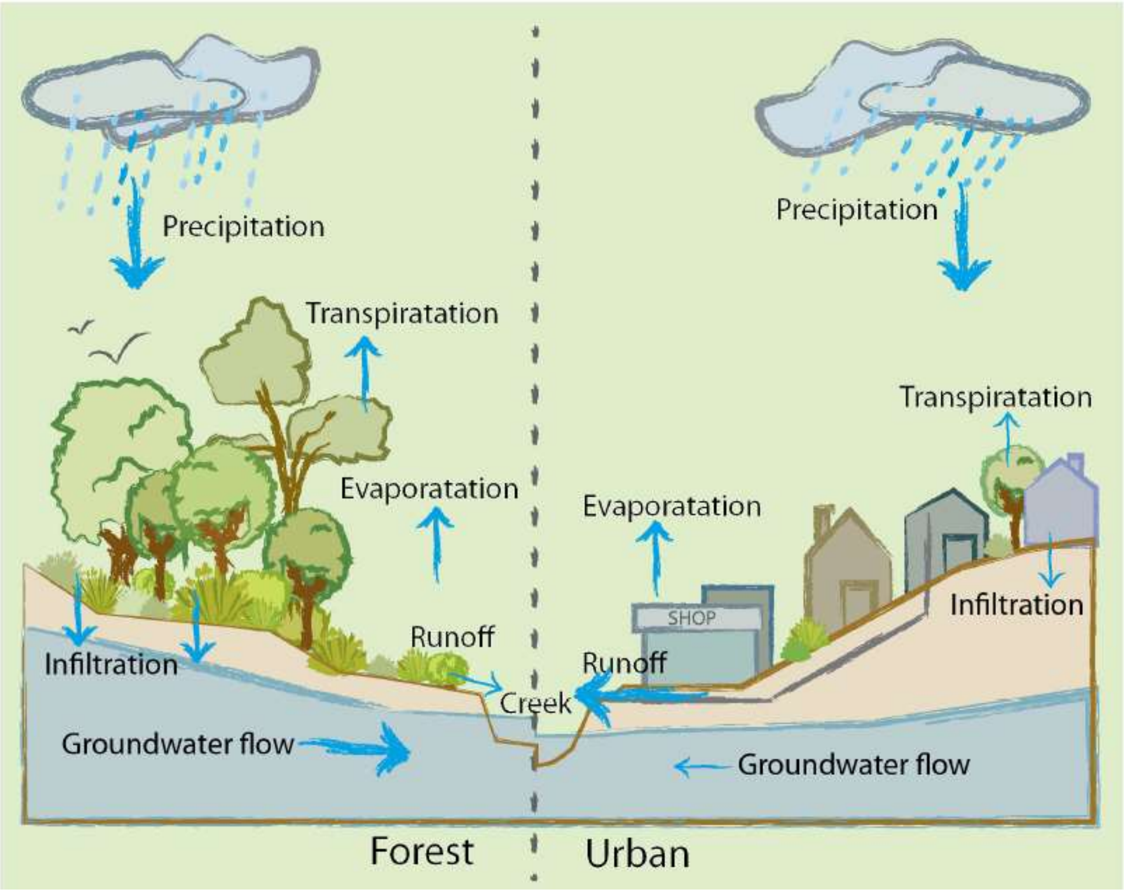
3. Demonstrate a **replicable approach for assessing waterway impacts**

Waterway Impacts

Part 1: Sharing the latest research

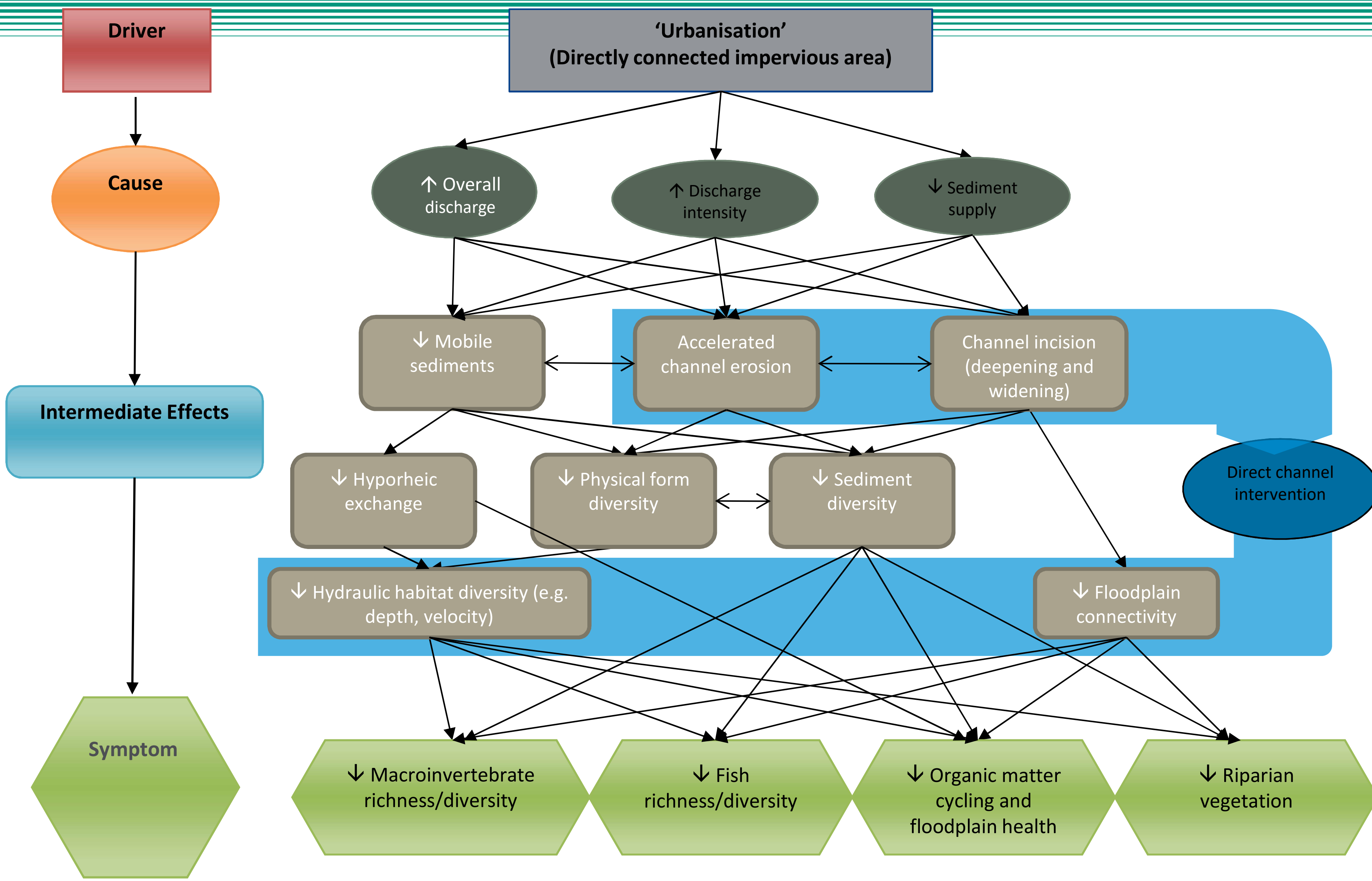
Stormwater impacts on waterways

Stormwater is increasingly being recognised as the biggest threat to our rivers and creeks



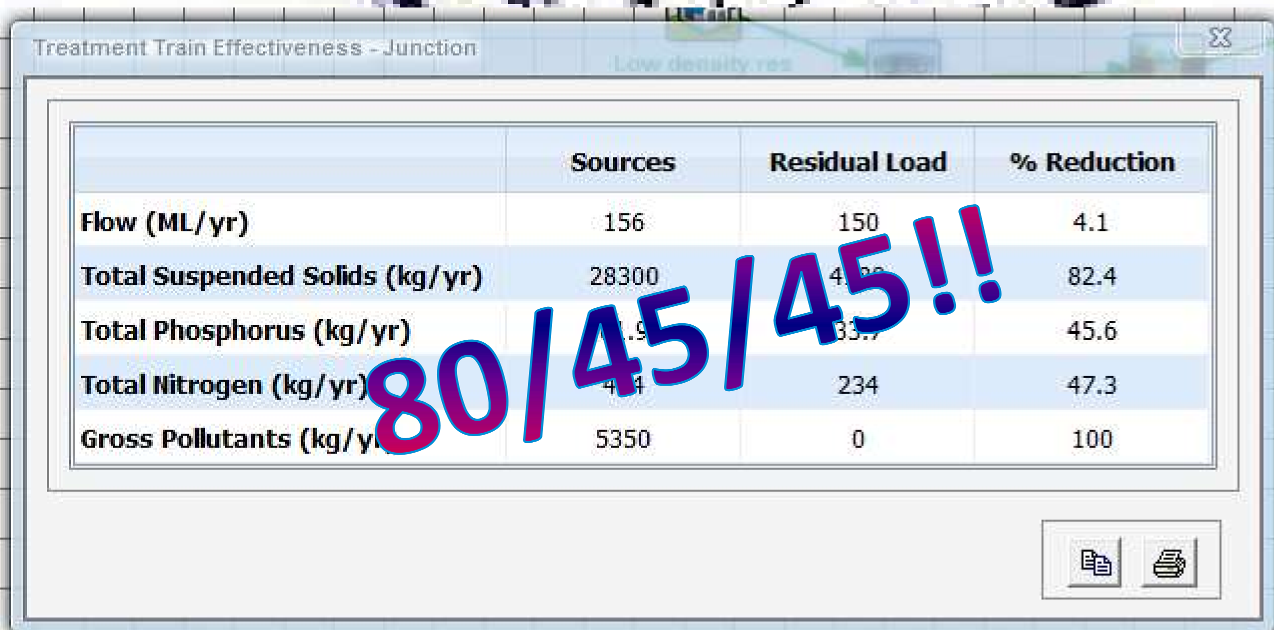
Ecosystems are complex...

Geomorphic processes

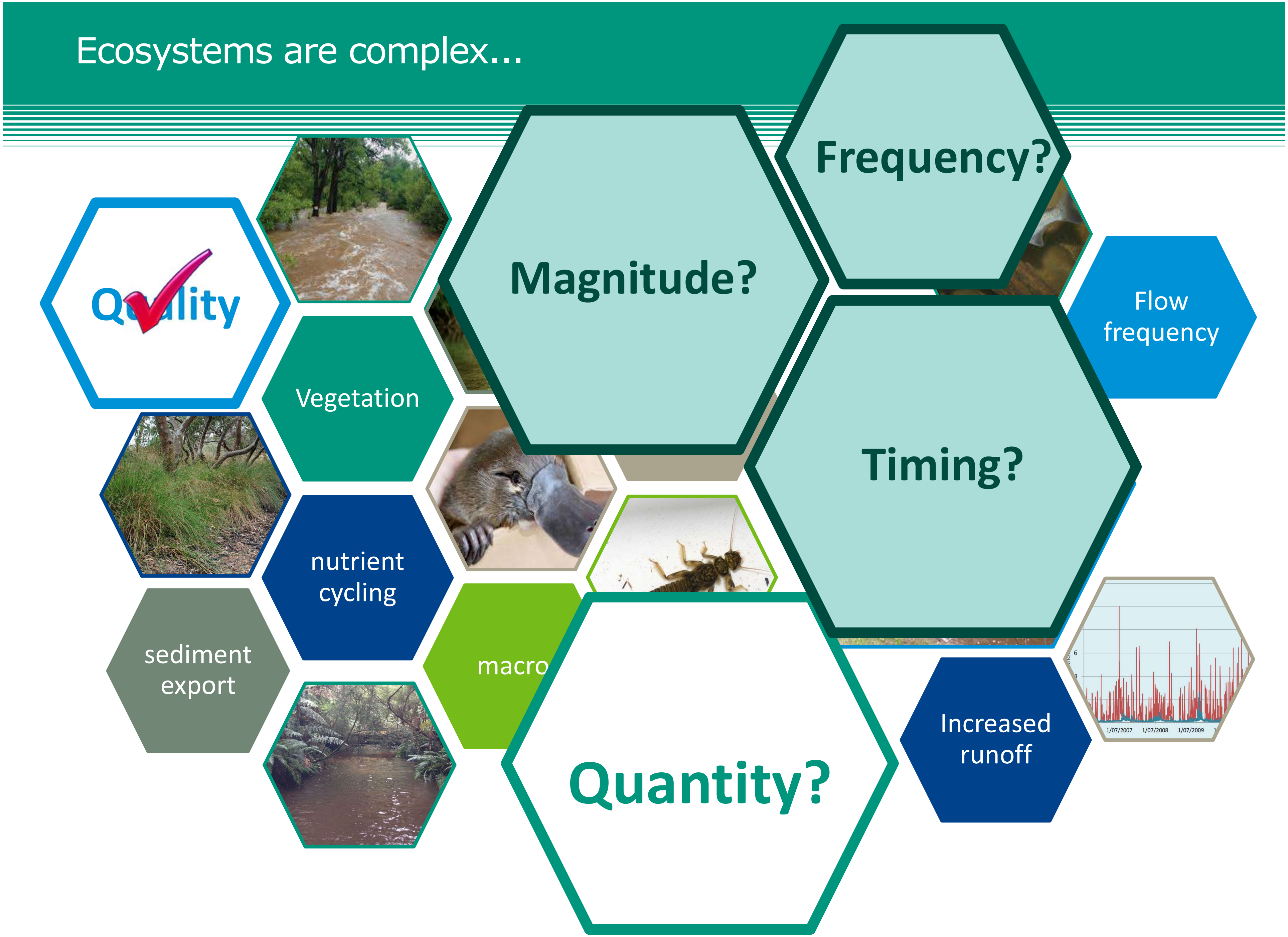


Source: Courtesy of Geoff Vietz

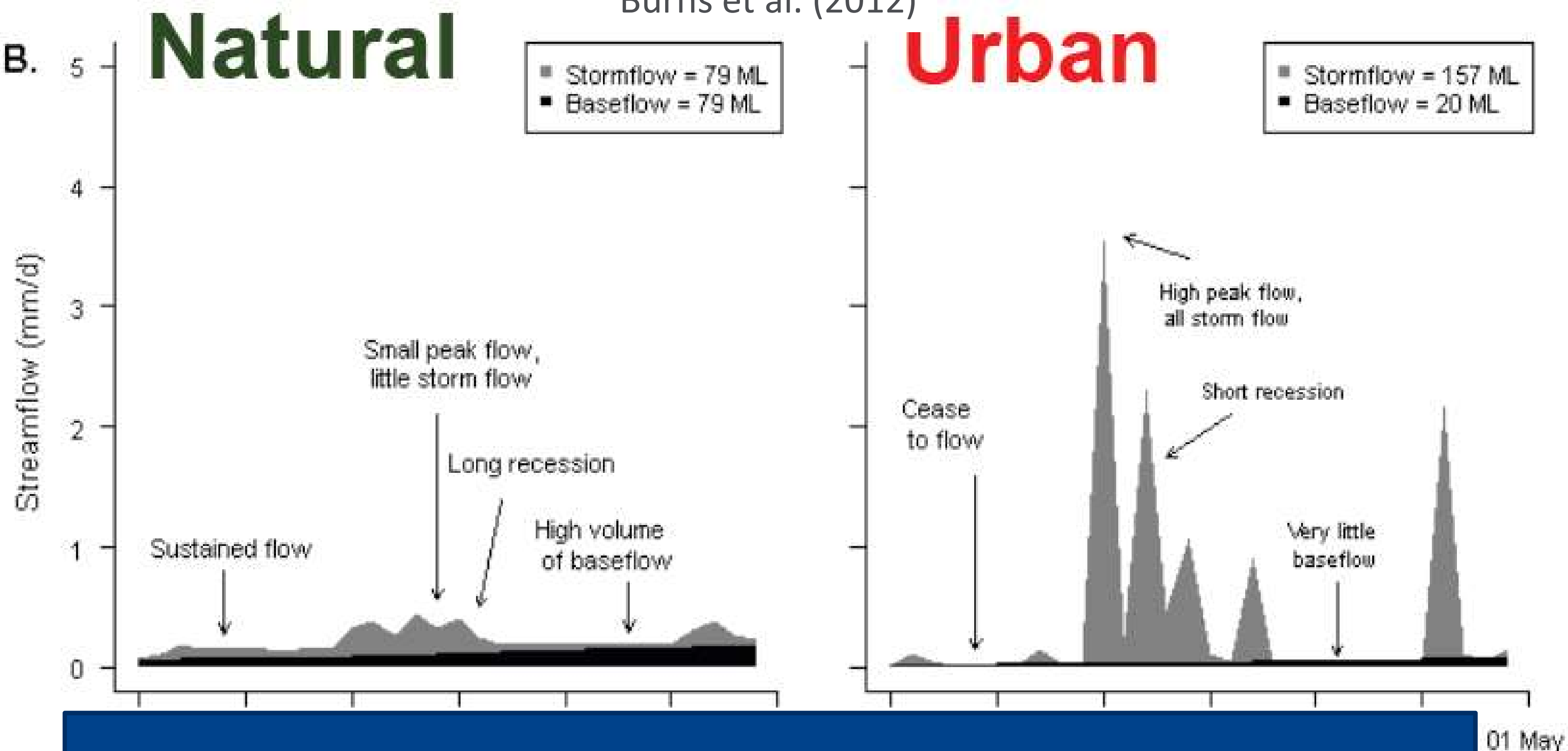
Making complex problems simple….



	Sources	Residual Load	% Reduction
Flow (ML/yr)	156	150	4.1
Total Suspended Solids (kg/yr)	28300	[illegible]	82.4
Total Phosphorus (kg/yr)	[illegible]	[illegible]	45.6
Total Nitrogen (kg/yr)	[illegible]	234	47.3
Gross Pollutants (kg/yr)	5350	0	100


Ecosystems are complex...
Quality
Vegetation
nutrient cycling
sediment export
macro
Magnitude?
Frequency?
Timing?
Quantity?
Flow frequency
Increased runoff
1/07/2007
1/07/2008
1/07/2009

Burns et al. (2012)



Manage stormwater with the aim of improving waterway health by mimicking the natural water cycle as closely as possible

Higher standards

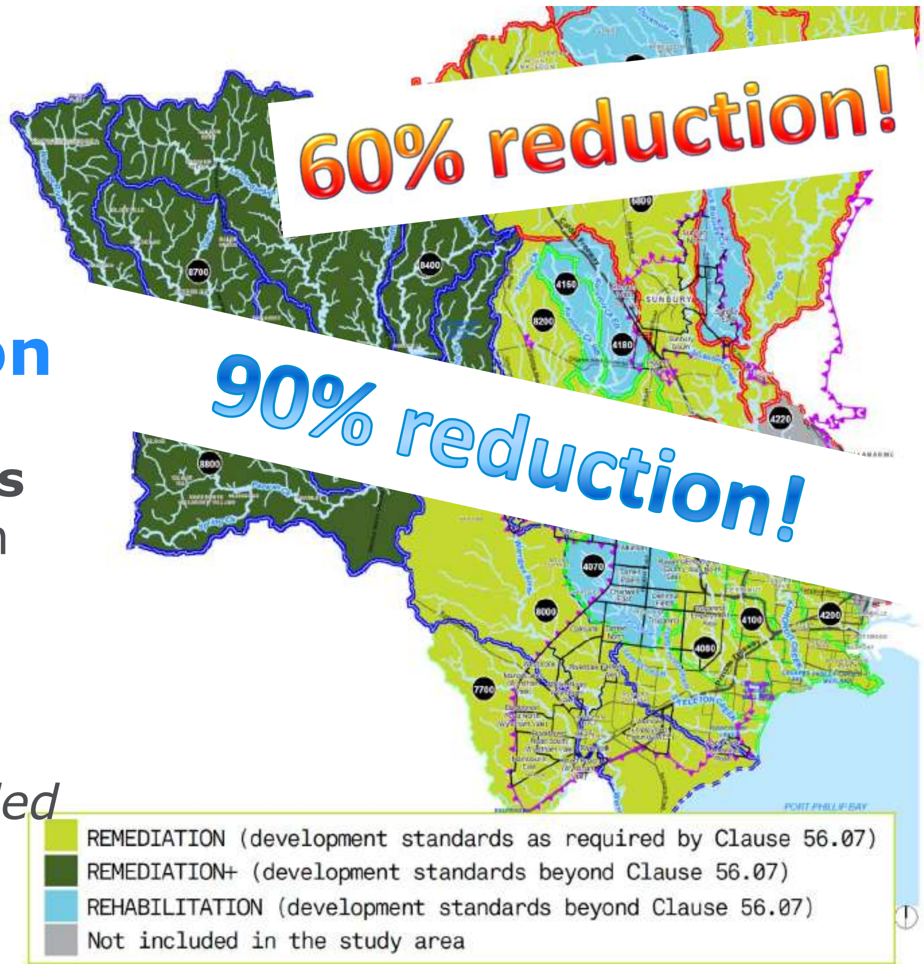
What do we want?

"Higher standards" =

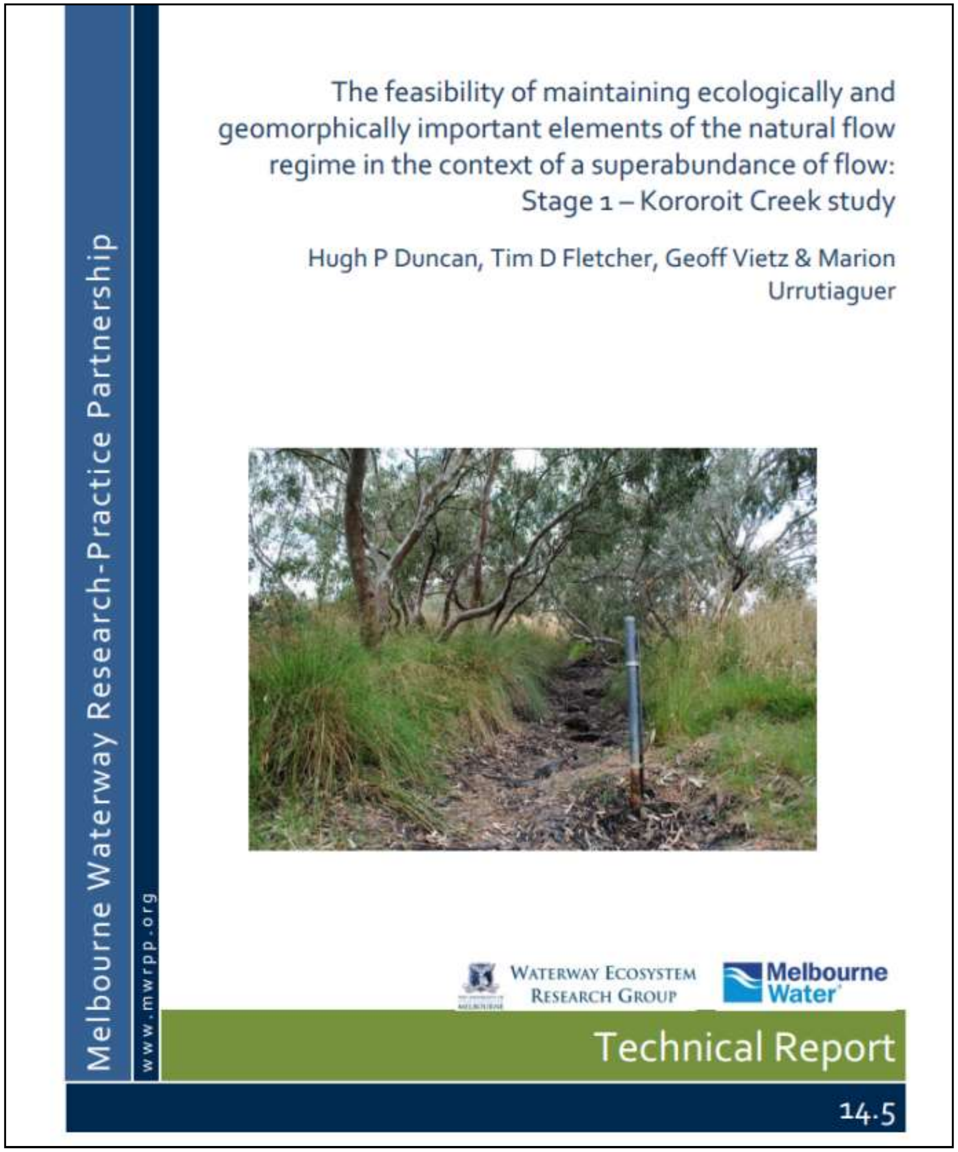
anything above current BPEM

To date, 90% flow reduction has been used as a surrogate for achieving other waterway metrics (ie only 10% of runoff produced from development is allowed to enter waterways)

Science suggests this is what is needed to mimic natural hydrology



Where does "90%" come from?

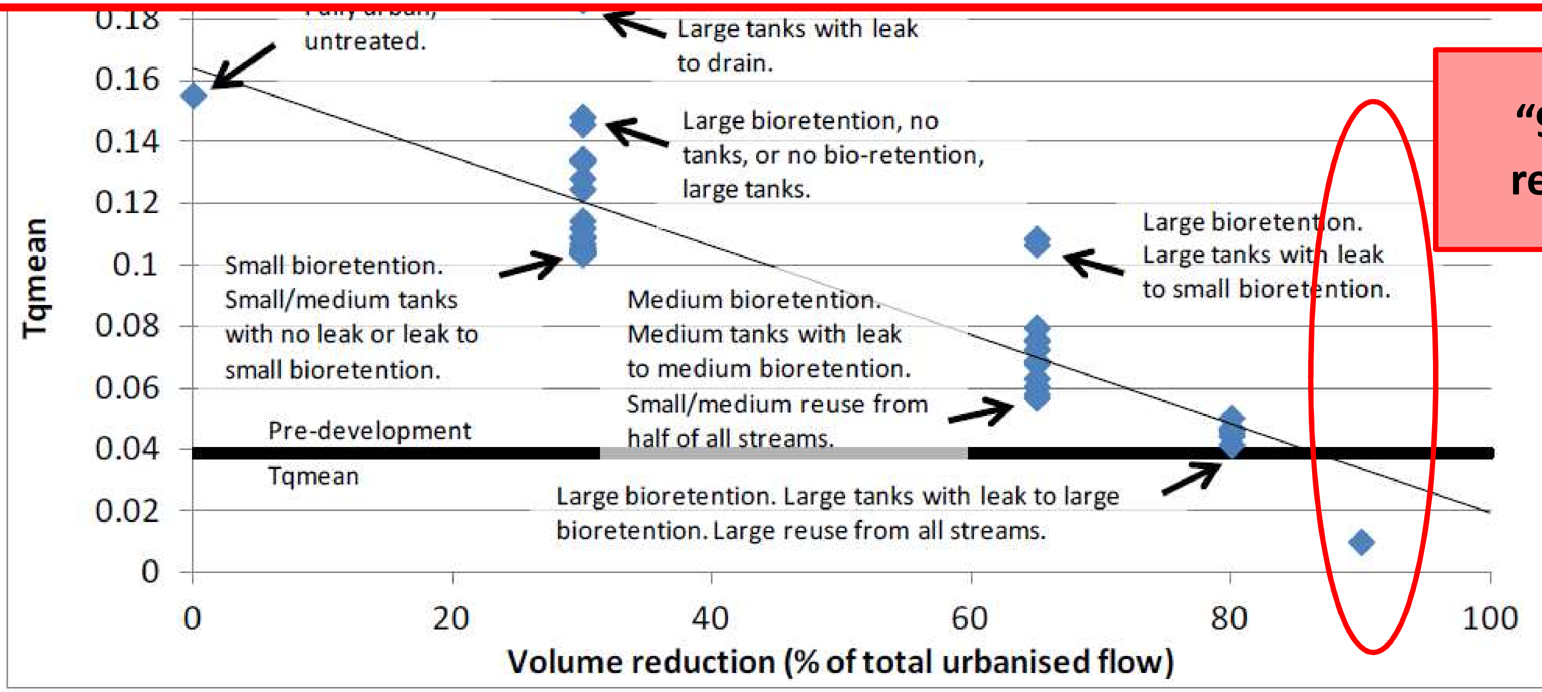


"Superabundant flows" work

Hugh Duncan, Tim Fletcher,
Geoff Vietz, Marion Urrutiaguer

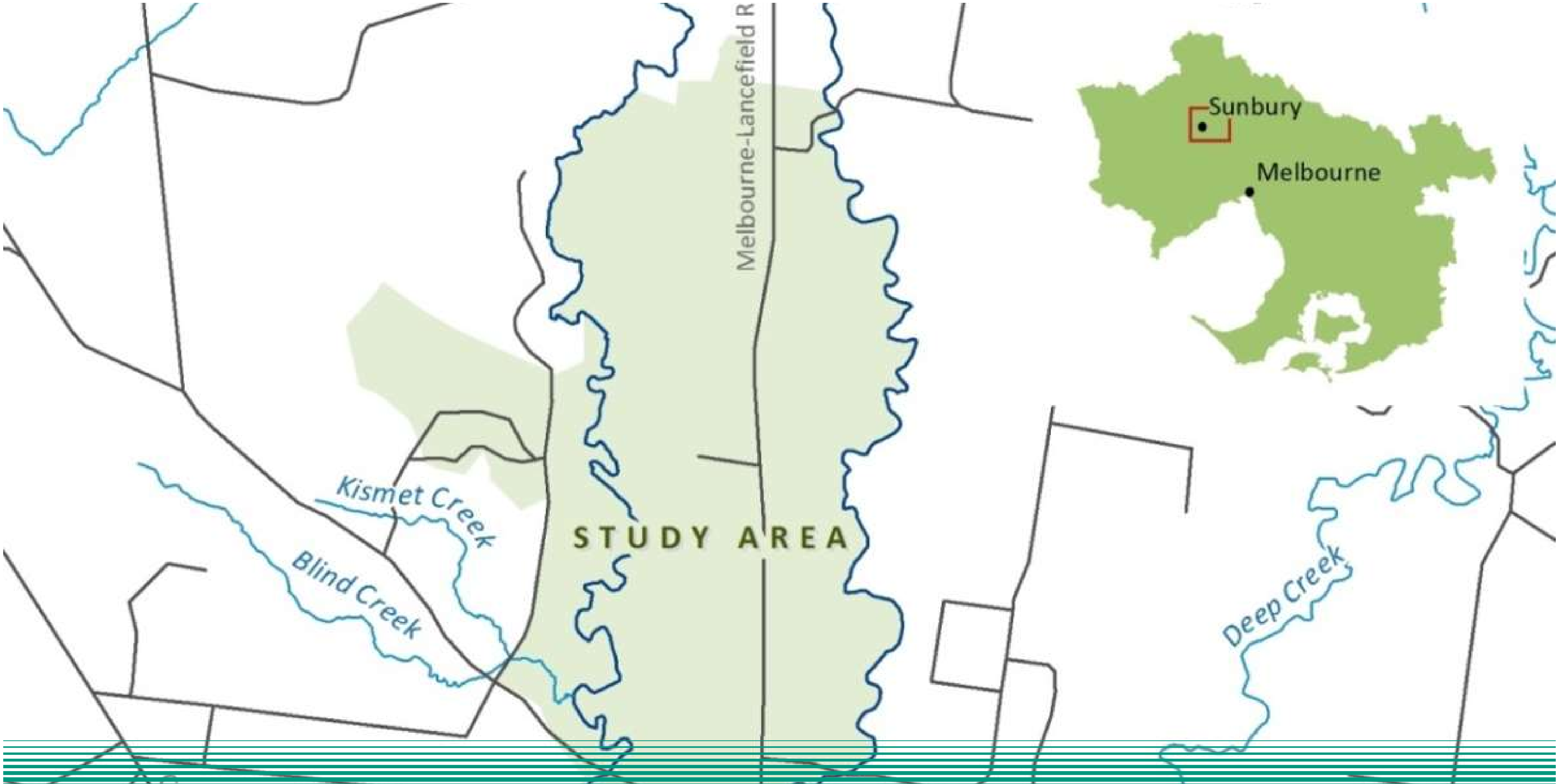
Where does "90% flow reduction" come from?

Behaviour is very similar for the two threshold metrics, representing bed mobilisation (time>1.9m^3/s) and bank mobilisation (time>3.8m^3/s), as shown in Figure 16 and Figure 17. Interpolation of the linear curve-fit suggests that a volume reduction between 80 and 90% is needed to restore these two metrics to their pre-urban targets.



"90% flow reduction"

Figure 16. Relationship between Tqmean and volume reduction. The "Pre-development" line represents the pre-developed level, based on measured flows.



Sunbury Case Study

Part 2: Applying the latest research

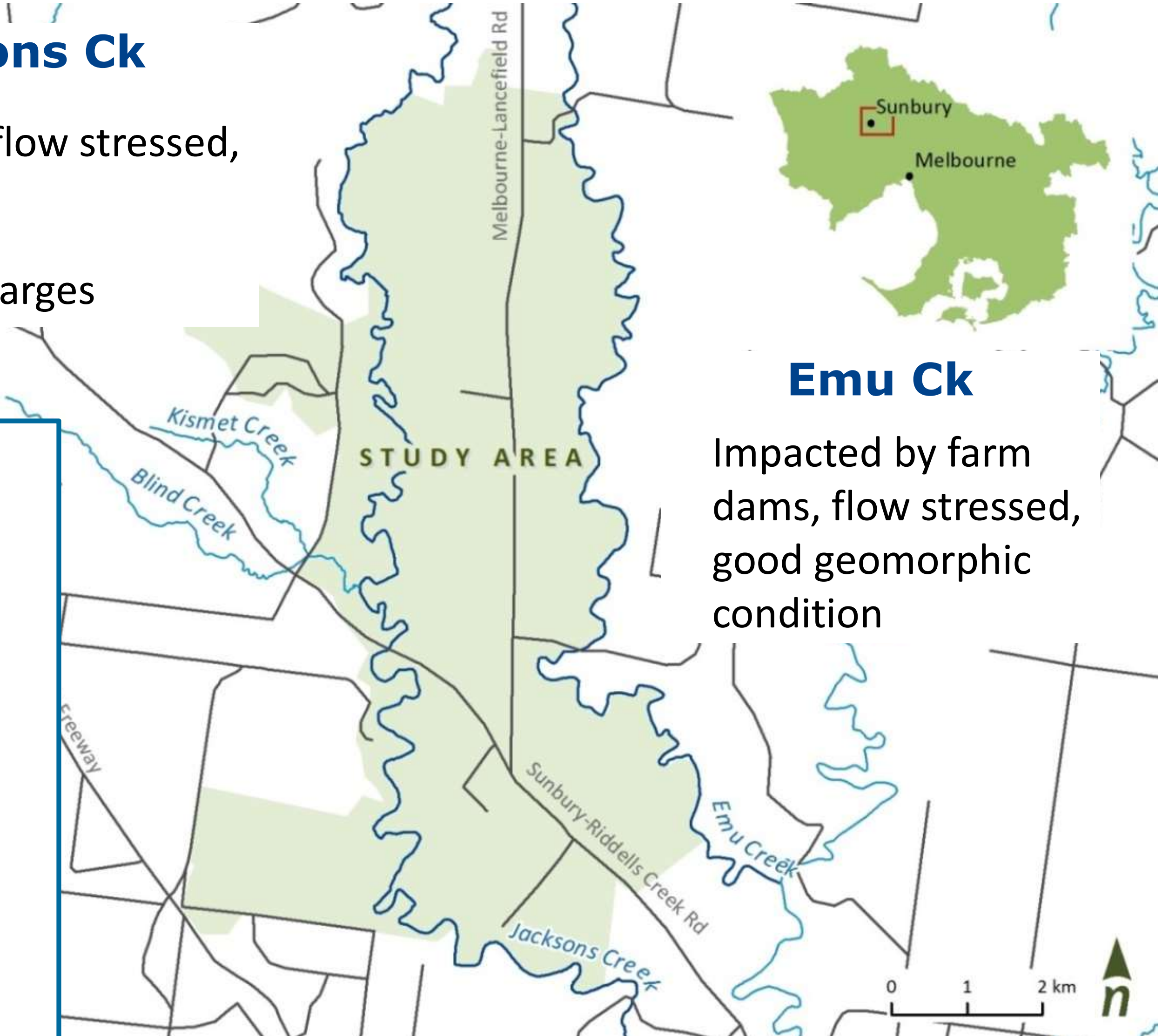
Sunbury Background

Jacksons Ck

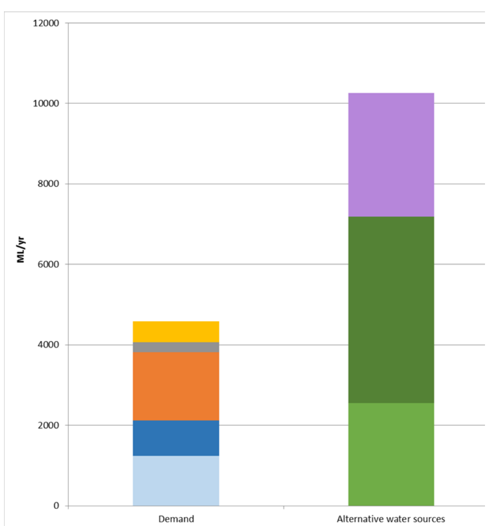
- Regulated, flow stressed, platypus
- RWTP discharges

Emu Ck

Impacted by farm dams, flow stressed, good geomorphic condition

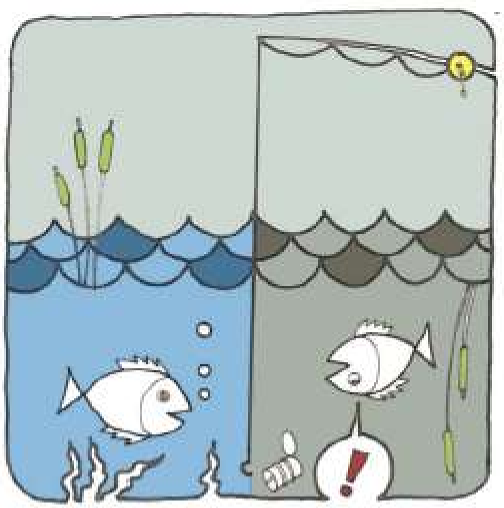


24,000 new homes

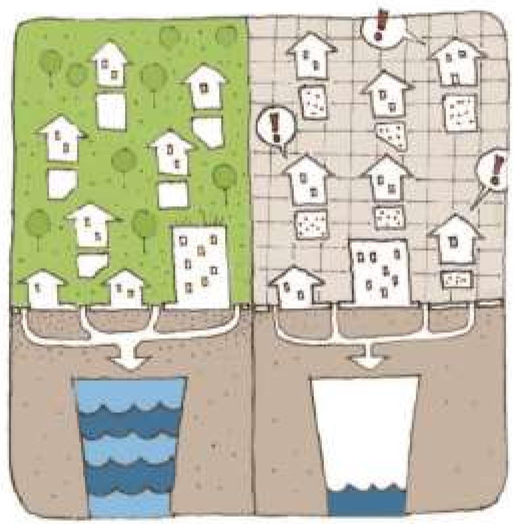


Sunbury IWM: Goals

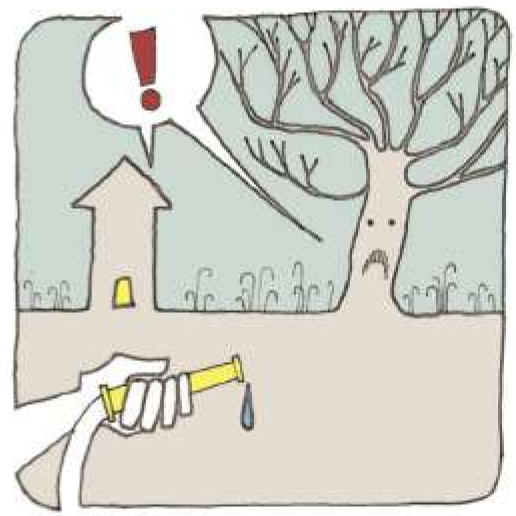
Three major goals



Keep the waterways healthy



Keep soils and landscape healthy

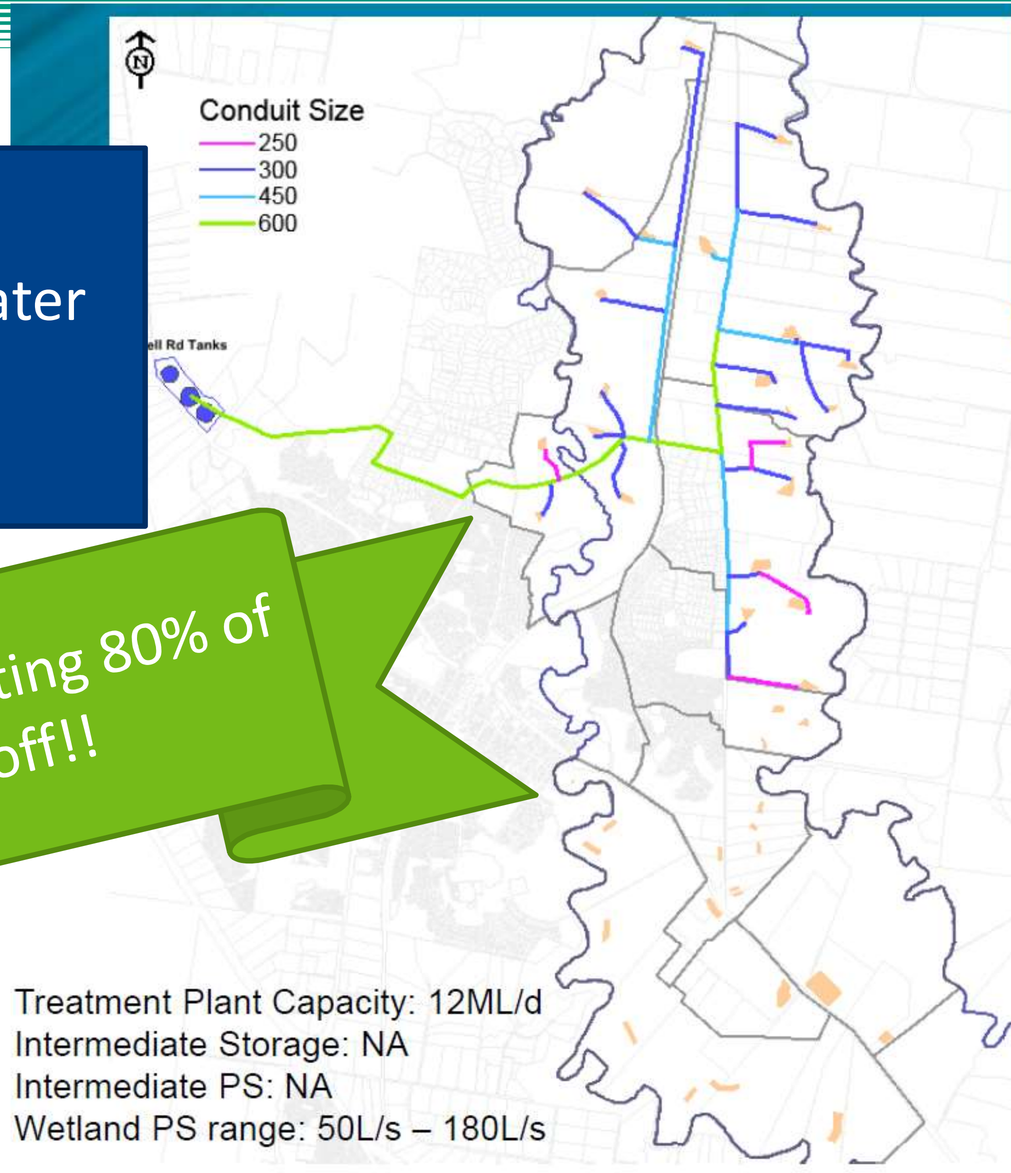


New water supplies

Deliverable solutions

Sunbury IWM Overview

Regional scale stormwater harvesting system



Now harvesting 80% of runoff!!

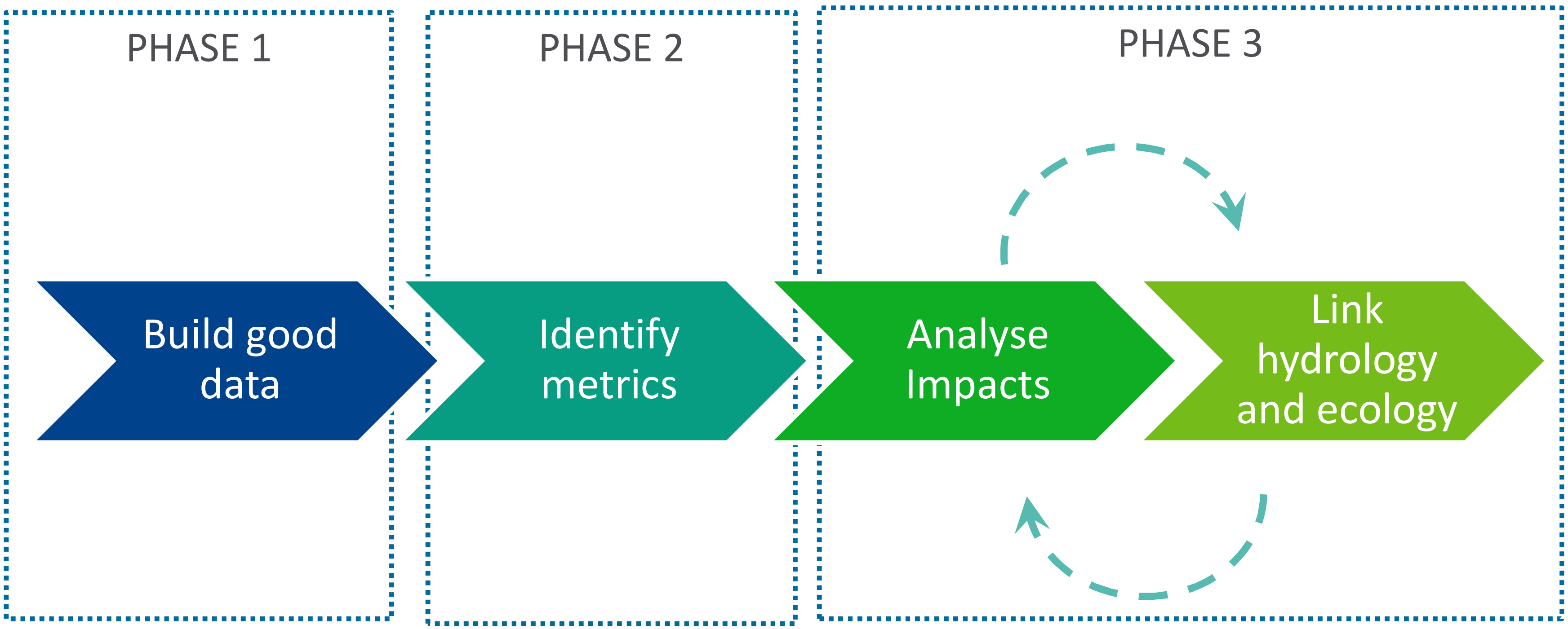
Key assumptions

1. Waterways are considered high value
2. Waterways require protection from urban flows
3. Harvesting 60-90% of stormwater will achieve (2)
4. SWH system is feasible

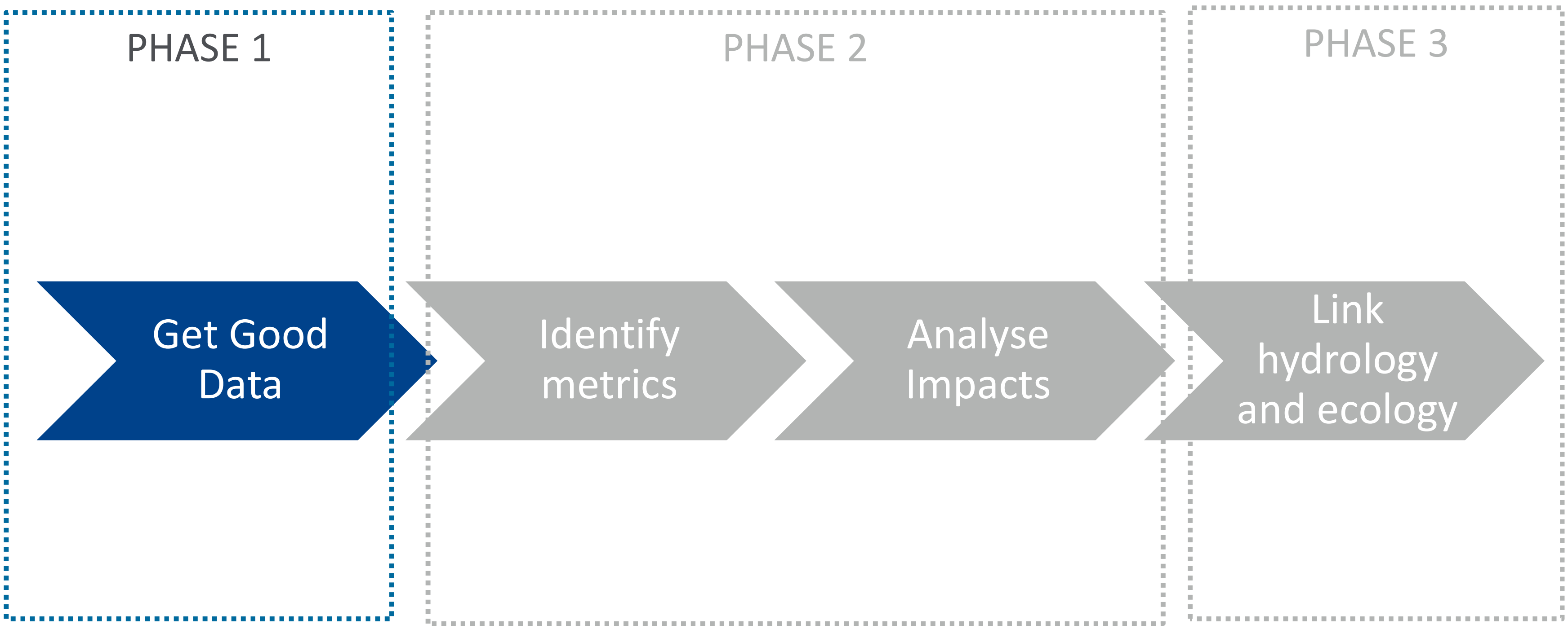
Can we design a SWH for waterways?

Part 3: Approach for assessing waterway impacts

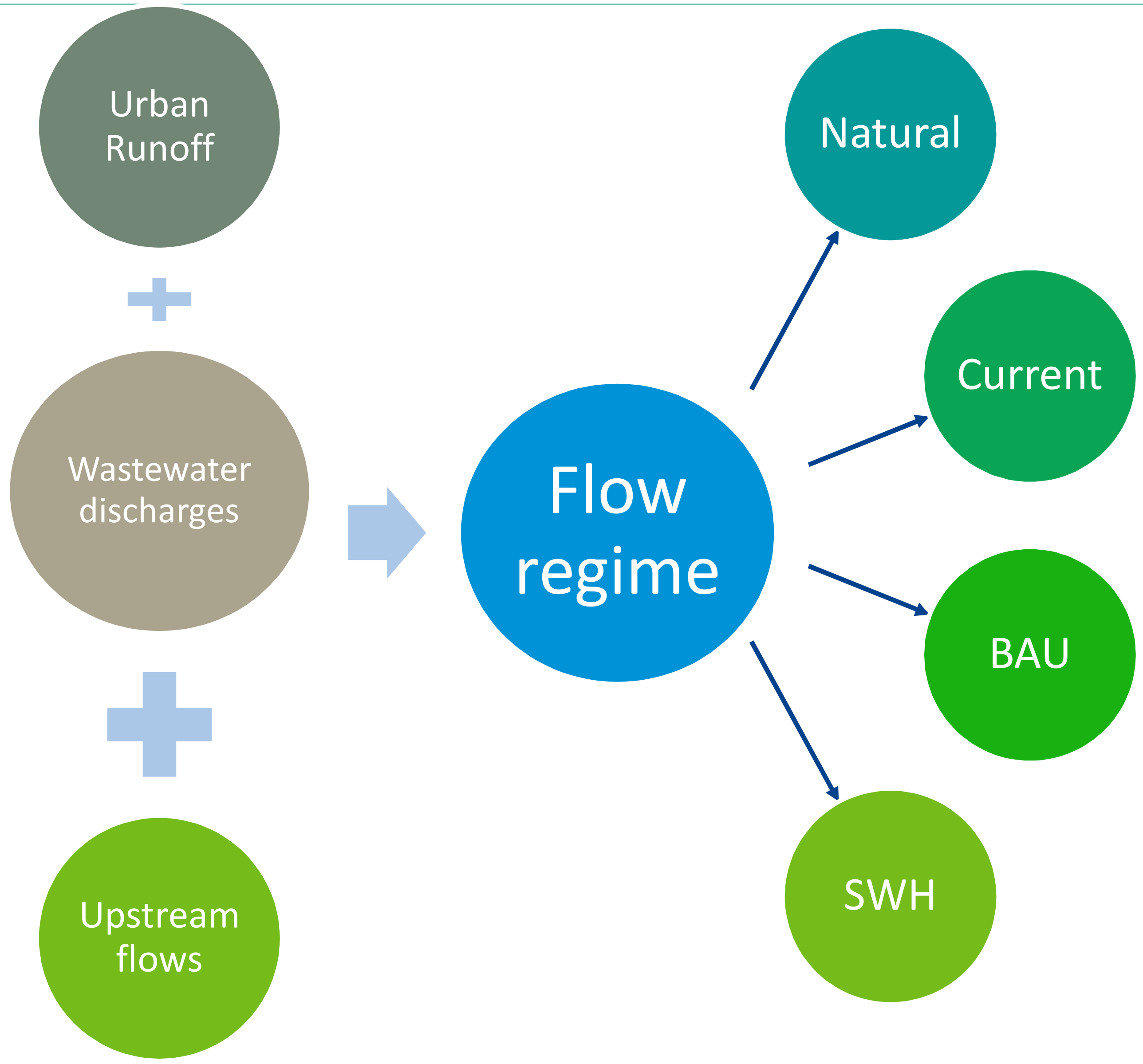
Sunbury Urban Flows Approach



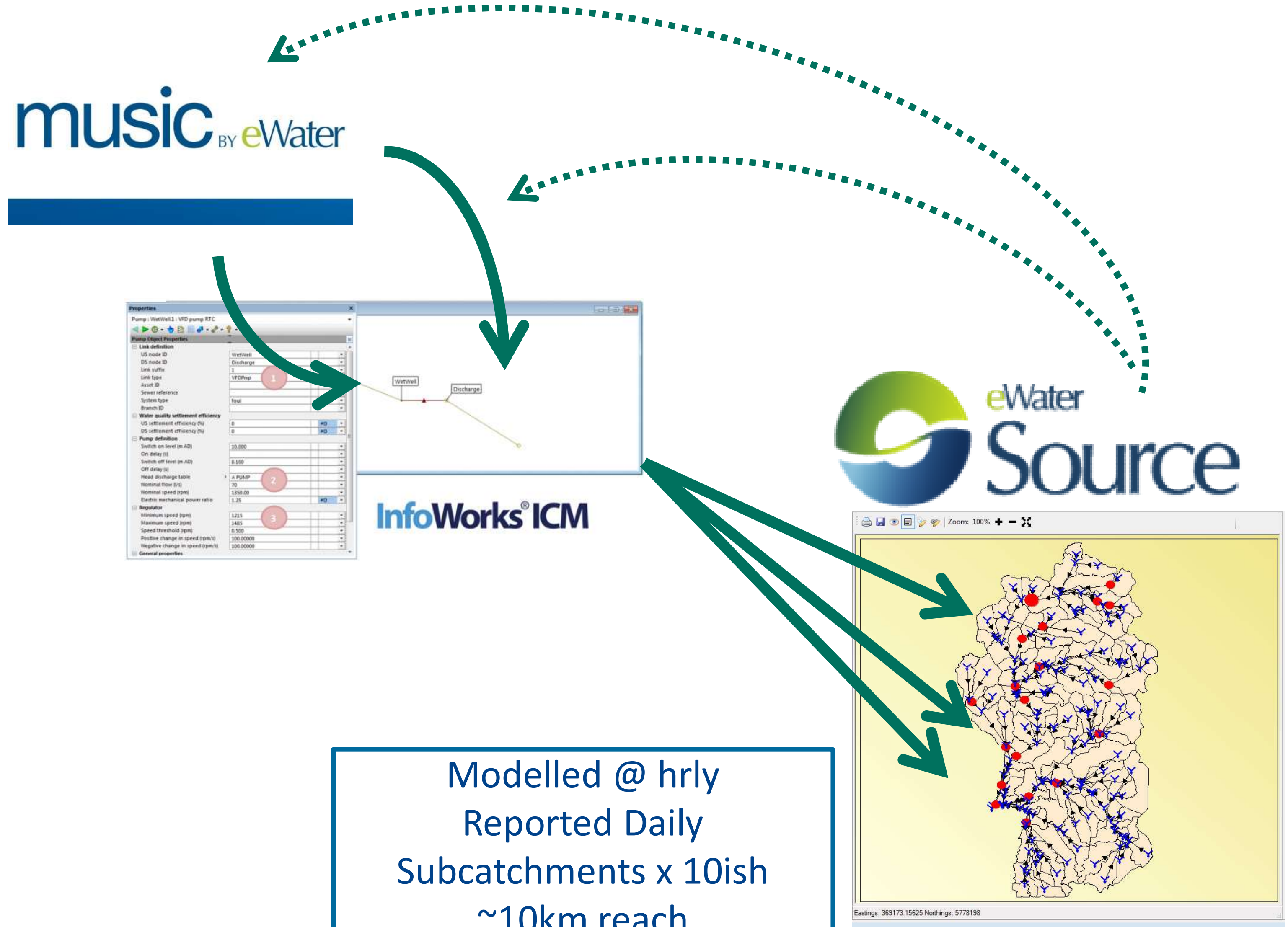
Sunbury Urban Flows Approach



Phase 1: Get good data

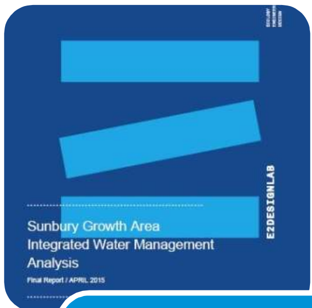


Sunbury – modelling progression



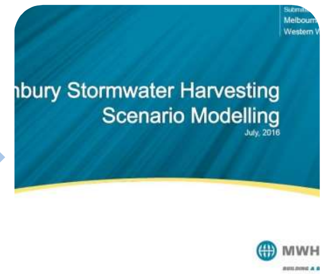
Modelled @ hrly
Reported Daily
Subcatchments x 10ish
~10km reach

Sunbury – modelling progression

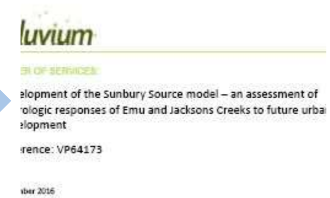


E2D – IWM strategy (MUSIC)

Alluvium – Oldbury (MUSIC)

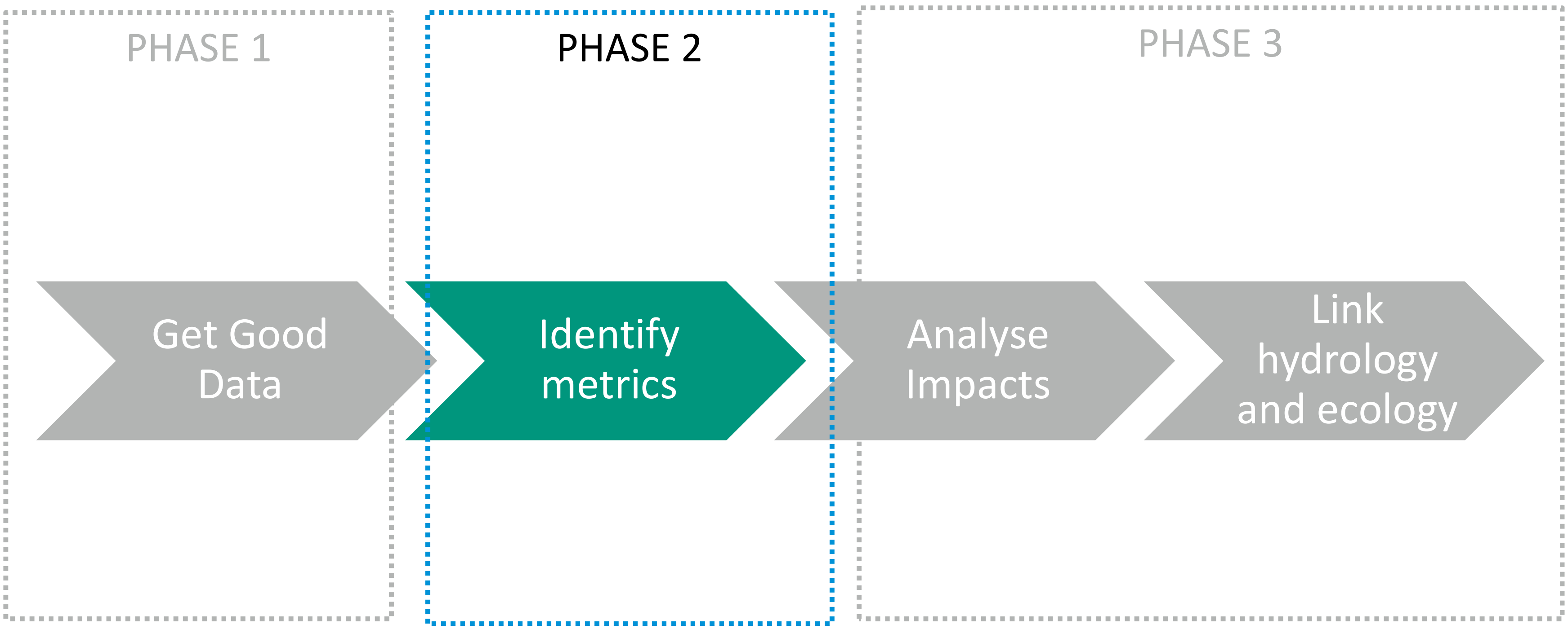


MWH SWH network (Infoworks)



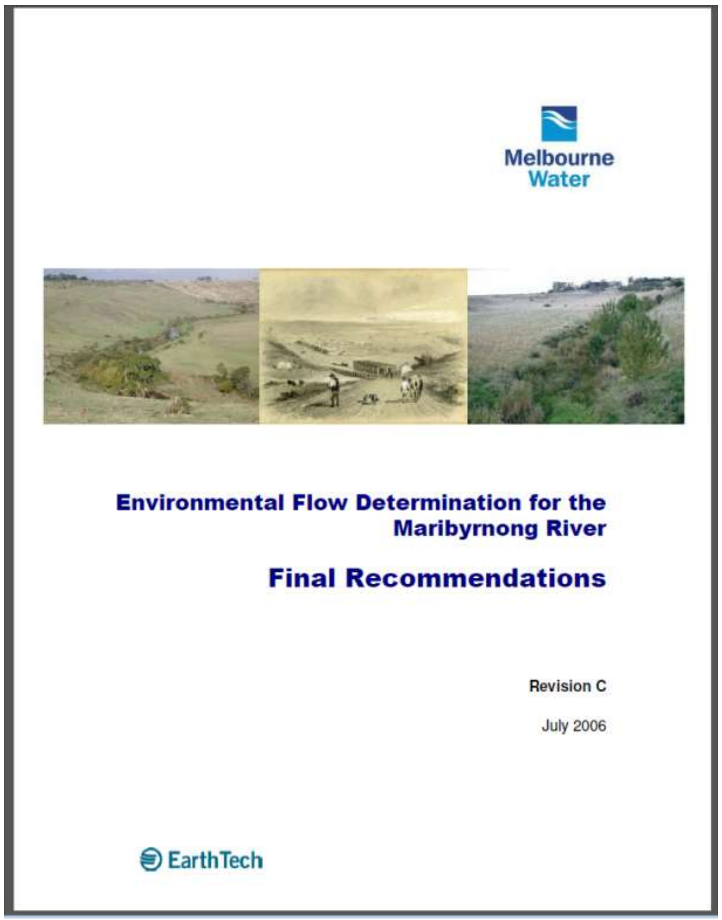
Alluvium - Source Modelling

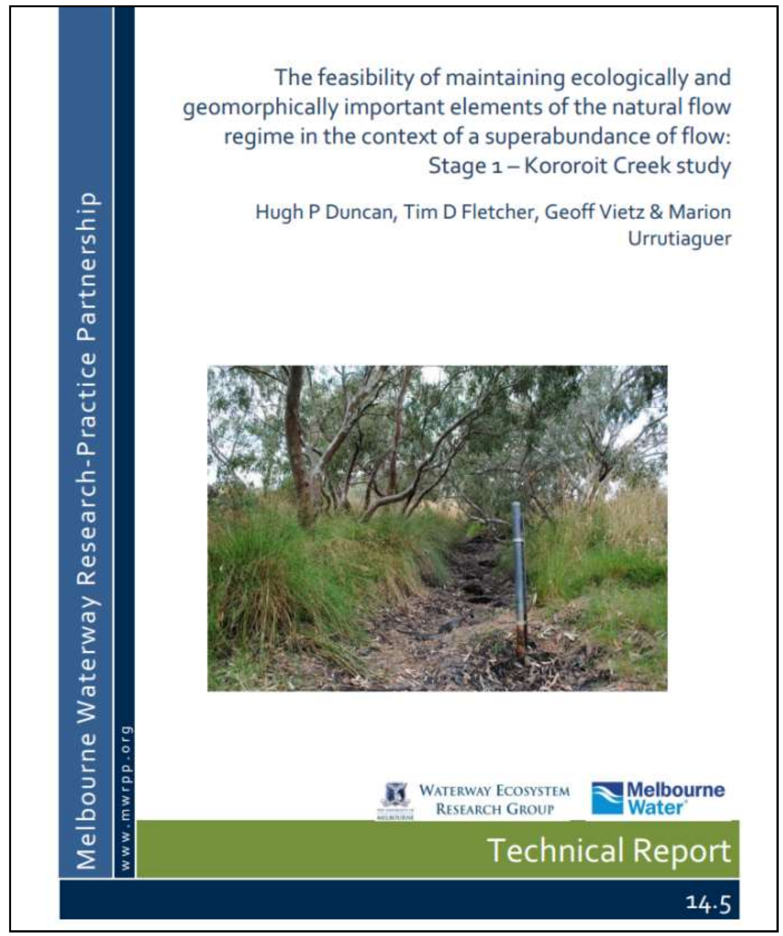
Sunbury Urban Flows Approach



Phase 2: Identifying metrics

Two key inputs:

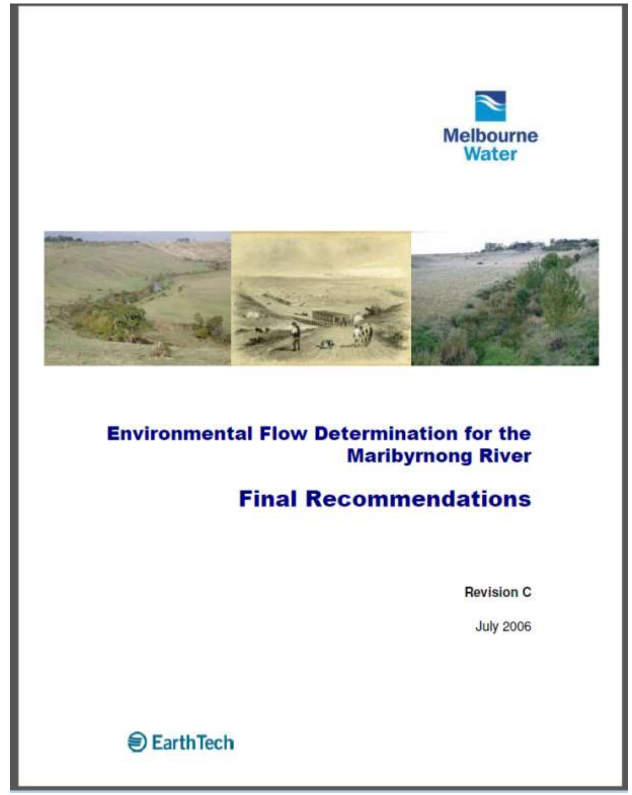




FLOWS Method overview

FLOWS method

- Developed in 2002, updated in 2013
- Consistent state-wide method for assessing flow requirements of water-dependant environmental values
- Scientific and transparent approach
- Based on natural flow paradigm
- Six flow components typically assessed
  - Cease to flow
  - Low flow
  - Freshes
  - High flows
  - Bankfull flows
  - Overbank flows
- Provides a **minimum requirement** (but rarely a maximum)



Maribyrnong FLOWS Study (2005)

Table 3-8. Flow Recommendations for Reach Three – Emu Creek

River		Emu Creek		Reach	Reach 3 – Emu Creek
Compliance Point		Emu Creek @ Clarkfield		Gauge No.	230 101
Flow				Rationale	
Period	Magnitude	Frequency	Duration	Objectives	Evaluation
Dec – May	Low Flow 6 ML/d (or natural)	Continuous	Continuous	**3-M1**, 1-M2, 3-F1, 3-V1	Median depth >0.1m over run to provide macroinvertebrate habitat and continual inundation of instream submerged vegetation.
Dec - May	Low Flow Freshes 14 ML/d	6 per period (or natural)	4 days (or natural)	**3-F2**, 3-Q1, 3-P2, 3-V2	Shallowest point between pools >0.12m to provide local movement of small bodied fish species during the low flow period.
Jun – Nov	High Flow 14 ML/d (or natural)	Continuous	Continuous	3-P1, 3-P3, **3-P4**, **3-V3**	Disturbance and prevention of terrestrial vegetation encroachment.
Jun – Nov	High Flow Freshes 50 ML/d	6 per period (or natural)	3 days (or natural)	3-M2, 3-M3, 3-M4, 3-F3, 3-F4, 3-F5, **3-V4**, **3-V5**	Bench wetting and inundation of all vegetation in the low flow channel to provide regeneration niches and prevent terrestrial vegetation encroachment.
Late Spring	Additional Flow 1000ML/d	1 per 2 years (or natural)	1 day (or natural)	**3-P1, 3-P5, 3-V5, 3-V6**	Inundation of gross channel and internal floodplain unit for seed dispersal to support the regeneration of endangered EVC – Creekline Grassy Woodland.

Superabundant Flows Study

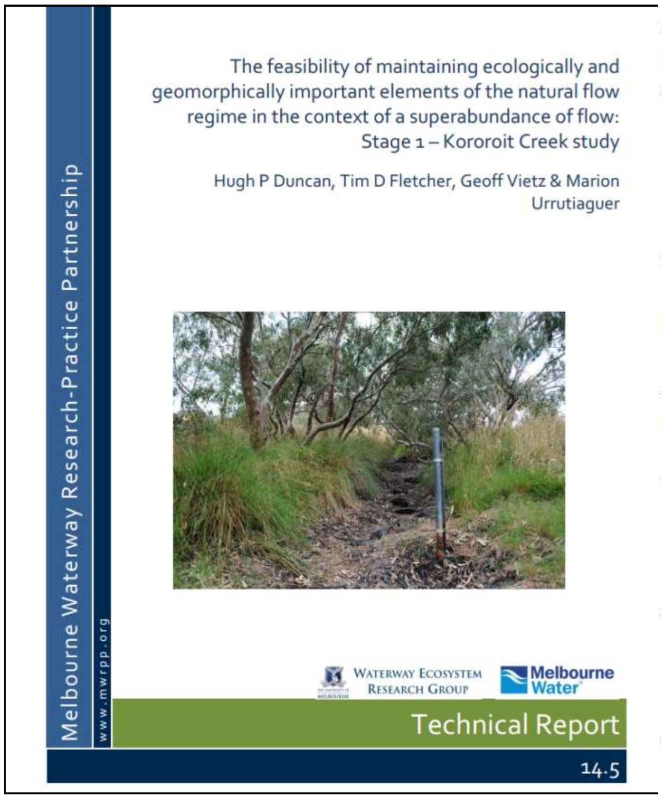


Table 3. Summary of final metrics chosen for the Kororoit Creek catchment

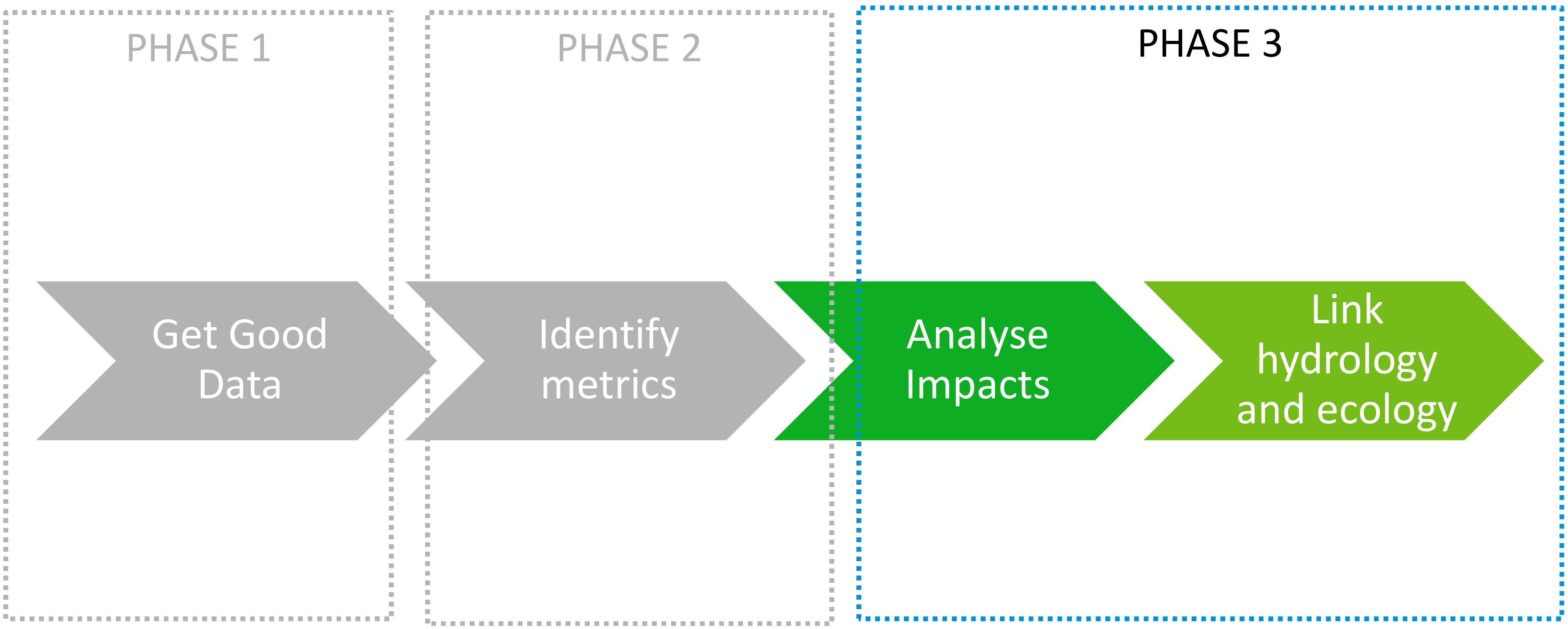
Flow aspect	Metric selected	Definition and comments on calculation	Ecological or geomorphic significance
Low flow duration	Days per year of zero flow. Mean duration of zero flow periods	Zero flow days in full record divided by number of years. Zero flow days in full record divided by zero flow periods in full record.	Low flow periods affect habitat availability, as well as facilitating presence of species adapted to ephemeral conditions.
Low flow frequency	*Not used for Kororoit Ck, due to ephemeral nature*	Published metrics are unsuitable for highly ephemeral stream. Geomorphic metrics (see below) cover this aspect better.	-
Duration	Tqmean	Fraction of days with daily mean flow greater than annual mean flow.	Duration of peak flows is an indicator of the duration of 'disturbance events' (both water quality and hydraulic)
Rate of change	R-B Index	Sum of the absolute values of change in mean daily flows divided by the sum of the mean daily flows.	Variability of flows is an indicator of the duration of 'disturbance events'
Timing	Month of minimum monthly flow	Take mean of all flows in period of record in Jan, Feb, etc., and find minimum of these mean monthly flows.	Seasonality of minimum flows important for alignment with seasonal biological events.
Bed mobilisation	Fraction of time > $Q_{1.5yrARI}/2$	Empirically derived based on analysis of sediments in study catchment and critical shear stress needed to mobilise them, combined with 1D hydraulic model.	Bed erosion influences habitat availability
Bank mobilisation	Fraction of time > $Q_{2yrARI}/2$	Based on commonly-used threshold for bank mobilisation	Bank mobilisation affects sediment transport, habitat availability, riparian vegetation, etc.

Metrics chosen

Jacksons Creek – (Dec-May)

Metric	Description	Target range	Objective	Comments
Low flow magnitude	No. of days <6ML/d	Target – 0	Instream vegetation, macros, maintiaining pools	Minimum flow requirement for waterway, supports macroinvertebrates (and therefore platypus)
Low flow freshes	5 events of 17ML/d for 4days	Target – minimum of 5 events	Fish, bank veg	Minimum requirement. Maximum captured in other metrics
Bed mobilising events	No. events $>Q_{1.5ARI/2}$ and No. events $>Q_{bed\ mobilisation}$	No target – report and compare	Macros, habitat disturbance	This captures the max/"ceiling" for flow freshes. This metric will be reported and compared between scenarios.
Uncontrolled releases	No. events of uncontrolled flow from the system	No target – report and compare	Water quality	
Phosphorous concentration	No. days phosphorous concentration exceeds Xmg/L	No target – report and compare	Water quality	Threshold concentration needs to be determined. Results will be reported and compared between scenarios
Bank erosion	No. events $>Q_{2ARI/2}$	No target – report and compare	Macros, instream vegetation	
Time above mean flow	TQ_{MEAN}	No target – report and compare	Macros, stream flashiness	

Sunbury Urban Flows Approach



Phase 3: Analysing the impacts on ecology

Convene expert panel

- Deliberative expert judgement process

Agree on targets for metrics

    - (informed by ‘natural’ scenario, but may be another value)

Analyse flow regimes to determine metrics

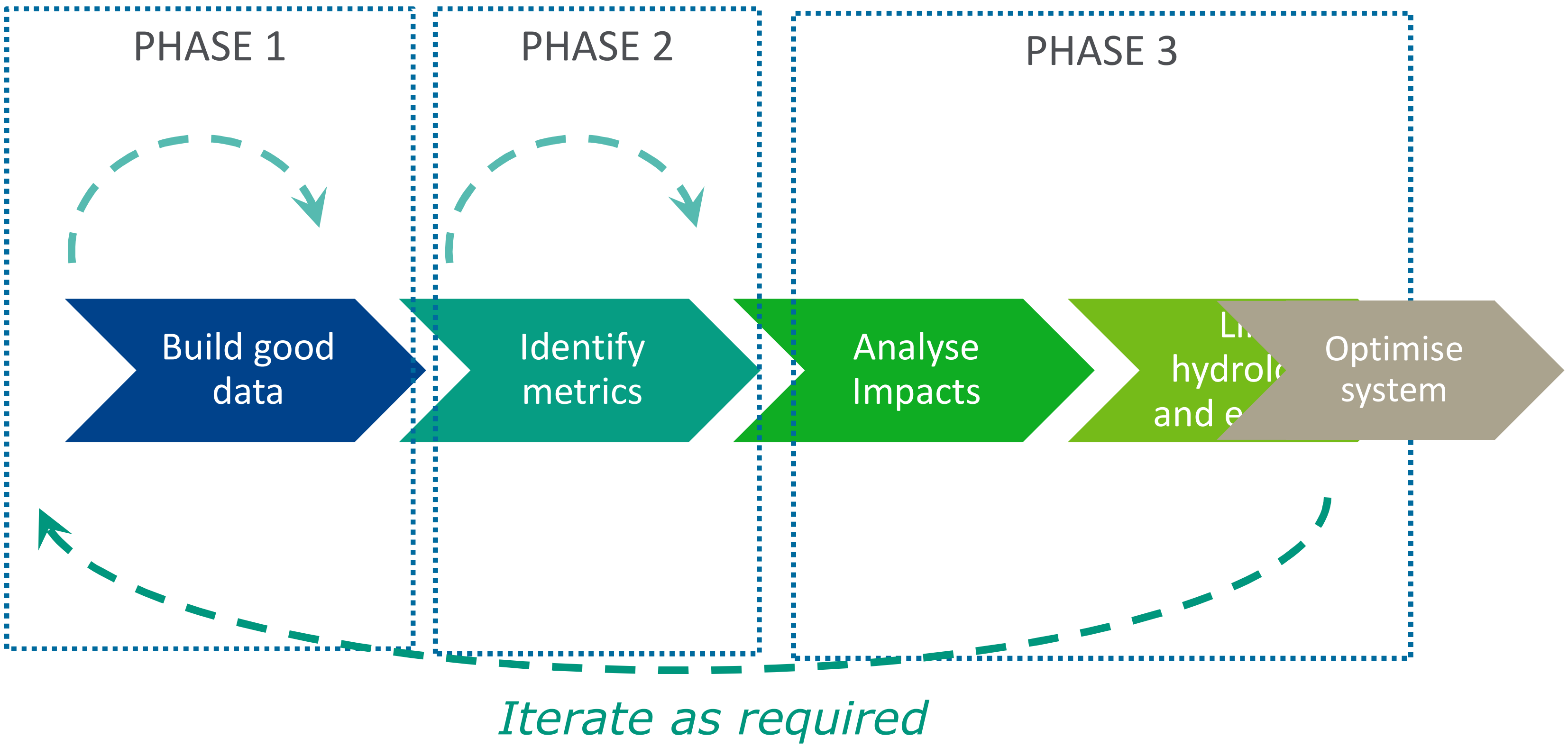
Compare metrics between scenarios

    - (natural, current, BAU SWH)

Adjust targets or metrics as required

.....linking hydrology and ecology is the tricky part!

Sunbury Urban Flows Approach



Key messages

Key messages

- **Current standards don't meet waterway protection objectives**
  - Do not account for variation or diversity in stream type (ephemeral, perennial), stream condition, values or pressures
  - Focuses on quality, not quantity
  - Nitrogen targets for the Bay do not account for degradation or impacts within the catchment
- Build **good data** (models, but FLOWS study not necessary)
- **"Goldilocks" scale**
- Use the **most appropriate modelling package** for the task!
- **Modelling integration** is possible
- The process is **iterative**
- **Setting an approach, not a standard** allows for flexibility and adaptive management