Prioritising stormwater mitigation sites in high-value catchments of the Dandenong Ranges

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THE UNIVERSITY OF MELBOURNE

Dandenong Ranges Stormwater Research Project 2016

Outline

Study Area

Stormwater impacts to ecosystem

Identifying room for improvement

Major investigation findings

- Biodiversity
- GIS study
- Stormwater flows

Observations of impacts

Development of the MCA

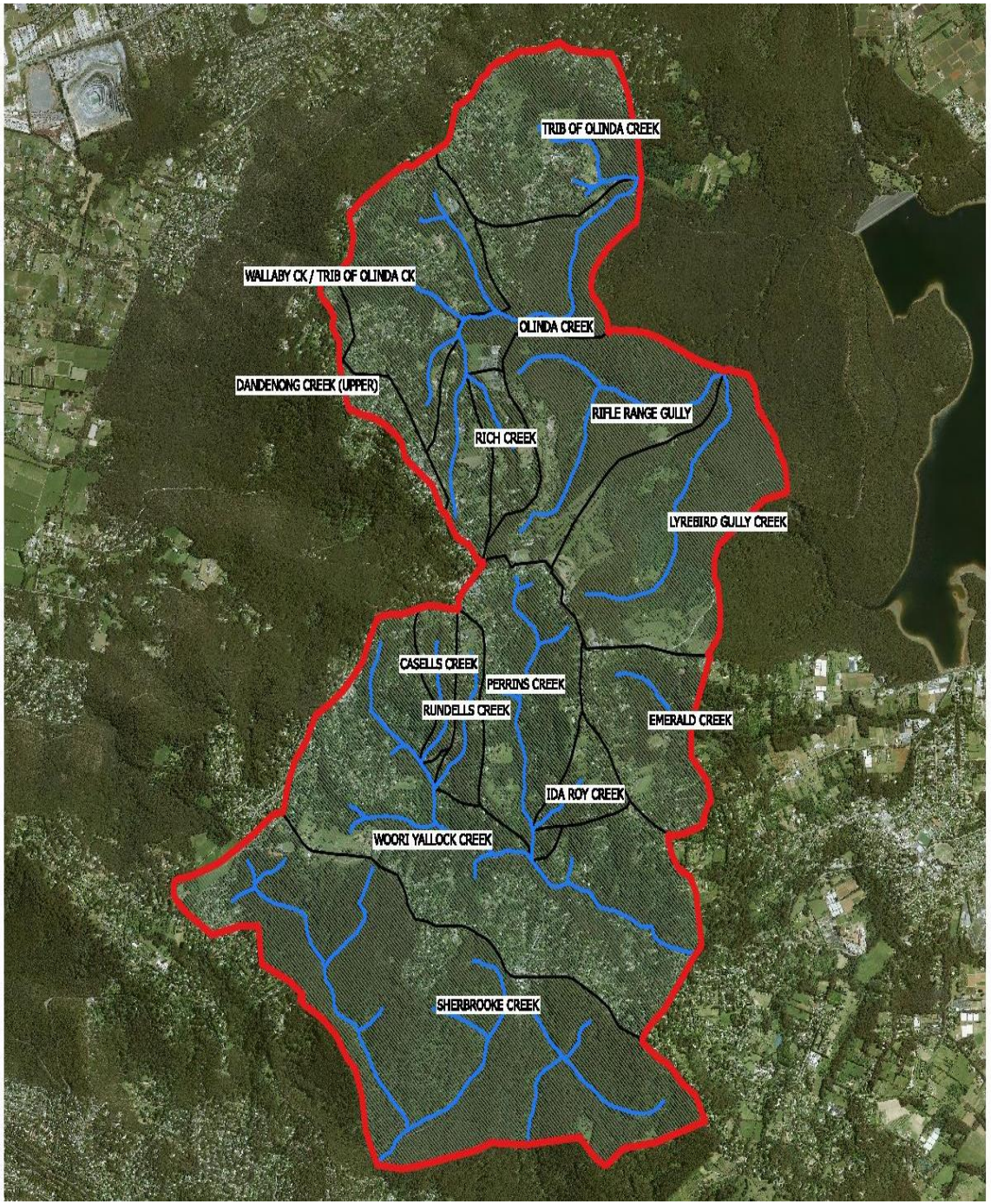
Treatment constraints criteria

Recommendations

Study Area

Upper catchments of Woori Yallock, Olinda and Monbulk Creek in Dandenong Ranges, Victoria.

Significant contributor to the Yarra River and Dandenong Creek catchments.

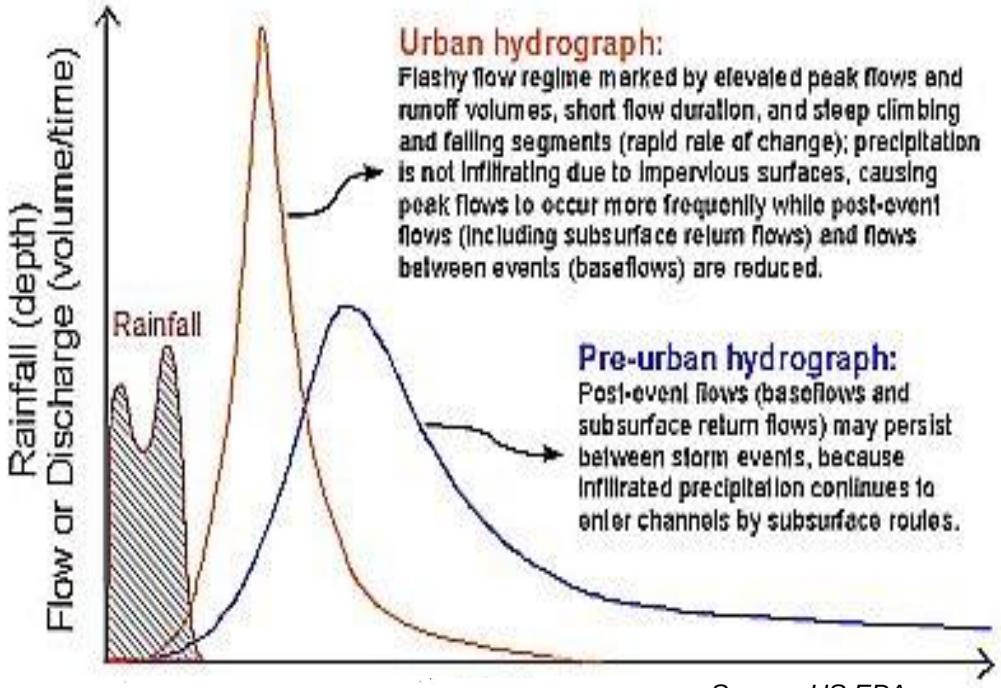


Dandenong Ranges: High value waterways and threatened species

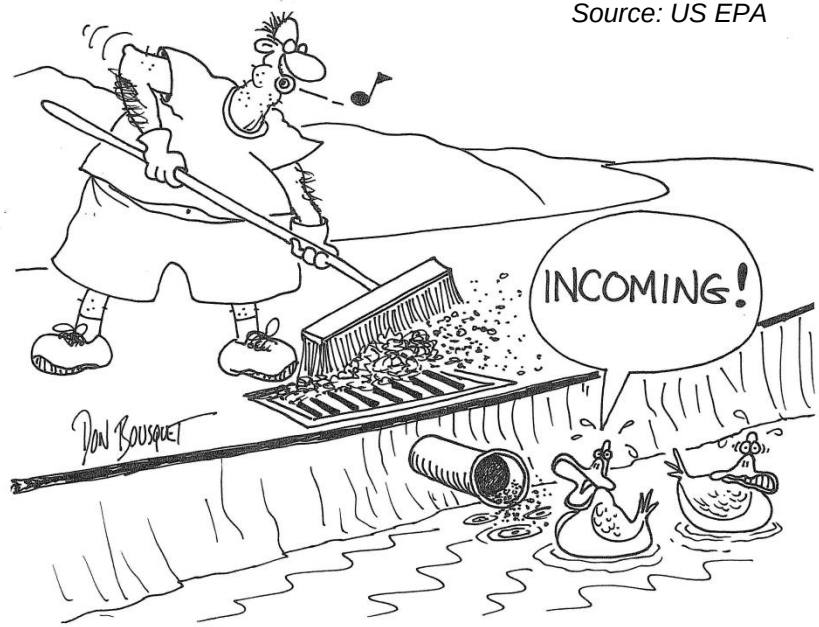
http://www.stphotographics.com/wp-content/uploads/2011/12/stream21.jpg

What we know: Stormwater impacts waterway ecosystems

- **Flow regime changes** – increased frequency, decreased base flows.
- **Water quality impacts**
- **Poor historical stormwater management in Dandenongs**



Source: US EPA



Stormwater impacts waterway ecosystems

Identifying room for Improvement

Increasing our knowledge base on local catchments in order to inform engineers and leverage funding for mitigation of stormwater impacts.

Liaised with WERG, Melbourne Uni in how to lead an innovate best practice project in stormwater research

AIM:

Prioritising WSUD projects at highest risk stormwater outfalls in the Dandenongs

Objectives:

1. Identify major stormwater outfalls and their impact on receiving waters.

2. Prioritise WSUD works to mitigate impacts and develop an area-specific stormwater management plan.

Major investigations

1. Biodiversity data – threatened species data

2. GIS work – determining engineered catchments

3. Stormwater flows and impacts

Threatened species include:

- **Dandenong Amphipod** (*Austrogammarus australis)* endangered
- **Sherbrooke amphipod** (*Austrogammarus hassei)* vulnerable (uncertain genetics)
- **Dandenong Burrowing Crayfish** (*Engaeus urostrictus*) Critically endangered
- **Slender treefern** (*Cyathea cunninghamii)* vulnerable

Cyathea cunninghamii

Engaeus urostrictus

Austrogammarus australis

Biodiversity data – threatened species database

Dandenong Burrowing Crayfish survey

Citizen science project

One scientist, 42 Volunteers, 16 sites, 400 trap-sets, 7 new records

Biodiversity data – threatened species data

Amphipod surveys

Austrogammarus australis and *A. haasei* survey

- 29 sites surveyed, 15 new records found
- Discovered in lower order streams
- Distribution dependent on upstream conditions

Photo – Jane Hollands FOSCk

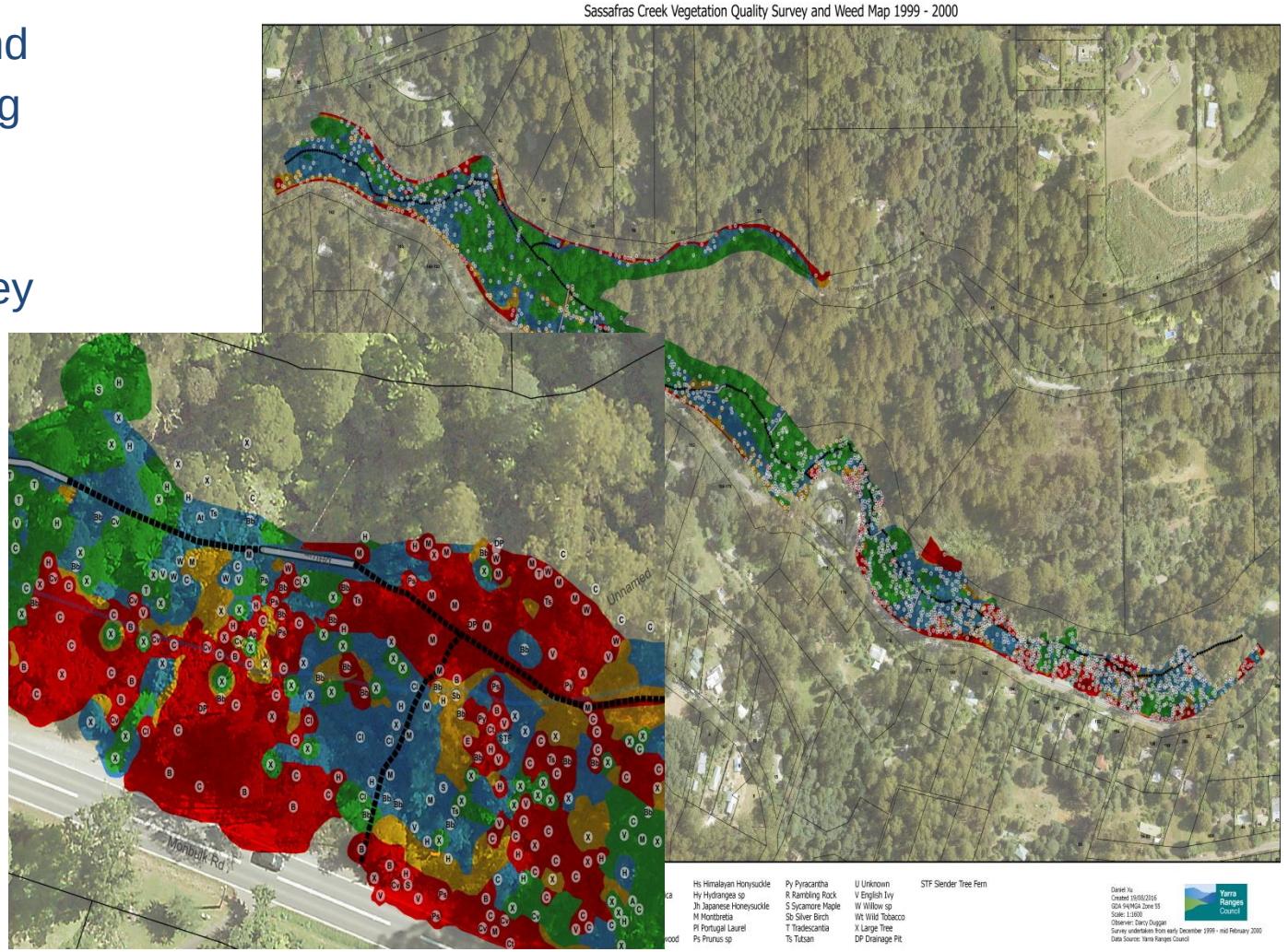
Biodiversity data – threatened species data

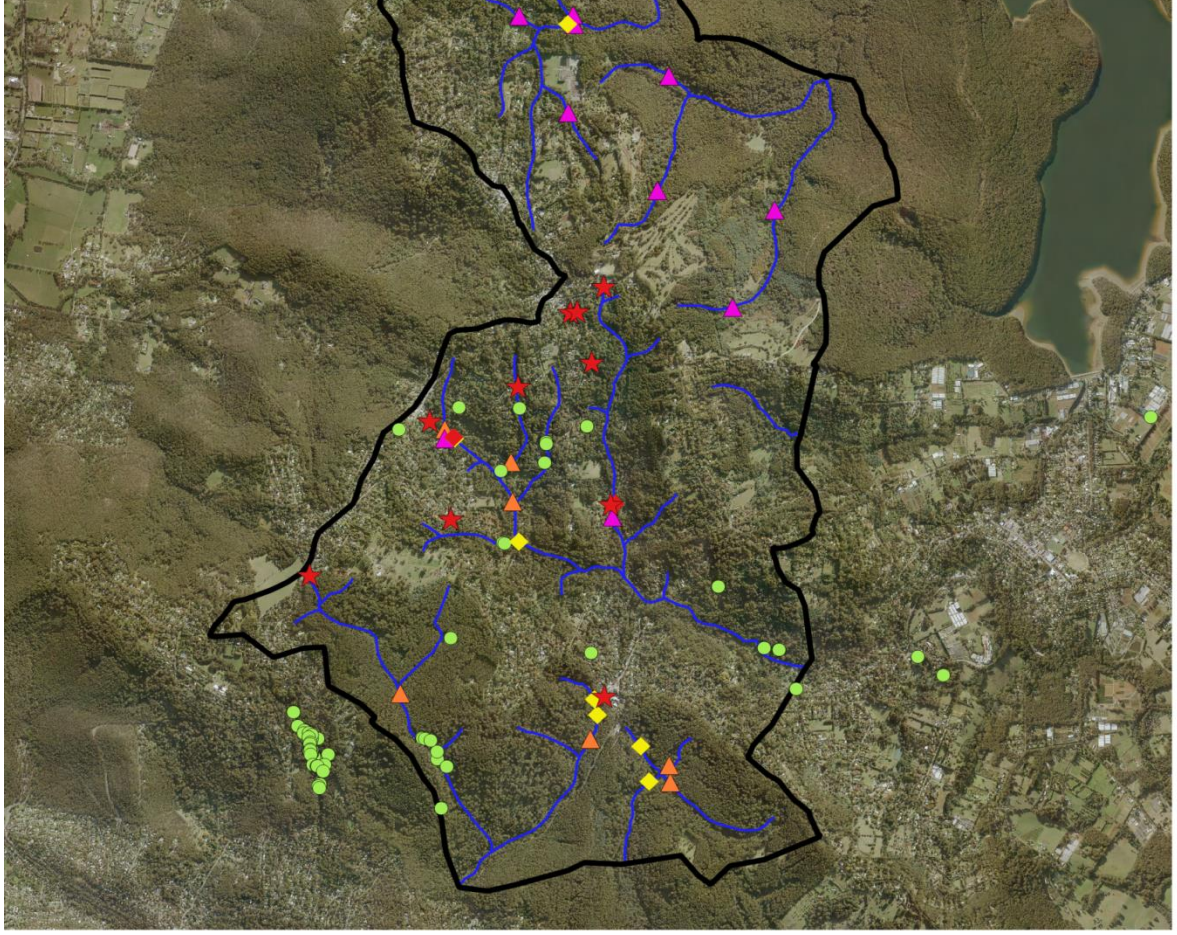
Slender Tree Fern

Slender tree-fern and weed-mapping along Sassafras Creek

Digitised 1999 survey and re-surveyed

Increase in weed spread in 2016





0 500 1000 1500 m

Legend

- MCA_TOP9_OUTFALL

DBC_survey_Di_Nov_2016_revised

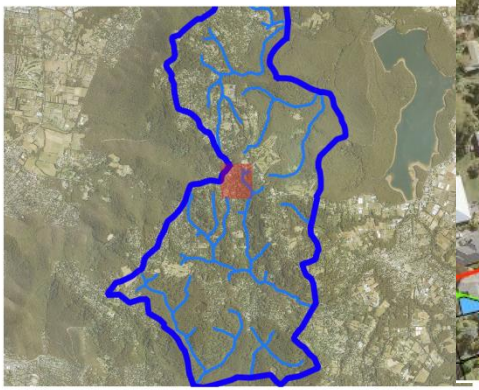
- Engaeus tuberculatus
- Engaeus urostrictus
- Overall_STF_data_revised_2016

Austrogammarus 2016 survey

- A. australis detected
- A. haasei detected

Determining Engineered catchments

- Important to have verified drainage data.
- 160 Engineered catchments 77 Outfalls!
- Natural Catchment vs Engineered catchments



Stormwater flows

'The most likely dominant process degrading macroinvertebrates instreams can be reversed by preventing increased frequency of surface runoff generated by EI during small to moderate storms' (Walsh, 2005)

EI Threshold of 2% for a number of ecological indictors, a significant drop in sensitive macroinvertebrates at this point.

Effective imperviousness (EI) (ha) and therefore Directly Connected Imperviousness % (DCI) calculated per sub-catchment and Eng. Catchment.

$$\frac{\text{EI score}}{\text{Engineered sub-catchment area}} \times 100 = \text{sub-catchment DCI\%}$$

Top 16 outfalls underwent further analysis. Strategically selected based on:

1. EI score
2. Proximity to waterway
3. Threatened species present

Further analysis

Included in MCA:

- **MUSIC modeling flows**
- **Overland flowpath** characteristics
- **Sheetflow velocity** (m/s) – the duration for stormwater to flow from outfall to waterway and therefore the scouring potential.

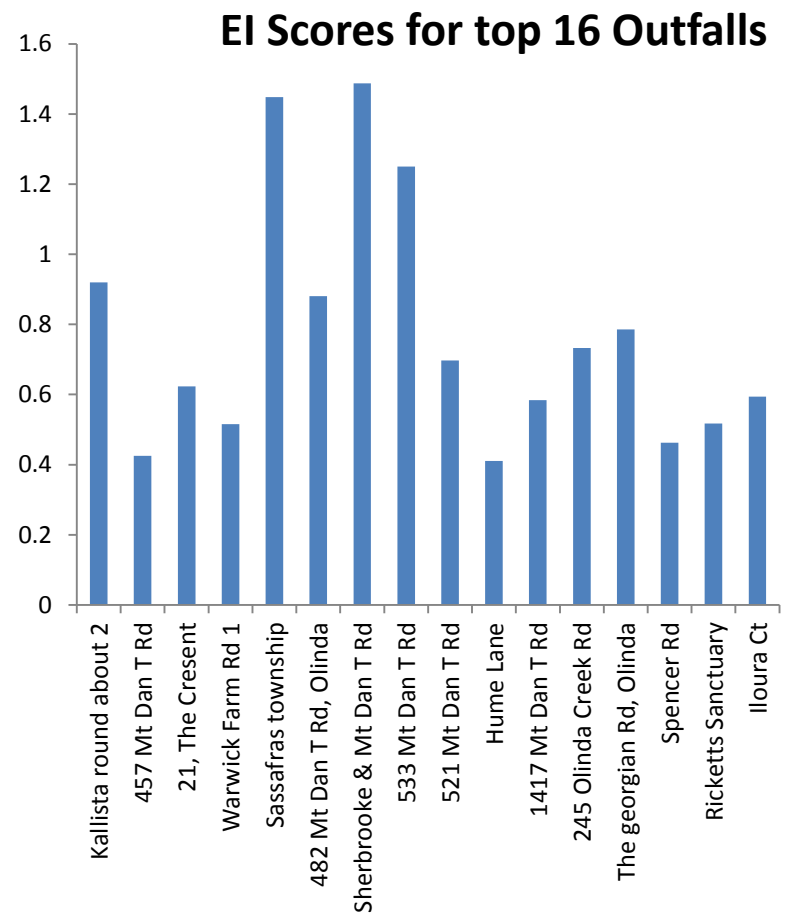
Not yet included in MCA:

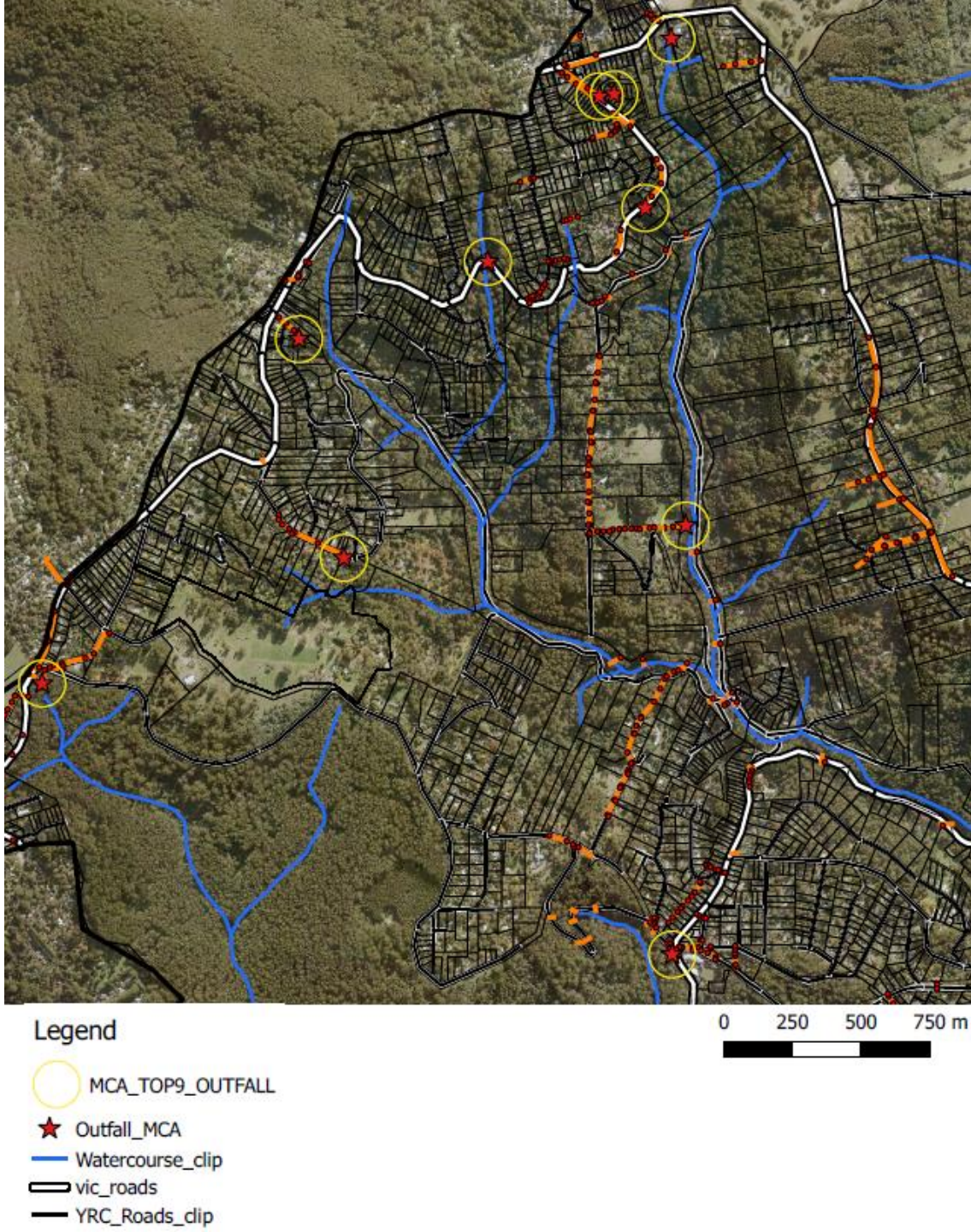
Hydraulic Modelling using TUFLOW 2D model (outsourced)

- Direct Rainfall technique, 7,000,000 cells in study area for 2yr ARI event.
- **Outputs include:** velocity, offline detention volume requirements, stream bed shear stress, pre-European vs present day peak flows etc.

- **Pre 1983 septic tank mapping**
- **Weed mapping –** Wandering Trad near outfalls
- **Community value score**

Stormwater flows





Observations of Stormwater Impacts

- Gully erosion – site visits, surveys, photos
- Stream sedimentation and bank instability observed.

Sherbrooke Ck.

Overland flow paths or erosion gullies?

- Uncertainty to conditions or circumstances an overland flow path treats stormwater effectively
- Scoured out erosion gullies seem to have very limited buffering effect due steepness of slope and low permeability
- WERG to advertise potential research project

Formation of MCA for prioritisation

AIM: Prioritising WSUD projects at highest risk stormwater outfalls in the Dandenongs

1. Multi-criteria analysis uses measured and modelled variables to generate:

1. **'Waterway value score'**
2. **'Outfall impact score'**

Each factor was characteristed between 0-1 based on their range.

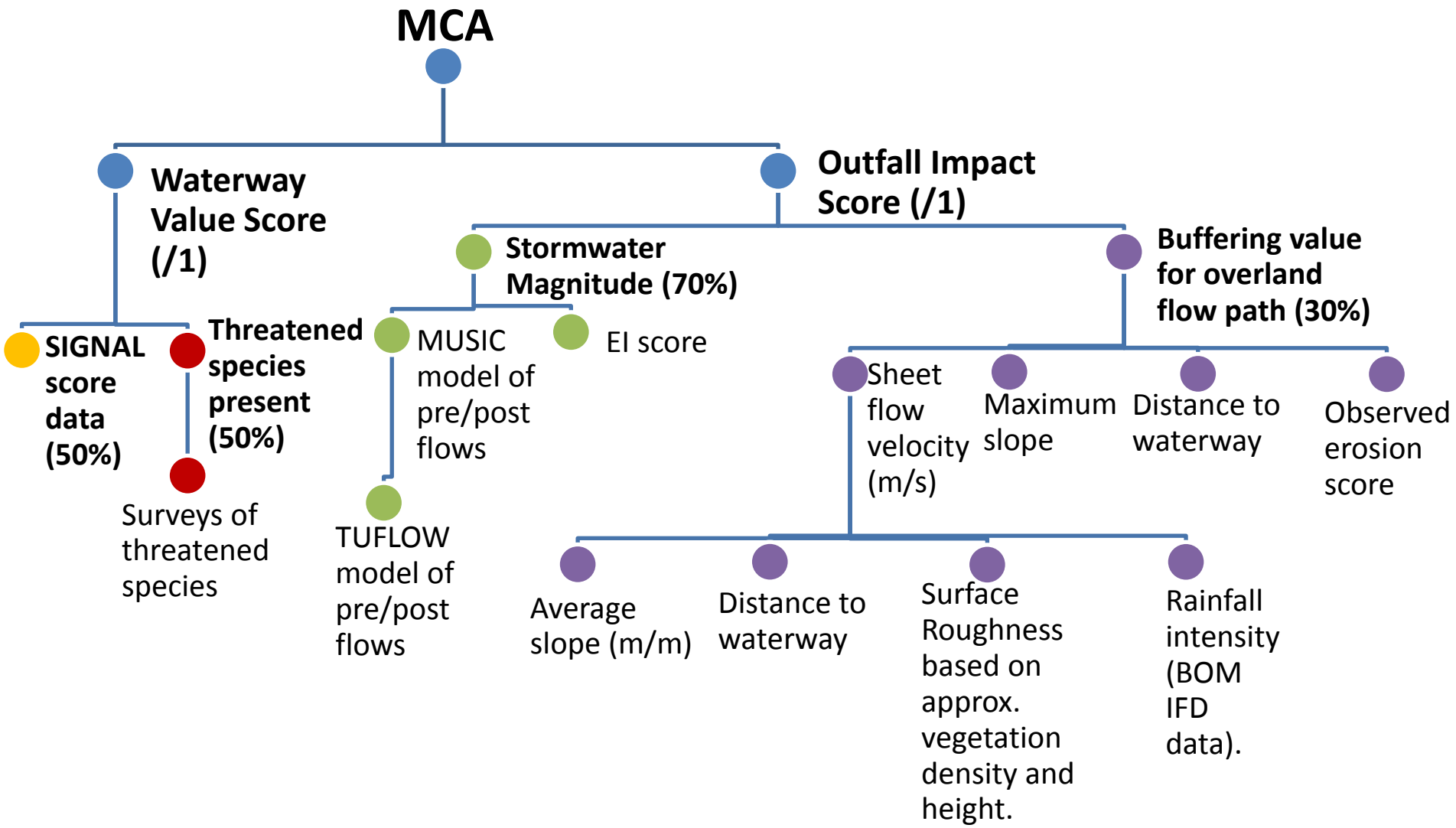
$$\frac{\text{(value – min value)}}{\text{(max value –value)}} = \text{range value}$$

For lower score = better (e.g. EI score)
Opposite for higher = better (e.g SIGNAL score)

2. Risk/vulnerability matrix

- Contrasts MCA outputs to prioritise projects

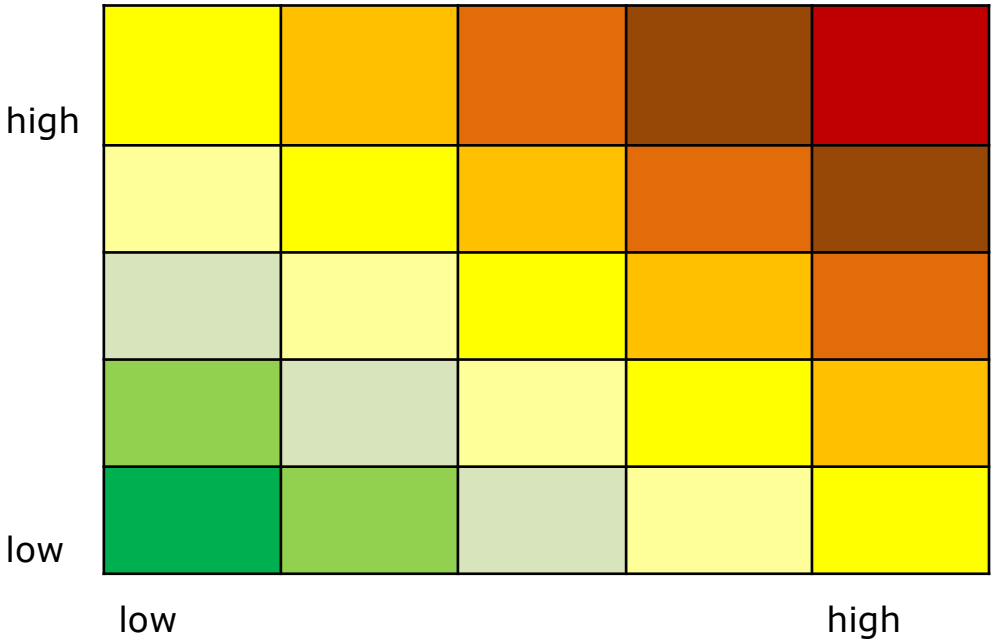
Data used for the MCA



Risk matrix

- Plot waterway value score against outfall impact score
- Indicates outfalls presenting highest risk to highest value waterways

Outfall impact score



Waterway value score


Scenario 1
High risk outfalls
Medium-high risk outfalls
Medium risk outfalls
Sassafras township
Kallista round about 2
Sherbrooke & Mt Dan T Rd
457 Mt Dan T Rd
21, The Cresent
482 Mt Dan T Rd, Olinda
521 Mt Dan T Rd
1417 Mt Dan T Rd
Spencer Rd
245 Olinda Creek Rd
Ricketts Sanctuary
Iloura Ct
Hume Lane
Stormwater Outfall Impact Value
Receiving Waterway Value
0
0.2
0.4
0.6
0.8
1

Treatment constraints (or practicability) considered after MCA:

Top 9 outfalls were investigated for treatment constraints

Sassafras township outfall was highest – serious erosion impacts & historic community concern

Location	Effective Impervious-ness value	Stormwater Impact score	Waterway value score	Available Public Land	Landslip Hazard score	Existing concept design	Priority for concept design?
Sassafras township	1.448	0.651207606	0.78345367	Yes	3	Yes	-
Kallista roundabout 2	0.92	0.529887494	0.804591837	Yes	0	No	Yes
533 Mt Dandenong Tourist Rd	1.25	0.650772258	0.635772358	Yes	1	No	Yes

So much for coil logs!

Summary of Findings

- This MCA model successfully identified the highest risk outfalls.
- The MCA provides strong merit for prioritising WSUD works and levering funding in high-value catchments.
- EI provides a great indicator of how significant the stormwater impacts might be.
- Engineered catchments in proportion to natural catchment area indicates the largest change in flow regime due to stormwater runoff.
- 7 new records of burrowing crayfish – doubling the known records and 15 new Amphipod records.

- Invest in WSUD projects in high-value upper catchments
- Capitalize on threatened species data to leverage funding and community interest
- Exhaust data already available. Engage with local friends groups and Universities early on to broaden historical and current catchment knowledge.
- Devote more into GIS work for catchment analysis, it's a powerful tool!
- TUFLOW 2D modelling is recommended to determine erosion hotspots and required detention volumes at relatively low cost. Be aware – further manual refinement was required to embed swales and pits along roads to direct flows to outlets.
- What is ideal (prioritised) isn't always practical, other factors can overrule what is achievable.
- Engage and request feedback from relevant stakeholders when finalising an MCA
- MCA → Risk matrix →Identify high-risk → Treatment constraints →Hydrological Modelling → CBA → Concept design

Next steps:

- localized management plans
- future scenario modeling
- concept designs
- cost/benefit analysis
- extension of project to all priority catchments

From Matt deBoer and I, THANKYOU:

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References

Stream restoration in urban catchments through redesigning stormwater systems: looking to the catchment to save the stream (2005). Author(s): Christopher J. Walsh, Tim D. Fletcher, Anthony R. Ladson. Source: Journal of the North American Benthological Society, 24(3):690-705. Published By: The Society for Freshwater Science. DOI: http://dx.doi.org/10.1899/04-020.1 URL: http://www.bioone.org/doi/full/10.1899/04-020.1