CRC for Water Sensitive Cities

Australian Government
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Business Cooperative Research Centres Programme

Optimal Actions to Reduce Nutrient Emissions in the Canning Catchment

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Outline

- ❑ Aim
- ❑ Values
- ❑ Conceptual framework
- ❑ Modelling approach
- ❑ Results
- ❑ Conclusions

Aim of the project

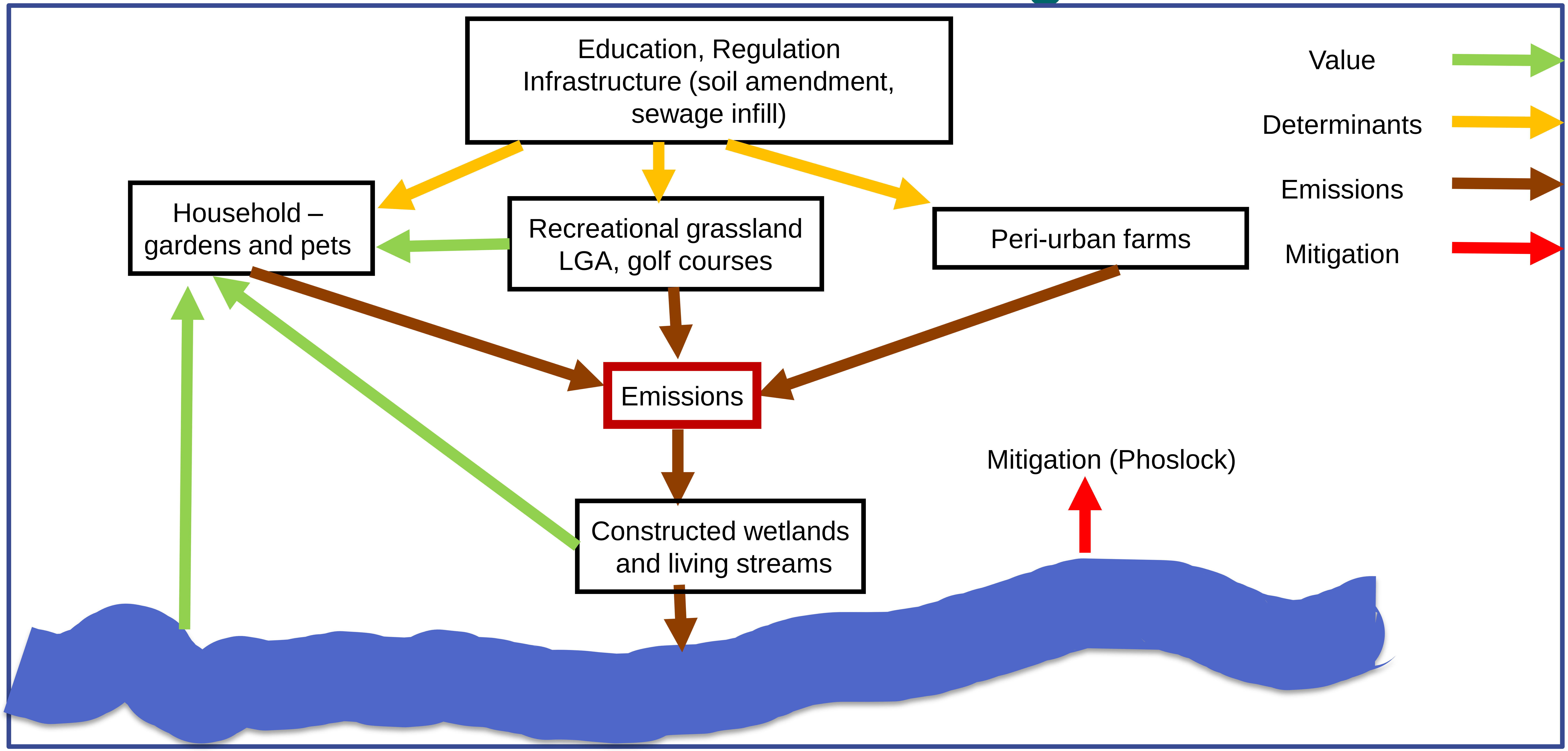
Determine a cost-effective action to reduce nitrogen and phosphorous emissions to the Canning River

- Optimal mix or abatement actions
- Trade-off between alternative actions
- Feasibility of achieving abatement targets
- Cost of achieving target

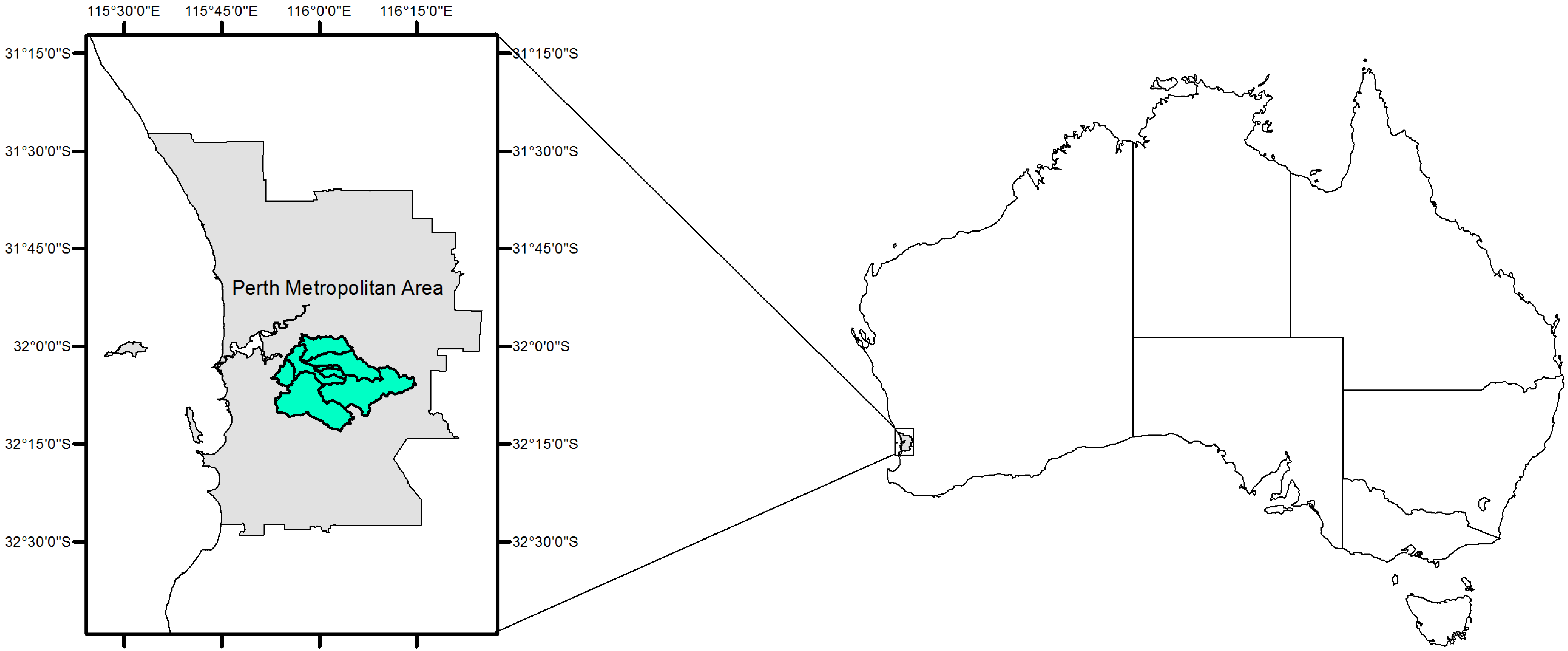
Values: why are they important?

- Setting a water quality target implies a value on the resource, in this case the value of water quality in the Canning.
- In 2012 a study commissioned by the Swan River Trust found that respondents from WA highly valued reducing fish kills, improving dolphin health and increasing the extent of river banks vegetation in the Swan-Canning
- Of particular relevance to this study is the estimate that the annual value of reducing fish kills from an average of 2 per year to 1 per year had a value of between $34 million and $59 million per year to WA residents.
- This analysis was repeated for the residents of the Canning catchment and their estimate WTP was $22 million per annum.
- This can be interpreted as a valuation of reduce nutrient emissions in the Canning to target levels.

Overview of Emissions and Mitigations



Study area


115°30'0"E
115°45'0"E
116°0'0"E
116°15'0"E
31°15'0"S
31°30'0"S
31°45'0"S
32°0'0"S
32°15'0"S
32°30'0"S
Perth Metropolitan Area

Modelling Approach

- Minimize present value of costs of achieving average annual emission targets

- By applying nutrient emission abatement actions across catchments and time

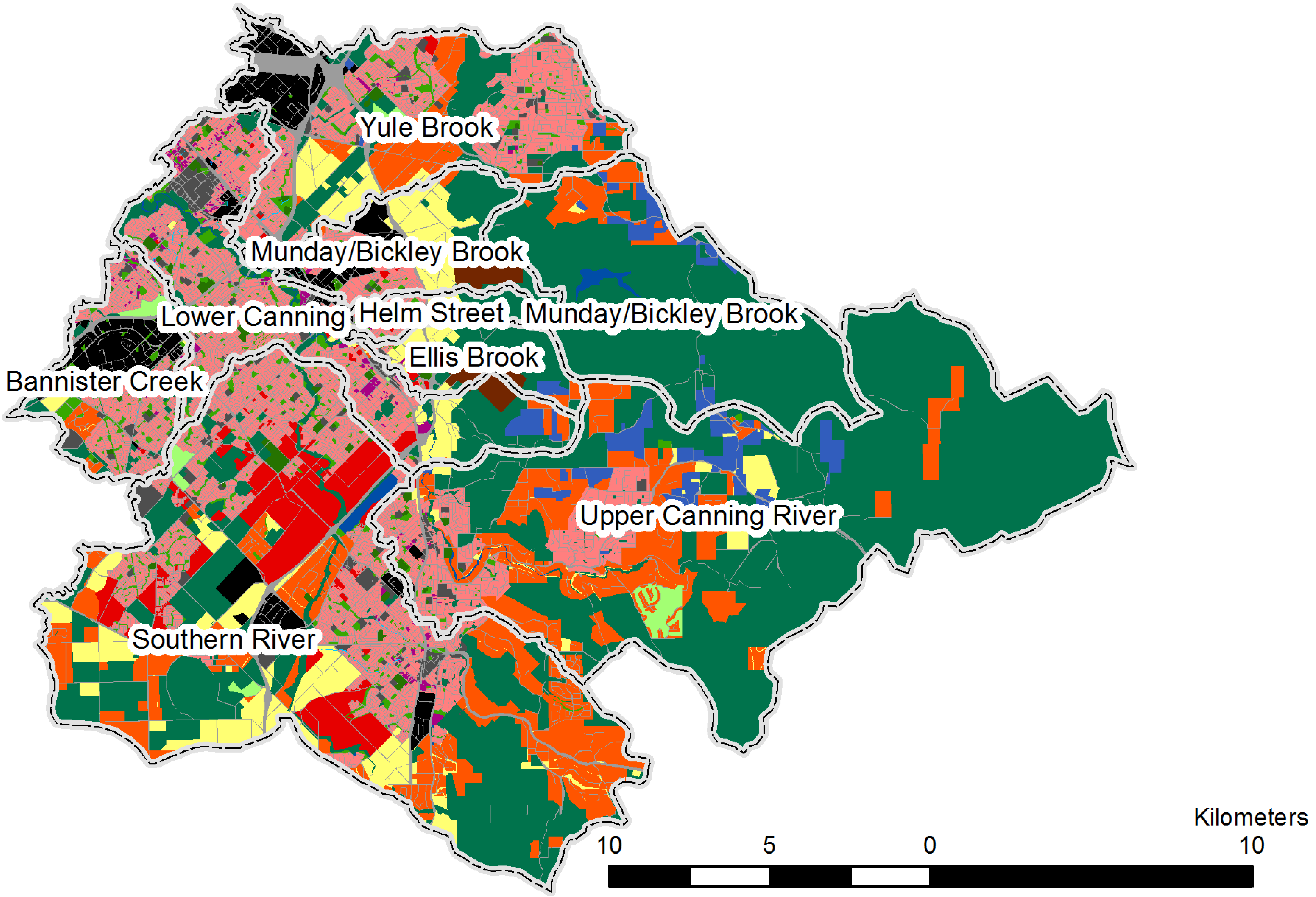
- Modelling unit: land use within a sub-catchment

Land uses

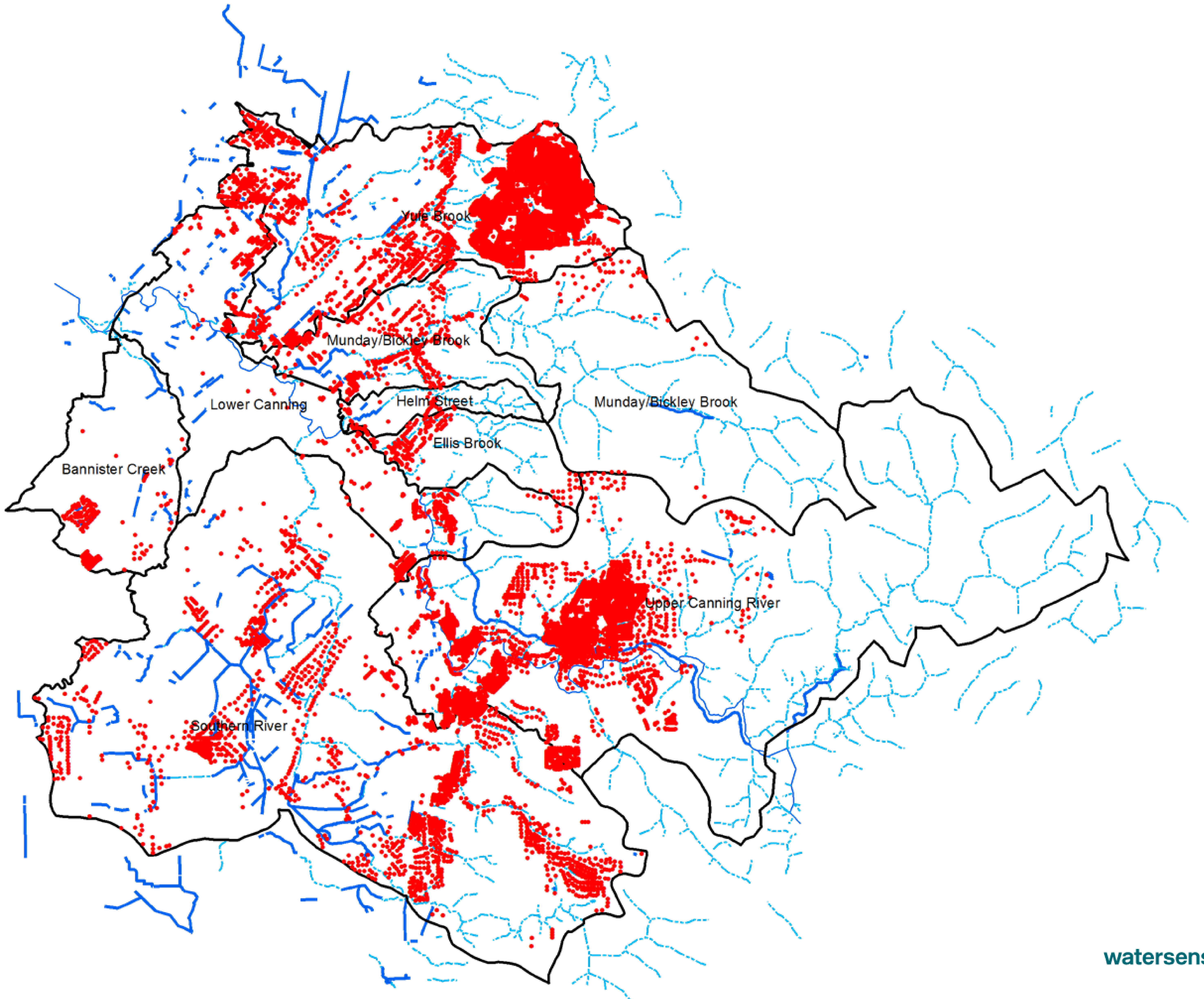
area__ha
21062
961
1787
23
357
1142
1907
461
1036
6245
2978
317
5323
7322

Land uses

- bush
- commercial
- development
- drain
- golf course
- horticulture
- industrial
- mining
- park
- rural residential
- rural
- sport
- transportation
- urban residential
- urban residential unitts
- water



Septic tanks



Data

Element of the model	Land use	Nutrient inputs	Transmission	Waterways
Data sources	Zoning maps Cadastre Aerial photos	UNDO Kelsey et al 2010	Joel Hall @ DOW Kelsey et al 2010	
Abatement		Infill septic tanks Behaviour change Slow release fertilisers Fertiliser action plan Ban regular fertilisers	Constructed wetlands Imported fill on developments	PhosLock
Data sources		Sergey Volotovskiy @ watercorp Ashton-Graham 2013 Kelsey et al 2010 Shuman 2003	Kelsey et al 2010 Mark Cugley @ DPAW	Mark Cugley Jennifer Stritzke @ DPAW

Emission abatement actions

- Infill of septic tanks ($20K, $30K, $50K, and $80K)
- Constructed wetlands
  - Cost: construction ($1.9 M/ha); maintenance 1% of construction cost
  - Remove N and P, different by catchment
- Imported fill (Iron man gypsum) for new developments
  - Cost $25K/ha
- Behaviour change to reduce garden fertilizer use (Urban Residential)
  - Intensive: $475/hh, participation 25%, reduction 50%, decline in 10 years
  - By phone: $50/hh, participation 5%, reduction 50%, decline in 10 years
- Fertiliser action plan (Agricultural land use)
  - Cost $30/ha/y, reduces P by 30%
- Slow release fertilisers (Public Open Space)
  - Cost $200/ha/y, reduces N by 20%
- Phoslock (Waterways)
  - Cost $340 per kg P removed

Other Modelling Assumptions

- 20 years time frame
- First decade "development" land use becomes urban residential (increasing emission)
- Emissions and abatement actions of last decade repeats in perpetuity
- Present value at 5%

Photo Credit: Jazmin Lindley

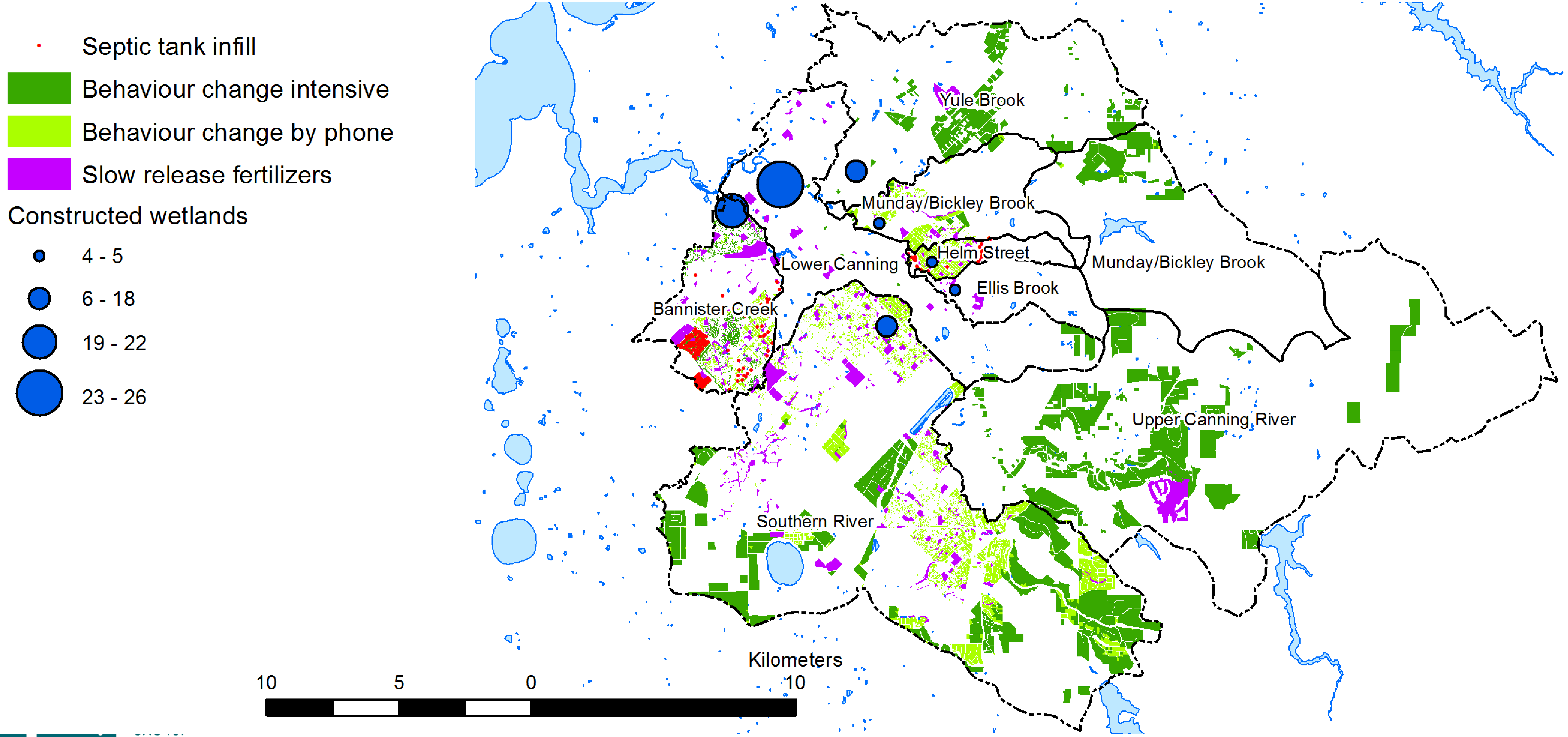
Abatement targets

	N export, ton/year	P export, ton/year
Current emission (our modelling)	58.1	4.5
20% of target	53.3	4.2
40%	48.6	3.9
60%	43.9	3.7
80%	39.1	3.4
Target (Maximum acceptable loads, Swan River Trust 2009)	34.4	3.2

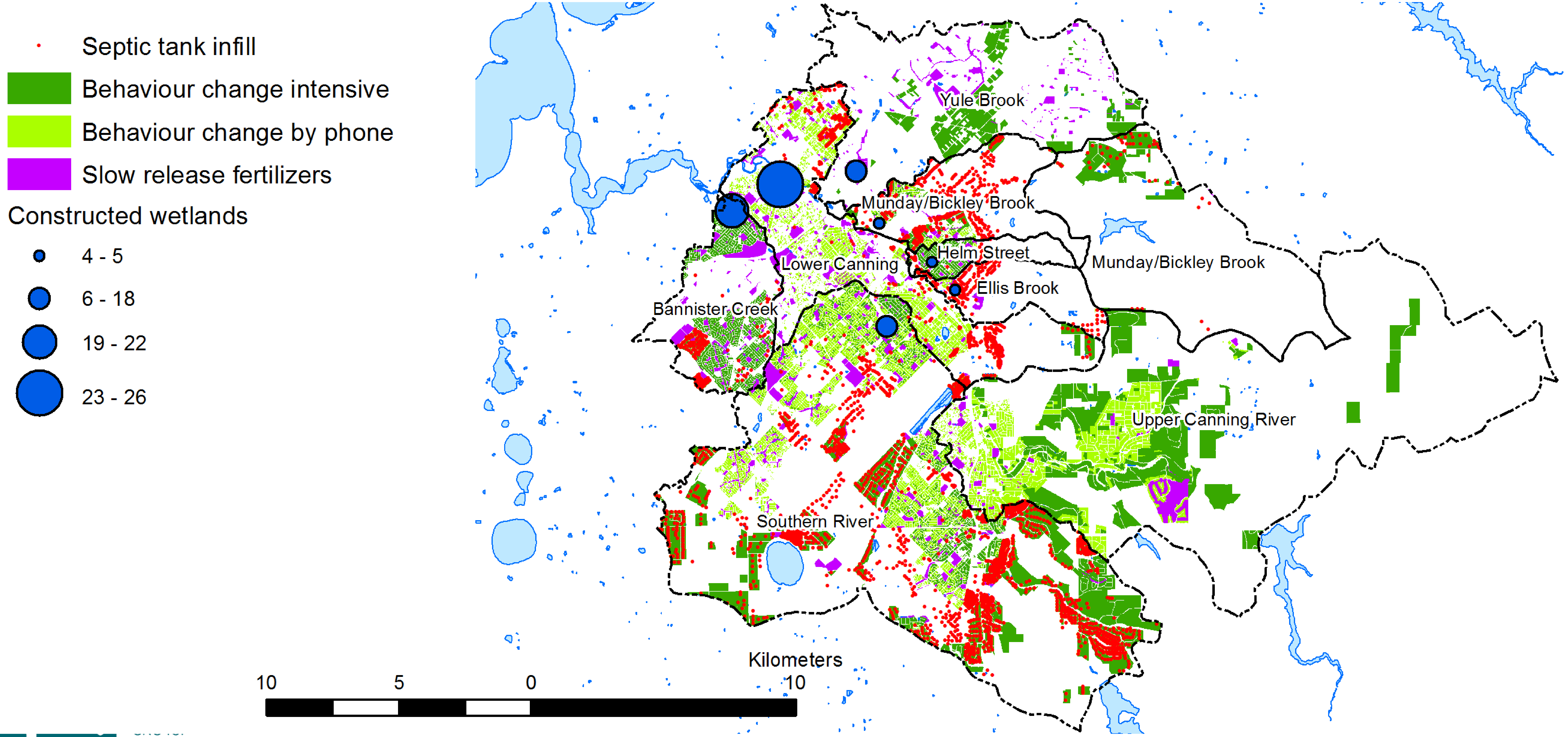
Results: Base case scenario

% of target	N export, ton/year	P export, ton/year	Infill of septic tanks, number	Constructed wetlands, ha	Imported fill on residential developments, ha	Behaviour change intensive, ha/year	Behaviour change by phone, ha/year	Ban regular fertilisers, ha/year	Fertiliser action plan, ha/year	Slow release fertilisers on POS, ha/year	Phos Lock, ton/year	Capital cost, $M	Annual cost, $M/year	Present value of cost, $M
20%	53.3	4.0	1,089	94.7	0	566	169	No	0	1,240	0	197.4	2.1	19.7
40%	48.6	3.6	4,166	94.7	0	697	345	No	0	1,652	0	335.1	2.9	163.4
60%	43.9	3.3	10,689	94.7	8	1,135	29	No	0	1,711	0	609.3	5.0	448.9
80%	42.5	3.1	12,097	94.7	1,787	1,212	59	No	0	1,711	0	736.9	5.0	616.3
100%	42.5	3.1	12,097	94.7	1,787	1,212	59	No	37	1,711	0	736.9	5.0	616.3

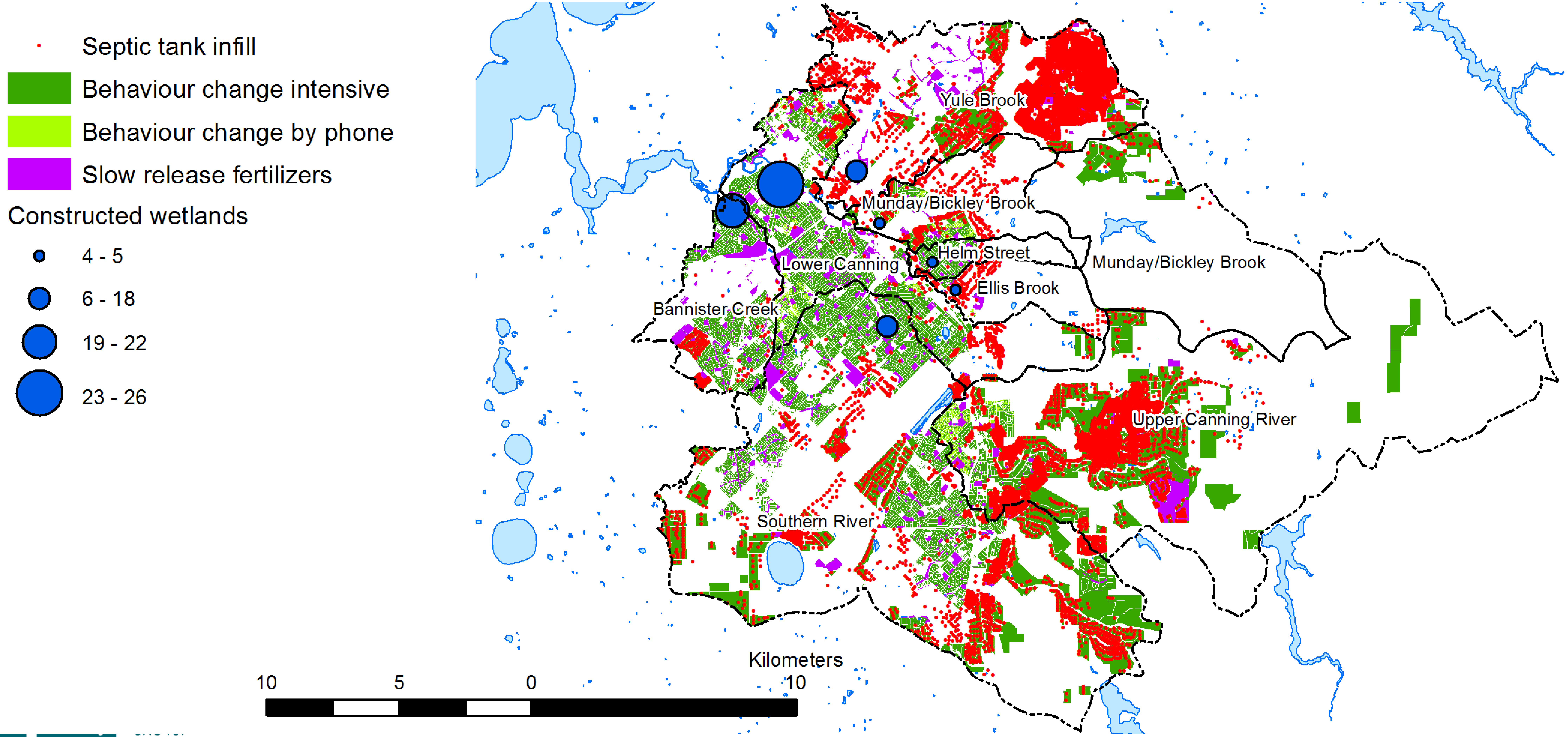
Base case scenario 20% target



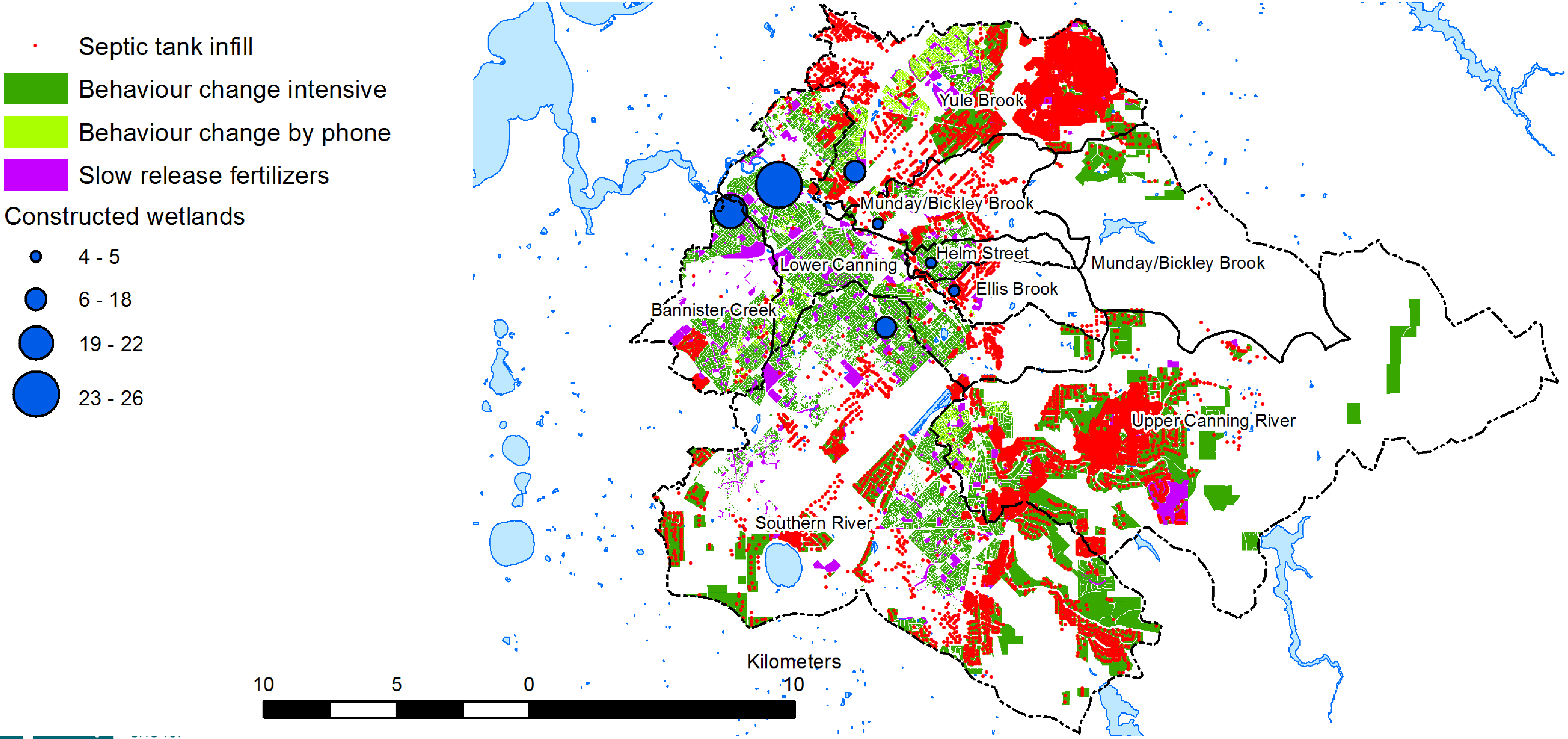
Base case scenario 40% target



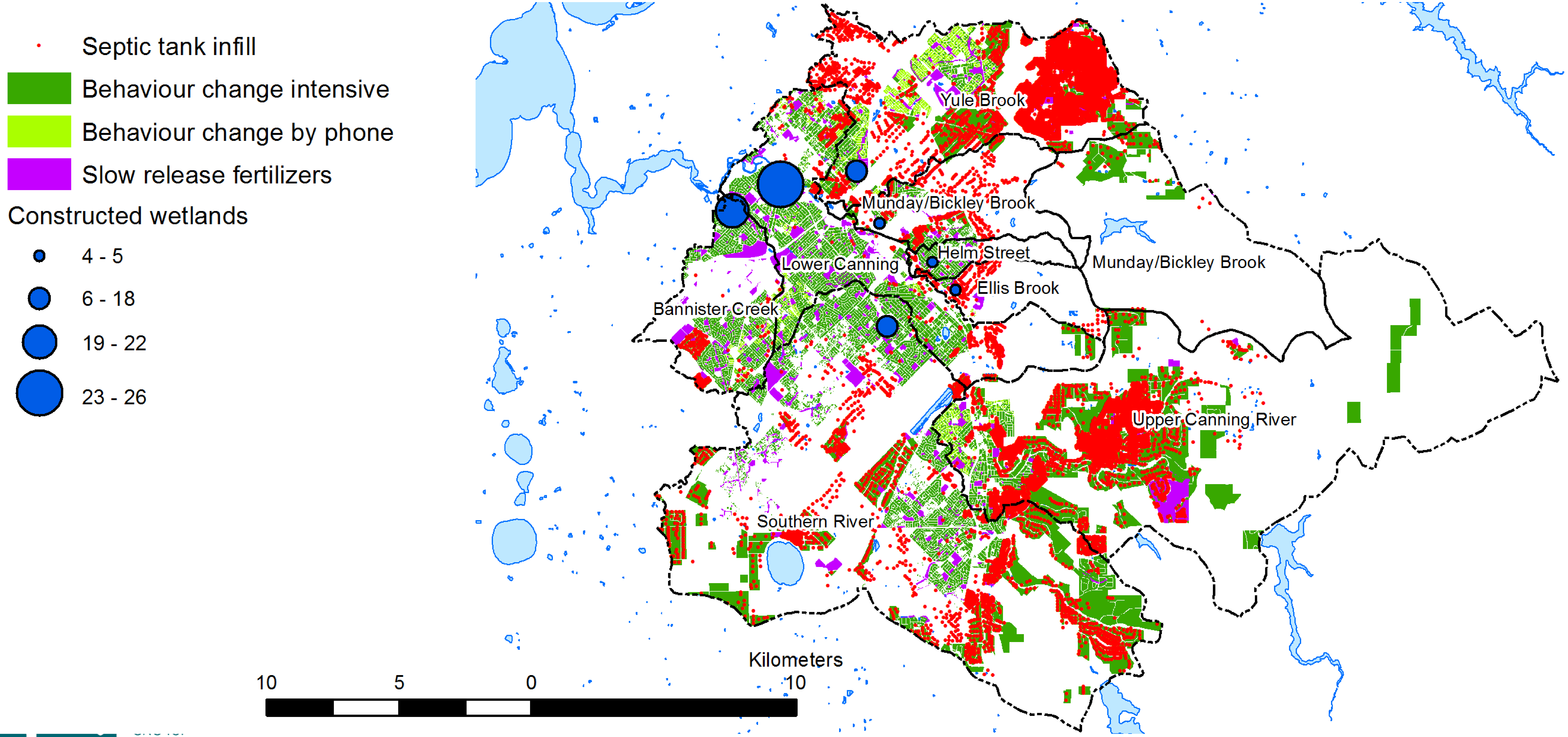
Base case scenario 60% target



Base case scenario 80% target



Base case scenario 100% target



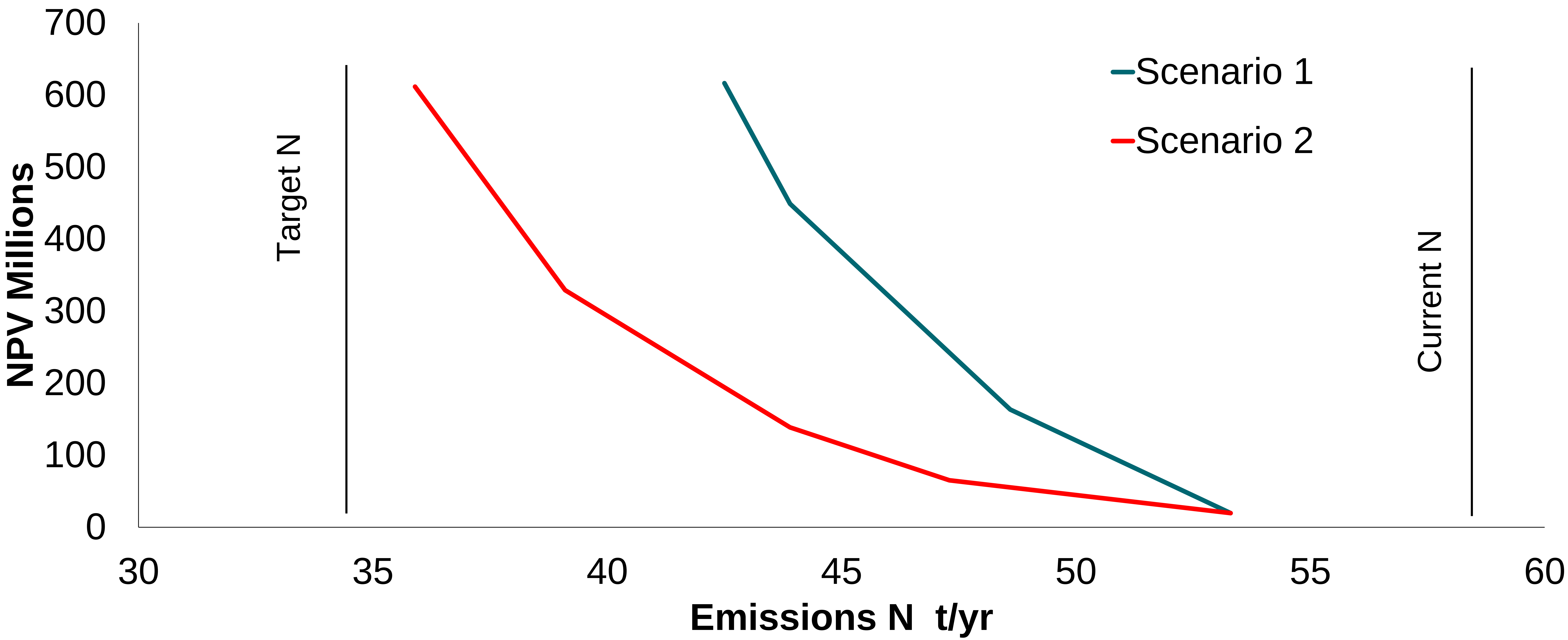
Alternative scenario: Ban regular fertilisers

% of target	N export, ton/year	P export, ton/year	Infill of septic tanks, number	Constructed wetlands, ha	Imported fill on residential developments, ha	Behaviour change intensive, ha/year	Behaviour change by phone, ha/year	Ban regular fertilisers, ha/year	Fertiliser action plan, ha/year	Slow release fertilisers on POS, ha/year	Phos Lock, ton/year	Capital cost, $M	Annual cost, $M/year	Present value of cost, $M
20%	53.3	4.0	1,089	94.7	0	566	169	No	0	1,240	0	197.4	2.1	19.7
40%	47.3	3.9	0	94.7	0	0	0	Yes	0	0	23.8	158.5	5.7	65.3
60%	43.9	3.7	1,928	94.7	0	0	0	Yes	0	0	17.2	239.3	5.7	138.7
80%	39.1	3.4	7,315	94.7	3	0	0	Yes	0	0	9.6	436.9	5.7	329.2
100%	35.9	3.2	12,097	94.7	1,787	0	0	Yes	0	0	10.1	736.9	5.7	611.5

Comparison of scenarios

Target N (t/y)	Target P (t/y)	Achieved N (t/y)	Achieved P (t/y)	10 y capital cost $M	Average annual cost $M	Present value of cost $M
Current emission						
		58.1	4.5			
Base case						
34.4	3.2	42.5	3.1	736.9	5.0	616.3
Banning regular fertilisers						
34.4	3.2	35.9	3.1	736.9	5.7	611.5

Cost of abatement at various nitrogen emissions targets



Conclusions

- At low levels of abatement, septic tank infill, constructed wetlands and slow release fertilizer provide least cost abatement actions
- The priority areas are Bannister Creek and Southern River catchments.
- The cost of achieving a 60% of reduction target of N and P is $449M, which is similar to a conservative estimate of the nonmarket value of water quality improvement in the Canning is $22M/y (discounted in perpetuity at 5% this give a value of $440M).
- When we include option of banning regular fertilisers, it is possible to achieve close to target loads for N at a cost of $612M

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