

Urban boundary disputes: reducing the exchange of water across urban ecosystem boundaries



Breen, P.F. & Wong, T.H.F

Ecological Engineering Pty Ltd

PO Box 12, Darling South, VIC, 3145

The Ecosystem Model



- Natural ecosystems tend to have limited flux of materials
- The retention and cycling of materials tends to be high

Impacted Aquatic Ecosystems



- Modified ecosystems tend to have a large flux of materials
- The retention and cycling of materials tends to be low

Ecosystem Protection and Water Cycle Management

- The ecological objectives of water cycle management are to:
 - Reduce water use and preserve environmental flows
 - Harvest and manage urban runoff to reduce the impacts of development
 - Reduce and reuse wastewater to protect both water harvesting and wastewater discharge environments

	Garden	Kitchen		Laundry		Toilet	Bathroom	
SOURCE		Cold	Hot	Cold	Hot		Cold	Hot
Potable		1		1			1	
Wastewater								
Treated Black	1					1		
Grey								
Stormwater								
Roof			1	1	1			1
Non-roof								
1. Preferred use; 2. Compatible use; 3. Non-preferred use; 4. Not compatible								

	Garden	Kitchen		Laundry		Toilet	Bathroom	
SOURCE		Cold	Hot	Cold	Hot		Cold	Hot
Potable		1	2	1	2		1	2
Wastewater								
Treated Black	1					1		
Grey	2					2		
Stormwater								
Roof	2	2	1	1	1	2	2	1
Non-roof	2					2		
1. Preferred use; 2. Compatible use; 3. Non-preferred use; 4. Not compatible								

	Garden	Kitchen		Laundry		Toilet	Bathroom	
SOURCE		Cold	Hot	Cold	Hot		Cold	Hot
Potable	3	1	2	1	2	3	1	2
Wastewater								
Treated Black	1	4	4	4	4	1	4	4
Grey	2	4	4	4	4	2	4	4
Stormwater								
Roof	2	2	1	1	1	2	2	1
Non-roof	2	4	4	4	4	2	4	4
1. Preferred use; 2. Compatible use; 3. Non-preferred use; 4. Not compatible								

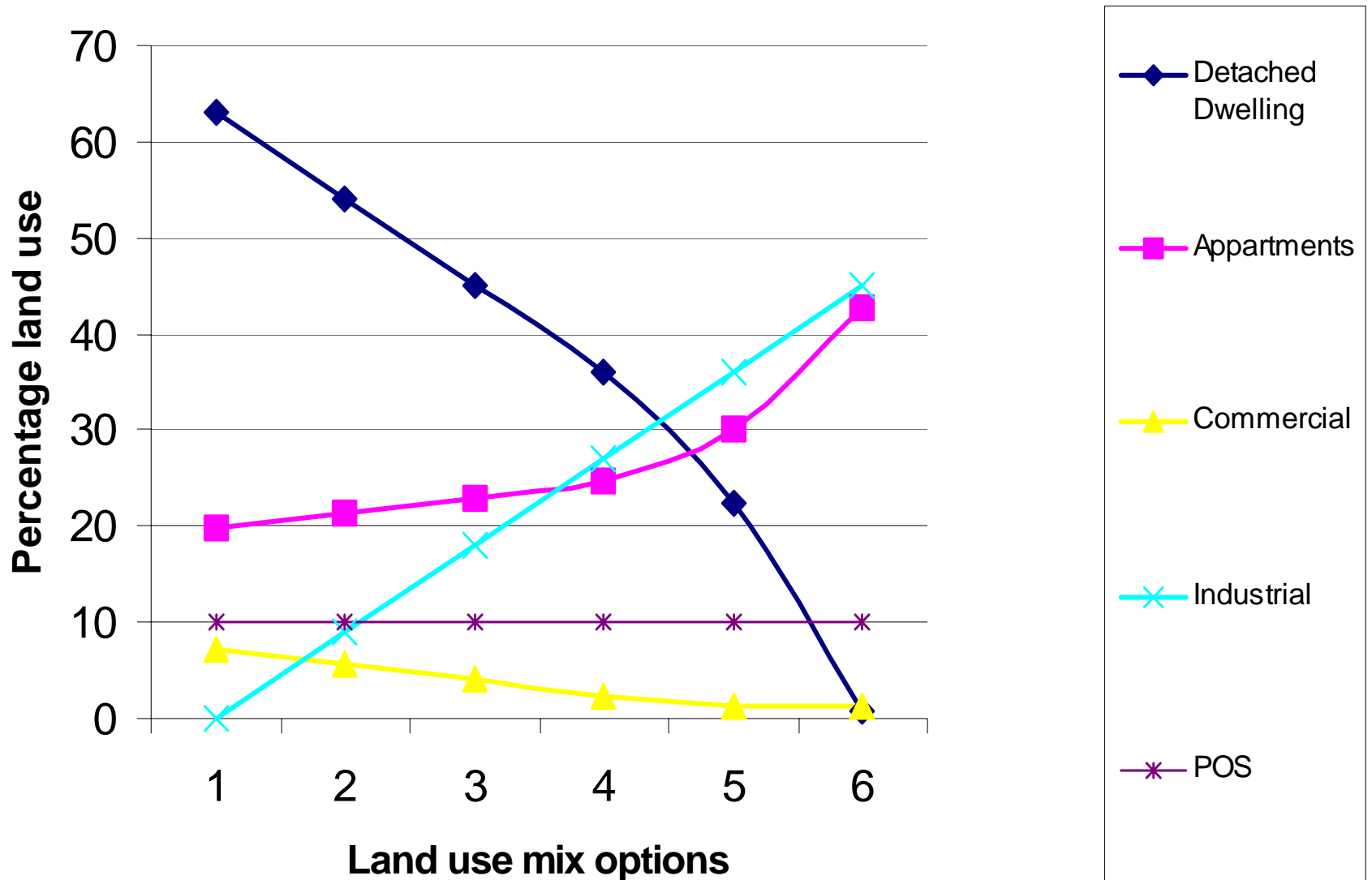
Water Balance Model

- To investigate the influence of land use mix on potable water demand and wastewater discharge
- Sustainable Water Index
 - $= (1 - \text{imported potable water use} / \text{total indoor \& outdoor demand}) \times (1 - \text{wastewater discharge} / \text{total indoor \& outdoor demand})$
 - SWI target = 1 (ideal)
- Standard unit area = 500m²
- Sydney rainfall, evapotranspiration and household water use data

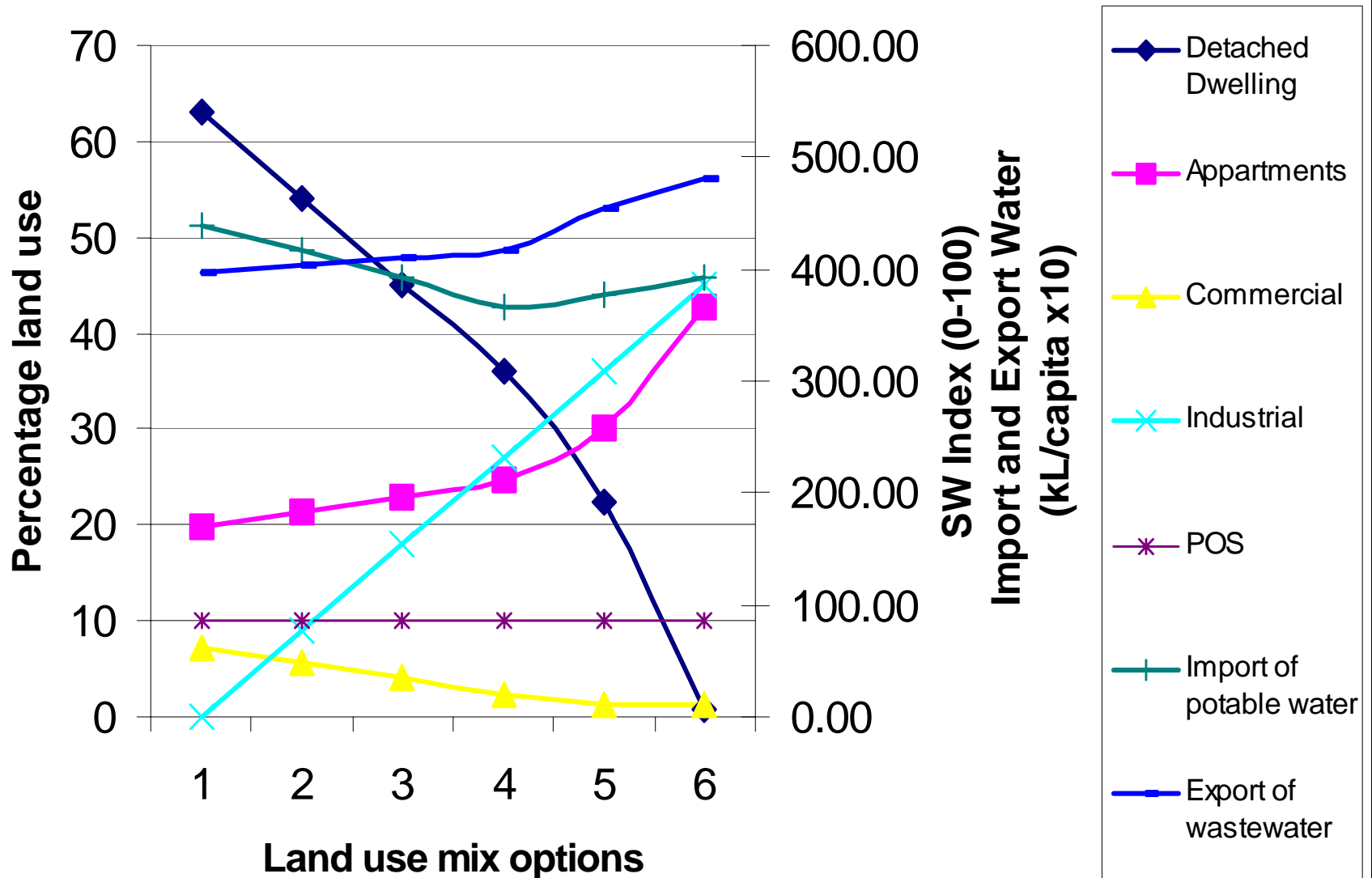
Model Land Use Categories

- Detached dwelling
 - 2.5 people
 - 300 m² roof
- Apartment (3 floors)
 - 10 people
 - 400 m² roof
- Commercial (3 floors)
 - 48 people
 - 400 m² roof
- Industrial
 - 8 people
 - 400 m² roof
- Population Balance
 - A condition of the simulations was that the population of detached dwelling + apartment = commercial and industrial

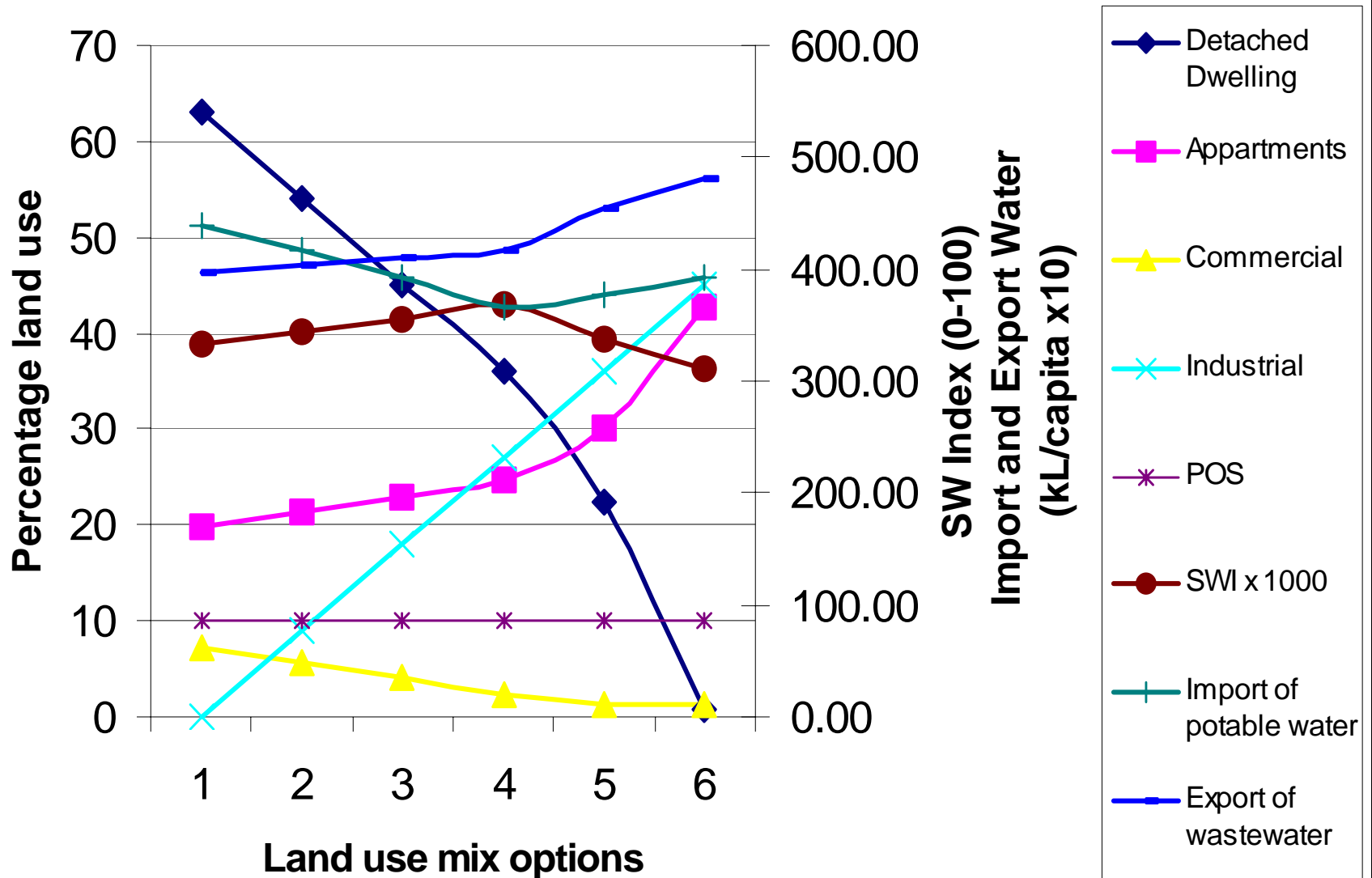
Sustainable water use with local recycling



Sustainable water use with local recycling



Sustainable water use with local recycling



Result for local recycling

- For the simulation conditions and current best practice reuse of roof water (for hot water) and greywater (for toilet flushing and garden watering)
- A land use mix of:
 - 36% Detached dwelling
 - 24.6% Apartment
 - 2.4% Commercial
 - 27% Industrial
 - 10% Open space
- Sustainable Water index = 0.43
 - (Potable Water saving of 68%, Reduced wastewater discharge of 63%), ie $0.68 \times 0.63 = 0.43$

Result for reclaimed water option

- For the same simulation conditions and current best practice reuse of roof water and reclaimed water use
- A land use mix of:
 - 36% Detached dwelling
 - 24.6% Apartment
 - 2.4% Commercial
 - 27% Industrial
 - 10% Open space
- Sustainable Water index = 0.64
 - (Potable Water saving of 71%, Reduced wastewater discharge of 90%), ie $0.71 \times 0.90 = 0.64$

Result for reticulated reclaimed water

- For the simulation conditions and current best practice reuse of roof water and reticulated reclaimed water
- A land use mix of:
 - 40.6% Detached dwelling
 - 15.4% Apartment
 - 3.5% Commercial
 - 10.5% Industrial
 - 30% Open space
- Sustainable Water index = 0.81
 - (Potable Water saving of 83%, Reduced wastewater discharge of 98%), ie $0.83 \times 0.98 = 0.81$

Conclusions

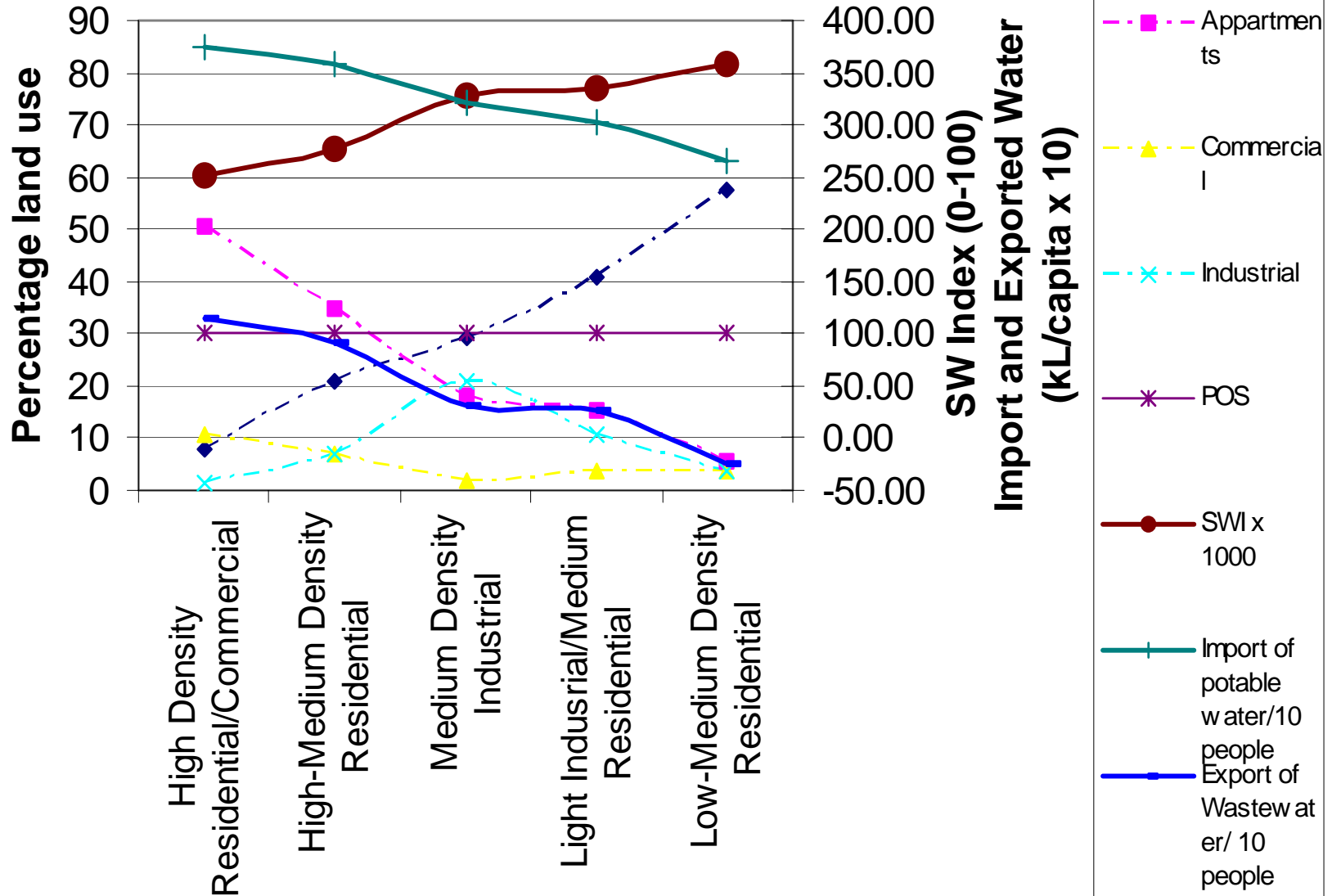
- Sustainable water use can be managed by managing land use mix
- Water reuse at the local scale is generally limited by reuse sources
- Reticulated reclaimed water use provides greater water saving possibilities and allows greater land use flexibility
- Public open space is an important factor in reducing wastewater discharges with reclaimed water use

Conclusions

- These results are dependent on Sydney climatic conditions, and the other constraints of the simulations (eg. population balance).
- This is a multivariate model, and so a range of other answers are possible
- However, with respect to water sustainability, green-cities **HAVE** to be **GREEN**, ie have approximately 30% open space



Sustainable water use for typical land use mixes



Natural Aquatic Ecosystems



- Even in aquatic ecosystems with strong longitudinal flow, local retention of materials is high
- For example benthic macroinvertebrate biodiversity in such a stream is typically over a 100 species

Impact of Urbanisation on Stream Ecosystems

- Urbanisation impacts on aquatic ecosystems by:
 - Increasing runoff rates in urban areas
 - Resulting in physical stream impacts
 - Biological impacts due to disturbance
 - Introduction of wastewater discharges
 - Decreasing environmental flows in water harvesting areas