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SWITCH, City Water

Groundwater Recharge and Birmingham

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Overview

- City Water KBS/DSS
  - Key advances
- City Water Balance
  - Design concepts
  - Implementation and outputs
- Birmingham Case Study
  - Background
  - Calibration/Validation
  - Scenarios
  - Illustrative results and groundwater impacts
- Concluding remarks

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Key Advances in City Water

- Significant weight is given to the integrated exploitation in IUWM of the ‘natural’ environment.
- The knowledge repository is designed to deal with aspects of the regulatory environment, legal frameworks, historical data and stakeholder interactions and responsibilities
- Modelling tools provide for indicators spanning a very broad range of time and space scales
- Can explore transitioning impacts across a city
- Designed for wide (Global?) application

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City Water Balance

- Water Flow and Quality

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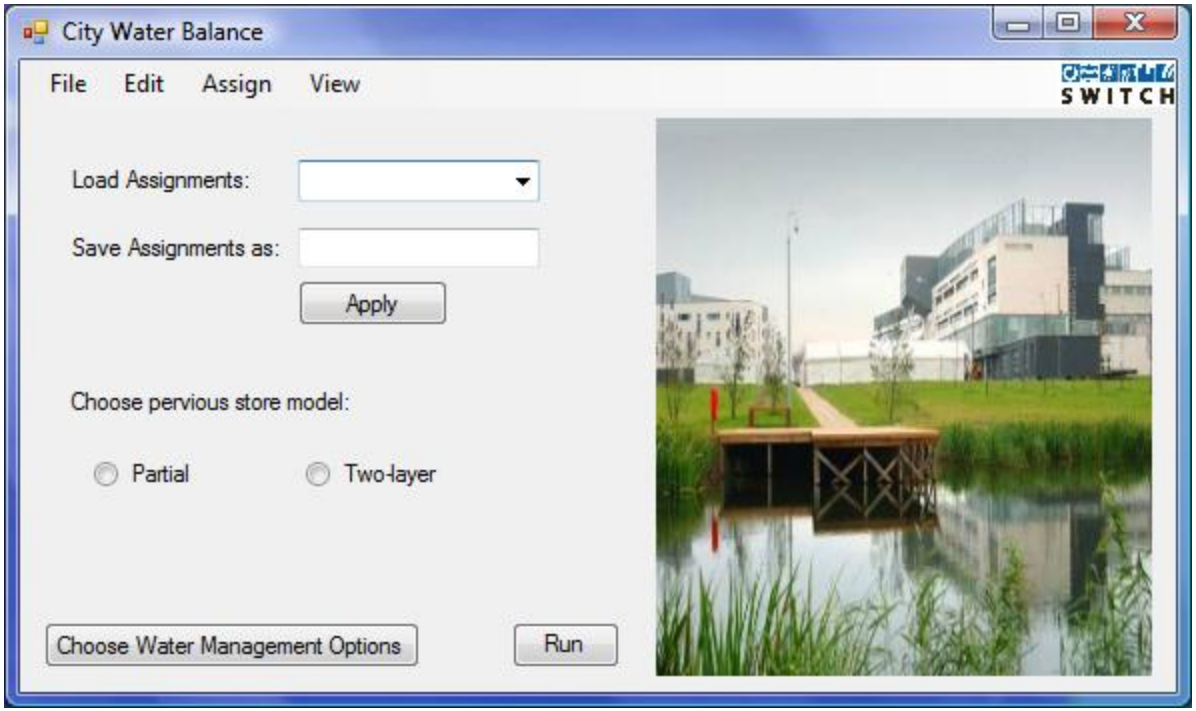
City Water Balance (CWB)



Mapping the cities water demand, supply, drainage, treatment and reuse.

Scoping the impact of changing these features either locally or globally

Exploring alternative Water management options

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CWB Concepts

- Based on readily available data sets
- Provide simple performance indicator outputs
- Models all elements of the water system (natural and man-made)
- SCOPING calculations only…. Daily timestep … indicative results

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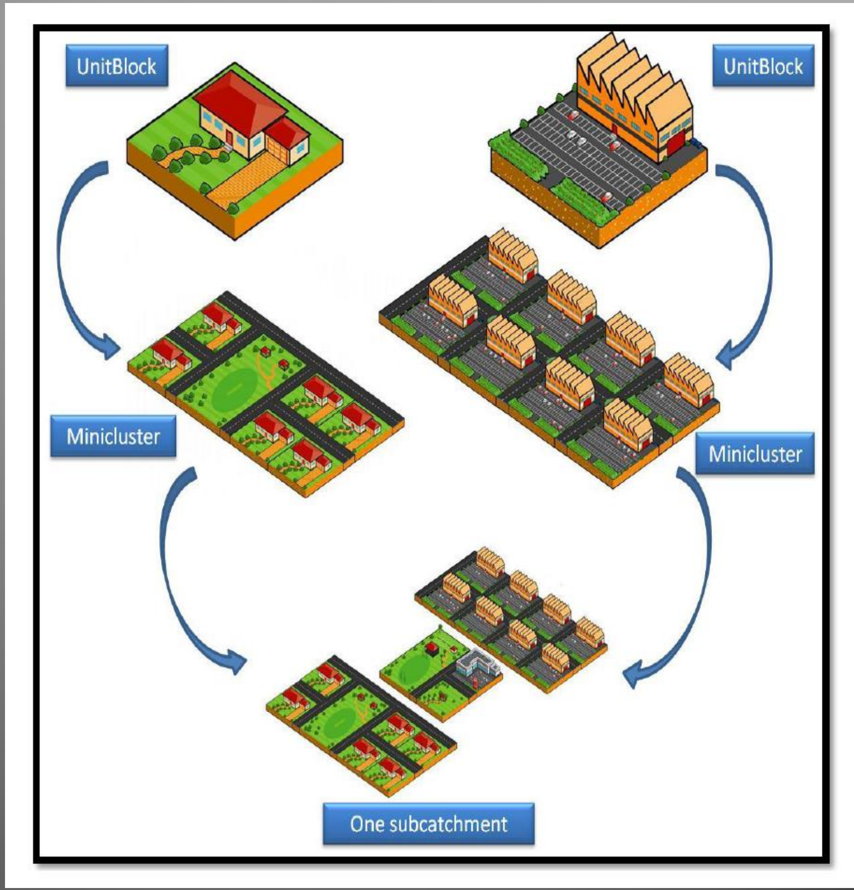
Core Concepts (Spatial Heirarchy)

- Spatial Discretisation
  - Unit Block
    - A basic land unit area
  - Minicluster
    - A neighbourhood covered by unit blocks of the same type
  - Sub-catchment
    - A common drainage area
  - Study Area (=City)
    - The whole area to be modelled



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Model Input – Cost and Energy

Raintanks_energy [Compatibility Mode] - Microsoft Excel

	Lifetime Cost (kWh)
Site preparation costs (e.g.excavation of hole for tank)	1768.841374
Components (concrete tank)	3,857
Electricity usage	450
Consumables	0
Maintenance	800
Total	6875.425202
Annual energy usage (kWh)	275.0170081
Energy usage kWh/m3 supplied	4.583616802

number of UB:	1	
Number of users	2	
Tank volume (m3)	2	From mode
Lifecycle (years):	25	(lifetime of longest lasting component
Annual supply (m3)	60	From mode
Pump efficiency (kWh/m3)	0.3	
Dosage (g/l)	0	

Components	Material	Quantity (kg)	Embodied energy (kWh/tonne)	Lifetime (years)	Lifecycle kWh
Main tank	HDPE	71.81549984	21,300	25	1529.670
Filters	Stainless steel	4	15,750	15	
Pump (main tank)	Stainless steel	16	15,750	10	
Impellors	GRP	1	27,800	10	6
Intermediate tank (100l)	PE	26.45705635	23100	25	611.1580
Pump (control unit)	Stainless steel	10	15,750	10	393
Pipes	PVC	3.637375244	18,800	25	68.38265
	PE	3.077779053	23,100	25	71.09669
	PE	0.20518527	23,100	25	4.739779
	Rubber	1.063232764	23,100	25	24.56067
	PE	14.54950098	23,100	25	336.0934
Cables	Copper	0.435	13,200	25	5.
	Copper	0.087	13,200	25	1.1
	Copper	0.435	13,200	25	5.

CWB 1m3 2m3 3m3 4m3 5m3 20m3 Data sources

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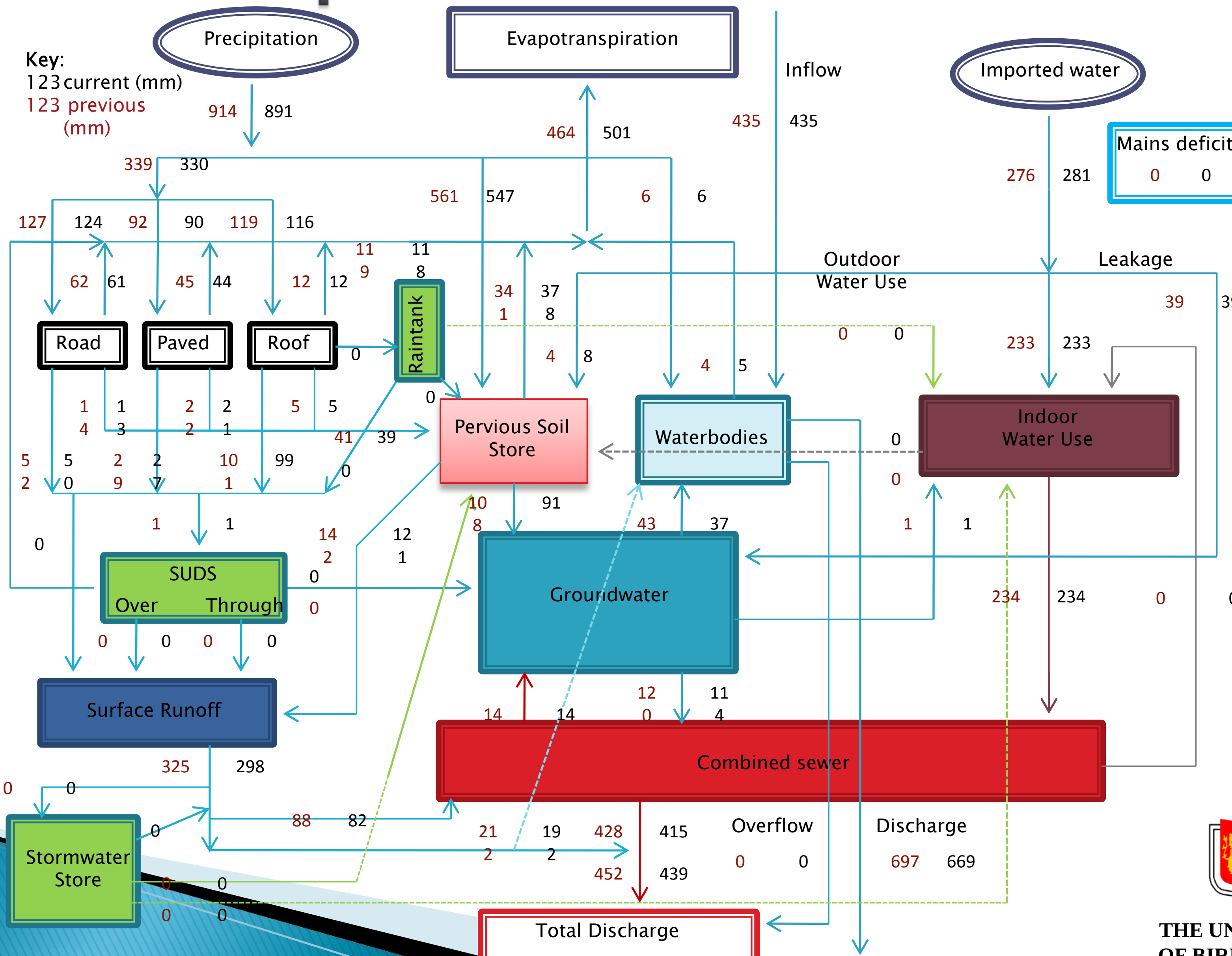
CWB Output – Flows



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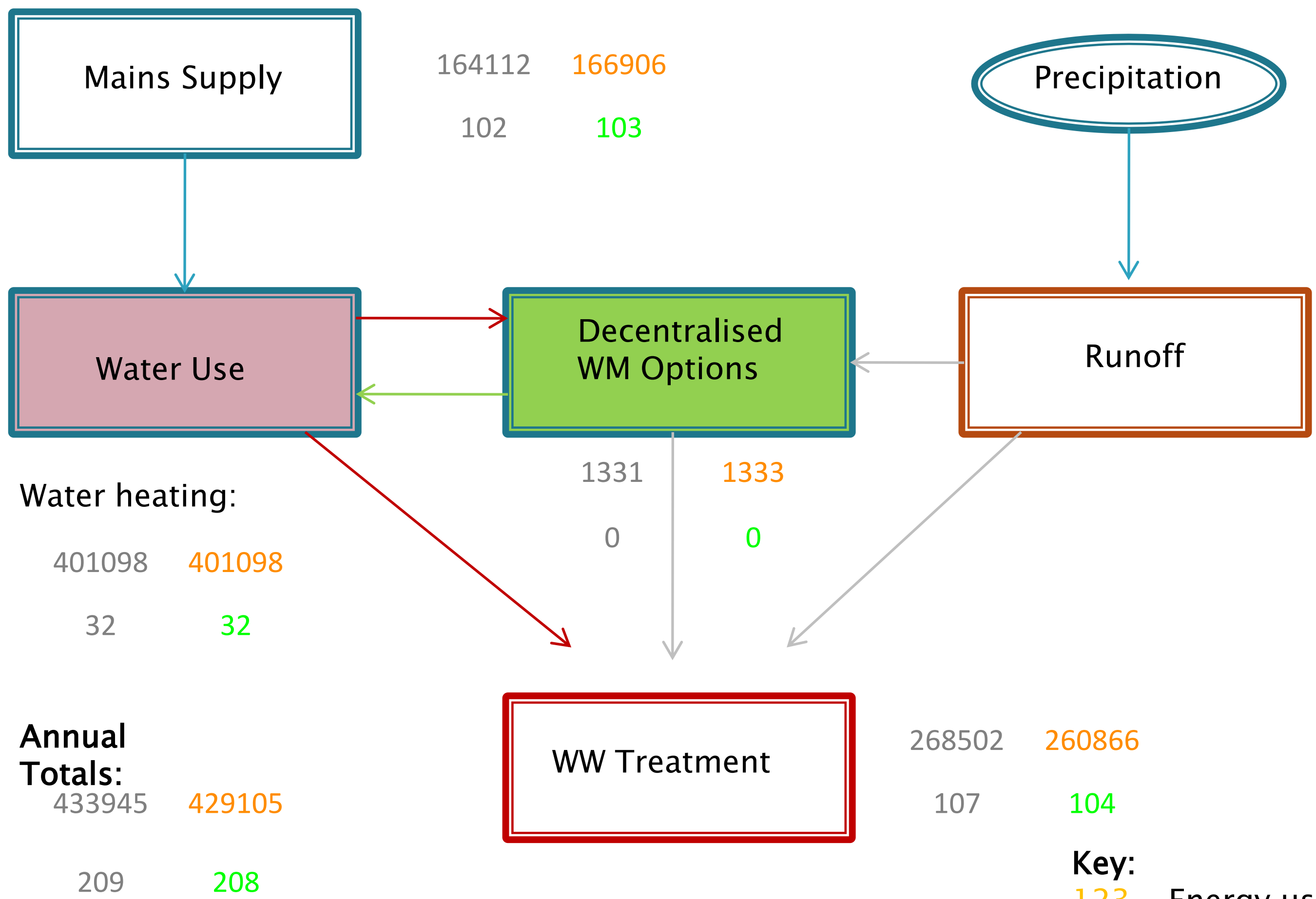
CWB Output – Cost and Energy



Key:
123 – Energy usage (MWh/yr)
123 – NPV Cost (Millions £/yr)
123 – Previous results

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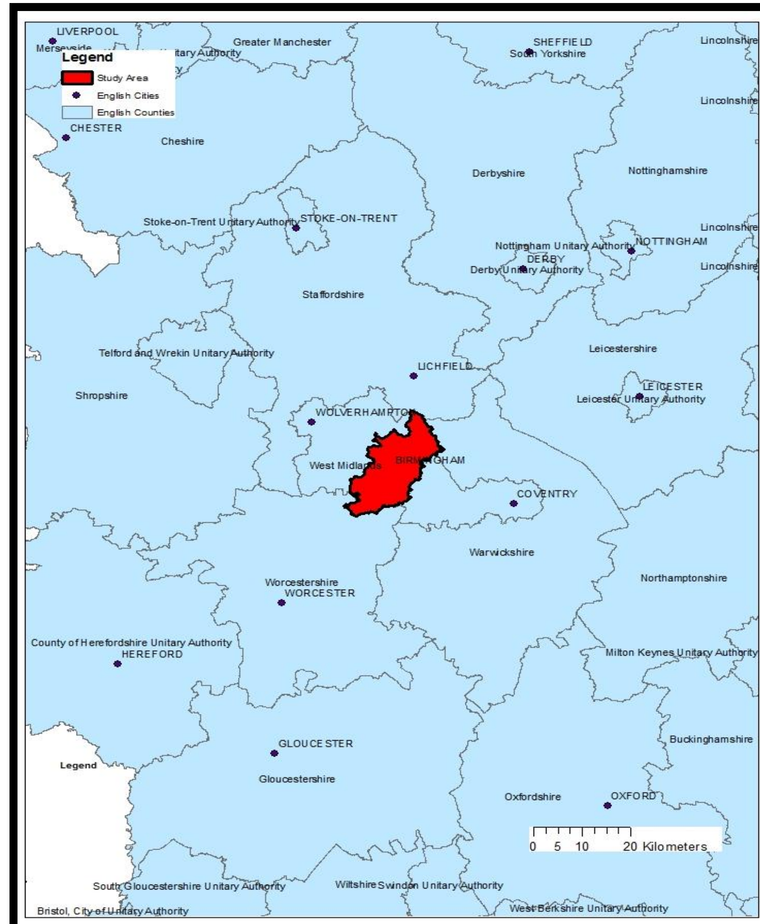
Birmingham

- Not all Birmingham or surrounding area
- Only Minworth catchment
- Data supplied from STW plus OS and areal land mapping



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Landuse within the Minworth Drainage Area

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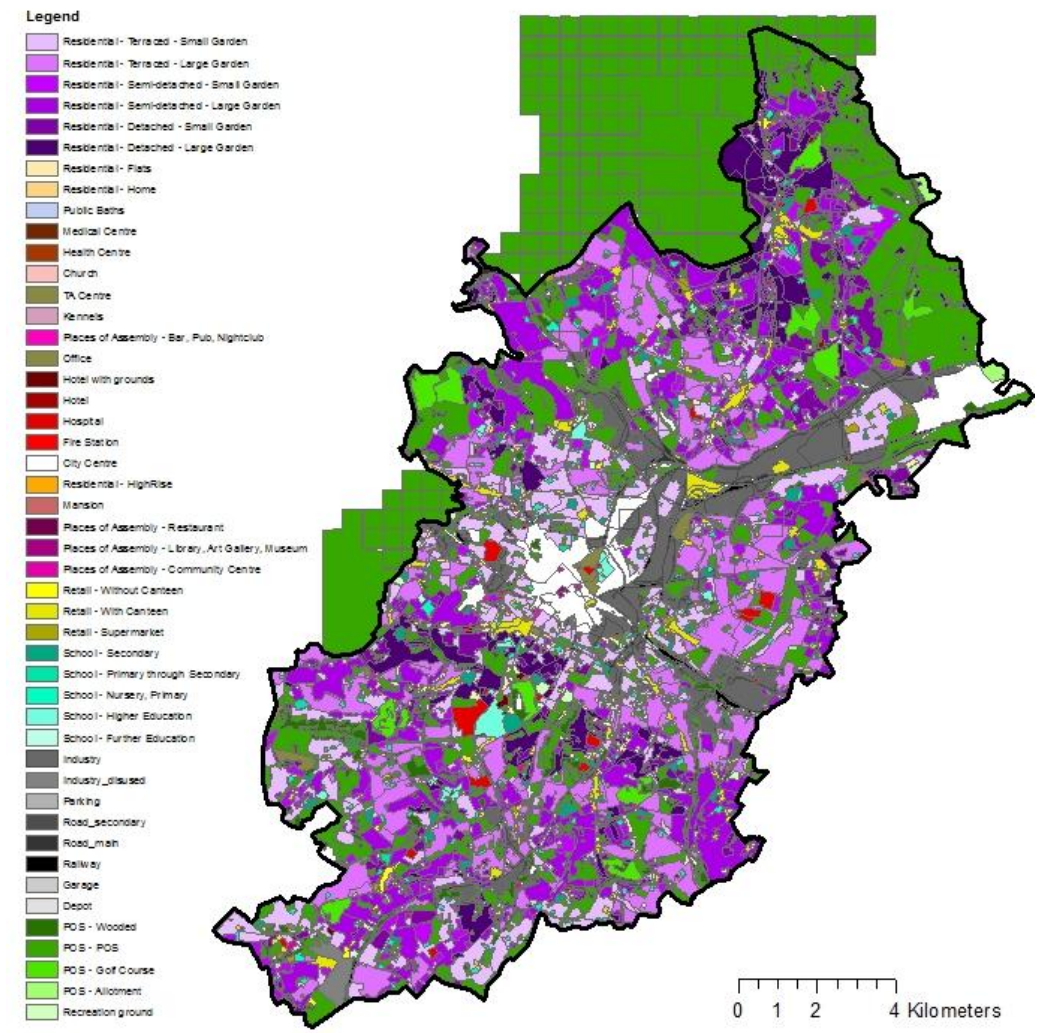

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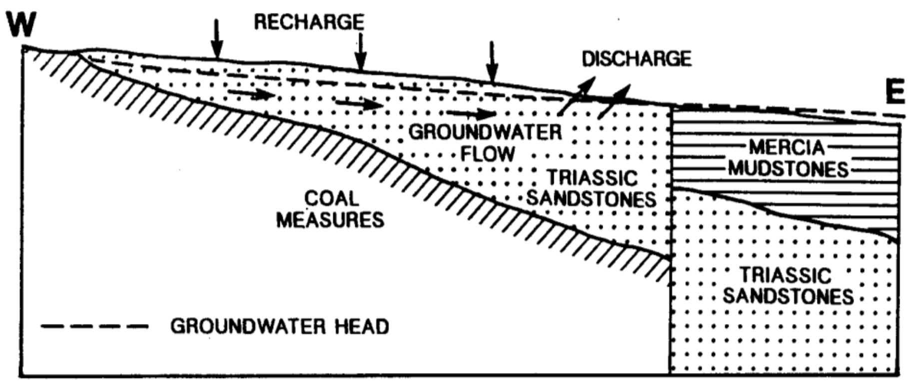
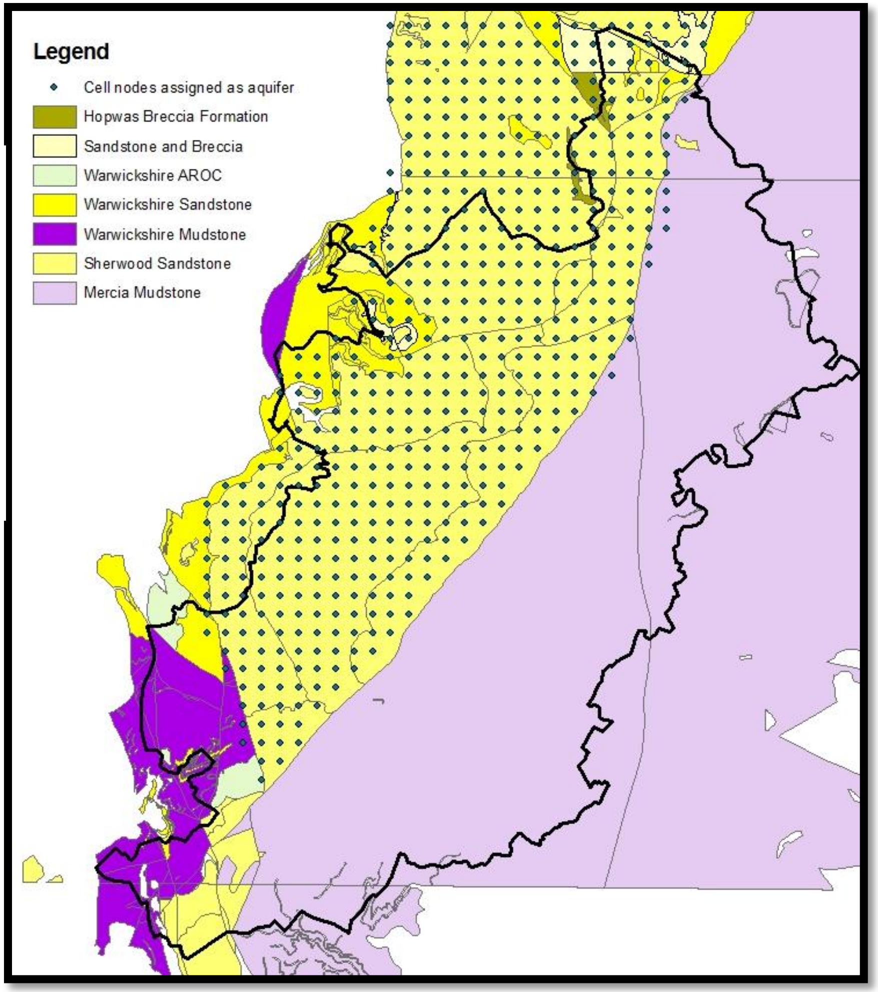
Groundwater





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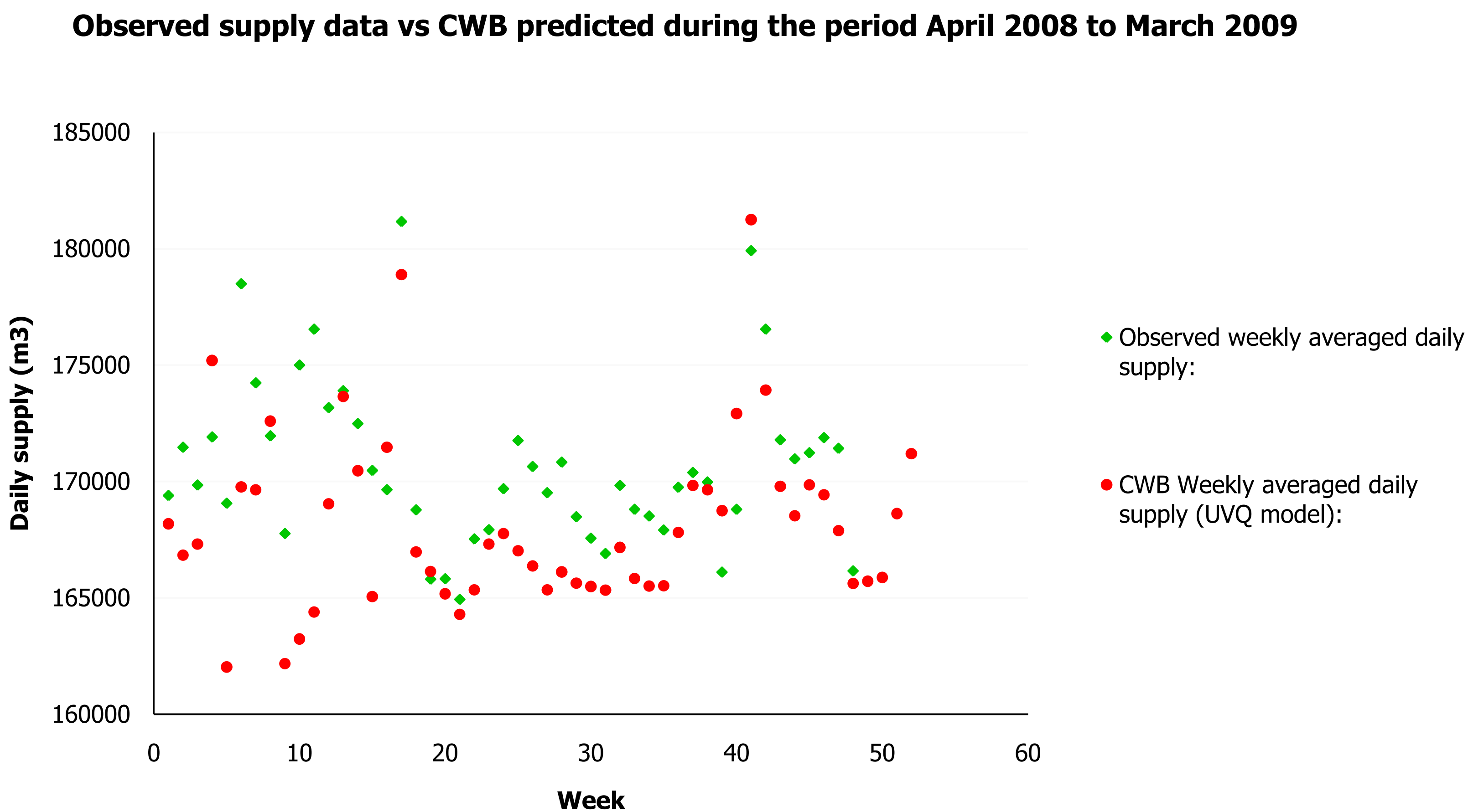
Calibration



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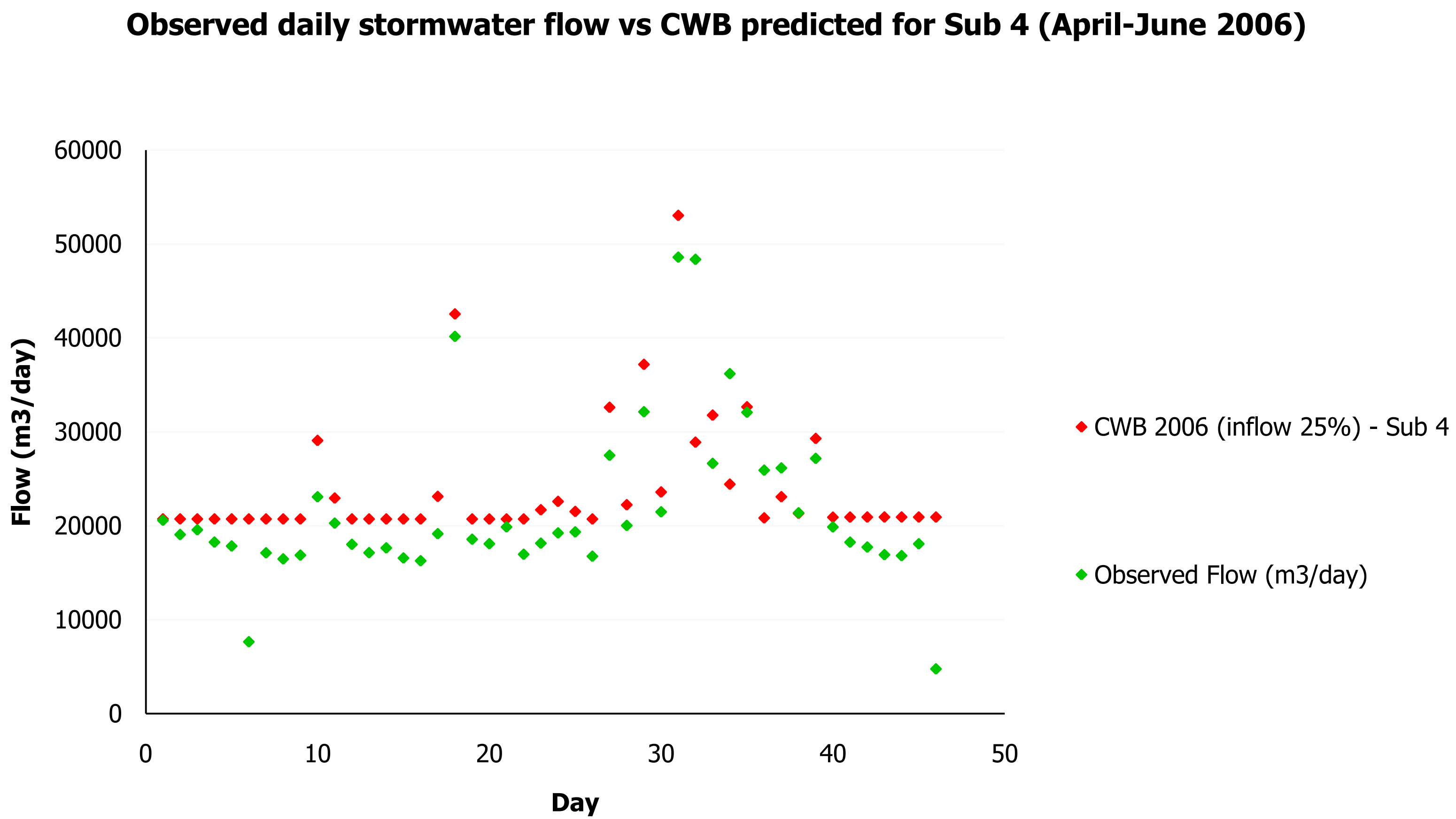
Validation



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Birmingham Learning Alliance Scenarios (2050):

1) Population doubled, 30% brown roofs, interrupted mains supply. Increased leakage.
2) Population doubled, 50 l/c/day supply from mains, recycled water to make up deficit. Increased leakage. Increased flash flooding.
3) Population stable. Mains water treated to non-potable standard. Increased urban agriculture.

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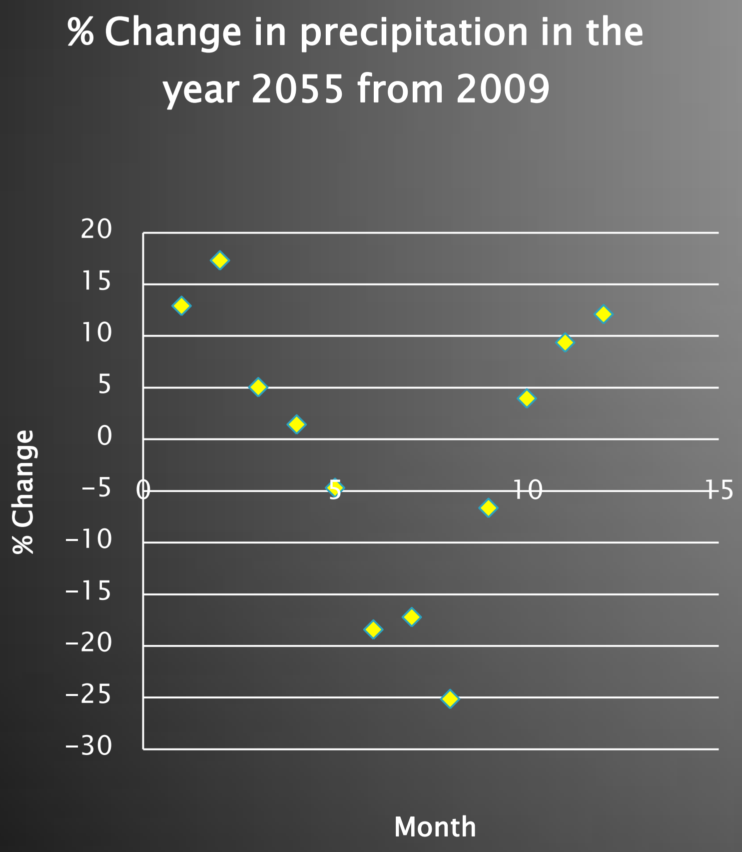
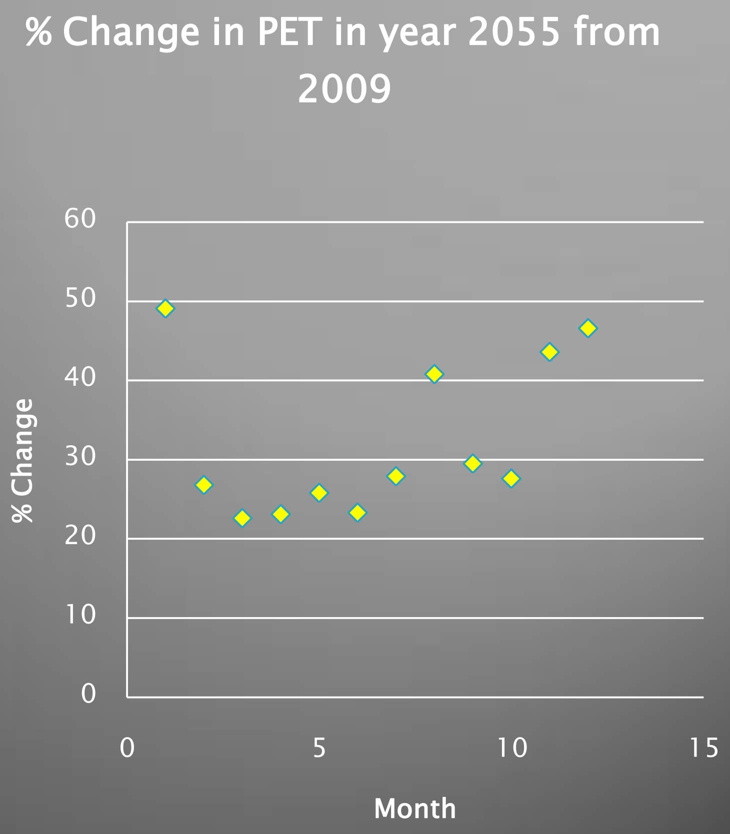
Climate change to 2055





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Current Conditions

- Impact of Climate Change given current conditions

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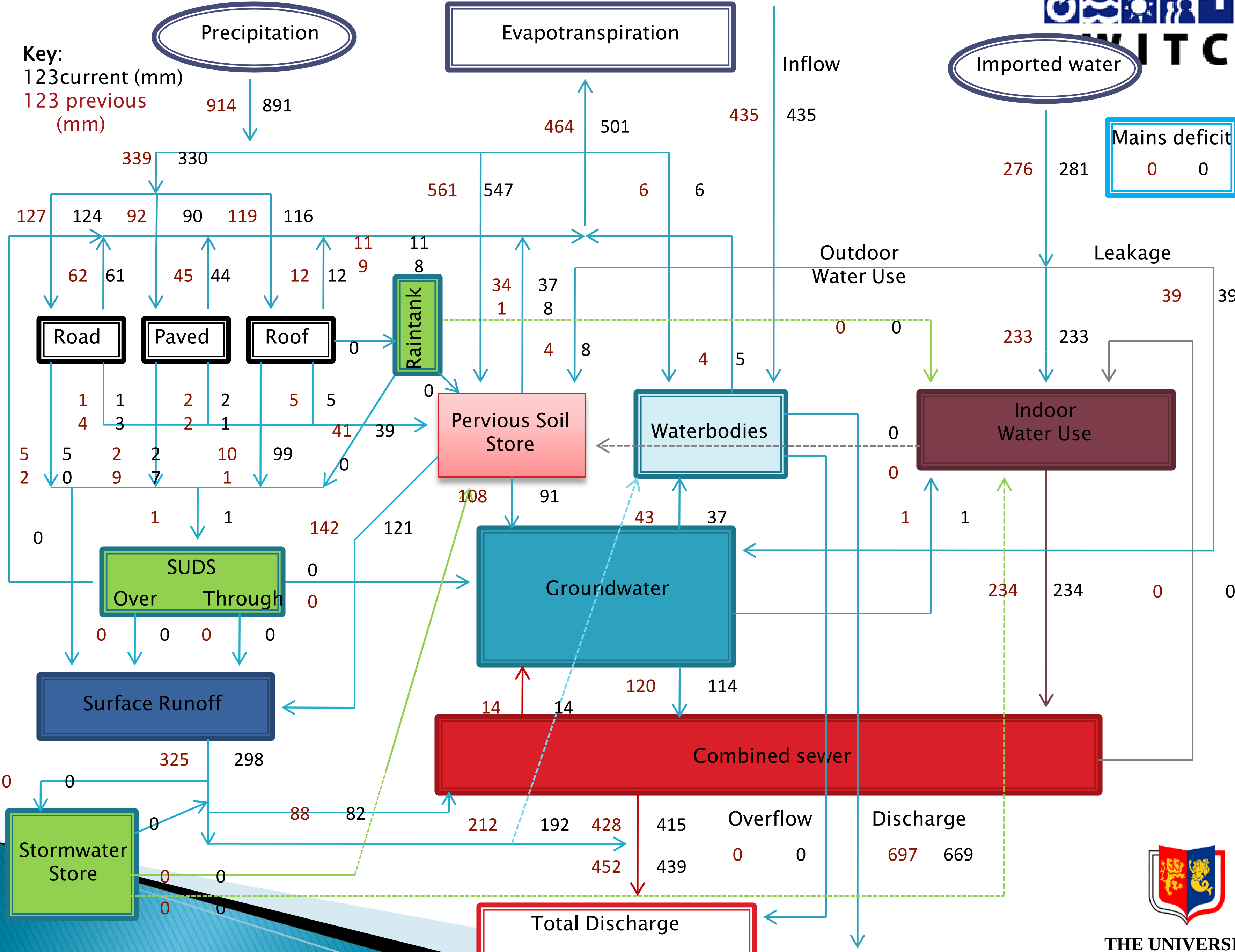

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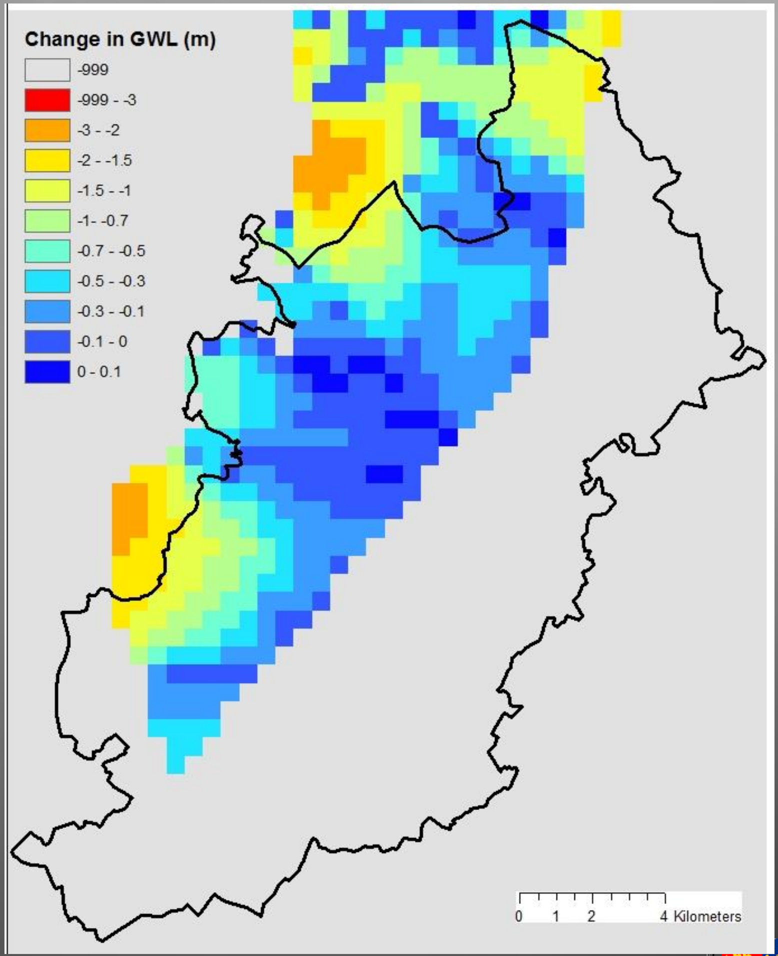
GW changes to climate change

- GW level responses on average to the revised climate state predicted for 2055
- but using the current 2009 waterscape for the city.



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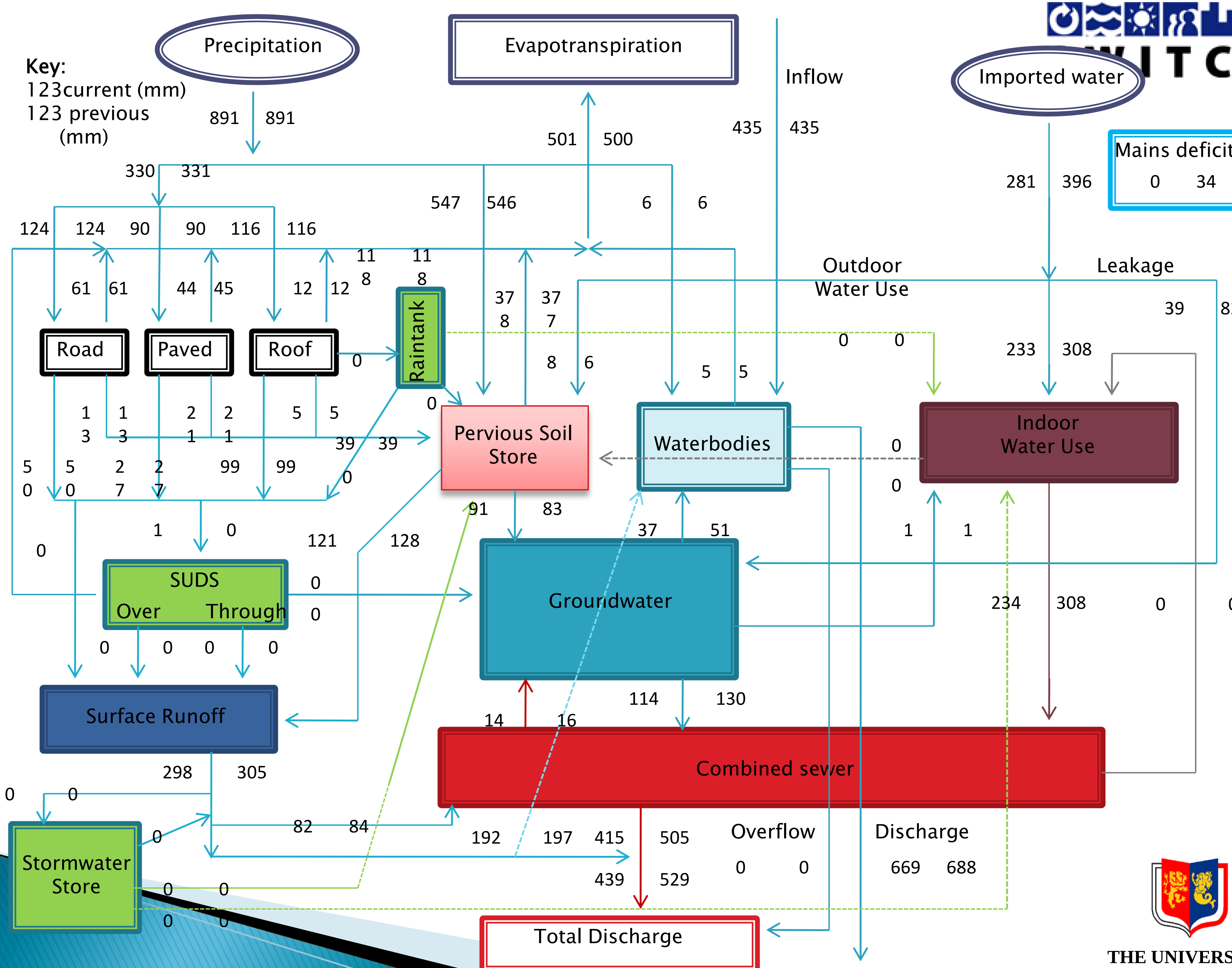
Scenario 1

- City centre and residential occupancy doubled since 2009. Mains leakage increased to 35%. The cost (energy and economic) of centralised supply increased by 50% and only 90% of demand could be satisfied by mains supply. Residential demand was assumed to be 130 l/c/day (*Water UK*, 2009b; *EA*, 2009). Climate data for 2055 were used.



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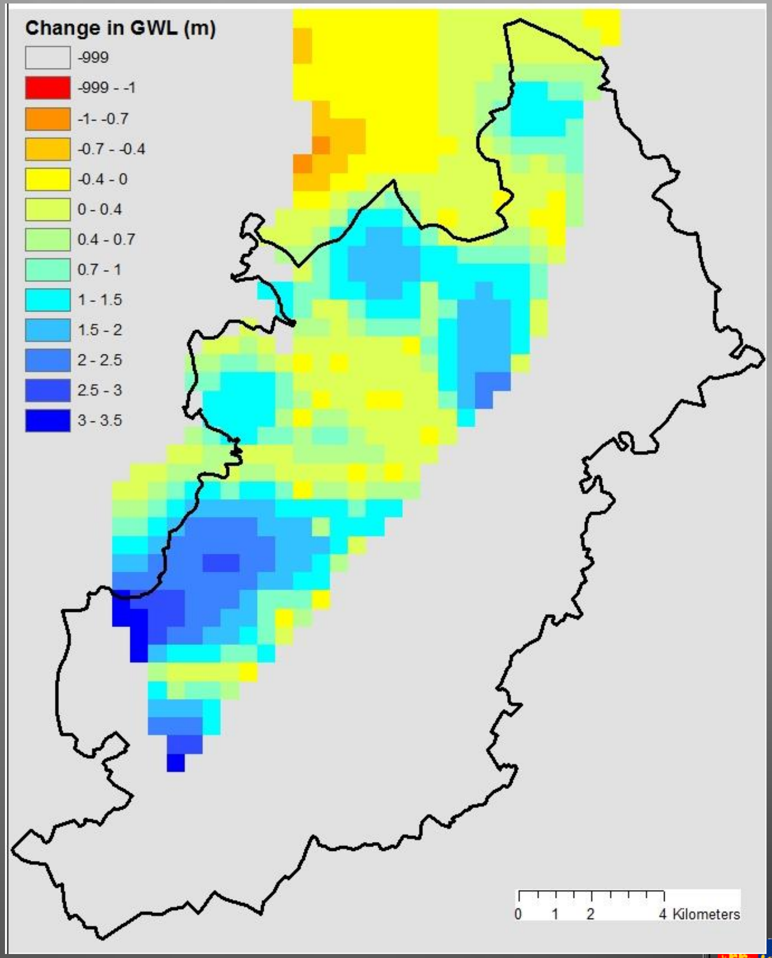
Scenario 1 – Business as usual

- City centre and residential occupancy doubled since 2009. Mains leakage increased to 35% Residential demand assumed to be 130 l/c/day
- Change in GWL from 2055 base case to Scenario 1 business as usual



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Scenario 1 – Strategy 1 – Brown roofs

- Introduction of brown roofs (50 year lifetime) to all non-residential buildings

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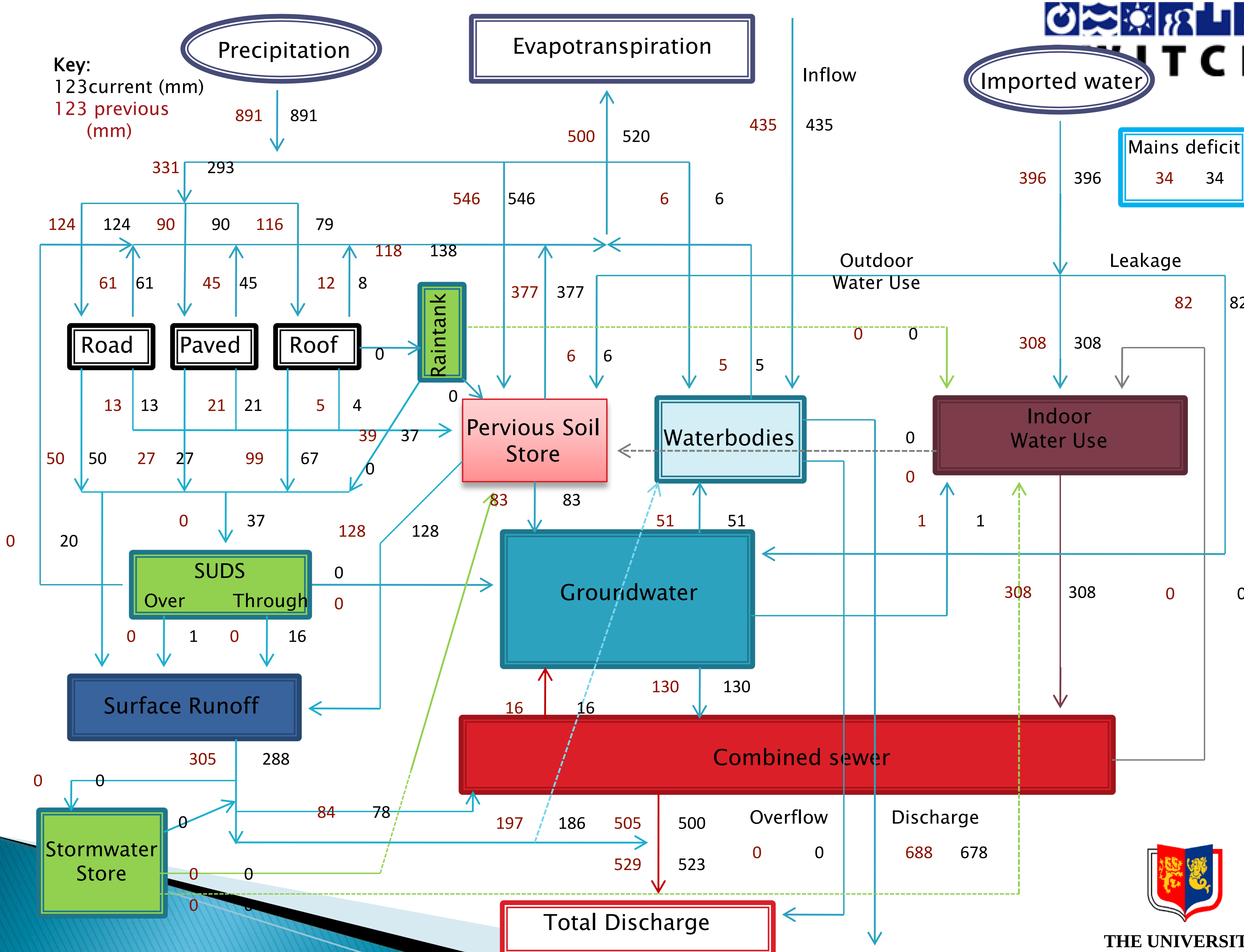

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Concluding remarks

- The SWITCH City Water Toolkit has been built to explore rapidly alternative strategies for alternative future scenarios
- The CWB Data and Model have been tested using the Birmingham Case Study – calibration is essential
- Useful data on GW behaviour can be extracted from CWB.
- Further testing of CWB is taking place in other cities.

- As IUWM gathers pace, the cross linkages and impacts will need to be considered with care.
- Strategic planning becomes an essential process for IUWM.

- Finally, sincerest thanks to Severn Trent Water for providing the water and wastewater data for Birmingham, the LA for the Scenarios and the EU for the funding.

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