Urban Water Supply In An Energy Constrained Australia

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Synopsis

- There is a strong link between water supply and energy use. Traditional options for urban water supply have been the low energy options – local capture and storage of rainwater, use of solar heating….
- Addressing the emerging global urban water problems may come at the price of higher energy demand, where future options canvassed include recycling, desalination, and remote storage.
- What are the implications of these options, and how can industry and governments effectively deal with these challenges, when water is a management issue relying on energy supply?
- For climate change adaptation to be effective, it is essential that implemented long term solutions for water supply mitigate and do not contribute to climate change or other forms of widespread pollution.

Measurements

Water Properties
Heavy, 1 tonne=1 k*l*
High heat capacity
c_p=1.2kWhr/k*l*
ΔH_v=630kWhr/
Viscous/turbulent
$\mu=10^{-3}$Pa.s

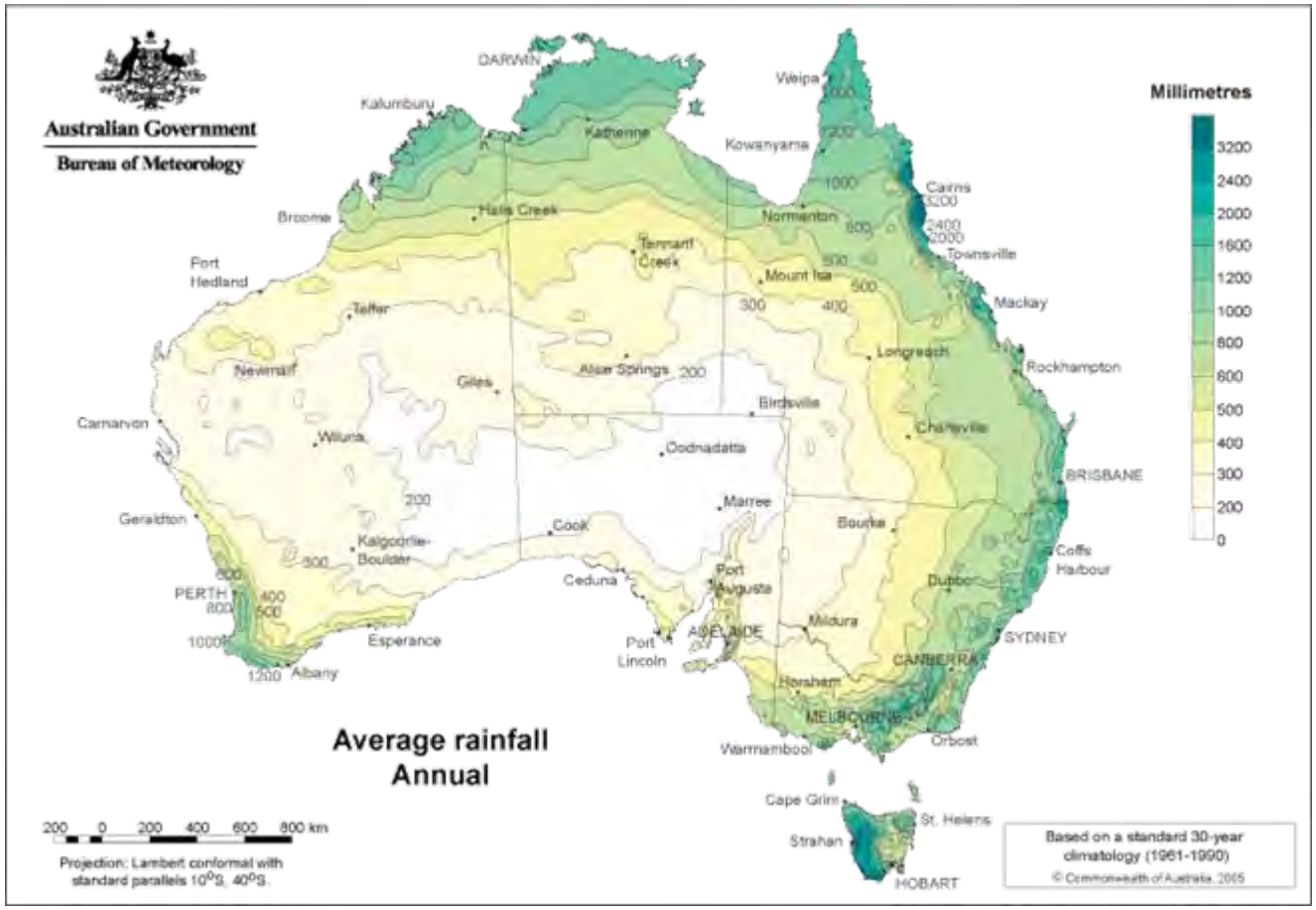
Energy implications

- Moving 100km
  0.3 kWhr/kl ($0.06/kl)
- Lifting water 1000m
  2.8 kWhr/kl ($0.56/kl)

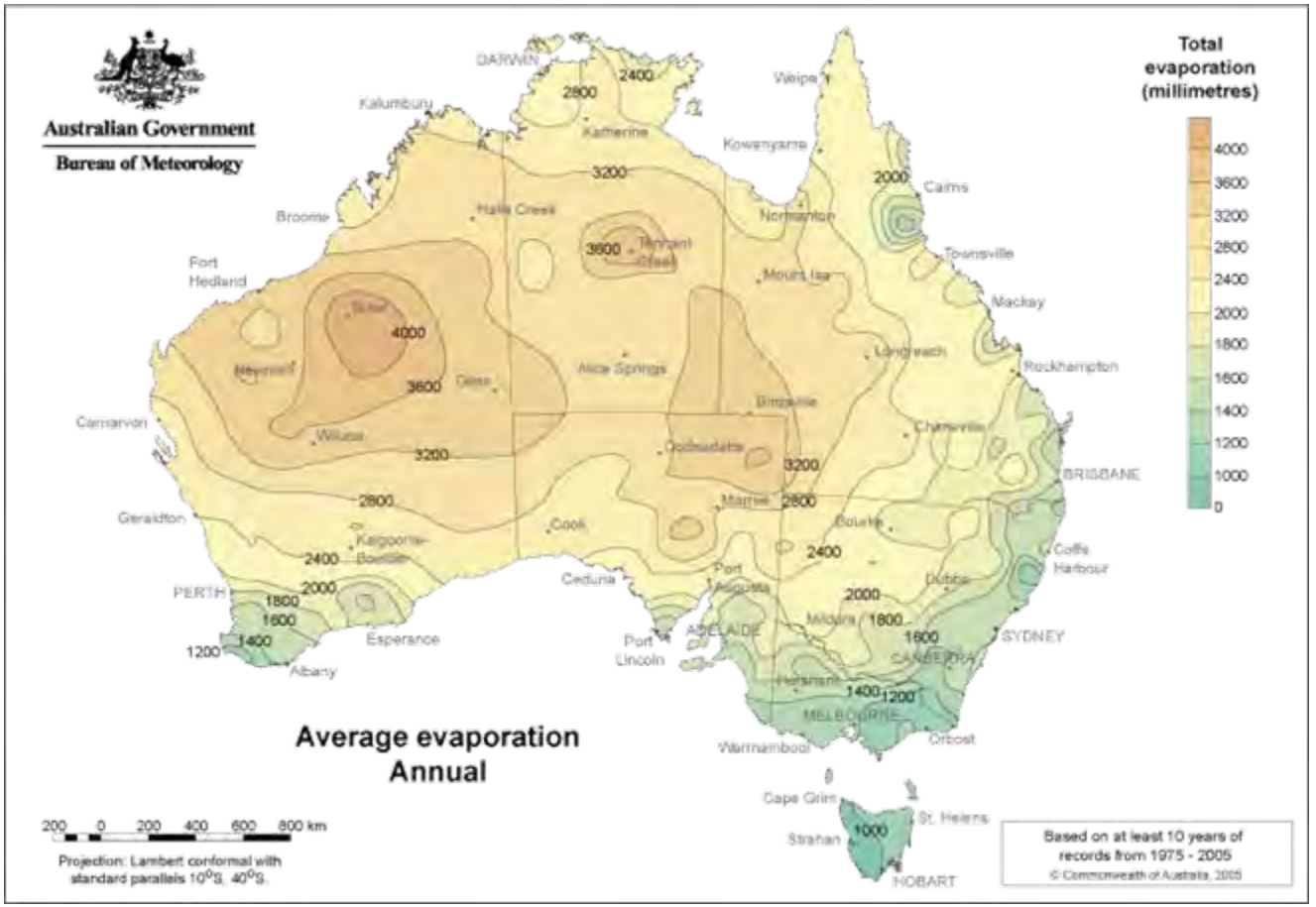
- Evaporating water
  730 kWhr/kl (80) ($146.00/kl)
- Heating 15→50°C
  41 kWhr/kl ($8.20/kl)

Australian hydrology

Australian hydrology



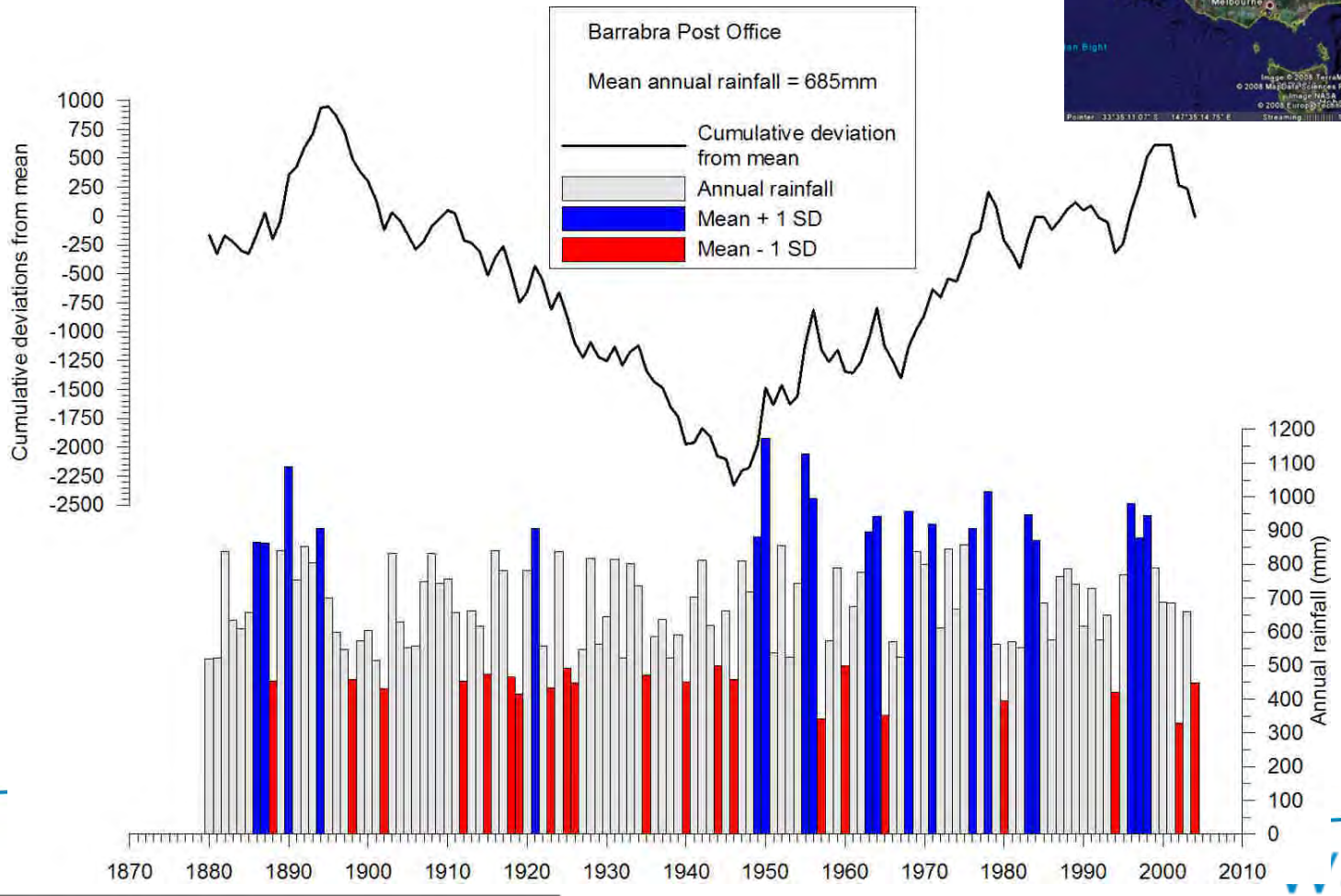
Australian hydrology



Australian hydrology

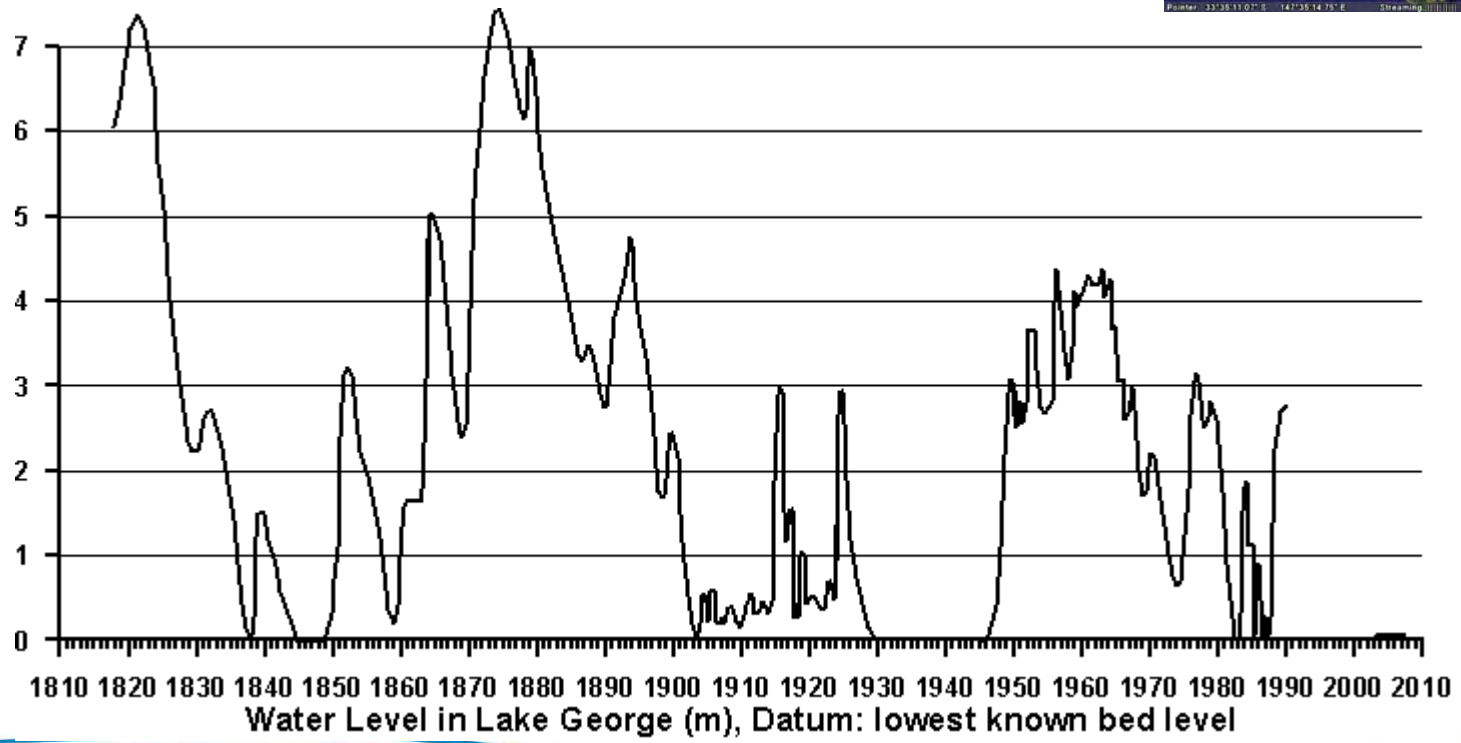
- Australia's development is limited by her water resources.
- In a land of high evaporation and weak seasonal rainfall, how should we manage water?

Climate variability

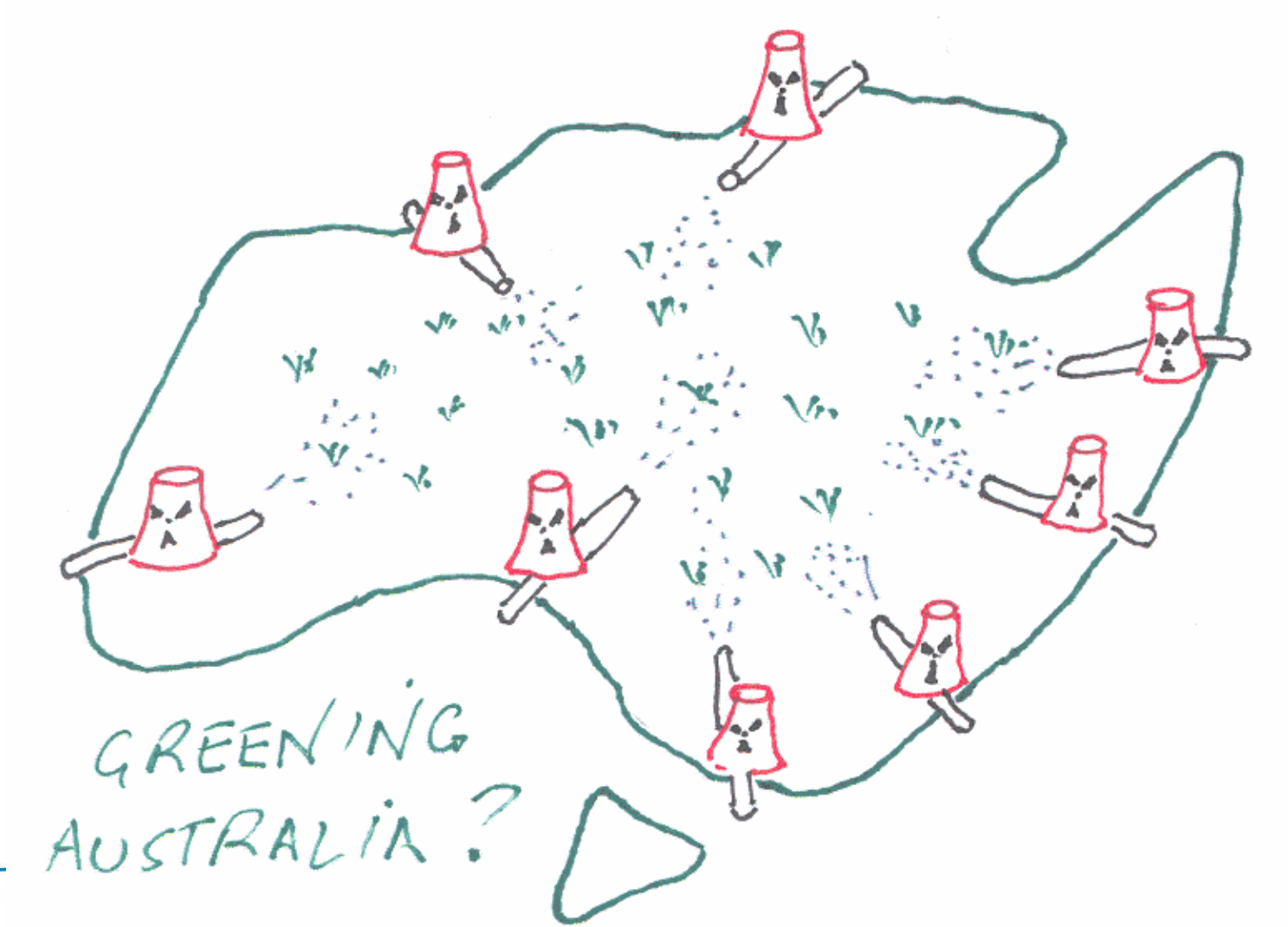


Climate variability

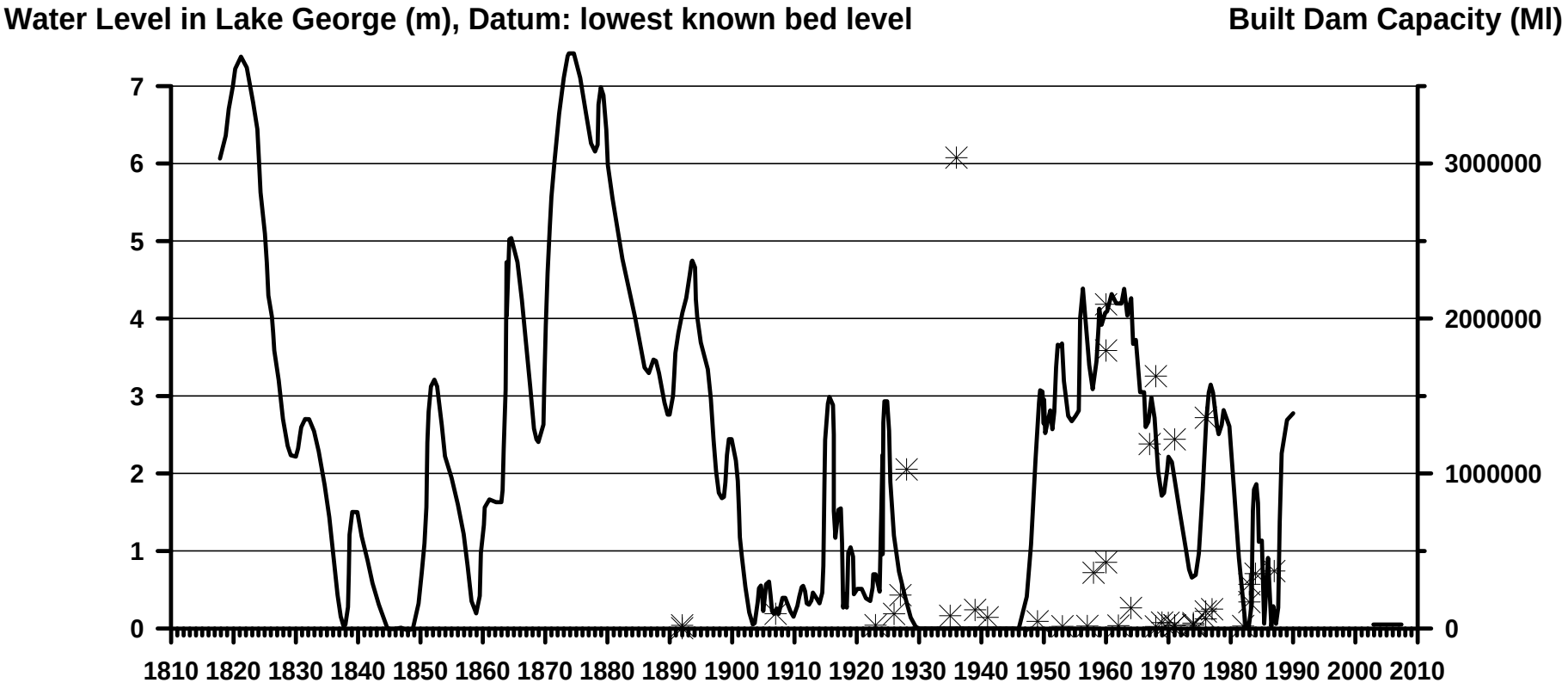
- Lake George



A vision for Australian water?



An historical view



Water supply development in Sydney

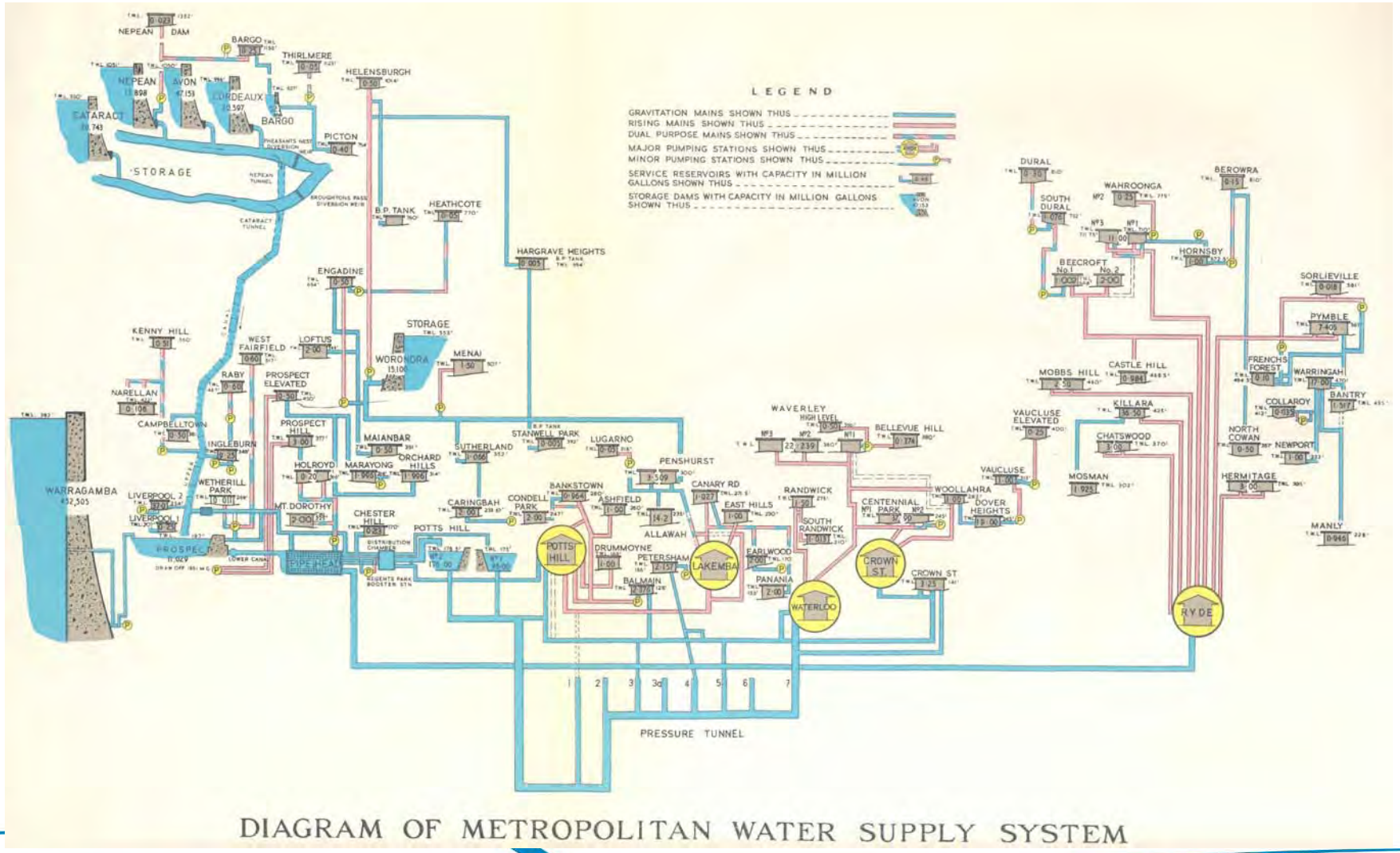


DIAGRAM OF METROPOLITAN WATER SUPPLY SYSTEM

How should we develop Australia's water resources which are critical to present needs and future development?

Strategy 1: Alternative Sources

Strategy 2. System Management

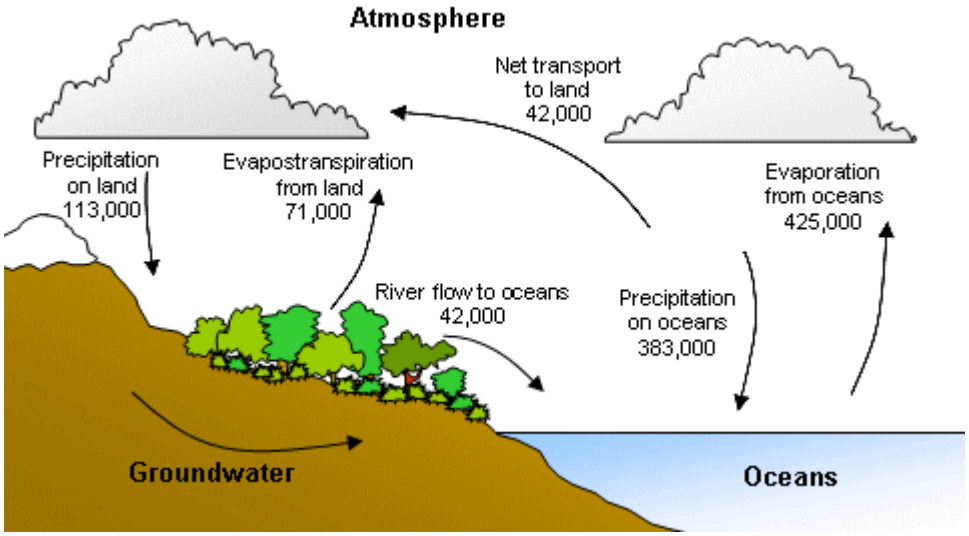
Strategy 1: alternative sources

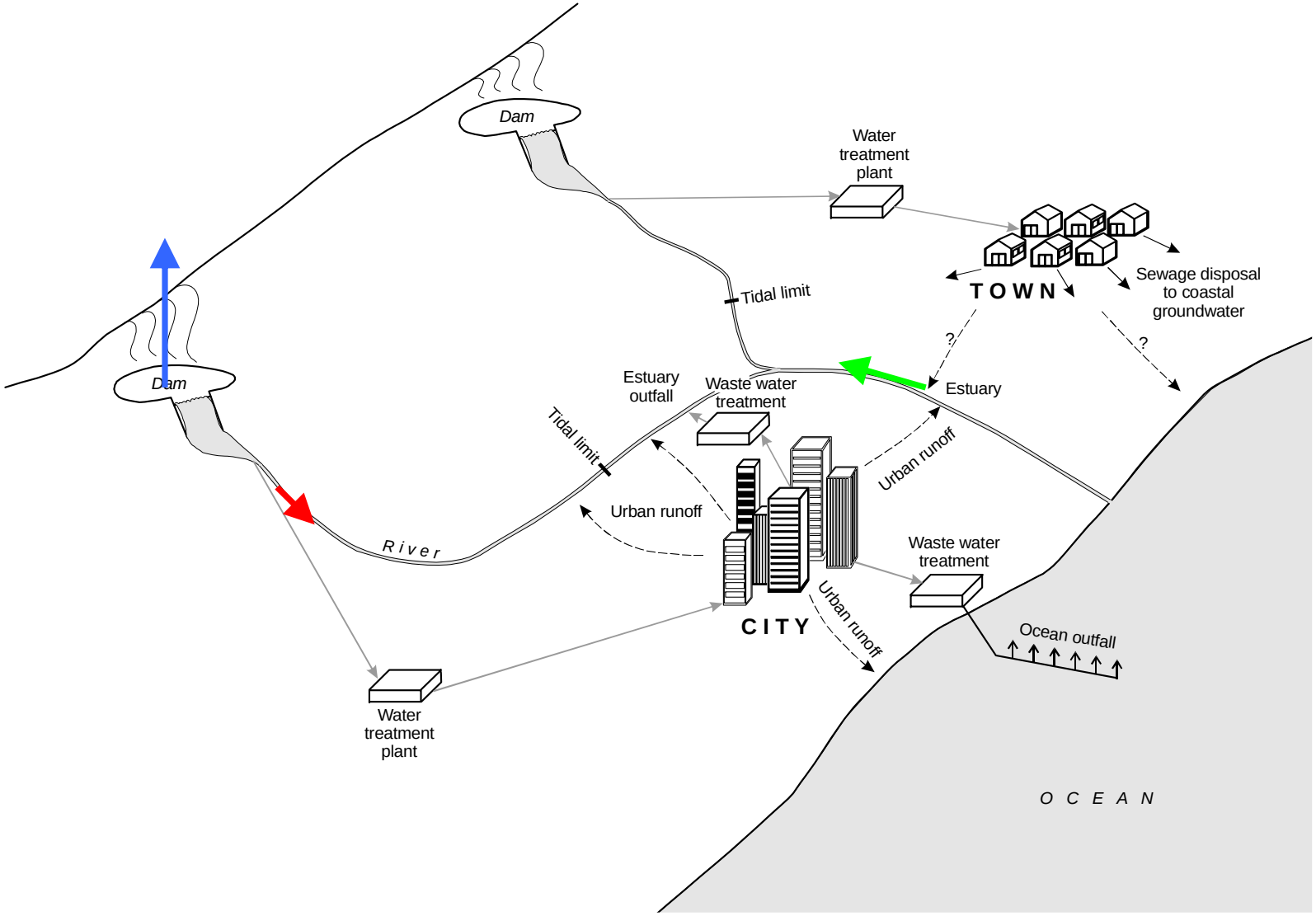
A. Storing pristine runoff
B. Groundwater sources
C. Roof water
D. Urban runoff
E. Treat and reuse
F. Desalinate

Strategy 1: alternative sources
A. Storing pristine runoff

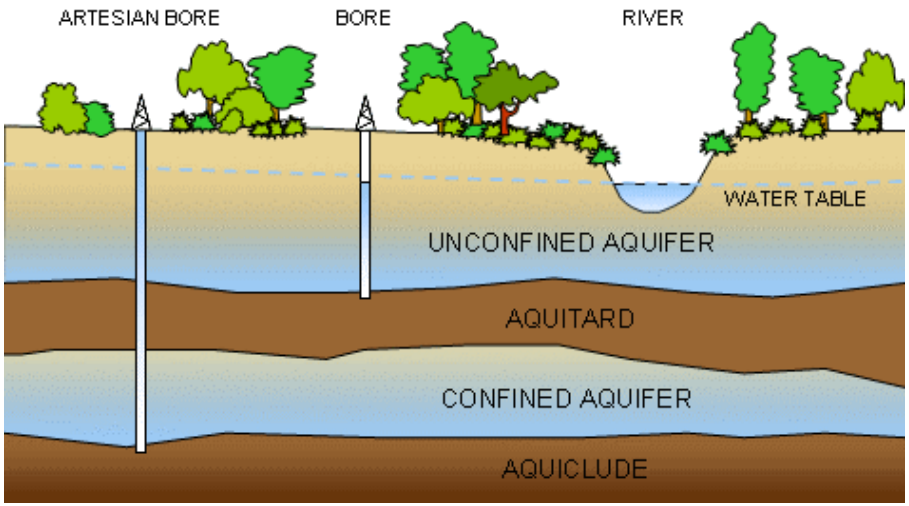
- Purified with enormous amounts of energy at no cost
- Very low treatment energy requirement – 0.015 kWhr/kl
- Lifted

- Evaporation
- Downstream effects




Dam
Water treatment plant
TOWN
Sewage disposal to coastal groundwater
Tidal limit
?
?
Dam
Estuary outfall
Waste water treatment
Estuary
Tidal limit
Urban runoff
Urban runoff
River
Waste water treatment
CITY
Urban runoff
Ocean outfall
Water treatment plant
O C E A N

Strategy 1: alternative sources
B. Groundwater sources



- Recently revisited
- Negligible direct evaporation

- Large aquifer storages required
- Easily contaminated
- Uncertainty in surface water connectivity

Strategy 1: alternative sources
C. Roof water

- Traditional rural approach

- Potential contamination routes
- pH and metal issues
- Dispersed treatment systems are expensive to maintain and difficult to monitor

Strategy 1: alternative sources
D. Urban runoff

- Highly contaminated
- Difficult to store

Strategy 1: alternative sources
E. Treat and reuse

- Steady supply

- High energy consumption 1kWhr/kl to achieve drinking water quality
- Community acceptance
- Cross-connection risk

Strategy 1: alternative sources
F. Desalinate

- Limitless supply
- Proximity

- Very high energy consumption 4kWhr/kl
- Brine and hyperconcentrate marine impacts

Strategy 2. System Management

A. Appropriate sources/ treatment
B. Catchment-wide water budgets
C. A clear perspective on energy consumption
D. A clear perspective on total implementation cost
E. Crisis management

Strategy 2: System Management
A. Appropriate source/treatment

- Household uses require different levels of water treatment: drinking, washing, gardening, waste removal
- Industrial requirements very different
- Recent paradigm: treat all water to drinking water standard
- The water man – focussed delivery
- Industrial recycling trivial

Perrier's 5-gal handled bottle gives consumers a better grip.

Strategy 2: System Management
B. Catchment-wide water budgets

- Catchments have a variety of water sources:
  - Runoff
  - Groundwater
  - Wastewater
- Coupling between systems presently poorly understood – potential cross-contamination
  - Coastal aquifer disposal
- Potential different uses for different sources
  - Country water use

Strategy 2: System Management
C. Energy consumption

Process	Best consumption Requirement (kWhr/kl)
Transport 10km	0.030
Treatment plant flow	0.007
Sand filtration	0.007
Aeration	0.014
Potable reuse	1.000
Desalination	4.000

water treatment

waste water treatment

⇩

The European problem

Strategy 2: System Management
C. Energy consumption

500 Ml/day (5.8kl/s) supply	Requirement
potable reuse ~30% of Sydney	21MW
No. of 600kW wind turbines	35 (at full power)
Area of solar panels req'd	240 footy fields
Discharge to Western NSW	73MW
Import from Cairns (2730km)	230MW
Desalination	100MW
Bayswater or Eraring PS	2640MW

Strategy 2: System Management
D. Total implementation cost

1. We move to full engineering feasibility investigation.
2. Operating energy consumption is part of the story.
3. Retrofitting existing infrastructure is complex

e.g. desalination v. reuse in Sydney – costs similar

Strategy 2: System Management
E. Crisis management

- Australia is a land of floods and droughts
  - Low cost (energy) supply during relatively wet conditions
  - Emergency water supplies: a sequence of management options of increasing cost as drought deepens.


•Unique hydrology
•Evaporation minimisation
•Appropriate sourcing
•Basix – a great piece of policy in NSW
•Reuse w/ a keen eye on energy consumption
•Judicious use of present membrane technologies
•long term optimised return
•Celebration of success?
•High energy solutions
•Australia is a wealthy country
• financial returns on higher turnover – better short term opportunity
•Sustainable in medium term?