Urban Water Supply
In An Energy Constrained Australia

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With due acknowledgement to Ian Acworth, Anna Blacka, Bruce Cathers, Stuart Khan, Brett Miller, Greg Peters, Aleksandra Rancic, Monika Stieler and Richard Stuetz.
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.
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
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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

Barrabara Post Office
Mean annual rainfall = 685mm
Cumulative deviation from mean
- Annual rainfall
- Mean + 1 SD
- Mean - 1 SD

UNSW - School of Civil and Environmental Engineering
Water Research Laboratory
Climate variability

- Lake George
A vision for Australian water?
An historical view

Water Level in Lake George (m), Datum: lowest known bed level  
Built Dam Capacity (MI)
Water supply development in Sydney
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

Winter et al. 1998
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
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

<table>
<thead>
<tr>
<th>Process</th>
<th>Best consumption Requirement (kWhr/kl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport 10km</td>
<td>0.030</td>
</tr>
<tr>
<td>Treatment plant flow</td>
<td>0.007</td>
</tr>
<tr>
<td>Sand filtration</td>
<td>0.007</td>
</tr>
<tr>
<td>Aeration</td>
<td>0.014</td>
</tr>
<tr>
<td>Potable reuse</td>
<td>1.000</td>
</tr>
<tr>
<td>Desalination</td>
<td>4.000</td>
</tr>
</tbody>
</table>

*The European problem*
### Strategy 2: System Management

#### C. Energy consumption

<table>
<thead>
<tr>
<th>Description</th>
<th>Requirement</th>
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</thead>
<tbody>
<tr>
<td>500 Ml/day (5.8kl/s) supply</td>
<td></td>
</tr>
<tr>
<td>Potable reuse ~30% of Sydney</td>
<td>21MW</td>
</tr>
<tr>
<td>No. of 600kW wind turbines</td>
<td>35 (at full power)</td>
</tr>
<tr>
<td>Area of solar panels req’d</td>
<td>240 footy fields</td>
</tr>
<tr>
<td>Discharge to Western NSW</td>
<td>73MW</td>
</tr>
<tr>
<td>Import from Cairns (2730km)</td>
<td>230MW</td>
</tr>
<tr>
<td>Desalination</td>
<td>100MW</td>
</tr>
<tr>
<td>Bayswater or Eraring PS</td>
<td>2640MW</td>
</tr>
</tbody>
</table>
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.
• High energy solutions
• Australia is a wealthy country
• Financial returns on higher turnover – better short term opportunity
• Sustainable in medium term?

• 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?