Tunneling for Desalination Projects in Australia

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Service Line Leader - Tunneling
Impact of Drying Climate – Dam Inflows

Notes:  
- A year is taken as May to April  
- 2005/06 inflow to 1st November 2006
The Desalination Process

Reverse Osmosis

Key components of SWRO:
- Inlet and outlet
- Pre-treatment
- Reverse Osmosis
- Post-treatment
- Water storage
- Water transfer
- Power supply

Fresh Water

Saline Water
Australian Desalination Projects with Tunnels

- **Gold Coast Plant (Tugun, 2008)**
  - 135 MLD capacity

- **Sydney Plant (Kurnell, 2010)**
  - 250 MLD capacity

- **Victorian Plant (Wonthaggi, 2012)**
  - 410 MLD capacity

- **Adelaide Plant (Pt Stanvac, 2011)**
  - 300 MLD capacity

- **Perth 2 Plant (Binningup, 2011)**
  - 150 MLD capacity
### Australian Projects

<table>
<thead>
<tr>
<th>Plant</th>
<th>Capacity</th>
<th>Year of Commission</th>
<th>Year of Commission</th>
<th>Total Capital Cost (AUD$)</th>
<th>Intake/Outlet Diameter (m)</th>
<th>Intake/Outlet Length (m)</th>
<th>No. of Intake/Outlet Risers</th>
<th>Vertical Alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold Coast (Tugun)</td>
<td>135 ML/day</td>
<td>2008</td>
<td>$943 Million</td>
<td>2.8 m/2.8 m</td>
<td>2.2 km/2.0 km</td>
<td>1/1</td>
<td>Incline</td>
<td></td>
</tr>
<tr>
<td>Sydney (Kurnell)</td>
<td>250 ML/day</td>
<td>2010</td>
<td>$1,443 Million</td>
<td>3.4 m/3.4 m</td>
<td>2.5 km/2.5 km</td>
<td>4/2</td>
<td>Decline</td>
<td></td>
</tr>
<tr>
<td>Melbourne (Wonthaggi)</td>
<td>410 ML/day</td>
<td>2012</td>
<td>$2,870 Million</td>
<td>4 m/4 m</td>
<td>1.2 km/1.5 km</td>
<td>2/2</td>
<td>Decline</td>
<td></td>
</tr>
<tr>
<td>Adelaide (Point Stanvac)</td>
<td>300 ML/day</td>
<td>2011</td>
<td>$1,500 Million</td>
<td>2.8 m/2.8 m</td>
<td>1.5 km/1.2 km</td>
<td>1/6</td>
<td>Decline</td>
<td></td>
</tr>
<tr>
<td>Perth 2 (Binningup)</td>
<td>150 ML/day</td>
<td>2011</td>
<td>$738 Million</td>
<td>2.4 m/2.0 m intake tunnels</td>
<td>0.9 km/0.9 km</td>
<td>2/1</td>
<td>Decline</td>
<td></td>
</tr>
</tbody>
</table>
GHD and Desalination Tunnels

1. Gold Coast – Owner’s Engineer for design and construction phase

2. Sydney – Prepared reference design, carried out majority of geotechnical investigations, client’s technical advisor for design and construction phase and prepared all technical tender documents.

3. Adelaide – Owner’s Engineer and prepared Environmental Impact Statement

4. Perth 2 – Alliance team member for Plant Engineering

5. Melbourne – Prepared environmental effects study, obtained approvals, reference design, Owner’s Engineer for design and construction phase.
## Tunneling Method

<table>
<thead>
<tr>
<th>Plant</th>
<th>TBM Type</th>
<th>Lining Type</th>
<th>Intake/Outlet Diameter (m)</th>
<th>Lining Thickness</th>
<th>External Water Pressure (bar)</th>
<th>No. of Segments</th>
<th>Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold Coast (Tugun)</td>
<td>Herrenknecht slurry shield</td>
<td>Precast segments</td>
<td>2.8 m/2.8 m</td>
<td>200 mm</td>
<td>5.7</td>
<td>6 (trapezoidal)</td>
<td>35 kg/m$^3$ (fibres)</td>
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<tr>
<td>Sydney (Kurnell)</td>
<td>Herrenknecht double shield</td>
<td>Precast segments</td>
<td>3.4 m/3.4 m</td>
<td>225 mm</td>
<td>5.0</td>
<td>6 (trapezoidal)</td>
<td>35 kg/m$^3$ (fibres)</td>
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<tr>
<td>Melbourne (Wonthaggi)</td>
<td>Herrenknecht slurry shield</td>
<td>Precast segments</td>
<td>4 m/4 m</td>
<td>230 mm</td>
<td>4.2</td>
<td>4 (parallelogram) 2 (trapezoidal)</td>
<td>35 kg/m$^3$ (fibres)</td>
</tr>
<tr>
<td>Adelaide (Point Stanvac)</td>
<td>Herrenknecht slurry shield</td>
<td>Precast segments</td>
<td>2.8 m/2.8 m</td>
<td>200 mm</td>
<td>5.5</td>
<td>6 (trapezoidal)</td>
<td>35 kg/m$^3$ (fibres)</td>
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<td>Perth 2 (Binningup)</td>
<td>Herrenknecht slurry pipejack (AVN)</td>
<td>Pipe jacking</td>
<td>2.4 m/2.0 m (2 intakes)</td>
<td>NA</td>
<td>3.0</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Project</td>
<td>Number of offshore Boreholes</td>
<td>Offshore Geophysics</td>
<td>Other Investigations</td>
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<tr>
<td>Gold Coast (Tugun)</td>
<td>8</td>
<td>Seismic reflection</td>
<td>Bathymetric profiling</td>
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<tr>
<td>Sydney (Kurnell)</td>
<td>0</td>
<td>Magnetic survey, electrical resistivity</td>
<td>12 on shore CPTs, bathymetric profiling</td>
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<tr>
<td>Melbourne (Wonthaggi)</td>
<td>3</td>
<td>Seismic refraction, gravity survey, magnetic survey</td>
<td>2 exploratory HDD holes, bathymetric profiling</td>
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<tr>
<td>Adelaide (Point Stanvac)</td>
<td>2</td>
<td>Seismic reflection and refraction</td>
<td>Bathymetric profiling</td>
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<tr>
<td>Perth 2 (Binningup)</td>
<td>5</td>
<td>unknown</td>
<td>Bathymetric profiling</td>
<td></td>
<td></td>
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</tbody>
</table>
Gold Coast Desalination Plant

Twin 3.4 m OD intake/outfall tunnels
2.4 km & 2.1 km sized for 170 ML/d
Gold Coast Desalination Plant

Diagram not to scale. All figures approximate.
Gold Coast Desalination Plant

- TBMs (75 m /week)
  - inlet
  - outlet
Gold Coast Desalination Plant
Victorian Desalination Project

Source: Aquasure
Victorian Plant - Cored HDD Holes
Victorian Plant - Riser Connections

Jack up Barge - 55 x 32 metres
Sydney Desalination Plant
Sydney Desalination Plant
Sydney Plant – Riser Options

Off-line Connection

In-line Connection
Sydney Plant - Riser Construction
Adelaide Desalination Plant
Adelaide Desalination Plant

The jack-up barge:

- weighs 2400 tonnes with cranes;
- has four legs, each 45 metres long;
- measures about 30 x 35 metres;
- includes a helipad so workers can be flown in and out at each shift;
- has GPS technology on board to ensure each anchored location is exact;
- once jacked into place, can maintain approximately 6 metres air space between the platform and the ocean.
Adelaide Desalination Plant

2.4 km of bored tunnel in 40 weeks

DN900 outlet riser, 20 m long. Manufactured from glass fibre reinforced plastic (GRP).
Perth 2 Desalination Plant

Innovative Construction:

• dual mode pipe jacking TBM for variable geotechnical conditions;
• orbital welder which provided a 360° HDPE weld around the pipe joints that provides protection against marine growth;
• Project specific jacking pipe design to achieve 100 year design life;
• Wet recovery of TBM and relaunch.
Perth 2 Desalination Plant