



2011 Australian Construction  
Achievement Award Submission

# Sydney Desalination Plant

John Holland and Veolia Water





2011 Australian Construction Achievement Award Submission

# Sydney Desalination Plant

John Holland and Veolia Water

1. Executive Summary	1
2. Introduction	7
3. Scope and Contract	11
4. Outcomes achieved against planned targets	17
5. Complexity, difficulty and optimisation of the construction task	21
6. Leadership and Management of Project Delivery	31
7. Key People	41
8. Letters of support	46



## 1. Executive Summary

The \$1.1B Sydney Desalination Plant, the largest desalination plant in Australia and the second largest in the world, was delivered on time and under budget with “an outstanding safety performance”. The plant, capable of delivering 250ML/d, reduces Sydney’s dependence on rainfall for its water supply and creates a durable legacy for the people of Sydney.

This world class facility marks a new high point for the Australian construction industry as the Joint Venture (John Holland and Veolia Water) delivered a highly specialised, complex process facility satisfying the terms of a fast-track Fixed Term, Lump Sum D&C contract, without major disputes or incidents throughout the project.

Despite numerous unique challenges, which were a feature of the complex tunnelling, marine and construction works, an integrated team consisting of the D&C Contractor (the Joint Venture of John Holland and Veolia Water), the Design JV (SKM and AECOM), the Operator (Veolia Water) and, significantly, the Client (Sydney Water) worked collaboratively to enable the Project to be delivered on time.

A Disputes Resolution Board (DRB) was established to provide recommendations to assist the parties to the D&C Contract resolve disputes arising out of Claims. As testimony to the success of this contract, no matter was ever referred to the DRB. (Refer to the DRB Chairman’s letter on page 46).



An integrated team worked collaboratively to enable the project to be delivered on time.



## Major Project Challenge – Time

The dominant challenge on this fast-track Project was the short timeframe. The need to deliver a fully operational process plant by the summer of 2009-2010 drove every aspect of the Project, impacting not only the development of particular solutions but also the very way the Joint Venture (JV) set about the Project.

## Major Project Solution – The Way the Joint Venture Collaborated

Assumption of risk was characteristic of the JV's activities throughout this Project. Under the DBOM tender, the JV had to assume total responsibility for all aspects of design, construction, commissioning and validation of the plant and to warrant, jointly with the Operator, that 'the Plant will be Fit for Purpose'.

Even before contract award, the JV took the risk of investing in specialised equipment including tunnel boring machines and a self-elevating platform (SEP) for marine drilling, to be able to commence at the earliest possible time.

For the tender stage, a fully integrated Project team (260 personnel) was created, operating out of a single office, to address major issues including design of a deliverable and cost-effective Project, as well as the planning of construction and commissioning activities.

The entire bid team including designers was seamlessly moved to Kurnell, enabling decisions to be made efficiently and in a way that ensured the participation of all parties.

The JV recognised the 'process' rather than 'turnkey' nature of the Project. Only intensive and extensive face-to-face participation could provide the level of input capable of achieving a satisfactory outcome, given both the testing timeframe and the extremely challenging construction conditions that would be encountered. The enduring benefits created via this approach included:

- Joint engagement by relevant specialists in multidisciplinary and time saving problem solving, no matter what the issue: design, procurement, construction, commissioning or handover
- Joint development of an agreed means to streamline contractually-specified processes of review and approval that otherwise might have delayed the Project
- Rapid development by the integrated team of time-saving solutions to significant design and construction issues.

## Chronology of Major Challenges and Solutions Tender & Design

Integration and collaboration were emphasised from the outset through:

- Early establishment of an integrated team to develop design innovations
- Early commitment to co-location on-site of the entire JV team and seamless transition to Kurnell
- Early procurement of long lead time items and early engagement of construction planners to interface with operation and commissioning personnel.

Major time and cost saving solutions were:

- Vertical and horizontal realignment of the tunnels, and use of a box cut to provide access to the tunnels instead of shafts, which made for safer and much faster tunnel construction and for a more efficient seawater pump station design
- Reconfiguring the plant layout with major improvements to the 125ML/d Blueprint design proposal - to allow the future expansion to 500ML/d without any impact on the operation of the first stage
- Negotiating a lease at Port Botany for the marine base, heavy lift load out wharf and riser precast yard.

## Offshore Marine Works

The offshore marine works were subject to numerous challenges:

- Working in the surf zone 300m off the cliff face at Cape Solander, in a marine National Park, imposed severe constraints on divers constructing foundations on the seabed, the floating equipment transferring and lowering the 64 to 74 tonne concrete riser heads, and the riser drilling activities
- No “sea state” or historical wave data was available for the work areas, which were subject to turbulent ‘washing machine’ conditions caused by high coastal currents and the reflection and refraction of waves off the rocky cliffs. Water depths varied from 25 to 28 metres
- No wharf access or landing access was possible in the Kurnell area. It was necessary to lease land at Port Botany adjacent to the tank farm at the rear of the revetment
- No geological information was available for the seabed construction or the riser drilling
- The seabed in the riser works areas consisted of large rock boulders overlaying broken sandstone ledges and open crevices. There was no sand overlay in which to drive a drilling casing, which was the case for the Gold Coast Desalination Plant
- A SEP, jack-up barge, capable of operating in the surf zone was not available in Australia.

These challenges were assessed by a combination of designers and constructors and agreed actions included:

- A reduction in the number of risers, based on extensive theoretical research and university modelling, saving time and reducing risk
- Providing two fully equipped dive barges to increase available dive time on the seabed
- The Seafox 6 SEP was chartered and refurbished in Singapore before being towed to Newcastle at an average tow speed of 4 knots. The drilling and screening equipment assembled on board the SEP was designed, manufactured and assembled by the JV team in Newcastle, before transfer to Sydney
- Refitting of the SEP to provide safe personnel access to the multiple work platforms, accommodating the reverse circulation drilling equipment, screening tanks, a 280t crawler crane and 12 x 1250 cfm diesel compressors
- Procuring the largest salvage sea anchors available in the Southern Hemisphere to hold both the work barges and the SEP in position
- Constructing working platforms at each riser location on the seabed by grouting within large grout-filled fabric socks
- Designing the riser structures to fix the drill casing in position on the seabed; structures were anchored to the seabed by the divers using an underwater track mounted hydraulic drill
- Separating drilling cuttings in the screening process on board the SEP to be barged to the Port Botany marine base for disposal as clean landfill
- Providing tug and helicopter support to transfer material and personnel from Port Botany to the SEP and barges operating off Cape Solander
- Establishing a precast yard at the marine base to cast the riser structures
- Designing and constructing a heavy lift wharf to load out the riser structures and GRP liners.

## Tunnelling to the open sea

For many other desalination plants around the world, intake and outlet conduits are pipelines installed in open trenches to the sea. On this Project, two 2.5km tunnels were driven through rock strata with virtually no geotechnical information available.

Challenges included:

- Potential for high water inflows into tunnels through fault zones and from a perched water table. Fault lines were evident on the coastal cliff face
- Potential for methane gas flows into tunnels from shale seams.

A number of measures successfully overcame these challenges:

- Use of a fully concrete lined tunnel (segmental lining)
- Boring the intake and outlet tunnels on the same alignment from the common portal in the box cut for over half the tunnel lengths. This parallel alignment and staging the tunnel boring provided knowledge of ground conditions from the first (outlet) tunnel that would likely be encountered in the second (inlet) tunnel
- The outlet tunnel was swung away from the initial common alignment to cross a potential fault line at 90 degrees. This fault line was projected from a crushed zone exposed on the coastal cliff face. The outlet tunnel was then progressively swung back to finish under the Approved outlet riser works area – outlet and intake riser areas are 600 metres apart along the coastal alignment
- Use of forward probe drilling in areas where dykes or joint swarms were considered likely to exist (based on observed surface features)
- Use of forward probe drilling from 300 metres inland from the coast to the end of the tunnels, 300 metres out under the Tasman Sea
- Making suitable provisions for grouting ahead of the TBMs, should significant water ingress be encountered
- Ensuring adequate physical separation of open riser shafts and unlined tunnel sections to prevent inundation of the driven tunnels. A Permit to Work procedure was established between the marine and tunnel teams, as riser locations were offset 4-6 metres from the tunnels
- Reassessing the risk of encountering methane by reviewing the geology exposed by the tunnel excavation.

## Plant Construction at Kurnell site

Challenges and solutions included:

- Poorly compacted sands to a depth of 20 metres with significant fluctuations in the water table required the use of 3852 CFA piles
- A high level rock work platform was constructed to maximise the number of piling rigs that could be accommodated on site
- Piling progressed from east to west to allow the major RO building and filtration blocks to commence at the earliest possible dates.
- With the need to commence all major structures concurrently it was necessary to prepare detailed crane lift and traffic management plans
- Dewatering of excavations had to be balanced to the capacity of the on-site storage and settling ponds as chemical treatment had to be limited to prevent adverse impacts on the adjacent Conservation Area and National Parks.

## Detailed design phase

A streamlined, time-saving review and approvals process, focussed on major design packages, was agreed. The process involved workshops attended by design, construction, operations and commissioning personnel to discuss packages in an open question and answer session with formal presentations made by the design team.

## Procurement

Tight time constraints meant that plant and equipment from long lead items (TBMs; SEP) to valves and exotic high quality materials (GRP piping; super duplex stainless steel pipe, pipe fittings and valves required to address the aggressive desalination environment) needed to be ordered from 17 countries around the world, often using preliminary designs.

Storing and tracking the large volume and variety of equipment and materials was achieved by establishing four warehouses and deploying an advanced tracking system in which every item was individually barcoded.

## Construction Management

The major challenge was to manage three Project sites safely and efficiently given fast-track construction and site congestion caused by multiple work interfaces.

Solutions included:

- Development of the innovative 'Lead the Way program' which inducted more than 230 subcontractors in a safety leadership program led by senior Project and Client management
- Unique involvement of senior Project and Client management in unscheduled 'safety walks' with workforce representatives
- Establishment of a Project specific Permit to Work system to address the permutations of electro-mechanical-hydraulic isolations – particularly important with commissioning commencing prior to completion of construction
- Establishment and maintenance of a good working relationship with Union Organisers
- Daily meetings of senior managers to ensure appropriate work sequencing.

A TRIFR of 15.8 was achieved for 5 million man-hours and a peak workforce of 1300. This is significant given the scale of the Project and the fact that key areas of risk included specialist marine diving and drilling, bulk earthworks, tunnelling, mechanical and electrical installations as well as commissioning works.

Stakeholder satisfaction was an important aspect of construction management. The JV delivered a \$1.1B Project, involving at peak some 1300 workers, in the middle of the Kurnell community, without attracting adverse press coverage.

Direct engagement by JV staff with the local Kurnell community and Sutherland Shire community, school, business and sporting groups resulted in positive interaction with sensitive stakeholders. An Out of School Hours facility was provided at the Kurnell Public School.

Environmental concerns included monitoring the well-being of a flying fox colony in the 15ha Conservation Area located on the 45ha site area. No adverse impacts were recorded during construction.

## Commissioning

To achieve the timeframe, the Operator was involved in all Project stages and was embedded in the commissioning team.

Importantly, the plant was commissioned in stages to enable expansion while still achieving operational targets.

## Handover

The Operator worked with the commissioning team to resolve issues, from a practical point of view, throughout the Project. At Project Completion, a seamless transition took place from the D&C phase to the O&M phase.

A world class desalination plant has been delivered on time and to budget. The challenge was to meet Sydney Water's requirements and the JV's budget goals whilst maintaining the highest standards of safety, environment and community considerations. This was accomplished.

"Sydney Water's Chairman, Tom Parry and Managing Director, Kerry Schott are both on record with their thanks and appreciation for a job well done." (Mike Watts, Company's Representative, Sydney's Desalination Project). See letter page 49.

## International Recognition

The Sydney Desalination Plant is one of four international projects short-listed for the Global Water Awards for 'Best Desalination Plant of The Year' - for plants commissioned in 2010. The winner is to be announced at a function in Berlin, Germany in April 2011.



## 2. Introduction

The world-class Sydney Desalination Plant represents a new high point for Australian constructors.

The delivery by the Joint Venture (JV) of a highly complex, fully operational \$1.1 billion process plant was a major D&C success as this was accomplished:

- Within the constraints imposed by a DBOM fast-track, Fixed Price Lump Sum contract
- Under budget
- On time
- Despite unique environmental and technical challenges posed by the plant's location
- With no major disputes
- To the satisfaction of the Client, Sydney Water.

Firstly, the assumption of risk marked the JV's activities throughout the Project. According to the terms of the contract, the JV partners were required to assume total responsibility for all aspects of design, construction, commissioning and validation of the plant and jointly with the Operator, Veolia Water Australia, to warrant that 'the Plant will be Fit for Purpose'.

Additionally, during the pre-tender period before the contract was awarded, the JV took the risk of ordering expensive and specialised long lead time items: tunnel boring machines (TBMs); and the self-elevating platform (SEP).



Reverse Osmosis Skids

Again in this period, the JV invested in creating an integrated design team that continued design innovation to achieve a deliverable and cost-effective Project. The team produced an innovative and time-saving design - involving co-location of the two tunnels and the use of a box cut instead of shafts to facilitate access by the tunnel boring machines, improving the seawater pump station design and providing easy access for the Operator.

Secondly, genuinely collaborative working relationships and problem-solving were achieved on the Project, notwithstanding the DBOM contractual context.

From the outset, project management worked to create a united team, involving the D&C Contractor, the Operator and, uniquely, the Client. The focus was on the Project rather than on the contract.

The JV recognised the ‘process’ nature of this Project. Because it was not a ‘turnkey’ project, JV management felt that only intensive and extensive face-to-face participation could provide the requisite level of input and focus that could effectively meet the Project’s challenges which were:

- The very short timeframe, and;
- The highly challenging marine and tunnelling construction conditions.

JV management took the risk of co-locating the entire team – designers, construction engineers, commissioning personnel together with the operating team – on site at Kurnell.

A major immediate benefit was the joint development by the D&C Contractor, the Operator and the Client, of an agreed means to streamline contractually-specified processes of review and approval that otherwise might have delayed the Project. Several formal approval sign-off steps were replaced by open discussion and negotiation.

Other major benefits were:

- Joint engagement by relevant specialists in multidisciplinary and time-saving problem solving, no matter what the issue – design, procurement, construction, commissioning or handover
- Rapid development by the integrated team of time-saving solutions to significant design and construction issues (see below).

The third area of achievement involved overcoming the unique challenges inherent in the Project: challenges imposed by the physical location of the plant, by the Client’s deadline for delivery of drinking water into Sydney Water’s distribution network by the ‘Summer of 2009-10’, and by the terms of the DBOM contract. These are discussed in depth elsewhere, but a brief summary is useful here to establish the context:

- Marine works were to be constructed in two areas nominated by Sydney Water, which were 600 metres apart, within the surf zone, 300m off the cliff face at Cape Solander, in a marine national park. Strong currents combined with reflection and refraction of waves off the cliffs produced ‘washing machine’ conditions. No geotechnical information or “sea state” and historical wave data was available
- Extreme weather conditions frequently adversely impacted these marine operations.
- Connection of the riser shafts to the tunnels was a demanding and tedious task involving special probing and excavation equipment
- Outlet and inlet tunnels were to be driven through rock strata about which minimal geotechnical information was available to indicate fault zones either on-shore or under the sea
- An aggressive plant environment was produced by the combination of sea water and high pressure
- Challenges included the necessity to develop procurement and logistics solutions to address early procurement of long lead time equipment and sourcing of specialized corrosion-resistant materials

- Unique environmental challenges included protection of flora and fauna at potential risk in the marine works area, the Conservation Area located on the construction site, and the drainage of the site into Towra Point Wetland reserve (a listed Ramsar wetland).

The fourth achievement is that Project targets were met. These include:

- Supply of water into the Sydney Water distribution network in the Summer of 2009-2010, as publically announced by the State Government and regularly referred to by the Sydney media
- Achievement of a corresponding completion date by which to align the desalination plant to the Water Delivery Alliance (WDA) pipeline
- Construction of more than 30 structures including pre-treatment facilities, sea water Reverse Osmosis building, post-treatment facilities, potabilisation system, switchyards, drinking water tank (40ML capacity), and wastewater treatment area
- Construction of a box cut (for launching of tunnel operations) and subsequent construction of the intake pumping station and screening plant
- Excavation of 2 x 2.5km intake and outlet tunnels, using two Tunnel Boring Machines, (TBMs), for connection with the offshore intake and outlet risers (design capacity 500ML/d)
- Construction and installation of the offshore intake and outlet risers (located approximately 300 metres off-shore) utilising drilling and lifting equipment mounted on a self elevating platform (SEP) and supply, service and support craft including tugs, barges and safety vessels
- Design and construction of buildings and pipework support structures to a design life of 25 years; concrete to 100 years
- Development and use of the industry-leading safety program, 'Lead the Way', that inducted a large workforce and some 314 sub-contractors in safety leadership
- Maintenance of staff levels despite the then (2007) tight market for skilled project staff.

Finally, the lasting legacy of this Project is much more than the delivery of a fully functional piece of critical public infrastructure.

The facility embodies the very best in construction 'smarts', delivered to the Client's high quality standards and tight timeframe, safely and without dispute. The ongoing relationship between the JV and the Client throughout the Project was second to none. This healthy and productive relationship was instrumental in achieving the Project's success and constitutes a model and a fine legacy for the construction industry as a whole.

Legacies of the Project for the construction industry include:

- Successful supply of water into the Sydney Water distribution network in the summer of 2009-2010
- Expansion and upgrade of the knowledge base regarding desalination technology. The desalination industry was relatively new to Australia in 2007 and the industry was not well versed in seawater reverse osmosis technology. The construction of the large and complex Sydney plant has contributed to the growth in knowledge and expertise in this field.

At the outset, the JV seeded its local teams with international experts. Today, because the Project educated a large team of designers, engineers and workers at various trades levels, the total local knowledge base regarding desalination technologies, processes and materials has been increased significantly. Many JV staff have gone on to work at desalination plants currently under construction in other States of Australia, and indeed, around the world.



- The delivery of a fast-track, complex project to exacting standards and involving all construction types and many disciplines has expanded the professional capacities of the industry as a whole as well as those of individual workers. The latter are now capable of working on incrementally larger and even more complex projects in Australia and overseas
- Demonstration by the private construction industry of its capacity for productive partnership with the public sector. No disputes were reported to the Disputes Resolution Board over the life of the Project
- Demonstration of successful design, construction, operation and maintenance of a sophisticated automated facility which runs effectively 'on its own'
- Promotion of engineering as a career. More than 40 major site visits were conducted on the Client's behalf, each with very positive outcomes, including visits by the Premier of NSW, various Ministers and Shadow Ministers, television and print media, and interest groups.

The plant also represents a legacy for the community as a whole. The people of Sydney benefit today and into the future from the creation of a much more robust water supply. The plant is capable of delivering 250ML/d; and there is adequate land to duplicate the plant to provide an output of 500ML/d.

### 3.Scope and Contract

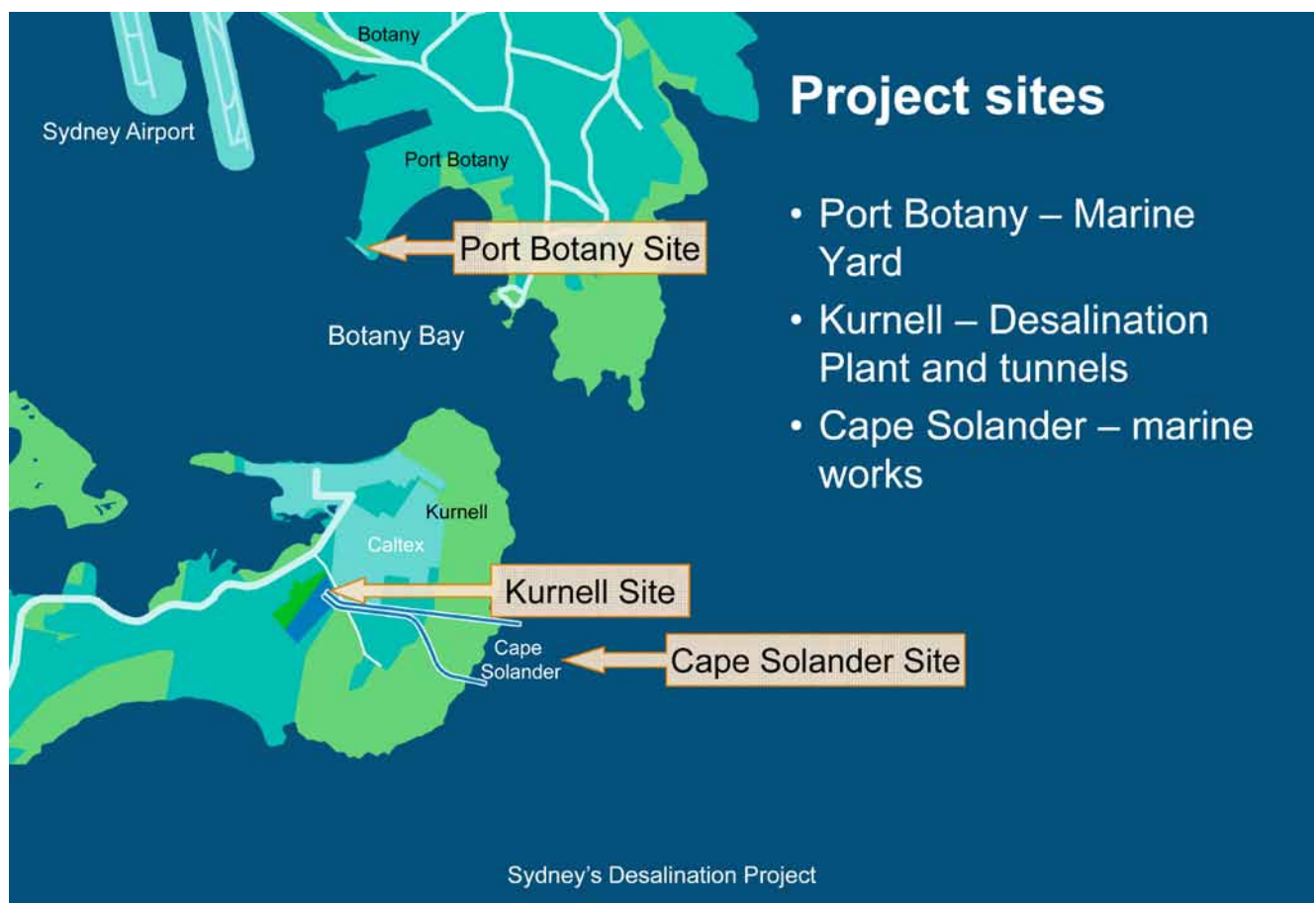
#### Scope

On 25 June 2007, Sydney Water announced that a joint venture of John Holland and Veolia Water Australia had been selected as the preferred tenderer to Design, Build, Operate and Maintain (DBOM) a “State of the Art” 250ML/d Reverse Osmosis Desalination Plant located on the Kurnell Peninsula, on the outskirts of Sydney.

On 18 July 2007 a Design and Construction (D&C) Contract and an Operation and Maintenance (O&M) Contract were executed; the D&C by the JV and the O&M, for 20 years, by Veolia Water Australia (VWA).

The D&C scope of work included designing and building the plant, the 2.5km long intake and outlet tunnels and deep water seabed marine structures 300m off the coast in the Tasman Sea. The tunnels and intake works are designed to allow the plant to be expanded to 500ML/d. The plant, located on a 45 hectare site, a third of which is a dedicated Conservation Area, consists of 32 structures including an intake pump station and screening plant, a pre-treatment plant including chemical dosing, dual media filtration and backwash treatment, seawater reverse osmosis facilities, a post-treatment plant, a waste water treatment and sludge management facility, storm-water retention basins, a 40ML drinking water storage tank, a 132 kV switchyard and sub-stations and an administration and central control building.

The D&C Contract was undertaken for a fixed lump sum price and required delivery by the summer of 2009/2010. The JV achieved this goal without any contractual disputes with Sydney Water.



This complex multi-discipline EPC project consisted of three main construction areas:

### 1. The Desalination Plant – a seawater processing facility

The plant includes seawater pre-screening and pumping, gravity sand filtration, 2-stage reverse osmosis and water remineralisation, as well as thickening and centrifuge dewatering of all waste solids streams. The process complexity and large scale provides significant challenges in integrating the design and construction of the required mechanical and electrical plant, and control system. The reverse osmosis, which forms the heart of the process includes 22 membrane skids modules. The corrosive nature of seawater and the high operating pressures of around 6000 kPa require highly specialised pumping and piping systems and rigorous quality control. The RO system includes 22 high pressure pumps (ranging from 400 to 600 kW) and 12 km of complex super duplex stainless steel pipe work.

The plant was designed to achieve world-standard levels of energy efficiency, with total power consumption guaranteed to be no more than 4.2 kWh/kl.

For the 1st pass RO trains the JV selected Dual Work Exchange Energy Recovery Devices (DWEER), which provide the highest efficiency and the lowest power consumption of all available options, and increased overall plant availability by significantly reducing downtime during maintenance and replacement.

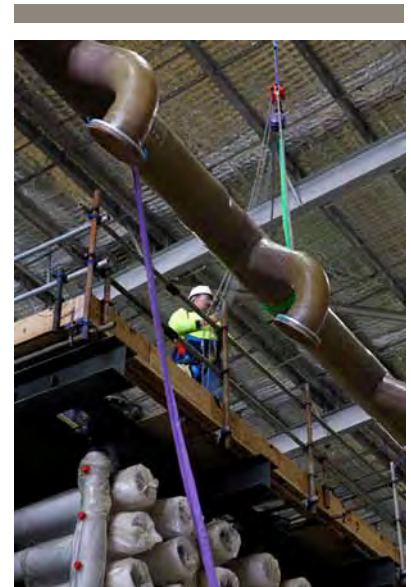
A further energy saving innovation was the removal of the 2nd pass permeate tank, retaining pressure through to the remineralisation mixing tank and avoiding a booster pumping station.

### 2. Tunnels & Connecting Galleries – the intake and outlet conduits to the Tasman Sea

Tunnelling works involved excavation of two 2.5 km long x 4.15m diameter tunnels using two Herrenknecht Tunnel Boring Machines. A segmental concrete lining was erected directly behind the excavation providing a 3.4 m internal finished diameter. Side galleries were designed to connect the tunnels to the riser shafts in the Tasman Sea.

### 3. Marine Works – construction in a coastal surf zone in the Tasman Sea

Marine works consisted of precast concrete construction and offshore installation of four intake and two outlet riser structures, each weighing 64 to 74 tonnes and drilling of 6 riser shafts 2.2 diameter x 23m long from the seabed, connecting to the side galleries constructed from the tunnels.



Manifold being lowered into position in the RO building



The first of the TBM components is lowered into the Box Cut.



Marine drilling at Cape Solander



## The D&C Contract

The D&C Contract was a Project specific document which was developed in numerous, and often lengthy, negotiating sessions held between the JV's in-house legal team supported by legal advisors, and Sydney Water's legal and financial consultants. The contract is similar to those used in PPP infrastructure projects. All D&C risk is taken by the D&C Contractor. Both the D&C and O&M contracts were performance based with penalties for non-performance.

One of the JV's most important initial tasks was to develop a Quality System that was capable of delivering quality through each phase of the Project delivery from design, procurement and construction, to final commissioning and handover. Quality was a primary consideration in all aspects of the Procurement Plan and strategies.

## Technical Information and Data

### Specifications

- 250ML/d plant with allowance for an additional 250ML/d
- Initial and additional plant design to allow for the addition of second stage pre-treatment filtration
- Plant design and construction by the summer of 2009/2010
- Fixed budget of \$1.1B

### Design

- 176 Design Work Packages
- 5,364 drawings
- 9,108 Design Documents (including specification and data sheets)
- Over 20,000 external vendor documents

### Design Life

- 100 year Design Life for tunnels and most concrete structures
- 50 year Design Life for building steelwork and marine structures
- 25 year Design Life for mechanical equipment
- A proving period of two years after completion to identify any process issues

### Earthworks

- 1 million cubic metres moved
- 50,000 cubic metres excavated from the boxcut

### Plant Area

- 45 hectare site, a third of which is dedicated Conservation Area
- 32 structures including pre-treatment facilities, sea water Reverse Osmosis building, post treatment facilities, potabilisation system, a 132kV switchyard, drinking water tank (40ML capacity) and wastewater treatment areas.
- Reverse Osmosis (RO) Building: 250m long x 80m wide
- Filter Buildings: 70m long x 50m wide x 2 No
- Pretreatment Pump Stations: 125m long x 25m wide x 2 No
- Drinking Water Tank: 75m diameter x 10m high
- Foundations: 3,852 CFA piles

## Structures

- Reinforced concrete slabs on ground (designed as suspended slabs)
- Structural steel building frames
- Precast wall cladding where required for acoustic dissipation
- Metal wall and roof cladding in all other locations

## Total Civils (for three work sites)

- 76,000m<sup>3</sup> of concrete
- 13,500 tonnes of reinforcing steel
- 3,000 tonnes of structural steel

## Mechanical equipment

- Pumps: 303
- Valves: 6,500
- Pipe fittings: 10,000
- Instruments: 9,000

## Cable Quantities

- Over 900km of data and electrical cables

## Piping

- 17kms of GRP piping
- 12kms of super duplex stainless steel pipes

## Reverse Osmosis technology

- 36,736 membranes
- 4,700 pressure vessels
- 13 Energy Recovery Devices – one for each 1st pass RO train; each Energy Recovery Device consists of 5 pairs of vessels

## Tunnels

- 2 x 2.5km tunnels
- Excavated diameter : 4.15m
- Internal final diameter: 3.4m
- Total number of segments: 22,848
- Total number of rings: 3,808
- Chemical dosing lines for intake tunnel
- 2 launch tunnels each 140m long with an excavation face of 17.6m<sup>2</sup>
- 2 Tunnel Boring Machines:
  - Cutter size: 423mm
  - Number of cutters: 26
  - Cutterhead Thrust (Theoretical) 6292kN; Power 1000kW (4 x 250kW); Torque (Continuous) 1300kNm; RPM (Max) 13rpm
  - Machine Weight (5 components) Approx 225 tonne
  - Minimum Steering Radius (m) 450

## Marine

- Number of ocean risers and structures: 6 (4 intakes, 2 outlets); drill hole diameter: 2.2m each; internal diameter: 1.5m each; riser liner length average: 20.81m; drill depth average: 24.49m; average drilling rates: 839mm/hr; quantity of grout pumped: 288,829 litres
- Inlet Structure Dimensions: 8.5m diameter x 5.15m height each made up of four separate units. Unit 1 – outside walls and base slab 62.8 tonne; Unit 2 – inner base slab 21.6 tonne; Unit 3 – top ring beam 50.9 tonne; Unit 4 – lid slab 58.2 tonne. Total: 193.5 tonne
- Outlet Structure Dimensions: 6.8m diameter x 3.5m height, each made up of two separate units. Unit 1 – outlet base: 74.5 tonne; Unit 2 – lid 53 tonne. Total: 127.5 tonne.

## Procurement

- 650 contracts across 17 countries
- 14,000 Purchase Orders
- 550,000 items barcoded

## Construction Equipment

### Plant Area

- 33kV substation specifically constructed for power supply for construction
- 29 cranes including 2 tower cranes
- Over 1200 items hired including elevated work platforms, scissor lifts (at one stage 113 scissor lifts operated in the Reverse Osmosis building), compressors, generators
- A wide variety of site vehicles

### Tunnels

- 2 Herrenknecht Tunnel Boring Machines and associated infrastructure – conveyor system, cooling plant, ventilation, power and water supply. Each double shield machine was 12m long and consisted of 5 components: a cutter head, front shield, telescopic shield, gripper shield and tail skin shield. 14 trailers accompanied each machine
- Grout plant and silos for the annulus backfill of the segmentally lined tunnels. Two part system: Solution A – cement/bentonite mix/retarder and Solution B – accelerator.

## Marine

- Seafox 6 Self Elevating Platform with 280 tonne Crane, 2.2m diameter Cluster Drill and 12 x 1250 cfm compressors
- LC20 Barge with 120t pedestal crane and A-frame
- Aquila Barge with 200 tonne crane
- Three (3) tugs
- Support vessel, Line boat and Safety Boat
- R44 Robinson Helicopter
- 200 tonne Crawler Crane (precast yard).



# The Seawater Reverse Osmosis treatment process

## 1 From ocean to plant

Up to 630 megalitres per day of seawater is gravity fed through a 2.5km long tunnel under the ocean floor and the National Park. It is collected at a low, lower than existing currents to minimise potential effects on marine life.

The seawater is pumped into the plant via five vertical shaft turbine pumps. At least four of the five pumps are required to operate at full capacity.

## 2 Pre-treatment

Seawater passes through a drum screen removing organics and particulates larger than 3mm. To help remove suspended solids in the filtration system, the pH is corrected and a coagulant and flocculant are added. Pre-treatment filtration uses four dual media filters of sand and coal.

**2a** A portion of clean, filtered backwash the pre-treatment filters with the remaining bulk of this water being pumped through five micron microfilters for a final clean before being pressurised up to 50 to 60 bar so as to flow across the reverse osmosis membranes.

## 3 Energy recovery

Energy recovery devices between each rack of reverse osmosis vessels enables 97.8 per cent recovery of unused pressure from the rejected concentrate, which is then re-used to assist in pressurising the feed.

## 4 Reverse osmosis

Reverse osmosis technology involves pushing seawater through a membrane to separate fresh water from the salt and other impurities.

At Sydney's Desalination Plant, fresh water is extracted in the membrane building via a two pass reverse osmosis system.

The first pass consists of:

- 13 trains (12 duty, 1 standby)
- 259 pressure vessels
- eight membranes per vessel (200 mm diameter) per train

The second pass consists of:

- seven trains (6 duty, 1 standby)
- 167 vessels per train
- eight membranes per vessel

## 5 Post-treatment

At this stage the water is so pure that minerals, salts and other elements need to be added to bring the desalinated water closer in taste and properties to treated drinking water from surface catchments.

## 6 Wastewater treatment

Solids are removed from the backwash water.

## 6a Discharge/dispersal

The concentrated seawater is discharged via two outlet risers each with four nozzles located approximately 300 meters out to sea in water 25 meters deep. Extensive environmental modelling shows the concentrated seawater is dispersed to within one part per thousand of background salinity within 50 to 75 meters.

Administration

The water is stored in a 40 million litre drinking water tank and pumped into an 18 km pipeline to transport the water into Sydney's drinking water network.

Substation

## 4. Outcomes achieved against planned targets

The JV delivered a complex process facility on time and under budget. The Project met or exceeded Sydney Water requirements. It also met the requirements of safety and environmental authorities and established cordial relations with the local Kurnell community, Sutherland Shire bodies and university and professional groups.

This contract was a hard-dollar, performance-based contract.

A Management System was developed in accordance with the following Australian and International standards:

- ISO 9001 – Quality
- ISO 14001 – Environment
- AS/NZS 4801 – Safety
- ISO 19011 – Auditing
- AS/NZS 4360 – Risk Management

A suite of 18 Management Plans were prepared and implemented to manage the various phases and functional areas on the Project and identify objectives and performance targets for each.



Vertical turbine pumps



## Safety

Sydney Water's, Project Director for the Sydney Desalination Plant Ian Payne, has stated that "an excellent safety record was achieved. Sydney Water regards the safety record for this large and complex process plant, to be the best achieved in the water industry."

Sydney Water set specific safety standards and engaged an independent safety auditor to monitor and measure the on-site safety performance. The JV achieved the criteria set for "outstanding safety performance".

A TRIFR of 15.8 was achieved for 5 million man-hours and a peak workforce of 1300. This outcome is significant in light of the scale of the Project and that key risk areas included specialist marine diving and drilling, bulk earthworks, tunnelling, mechanical and electrical installations and commissioning works.

The outstanding safety performance statistics achieved are detailed below.

Incident Frequency Rates	Project Actual	Project Target
LTIFR	2.44	0
AWIFR	8.95	5.0
MTIFR	5.09	7.0
TRIFR	16.48	12.0

\* Please note that the Project Targets were established by Sydney Water in reference to "ideal project conditions."

## Time

First water was delivered into the Sydney Water distribution network on 28 January 2010 and the plant was fully operational as originally scheduled.

## Cost

The Project was completed for the tendered Lump Sum Price and the cost was within the estimated budget. Agreed variations amounted to less than 0.3% of the contract sum.

## Quality

One of the JV's most important initial tasks was to develop a Quality System that was capable of delivering quality through each phase of the Project delivery from design, procurement and construction, to final commissioning and handover. Targets applicable to the Quality System and achievements are shown below:

Performance Indicator Targets			
Measure	Target	Achievement	
Audit Rate	Number of audits to be conducted during construction period.	1 per month	2.58 audits per month were conducted
Inspection Rate	Number of Punch List Inspections per month during construction period.	15	19.3
Days Delays (DD)			
Due to Rework	Delays = number of days used to rework/repair defects X 100 divided by the total project days for the period	Not to exceed 1% of total project days	0.24% of total days were lost due to rework



The combination of seawater and high pressure in a desalination plant produces an aggressive environment. The JV team, together with the Independent Verifier engaged under the D&C contract and Sydney Water in-house technical and consultant engineering teams, collaborated in design and quality audits to ensure materials and workmanship complied with the relevant standards.

High quality corrosion-resistant materials were used for all components handling or exposed to seawater and a rigorous monitoring system was put in place to track maintenance.

The Project Durability Plan set critical high quality standards that were achieved in construction.

The Project conducted more than 30 audits, in line with ISO9001, on subcontractors and suppliers to identify areas where these companies could improve their operations. These audits were conducted by RABQSA certified Lead Auditors and focussed on improving systems and processes generally as well as witnessing project product. Follow-up on some 100 action items led to the introduction by subcontractors and suppliers of improvements, thus enhancing the industry profile.

## Environment

The Kurnell plant is located within a Conservation Area bordering a National Park. The inlet and outlet risers are located in a Marine National Park.

Flora and fauna in these areas include a Flying Fox colony, Weedy Sea Dragons, a variety of sea grass habitats, kelp and sponge. The East Coast whale migration corridor passes through the marine park. Up to 1200 whales migrate annually along this corridor.

Additionally, drainage of the site into Towra Point Wetland reserve (a listed Ramsar wetland) was a significant environmental issue.

Early achievement of Department of Planning Environmental Approvals was on the critical path. During the tender and Preliminary Activities (pre-award) periods the JV's fully integrated project team completed planning that enabled submissions to Sydney Water and regulatory authorities immediately on award of the contract.

The JV's construction environmental planning allowed construction to commence at the earliest possible date and resulted in negligible short term impacts on flora and fauna.

No infringements or major incidents occurred during the construction of the plant.

## Sustainability

The JV guaranteed to achieve a power consumption rate of 4.2kWh/kl. This rate has been achieved or bettered. The current rate is 3.2kWh/kl.

The process design allows the plant to operate at 0, 25, 50, 75, and 100% for each of the two 125ML/d modules. The plant incorporates DWEER Energy Recovery Devices and is designed to operate at a steady flow and recovery rate within a range of 15 to 25 degrees C. The flow is maintained by varying the operating pressure. This minimized the OPEX and reduces the overall energy demand.

A detailed Durability Plan established an extended design life for materials including concrete, which for submerged seawater structures is 100 years.

Waste treatment facilities minimise chemical demands and provide for the productive reuse of lime sludge.

---

## Stakeholder satisfaction

The JV delivered a \$1.1B project involving, at peak, some 1300 workers, in the middle of the Kurnell community without attracting adverse press coverage.

The JV formed close relationships with the Kurnell and wider Sutherland Shire community and contributed in a number of ways to the community, including the construction of an Out of School Hours care facility for the Kurnell Public School. The school community of parents and teachers developed a strong relationship with the Project and speak highly of the JV partners.

Local councillors, despite their opposition to Sydney's Desalination Project, acknowledged the JV partners as good corporate citizens and made no adverse comments about the JV.

Only 17 complaints/enquiries were received throughout the Project, and all were successfully closed out.

## 5. Complexity, difficulty and optimisation of the construction task

In addition to contractual terms and the timeframe set by the Client, the unique risks that attended the Project shaped the construction task in important ways.

- The intake and outlet risers were located in two approved locations 300m off the cliff face at Cape Solander, in a marine national park. Waves and currents off the cliffs produced 'washing machine' conditions. No "sea state" or historical wave data was available. This location imposed severe constraints on:
  - Divers constructing foundations and placing structures on the seabed
  - Floating equipment that transferred and lowered the 64 to 74 tonne concrete riser heads
  - Movement of support vessels to and from the riser locations
  - Jack-up rig drilling activities
  - Installation of the riser liners and valve system – GRP liners grouted to the full depth of the risers
- Extreme weather conditions frequently adversely impacted this area and these operations
- No geotechnical data was available for the seabed construction or the riser drilling. Many large voids and crushed zones caused challenges for the drilling operation
- There was a need for close coordination between the marine and tunnel construction works as the 2.2 metres diameter riser shafts were as close as 4 metres to the tunnel horizontal alignments. This was critical given there was potential for a major fault adjacent to the intake tunnel. A Permit to Work system was adopted to ensure only one activity was in operation at any time – no riser drilling if a Tunnel Boring Machine was operating and vice versa.



The Seafox 6 in position off Cape Solander.



- Connecting the tunnels to the completed 23m deep riser shafts was a demanding and specialised manual mining task using a small hydraulic breaker and high pressure water blasting. These side galleries were excavated from the tunnel through an unreinforced section broken out of the concrete tunnel lining. Probe drilling was carried out prior to excavation of each short section of the galleries. Water blasting was used to trim the shape of the galleries which were progressively supported by rockbolting. Water blasting was used for the final break-through to the riser shaft. A GRP liner was installed and grouted into position to connect the risers to the tunnels
- Outlet and inlet tunnels were driven through rock strata, about which minimal geotechnical information was available. The existence and/or location of fault zones either on-shore or under the sea was not known. Potential dangers included high water inflows into tunnels in fault zones and from a perched water table, and methane gas flows into tunnels from shale seams
- An aggressive plant environment was produced by the combination of sea water and high pressure
- Unique environmental challenges included protection of flora and fauna, presence of a high water table, and site drainage.

## Logistics

On the main plant site, the highest levels of coordination and sequencing were required to integrate civil, mechanical, electrical and instrumentation work within a 30 hectare construction site. More than 5,000 people were inducted onto the Project and over 5 million man hours worked. This required logistical balancing of large numbers of workforce, sub-contractors and plant. During the main construction period there were 29 cranes, including two tower cranes, operating simultaneously on site.

To coordinate the three different construction areas, senior discipline managers and work packages coordinators met daily to coordinate and sequence activities on these very congested sites. Sound and reliable engineering practices and principles guided their decision-making.

To minimise rework and clashes among the various disciplines and designated Work Lot areas, the entire plant was modeled using a 3-D AutoCAD-based design package. This enabled teams to reduce the number of potential clashes and to resolve detected clashes quickly and efficiently.

The dominant challenge on this fast-track project was the short timeframe. The need to deliver a fully operational process plant by the Summer of 2009-2010 drove every aspect of the Project, including procurement logistics. The restricted timeframe for procurement required reliable and exact procedures and systems.

In effect, all equipment and material – not simply long lead time items, such as the TBM's and the SEP - were on the critical path.

Challenges included:

- Procuring, storing, coding and despatching more than 550,000 items of equipment and materials
  - more than 650 contracts and 14,000 purchase orders were issued
  - an on site warehouse and lay down area were established along with three leased lay-down areas nearby
- Sourcing and ordering specialised equipment and exotic materials from 17 countries with many items requiring factory testing prior to shipping. Off shore inspection teams ensured correct standards and specifications were met
- Sourcing and ordering materials and items across disciplines (civil, electrical, mechanical, and instrumentation)

## Commissioning

The demanding job of Commissioning was made especially difficult in a high pressure seawater environment, by the presence of high voltage electricity, large volumes of chemicals, and other work modules proceeding nearby.

The plant was commissioned in stages to enable expansion while still achieving operational targets. During initial commissioning, the plant was operating to produce 125ML/d while simultaneously building was ongoing to enable operations and production of an additional 125ML/d.

The management methods listed below enabled the commissioning team to work closely with the plant Operator, not only saving some two to three months in construction time but also optimising the process, improving plant performance and reducing energy costs:

- Early formation of the commissioning team to participate in design reviews, changes in design to aid commissioning, performing factory testing of the SCADA/PLC software and preparation of more than 500 commissioning check sheets, method statements and test plans
- Appointment of a strong commissioning team, including a group from the Gold Coast Desalination Project
- Sourcing experienced engineers from the JV companies, from within Australia and internationally
- Formation of a dedicated pre-commissioning team to systematically inspect, set-up and test every discrete piece of equipment before it was handed over to commissioning, thus providing consistency across thousands of pieces of equipment onsite
- Development of stringent 'Permit to Work' and 'Equipment Energisation' processes to manage the safety issues arising from the work of construction teams around energised equipment. A dedicated Permit to Work team ensured the correct isolation of every piece of work on energised equipment, removed hazards, and acted as an independent auditor of as-built information.

## Interfaces

A major interface task was the coordination of all aspects of construction site activities with the neighbouring Water Delivery Alliance (WDA). A cooperative spirit existed throughout the Project. A focus on establishing and maintaining good relationships ensured the physical interface worked and relationships were not strained.

The JV and the WDA presented a common face to the public and worked together when dealing with environmental authorities and major stakeholders such as the Sydney Airport Authority.

Construction activities required coordination with both the operation of Sydney Airport and shipping movements at Port Botany. Maritime NSW and the Sydney Ports Operator had to be provided with time schedules for all floating plant and helicopter movements. The Sydney Airport Operator and Air Traffic Controllers required advice about all over-height lifting equipment operating on both the Kurnell and Port Botany sites.

Another major interface, that of safety, involved discussion with Sydney Water, WorkCover NSW, ComCare and Emergency Services. John Holland is covered Australia-wide by ComCare regulations, and with the NSW State Government D&C contract, the JV also undertook to comply with NSW WorkCover legislation.

## Constraints

Time constraints imposed major challenges for achieving the program schedule.

Design innovation was driven by the need to meet tight deadlines. Innovations included reducing the number of risers to lessen time spent on relocating the SEP for drilling; co-locating the tunnels and using the box cut.

Other innovations included using a novel “above grade” piling construction methodology and selecting a lifting seawater pump station that eliminated deep shafts – tunnels slope down to the risers. Cost and time that might have been spent on constructing the pump station and tunnels was reduced significantly, contributing to the timely completion of project as well as reducing O&M costs.

The DBOM contract was negotiated by lawyers but had to be built by construction contractors. The fully integrated project team understood their task as meeting the intent of the contract collaboratively. A major immediate benefit of this approach was the joint development of an agreed means to streamline contractually-specified processes of Client review and approval, to one that reduced the approvals cycle and expedited decision-making.

Because the DBOM contract was awarded during the 2007 pre-GFC boom, skilled tradesmen and staff were in high demand particularly for mechanical and electrical trades. The JV was able to transfer staff from the Gold Coast Desalination Project as well as recruiting both interstate and overseas.

Shift work was required in some cases to clear bottlenecks in assembling, testing and commissioning.

As discussed in the unique risks section above, technical constraints included:

- Location of riser shafts in a surf zone on a rocky ledge and absence of “sea state” or historical wave data in respect of the ‘washing machine conditions’
- Absence of geotechnical data for the tunnel boring and riser drilling

The dewatering, discharge and overall site water management constraints are discussed in the Environment section.

## Optimization of the Construction Task

### The Outfall System

The concept design for the concentrate outfall system featured four riser shafts connected to a single driven tunnel. During construction of the riser shafts, adverse marine conditions had the potential to negatively impact personnel safety and therefore the ability to meet the program schedule.

Because high risk activity occurred when the self-elevating platform (SEP) was relocated from riser position to riser position, the JV investigated whether the number of risers, and thus the number of relocations, could be reduced.

Extensive theoretical analysis was undertaken which indicated that the number of risers could be reduced without adversely affecting the hydraulic performance of the plant. Reduction in the number was achieved by revising conservative design contingencies to achieve more realistic parameters and by redesigning the discharge system to incorporate larger and more numerous discharge nozzles on each riser cap.

This latter alteration – of the discharge nozzle diameter – was not adopted until physical modelling confirmed that the resulting concentrate plumes met all environmental criteria.



## Excavation of the Box Cut

The Sydney Water Blueprint Design assumed that each of the inlet and outlet tunnels would be excavated from its own vertical shaft, and that a separate seawater pumping station would also be constructed. To provide early access for tunnelling, the JV team determined that both driven tunnels could be excavated from a common open cut launch chamber rather than from individual shafts.

The launch chamber for the tunnels, and the excavation required for the seawater pumping station, were combined into a common box cut. Locating the box cut in that part of the site where the underlying rock was at its most shallow, enabled sufficient rock cover to be provided to the tunnels without the need for excessively deep excavation.

Adoption of this innovative design permitted tunnelling operations to commence much earlier than otherwise would have been possible.

Additionally, this design provided a simple, direct connection between the pump station and the driven tunnels.

## Constructing the foundations to buildings and pipelines

Poorly compacted sands overlaying Hawkesbury sandstone were present on the plant construction site. The 20m deep sand layer was highly permeable, producing significant fluctuation in the level of the water table. Design of buried pipelines and building structures assessed the likely settlement/flotation of each structure under different groundwater conditions and designing accordingly.

Characteristics of the final design included:

- Majority of buildings designed as suspended slabs supported on multiple CFA piles (with lengths up to 22m in some cases)
- Buried pipelines designed with sufficient overburden to prevent buoyancy issues when the water table was at a high level
- Detailed analysis of potential differential settlement between buildings and buried pipelines, with some pipelines supported on piles and others provided with flexible couplings
- Use of engineered fill beneath un-piled structures to restrict potential ground movement.

The JV established a piling methodology for the plant area that accelerated the piling operations: a high level rock work platform allowed double the number of rigs to operate concurrently.



Excavating the Box Cut



Pre-treatment Filters  
piling and excavation

## Community

To address community concerns, the Project's community relations team formed direct relationships with industrial, commercial and residential neighbours in Kurnell through one-on-one meetings and regular information updates.

At project commencement, primary stakeholder groups were identified as:

- The local Kurnell community
- Sutherland Shire Council
- The Sutherland Shire community.

Environmental groups such as the whale watchers are discussed on Page 29.

Secondary stakeholder groups were also identified. These groups had the potential to be credible advocates for the Project:

- Professional groups such as Engineers Australia, Young Water Professionals and many others who could act as expert advocates for the Project
- Members of the education community whose educational interest in the Project could be utilized to foster support of the Project.

All media liaison was undertaken by Sydney Water, with support provided as required.

## Kurnell School

Kurnell Public School was identified as the focus for contributing to, and building relationships with, the wider Kurnell community. Kurnell Public School is the only school in the area and most residents have an association with it.

In discussions with the Principal and the P&C, the JV determined that the most urgent need was the school's Out Of School Hours (OOSH) facility, a rundown and unsuitable building accommodating up to 20 children before and after school.

A team from the JV including the Community Relations Manager, a project engineer, members of the workforce and a number of contractors assessed the facility. As a result, the JV replaced the existing building with a new demountable, double the size of the existing one, while subcontractors installed electrical wiring and fittings, plumbing, a kitchenette, air-conditioning, decking and ramp for disabled access. The total cost to the JV and its contractors was \$60,000.

Additionally, the JV built on this relationship by:

- Hosting school excursions and providing education resources
- Hosting P&C site visits
- Making presentations to students, staff and the P&C about the project
- Continuing to give to the school through staff fundraising and various in-kind gifts such as recycled paper.

## Sutherland Shire

Initially, Sutherland Shire Council and the Sutherland Shire community strongly opposed the construction of a Desalination Plant at Kurnell. Protests and rallies were regularly held at Kurnell before construction began, and there was initial antagonism towards project staff.

The JV's community involvement initiatives aimed to highlight its genuine interest in contributing to Shire life by:

- Participating in the Cronulla Surf Club Shark Island Swim and Wanda Surf Club's Sutherland to Surf
- Facilitating Sydney Water sponsorship of the Wanda Surf Club's Sutherland to Surf event

- Hosting Shire high-school visits to the plant
- Establishing a speakers program: 23 presentations were made to community groups in the Shire including Probus, Rotary and Lions
- Fundraising for a number of Shire organizations including the Sutherland Hospital Cardiac Unit, Amelie House Women's Refuge and the Sutherland Shire Christmas Lunch for the Homeless
- Registering Silver Beach at Kurnell for 'Clean Up Australia' for two consecutive years
- Attending to complaints – only a small number – promptly and courteously
- Participating in community information sessions
- Donating \$2,000 to the Kurnell Youth Development Program through Sydney Water's safety scheme.
- Participating in the Community Project Liaison group
- Hosting of site visits by the Sutherland Shire Council Executive, Mayor and Councillors
- Facilitating interaction between the JV environment team and the Council environment team
- Building relationships with the Council Engineering unit.

### Professional Groups

As members of professional groups are seen as credible and informed experts by the general community, the JV connected with them to build positive exposure. The community relations team provided guest speakers, made detailed presentations, hosted site visits, and provided information to trade magazines.

Evaluations and feedback among professional group members indicated a high level of support for both the Project and the reputation of the JV partners.

Professional groups to visit the site included:

- Welding Technology Institute of Australia
- Institute of Quarry Makers
- Association of Consulting Engineers
- Young Water Professionals
- Engineers Australia
- Education community representatives.

### Environment

Harsh environmental conditions were present on the site: high humidity, with salt-laden air and frequent splashing with sea water. Measures to address these conditions included:

- Design and construction of buildings and pipework support structures to meet the specified design life
- Setting high quality standards for corrosion-resistant materials
- Establishment of a rigorous monitoring program to ensure effective maintenance.

A major environmental constraint on the Project was dewatering, discharge and overall site water management. Considerations included the high water table of the Botany Bay Aquifer; drainage of the site into Towra Point Wetland Reserve (a listed Ramsar wetland), and high water production because of the installation of numerous spear points throughout open excavations.

Measures taken in this regard were:

- Establishment of a comprehensive water quality monitoring project to ensure no pollution of receiving water ways



- Supplementation of sedimentation basins, initially constructed to satisfy storage capacity on site, by the construction of infiltration basins in sandy areas at the back of the site to further reduce offsite discharge
- Implementation of segmentally lined tunnelling and progressive grouting methods to minimize groundwater intrusion and reduce the discharge of water from the tunnelling operation
- Installing an extensive groundwater and discharge water monitoring program and schedule to ensure effective detection of any potential issues
- Waste classification was required for fill brought onto site as well as spoil generated from construction activities. Dedicated areas for stockpiling excavated material were established so that spoil could be progressively used throughout the excavation, backfilling and elevating the site to the 1:100 year rainfall event
- The tunnels generated over 170,000 tonnes of spoil with 75% reused at a local commercial quarry operation, and 5% sent to the Water Delivery Alliance constructing the water delivery pipeline
- The remaining 20% of spoil was reused onsite for construction purposes or stockpiled for later reuse
- Landscaping and earth bunding reused spoil locally saving on transport costs and associated greenhouse gas emissions
- Similarly 100% of the spoil generated during the marine drilling operation was sent to a local marine construction site for backfilling
- Waste management on site of construction water, construction waste, and general rubbish was an opportunity to reduce the overall impact of the Project on the receiving environment
- 7ML of groundwater and surface water was reused for dust suppression and hydro-static testing, thereby reducing the need to treat, store and discharge the water.
- Approximately 80% of all general and mixed construction waste was recycled. Tyres, excess concrete, oily water, oily rags, steel reinforcement toners, and timber pallets were sent to companies that guaranteed 100% recycling.

Environmental Management Measures included:

- Establishment of an extensive monitoring program to ensure effective detection of any potential issues and to assure continuous improvement. The reporting regime was also substantial to satisfy the Client's expectations
- Involvement of all JV staff in environmental management: every person working on site participated in an environmental induction, presented by one of the qualified site environmental advisors
- Evolution of the Environmental Management team with the needs of the Project, for each major component of work: civil, tunnelling and marine. At least one full time qualified environmental advisor supported each construction team throughout each phase of work
- Appointment of a dedicated Environmental Construction Manager throughout the whole life of project. During the pre-construction period an environmental planning and approvals team guaranteed all approval and compliance requirements
- Parks and Wildlife staff and volunteers were invited onto site and briefed about the works. Site visits continued regularly throughout the construction works
- JV staff assisted Parks and Wildlife in their frequent park walk surveys to assess signage in the National Park.

## Whale Migration

The marine construction works took approximately 18 months to complete and were situated directly in the whale migration path at Cape Solander. NSW Parks and Wildlife in conjunction with Macquarie University had been conducting a research program into the whale migration path for a number of years with the final year of their research project occurring simultaneously with marine works located on the migration path. The JV successfully engaged with Parks and Wildlife, Macquarie University and the Whale Watching volunteers to turn animosity into a positive working relationship based on trust and goodwill. In cooperating with these groups, the JV ensured that marine staff members were well versed on whale and other marine protection regulations and felt confident about managing sensitive marine protection issues. Macquarie University and NSW Parks and Wildlife staff worked collaboratively and positively with JV staff.

Specific actions included:

- JV Community Relations and Environment Managers attended a start of season briefing on board whale watching boats in the Tasman Sea
- Parks and Wildlife staff identified approaching whales and briefed JV marine crews if work needed to stop
- Fund-raising contributions were made to the Whale Watching Volunteers' special interest project
- JV staff visited volunteers daily on their watch.

## Drilling solutions

Drilling solutions developed to substantially minimise the environmental and visual impacts of the operation included:

- Adoption of a recirculation method for offshore drilling works which involved the use of a drill casing, assembled on the SEP, and lowered to a steel ring located within each riser structure on the seabed
- Undertaking drilling activities in a completely contained operational environment, by reverse circulation of seawater
- Extensive monitoring and adjustment of undersea work practices, including appropriate direction of water jetting and placement of protective boulders on the sea bed to protect the marine flora and fauna habitat
- Collection of recirculation spoil through the drill sleeve including its separation into skips on the SEP.



Green and Golden Bell Frog



Grey-headed Flying Fox



A pair of migrating Humpback Whales pass by

## Improvement of environmental amenity

Environmental amenity was improved through:

- Implementation of a Vegetation Management Plan encouraging native revegetation and reduce noxious weeds in the Conservation Area
- Dedication of 2000 man hours to increase native vegetation cover to 90%
- Integration of the plant site into its surrounds. Design, finishes and colour of buildings and structures have been well considered, while landscaping utilises natural resources
- Permanent stormwater management system was designed using Water Sensitive Urban Design Principles. The system conveys roof and storm water into a biofiltration basin designed to reduce the annual average pollutant load from site as well as replenishing the groundwater aquifer in the Conservation Area
- Stormwater system drainage points were designed to replicate the natural overland flows prior to the development being established, such as the 30 metre long sheet flow spillway design alongside vegetation communities that were historically inundated with overland flows.

Overall, compliance with strict requirements was evidenced by the fact that no infringements or major incidents occurred during the construction of the plant.

## Heritage

Neither aboriginal nor European heritage issues were required to be addressed as the area was a former industrial site. The only issue that arose during the Project was the discovery of human remains within the sand dunes. This became a NSW Police matter.

## Project financing and initiation

Not applicable.



## 6. Leadership and Management of Project Delivery

### Project Team Relationships

The Joint Venture's general approach to the leadership and management of project delivery was to form a genuinely united team, involving the JV, the Operator and – uniquely – the Client, to meet and manage project challenges.

The project was complex – involving construction, tunnelling and marine works – and the reliability of the water production and delivery processes was critical. Given these constraints, the JV initially focused on assembling skilled design, engineering, contracts, procurement, construction and commissioning personnel and melding them into a cohesive team. The goal was the creation of a team capable of the kind of dynamic collaboration that would develop solutions readily as well as maintain momentum over the long haul that lay ahead.

The JV invested in creating this team even before the contract was awarded and during the tender period, immersed design and engineering personnel in assessing the original Blueprint Design at Macquarie Park offices. A number of intensive, day-long, collaborative sessions 'broke the ice'. More than 150 people participated in these meetings led by the JV's Project Director as well as the Communications team.

Those participating included civil construction engineers, Contracts personnel, Operator personnel, Design JV personnel (SKM and Maunsell/AECOM), and Sydney Water representatives.

Measures adopted even at this early stage included holding weekly Project Update meetings. Senior management and speakers from various disciplines reported on the progress of solutions achieved, with issues and questions raised from the floor and addressed on the spot. A noticeable camaraderie emerged from these straightforward Q&A sessions, as well as a sense of momentum reflecting the perception that joint contributions were the key to resolving issues and solving problems.



The tunnelling team completed the 2.5 km long intake and outlet tunnels LTI free

Upon award of contract, a formal project launch featured a sophisticated slide show which strongly consolidated collective perceptions of the way forward.

A vital aspect of the JV's 'one team' philosophy was the co-location of all personnel, including designers and Client representatives onto the Kurnell site with construction staff. With a great deal of initial reluctance to move to a site on the outskirts of Sydney, JV management ensured all personnel were included in discussions regarding the relevance of the move. One major hurdle was overcome by providing an onsite cafe that matched CBD standards for espresso coffee, and offered a wide range of high quality food. Additionally, a bus service was provided to and from two CBD locations morning and afternoon.

Once co-location had been achieved, senior management continued to foster the 'one team' culture. Open meetings discussed the goals developed by the team which were published in project posters. JV personnel were encouraged to individually identify the goals they wanted the project to achieve in light of their declared collective wish to look back with pride on their endeavours, five years down the track.

Despite the apparent simplicity of the message, the evidence is that it worked. It established, for each individual, straightforward perceptions of their involvement in a worthwhile and critically important project, linking its achievement to their ability, and to regard their work with satisfaction and self-respect.

The wearing of project shirts by everyone encouraged identification with and involvement in, the collective goals of the project. The continuation of open meetings, hosted by senior management with specialist presenters from various disciplines, ensured that everybody rubbed shoulders with everybody else and learned about the project from different perspectives.

Regular social events worked to consolidate team identification. A variety of self-organised groups sprang up; a rock band was formed and performed at the Australia Day barbecue; a soccer team joined the local competition; teams participated in local community ocean swimming and cycling events; and staff took a prominent role in helping the local Kurnell community.

The 'Lead the Way' safety program contributed in a major way to building a dynamic collaborative team. The major contribution of this program was its development of competencies for site supervisors. It also established an interface in which senior project management took the time and invested the effort in involving subcontractors in safety and risk assessment. Many subcontractors commented that this was the first time they had ever encountered project management interested in involving them in this part of the safety process.

Close technical cooperation between the JV, the Design JV, the Operator and the Client during the design, commissioning and start-up phases ensured a 'seamless' integration of this new water resource into Sydney Water's overall supply and delivery system.

Early Operator involvement made a vital contribution to the project's success. The Operational Plant team were part of the bid team and on site from the start of works. The full Operations team of 32 people was progressively recruited and trained during this period.

The JV worked with the Client throughout the design, procurement, construction and commissioning phases to ensure long term operational requirements were fully considered and a whole of life approach adopted for this asset. This included running CHAIR 3 workshops on operations and management safety and full participation in HAZOP and FMECA reviews during design.

## Legacies for the construction industry

The desalination industry was relatively new to Australia in 2007 and the industry was not well versed in seawater reverse osmosis technology. The construction of the large and complex Sydney plant contributed to the growth in knowledge and expertise in this field. At the outset, the JV seeded its local consulting groups with international experts. Today, because the project educated more than 300 designers and engineers as well as a large number of workers at various trades levels, the total knowledge base regarding desalination technologies, processes and materials has been increased significantly.

The delivery of a complex project to exacting standards covering many types of construction and many disciplines has expanded the professional capacities of the individuals involved as well as the industry as a whole. They are now capable of working on incrementally larger and even more complex projects in Australia and overseas.

The project conducted audits in line with ISO9001 on subcontractors and suppliers. This process has led to each of these companies improving their systems in some way to provide a benefit for the industry.

The project also promoted engineering as a career. More than 40 major site visits were conducted on the Client's behalf, each with very positive outcomes, including visits by the Premier of NSW, various Ministers and Shadow Ministers and television and print media.

The 'Lead the Way' Certificate IV program provided 314 subcontractor supervisors with core competencies in Safety Leadership, Risk Management and Incident Investigation. Coaches were engaged to provide a minimum of three personal on-site coaching sessions to every participant to embed the learnings in the field. The Client, Sydney Water, has since requested that this program forms an integral part of all their asset delivery projects.

Importantly, the construction industry demonstrated its capacities for productive partnership with the public sector in delivery of this critical infrastructure for the people of Sydney. No disputes were reported to the Disputes Resolution Board.

The end result is that the people of Sydney benefit today and into the future from the creation of a much more robust water supply.

## Lessons Learnt

Fundamental lessons were learnt on this project, with applications for other Australian and overseas desalination projects.

The first is the importance of investing in the pre-treatment process. Robust pre-treatment is essential to achieve the level of purity that will facilitate effective and efficient membrane processing. The measure for the pre-treatment filtering is the Silk Density Index (SDI): the higher the number, the more impurities. The SDI target of 3 (i.e., 95%) was surpassed by the pre-treatment filters which are performing nearer to 2, thereby giving Sydney Water confidence that the reverse osmosis membranes will work to peak effectiveness.

The second lesson is the importance of not skimping on materials. Seawater reverse osmosis constitutes an aggressive environment in which corrosion resistance needs to be very high. Design responded by incorporating highly durable materials and measures such as:

- Use of specialist concrete mixes incorporating high proportions of Granulated Blast Furnace Slag
- Coating galvanised members in particularly high risk areas with Epoxy Mastic
- Use of corrosion resistant materials including aluminium, GRP and duplex and super-duplex stainless steels
- Engineering details to prevent ponding of freestanding water
- Elimination of corrosion-promoting crevices.

Where the use of corrosion-resistant materials was not appropriate, a rigorous maintenance program was introduced.

Significant for future desalination projects is considering the strategic implications of investing in the design and application of 'best practice' reverse osmosis materials. Their expense cannot be assessed in dollar terms alone. The example of the 12-14 month 'queue' for high quality high pressure pumps indicates the hidden expenditure of resources: the project team must invest time and expertise in planning, coordinating and sequencing the receipt and eventual installation, testing and commissioning of these best practice materials.

### Contribution to the design process

The JV Design Managers led the fully integrated design team which included RO water treatment specialists from Veolia Water (France), design engineers and technicians from the Design JV (SKM and AECOM), the Operator and the Client, working together on site, generating strong outcomes:

- Design amendments and solutions were based on extensive research, trials and university-based modelling
- 170 design packages were reviewed by both the construction and O&M teams
- Rigorous risk assessment processes were deployed throughout the design process to ensure high standards necessary to maintain security of supply
- Stringent quality specifications were designed to meet the most extreme conditions that could be envisaged in the relevant environments
- Comprehensive and exacting online monitoring was established for all critical parameters
- Redundancy mechanisms, as well as equipment, were 'designed in' to meet worst case eventualities.

Design contributions by the JV included:

- Design of similar alignments for both the inlet and outlet tunnels separated by a rock pillar for almost half the tunnel lengths, enabling the trailing TBM to take advantage of geotechnical conditions encountered by the leading TBM
- Removal of the 2nd pass permeate tank, retaining pressure through to the remineralisation mixing tank and avoiding the necessity to construct a booster pumping station
- Design, manufacture and installation of SEP platform materials and equipment
- Design, manufacture and installation of TBM spoil disposal and support equipment
- Development of a high fidelity process simulation model of a virtual plant to enable Operators to test and trial different operating conditions and predicted the most cost effective, sustainable or energy efficient operations of the plant
- Development by the JV and the Operator jointly of an innovative energy power model that incorporates seawater temperature salinity and other factors to predict the daily energy consumption of the plant. The plant is one of the most efficient desalination plants in the world utilising only 3.2kWhr per 1000 litres of drinking water.
- Designing in the redundancy necessary for critical infrastructure, eg provision of two pre-treatment filter screens: 100% redundancy was designed in, each screen capable of handling 100% capacity
- Reduction of riser numbers and diameter of nozzles (discussed above)
- Development of unique operating protocols and procedures that enable the plant to be shutdown, mothballed and start up again as needed.



A vital consequence of the redundancy philosophy referred to above was the design and installation of comprehensive instrumentation to monitor each process component. Literally hundreds of thousands of finely calibrated individual monitoring and control systems are vital to the ongoing operation and maintenance of Sydney's Desalination Plant. Additionally, each monitoring and control system requires its own maintenance program which, in turn, are also monitored.

One example of such instrumentation is concerned with asset management and membrane management. A unique membrane management tool captures and records information about the plant membranes. Information captured includes individual data on procurement, installation, location, water production and quality, cleaning, storage, preservation and remaining economic life for each of some 40,000 reverse osmosis membranes within the plant.

The JV's investment in robustness extends to addressing the sensitivity of reverse osmosis membranes to hydrocarbons in sea water. Four separate analysers are deployed capable of 'tripping out' the system and a total of three layers of protection are located strategically throughout the plant.

### Planning and control of design and construction operations

Recognising the complex nature of the Project, a senior management Contract Control Group was formed by the JV and Sydney Water executives. This was the corner-stone for creating a collaborative Project management structure. CCG meetings were held monthly and received reports from the JV team, the Independent Verifier (IV) and Sydney Water's Project team.

The JV began the planning of design and construction operations in the pre-tender period.

As noted, early risks were taken by the Project procurement team in ordering, prior to award, two tunnel boring machines from Germany and the off-shore self elevating platform (SEP) .

Other early decisions demonstrated the capacity of senior Project management to achieve important strategic positioning for construction operations.

These included:

- Establishment of a strong safety culture - extending to subcontractors - to ensure the well-being of more than 5,000 people inducted onto the Project
- Establishment of a stringent environmental management plan covering both marine and land construction sites
- Institution of a proactive, subtle and comprehensive community relations program designed to build understanding and negate adverse opinion
- Creation of a commissioning team which participated in design reviews, made changes in design to aid commissioning as well as performing factory testing of the SCADA/PLC software and preparing more than 500 commissioning check sheets, method statements and test plans.

A unique 'defence style' Systems approach was used to manage multiple interdependent construction and process projects in terms of coordination, sequencing and integration: plant, tunnelling and marine construction; mechanical, electrical and instrumentation works; and Project commissioning.

To minimize the number and severity of clashes between disciplines, and different structures, the entire plant was modelled using a 3-D AutoCAD-based design package called AutoPlant.

The JV employed the latest in information management systems, making an early and crucial decision to use inCITE, a web based collaboration tool, for communication, documentation and design approval. This produced a streamlining of review processes with more than 7,000 internal design documents and 20,000 external vendor documents reviewed and approved by as many as four (4) separate entities.

A team of onsite system developers heavily customised the system during the Project to make the entire process more efficient and streamlined. The versatility and transparency generated by this innovation enabled electronic management of documentation to be maximised and printing to be minimised as well as providing key Project stakeholders with complete confidence in the status of the Project.

Approval of workflows through inCITE software generated a fully auditable and traceable path for each approved document. When documents were updated, the system triggered automatic notifications to internal and external parties as well as updated progress registers for reporting purposes. The system ensured only the latest version of any document was available to the Project team while still enabling access to historical records where required.

Some 3,500 Work Lots were created to manage the Project. A Lotus Notes-based database was adopted to compile the quality records associated with each Work Lot. This tool enabled real time monitoring and management of the status of completed work and closed Work Lots. The database was fundamental to the presentation of Completion Plans for review. The latter were part of the comprehensive external review and approval process to achieve contractual completion.

## **Safety and Occupational Health**

A significant initiative was the subcontractor safety leadership development program 'Lead the Way' discussed in detail earlier in the submission.

Another innovation was the location of a doctor on site whose services were made available to all employees and sub-contractors for both work and non-work related issues. The Project was able to maintain a successful early intervention programme which assisted Project employees with their return to work and also managed any personal health issues.

## **Environment**

Effective construction environmental management was evidenced by no infringements or major incidents during the construction of the Desalination Plant.

Environmental management of this Project was subjected to close scrutiny by many environmental regulators including the NSW Department of Environment, Climate Change, and Water; the Commonwealth Department of Water, Heritage, and the Arts; and the NSW Minister for Planning.

To meet regulatory requirements prior to development or construction work, environmental documentation was developed to meet the Environmental Assessment of the Concept Plan and the Preferred Project Report for Sydney's Desalination Project, the NSW Minister for Planning's Conditions of Approval (MCoA) and contractual obligations. The Environmental Management System was developed in accordance with the requirements of ISO 14001:2004 and was consistent with the corporate EMSs of John Holland and Veolia Water.

The Construction Environmental Management Plan was supported by a suite of environmental planning and management instruments (12 environmental management plans, 7 environmental work method statements, 14 environmental work procedures, instructions and forms) to minimise and manage environmental, heritage and community impacts and risks. Environmental management plans were verified by the Independent Verifier and provided to the Client for endorsement and approval from relevant regulatory departments. A substantial reporting scheme was established to satisfy internal and regulatory stakeholder requirements and the Client's expectations.

## Industrial relations

The approach taken to Industrial Relations was pro-active and constructive, resulting in less than 0.004% lost time on site (200 man hours from 5,000,000 worked) due to industrial issues, a best practice result for a major infrastructure Project. From the outset of the Project through to its completion, the industrial relations framework involved:

- Engagement of key union stakeholders and negotiation of a flexible industrial agreement that provided for a highly productive JV workforce
- Formation of a dedicated skills training team that developed and implemented plans to upskill the workforce. This included training opportunities and options to redeploy the workforce during inclement weather, a significant improvement against industry standards
- Establishment of strong communication channels with a broad range of key stakeholders including both subcontractors and employees. This ensured key information about site working conditions, delivery program, amenities and codes of conduct was disseminated across the Project in a timely and effective manner
- Establishment of effective, prompt and easily accessible processes for the resolution of disputes and grievances. This was balanced with a firm zero tolerance approach in respect of any unlawful behaviour
- Implementation of a significant communications plan and ongoing engagement with Project subcontractors in relation to the introduction of a Project-wide drug and alcohol testing program. The program set new industry standards for a major construction project in NSW and involved the establishment of a well received testing regime to support the Project's zero harm safety philosophy. There was zero disputation in relation to this significant program.

## Use and development of new technologies

### Tunnel Boring Machines

The TBM's selected for the Project were two 4.15m excavated diameter Herrenknecht Double Shield TBM's which incorporated the most advanced TBM technology available in the World.

In normal operation ("double shield mode"), the gripper shoes are energized, pushing against the tunnel walls to react against the boring forces. The main propelling cylinders are then extended to push the cutterhead support and cutterhead forward. The rotating cutterhead cuts the rock and as the machine advances, the telescopic shield extends to keep everything in the machine under cover and protected from the ground surrounding it.

The gripper shield remains stationary during boring. A segment erector was fixed to the gripper shield allowing the 3.4m internal diameter pre-cast concrete tunnel lining segments to be erected while the machine was boring. The segments were erected within the safety of the tail shield. The Double Shield is capable of erecting the tunnel lining simultaneously with boring, allowing it to achieve high performance rates. The completely enclosed shielded design provides a safe working environment.

The tunnels were continuously lined with universal taper precast tunnel segments as the tunnel advanced. The tunnel segments were 1.2m in length and there were six segments per complete ring. The 25,200 segments required for the works were fabricated off site. The adopted segment design allowed the outlet tunnel to be bored around curved alignments providing a 90 degree intersection of the tunnel with the projected fault line, and allowing termination in the designated Outlet Riser zone.

The process of spoil removal was undertaken by continuous conveyor. The TBM's fixed conveyor delivered cut rock from the cutterhead to a continuous conveyor hanging in the tunnel crown to travel to the portal, to be transferred to a stationary stacker which deposited the rock in stockpiles on the surface. The loop take-up for the continuous conveyor was positioned, at ground level, underneath the stacker. The continuous conveyor enabled 200m of advance prior to installation of the next belt. Continuous conveyors were selected as the spoil removal method to provide the most flexibility and highest potential TBM advance rates.

### Seawater Reverse Osmosis

The Seawater Reverse Osmosis process is, by its very nature, complex however the "state of the art" is changing rapidly with research and development improving the process and the efficiency of material and equipment. Prior to 2007, Veolia Water Australia (VWA) had conducted Pilot Plant studies at Kurnell for Sydney Water under a separate contract which was linked to a previous Call for EOIs for an Alliance delivery of the entire Desalination Project.

VWA is involved in an ongoing process of using and developing new technologies for water treatment. Hence numerous new technologies and innovations were included in the process equipment design and construction delivered by the JV for the Sydney Desalination Plant. Two typical examples are described below – shock chlorination fed by pipes installed in the intake tunnel to the inlet risers and the DWEER devices installed in the Process Trains in the RO building.

An R&D platform has been established by VWA at the Plant to continue to test the advances in desalination technology. This includes the testing of the latest developments in membrane technology that could lead to further reductions in energy usage.

Shock chlorine injection is done in order to control sea shell growth and sea flora within the tunnel and structures.

Continuous chlorination is not recommended in the case of Reverse Osmosis because of problems encountered on the membranes when de-chlorinating on a continuous basis with sodium bisulphite. In such operating conditions, RO membranes are known to encounter severe fouling problems.

Shock chlorination is an efficient means of protecting the intake pipes (offshore tunnel and onshore pipes) and intake pumping station and is designed on the basis of a frequency of one hour per day.

The shock dosing treatment is automatically controlled on a flow pacing basis with the flow signal being provided from the main plant inlet flowmeter.

Different types of energy recovery devices were considered to be used on 1st Pass SWRO Trains, which include the following:

- Energy Recovery Turbine
- DWEER – Work Exchanger
- ERI - Pressure Exchanger
- Turbo Charger.

DWEER from Calder was selected for the Sydney Desalination plant, since it has the best energy recovery efficiency and less concentrate mixing inducing the minimum power consumption.

The Dual Work Exchange Energy Recovery system is highly efficient due to the fact that hydraulic energy is transferred directly from the concentrate to the seawater across a piston, rather than by conversion to rotating energy and back to hydraulic energy, as in pump or turbine systems.

This energy transfer occurs within pressure vessels, which continually charge and discharge. The presence of the piston limits the leakage of concentrate to the feed. The equipment supplied guarantees a leakage value of less than 1.8% of concentrate flow.



The energy recovery system is designed on the basis of five DWEERs per train (Quad DWEERs).

The system is controlled by a hydraulic power pack for the Linx actuators, which in turn is controlled by a control cabinet, interfaced to the plant control system.

The main advantages of the DWEER system versus a turbine system are:

- Proven technology and References - simple ERD system two pressure vessels and Linx valve ⇒ robust and reliable mechanical component
- Chosen system for four of the biggest RO plants in the world : Ashkelon in Israel 100GL/year, Gold Coast in Queensland 45GL/year, Sin Spring in Singapore 38GL/year and Sur in Oman 28GL/year)
- A well controlled technology
- High Energy recovery efficiency at the design duty point (95.9%)
- Energy consumption reduction by 15 to 20% compared to the turbine device.

The DWEER system is designed to minimise corrosion by using super duplex stainless steels for the pressure vessels, Linx valves and check valves.

Beside the benefit of the low energy consumption, the DWEER system is also a low maintenance system.

The ERD recirculation pump is a vertical centrifugal pump and was installed between each DWEER skid and RO skid in the RO building. Each RO ERD skid has its own dedicated ERD recirculation pump.

## Training and development initiatives

The Project's training plan promoted and facilitated a culture of continuous improvement through skills enhancement and extending the expertise of personnel engaged across the Project.

Training activities first commenced in August 2007 at the Project's bid office at Macquarie Park, North Ryde. As of 5th November 2007 training operations were conducted primarily onsite at Kurnell and also at various external sites related to specific Project operations, eg Port Botany Marine Works.

Over the course of the Project, 6045 people participated in various types of training programs. The distribution pattern of participation was as follows:

Group		Number of Participants
Subcontractors		4961
Veolia		107
Sydney Water		60
SKM		150
Maunsell		116
John Holland	Secondees	132
	Project Salaried	172
Project staff	Workforce	113
	Temp/Casual	62
	Contractors	143
Other		29

Overall, 32,407 training 'participations' were conducted through internal and external programs. (In this instance, a training 'participation' is defined as 'one person attending one training program').

Training was conducted across a diverse range of areas: 260 different types of training sessions were offered across the life of the Project. These ranged from generic training programs, such as OHS General Induction for the Construction Industry and Systems training, to more extreme forms of training such as Helicopter Underwater Escape Training for Seafox 6 crews. Internally, 152 programs were conducted.

Project induction was successful and provided newcomers with an informative, technical, and engaging welcome. All in all, 5901 people completed the induction. Of these, 5719 went on to complete one or more workplace site inductions for other specialist sites such as the marine precast yard, tunnels, the Kurnell plant, and the offshore SEP drilling rig – the Seafox 6. As the Project rolled out, 4091 people also participated in Drug and Alcohol Management awareness training.

### **National Code of Compliance**

Full adherence to the National Code of Practice was essential for the JV to secure the highest level of compliance with legal obligations and ensure ethical tendering requirements. NCOP compliance also ensures that excellent standards of occupational health and safety throughout the Project are maintained.

All relevant personnel were trained by both internal company specialists and the Australian Building and Construction Commission (ABCC) which ensured full compliance across the Project. Each supplier and sub-contractor was assessed against NCOP requirements and a number of measures were in place to prevent non-compliant entities from participating on the project. The overall approach to the NCOP was successful in adherence to the code and related principles such as freedom of association.

## 7.Key People

### Project Team

#### **Bob Evans – Bid Director and Project Director (2005-2008)**

Bob Evans has over 40 years experience in successfully managing/leading private sector business enterprises and directing development and service contracts for both public utility and private sector Clients. He was the Infrastructure Director for the 2000 Olympic Games, and the project Director for the ANSTO Replacement Research. Bob led the bid team for the Sydney Desalination Project from late 2005, bringing a large team together to prepare the tender submission which won the project in 2007. He was then appointed Project Director, taking responsibility for the engineering design, procurement process, site establishment, and the first 15 months of construction.

#### **John Barraclough – Project Director, Project Director (2008-2009)**

John has held senior management positions in both the private and public sector, including central roles with the NSW State government and as Executive Director of Development with the Sydney Olympic Coordination Authority. He has been involved in the delivery of infrastructure ranging from the M4 toll road and Olympic venues through to the Epping to Chatswood Rail Line and Parramatta Transport Interchange, and led the Transport Infrastructure Control Authority. He was appointed to the role of Project Director at the Sydney Desalination Plant in 2008, taking the project through to mid 2009.

#### **Malachy Breslin – Project Director, Project Director (2009-2010)**

Malachy has vast experience as a project director on multi-million dollar projects in the Middle East including the Dubai Autodrome Project, Dubai Festival City, Muscat Palace in Oman and the King Abdullah Canal in Jordan. Malachy joined the Sydney Desalination Project as Deputy Project Director in early 2008, before being appointed to the position of Project Director in mid 2009 to lead the later phase of construction and the commissioning phase. Malachy is currently Project Director of the Hunter8 Rail Alliance.

#### **Emmanuel Toulan – Desalination Area Manager**

Emmanuel has over 20 years of experience in Design and Build projects of various kinds as Site Manager and Project Manager (in both water and civil works). He has experience in large international and sensitive jobsites for large projects. Emmanuel has worked in several countries and within the JV structure of several companies. At the Sydney Desalination Plant he was in charge of the construction of the plant from design through procurement through construction. He is currently Deputy Project Director, OTV SA – Hong-Kong, in charge of the construction of a 2000T/d incineration plant from design through procurement through construction.

#### **Benoit Guerin – Design Director**

Benoit has 20 years experience in multidisciplinary and multinational team management and technical expertise in all fields connected to water treatment from process to structure, development of new processes through pilot schemes and implementing them at industrial scale. Benoit led the design team at Sydney's Desalination Plant including JV design managers and engineers and technicians from the Design JV. He is currently Latin America Business Development Director for Veolia Water America's Industrial Business Group, based in Houston.

---

### **Stephen Neal – Design Manager**

Following heavy involvement in preparation of the technical and commercial submissions for Sydney Desalination Project tender, Stephen was appointed Design Manager (Tunnels and Marine), responsible for the driven tunnels, the box cut for the pump station, the marine risers (including assisting the construction team to develop construction methodologies), all civil design within the plant, all structural design within the plant and permanent power supply.

---

### **Mustafa Ali – Contracts Manager**

Mustafa's main area of expertise is contract management but he has also been involved in project management and risk and opportunity analysis. Most recently as Contract Manager at Sydney's Desalination Plant, Mustafa was responsible for managing the head contract and ensuring all obligations were fulfilled. He worked closely with the Client through all phases of the project, from design to commissioning and hand-over to the Operator.

---

### **Bart Pontey – Civil Construction Manager**

Bart has over 15 years civil engineering experience, both in design and construction of major multi-disciplined infrastructure projects both in Australia and overseas. As Civil Construction Manager on the Sydney Desalination Project, he headed the team of engineers and supervisors delivering both the precast structures for the marine works, and delivering the civil works for the Kurnell plant.

---

### **Paul Cotts – Civil Construction Superintendent**

Paul Cotts was one of the first people on site for the Sydney Desalination Project, and was responsible for site set up and establishment of offices for the project team. As civil construction superintendant, Paul was responsible for the supervision of construction works, management of site supervisors, hiring of all direct labour, control of craneage to site, and mentoring and coaching of workforce, junior engineers and supervisors.

---

### **Matt Phelan – Civil Construction Superintendent**

Matt's initial role at the Sydney Desalination Project, was as General Superintendent for tunnelling, the Seawater Pump Station and Drinking Water Tank construction. Matt has had extensive experience throughout Australia and overseas on major underground construction. After Paul Cotts was seconded to another project in 2009, Matt was appointed Civil Construction Superintendent for the project. Matt is respected for his ability to lead and motivate the workforce whilst maintaining a safe and productive environment.

---

### **Ivan Karaban – Marine Manager**

Ivan is the Construction Manager for Civil Engineering in the NSW/ACT region. His responsibility includes providing support for projects within the region and working with Clients to achieve best outcomes. Ivan joined the desalination project to oversee off-shore construction.

---

### **Mark Laughton – Marine Superintendent**

Mark has been involved in the construction industry for over 30 years, and while at the desalination plant was responsible for supervision of off-shore construction including seabed preparation, installation and anchoring of the precast riser units, construction of the load out wharf, operation of the jack-up barge, safety and operational method statements and procedures.

---



---

### **Duncan Shires – Tunnelling Project Manager**

Duncan is a qualified civil and mining engineer with over 16 years experience in underground construction, heavy civil works and underground development mining.

Duncan was a Section Manager on the Lane Cove Tunnel project and has had extensive experience across Australia and overseas. Duncan headed the team constructing the tunnels, the Seawater Pump Station and the Drinking Water Tank.

---

### **Mark Wheeler – Piping and Mechanical Manager**

After starting his career in the Royal Navy, Mark went on to senior roles at a variety of processing plants throughout Europe, the Middle East and Australia. Mark managed a diverse mechanical construction team throughout the desalination project, successfully working with other disciplines to ensure the successful delivery of a highly complex and technically challenging processing plant. He moved into the Area Manager role as the construction progressed and oversaw the handover through to the last stages of the demobilisation.

---

### **Mark Thompson – Commissioning Manager**

Mark specialises in the design and commissioning of advanced water and waste water treatment plants. He has a wealth of international experience in large water infrastructure projects, having worked in 15 countries and more than 60 WTP and WWTPs. As Commissioning Manager of the 250ML/d Sydney Desalination Plant, he had overall responsibility for pre-commissioning, commissioning and performance testing of the plant.

---

### **Ian Gabriel – Operations Manager**

Ian is an Industrial Chemist with over 12 years of experience in water and wastewater operations, including 5 years in operations management. Ian joined the project in January 2008 and was responsible for establishing the Operations and Maintenance team in time for commissioning and handover of the plant. He was also responsible for providing operational input into the design, procurement, construction and commissioning stages of the project. Ian is now managing the operation and maintenance of the completed plant which has now supplied over 60 billion litres of drinking water into Sydney Water's supply system.

---

### **Tim Fleming – Safety Manager (2007-2008)**

Tim has 19 years experience within civil and building construction, mining and infrastructure projects with over 12 years direct experience within OHS&WC Management and Emergency Services. As Project Safety Manager for the Sydney Desalination Plant, Tim was responsible for implementing and managing safety produces for the main plant, tunnelling and marine works. He is now Regional Safety Manager – NSW/ACT, responsible for the OH&S and workers compensation management of all John Holland operations within the region.

---

### **Keith Maskey – Safety Manager (2008-2009)**

Keith has over 13 years experience as the Project Safety Manager on major infrastructure projects. Keith has experience working at all levels as a safety practitioner. On Tim Fleming's appointment to the regional safety role, Keith was appointed Safety Manager at a time when the major construction works were being undertaken at the main plant site. He is currently the Project Safety Manager for the Bulk Water Alliance Enlarged Cotter Dam Project in Canberra.

---

---

### **Martha Halliday – Community Relations Manager**

Martha specialises in stakeholder management across a range of disciplines having worked in the education, science and technology and construction sectors. Martha achieved remarkable success in breaking down barriers with the local community, the local council and various interest groups which initially opposed construction of the Sydney Desalination Plant. She undertook numerous presentations and tours for key stakeholders and achieved success in building understanding and acceptance of the Plant.

---

### **Brenda Parker – Communications Manager**

Brenda is a senior communications practitioner with over 25 years experience in the industry, and is Regional Communications and Stakeholder Manager for John Holland. As Communications Manager for the desalination plant, Brenda was responsible for preparing information for media releases, co-ordinating all ministerial and media visits to the plant, and liaison with Sydney Water's media and government relations staff. She was also involved in establishing crisis communications protocols, and wrote a regular newsletter for project staff and contractors.

---

### **Gina Spyrakis – Environmental Manager**

Gina has extensive experience in delivering multi-stakeholder projects and working successfully with Clients, industry groups and community members. Over recent years she has been involved in the field of construction environmental management, focusing on development and implementation of management systems, project approval, environmental leadership and training and awareness initiatives. At the Sydney Desalination Plant, she was responsible for managing a team developing and implementing environmental management systems.

---

### **Greg Amadio – Compliance Manager**

Greg is a qualified and experienced systems and compliance practitioner and has been involved in systems development and project setup as well as training of others in management systems. The projects he has worked on typically have been highly complex and fast-track, necessitating close co-operation with a multitude of stakeholders. At the Sydney Desalination Plant he managed the collaborative quality and compliance auditing in which Sydney Water and the IV participated.

---

### **Bill Gooley – Commercial Manager**

Bill has over 30 years experience in commercial and finance roles in heavy industry and construction. His main areas of responsibility on the Sydney Desalination Plant project were cost control, progress claims, cash management, project administration, accounts payable, financial reporting, internal control, insurance and IT. He provided extensive support to the procurement and subcontracts areas.

---

### **Anna Morris – Industrial Relations and Human Resources Manager**

Anna has extensive experience in human resources and industrial relations and is a qualified solicitor. At the Sydney Desalination Project, Anna was responsible for all HR and IR matters including, payroll, recruitment, site induction, training/ development and overall site security. She was also responsible for implementing actions to maximise National Code of Practice compliance, minimising risk of subcontractor industrial relations issues through review and internal advice in relation to industrial relations plans, and developing and implementing retention plans and strategies for key site personnel.

---

## **The Joint Venture Steering Committee**

### **John Holland**

Executive General Manager, Strategic Projects – Dennis Brewer

General Manager Water – Greg Taylor

### **Veolia Water Australia**

Chief Executive Officer – Peter McVean

Executive Vice-President, Major Projects Group – Michel Canet (Olivier Caumartin - by rotation)

### **Dispute Resolution Board**

George Golvan SC (chairman)

Graeme Peck

Ron Finlay

George H. Golvan Q.C.

Barrister

ABN 70 286 890 918

Liability is limited by a scheme approved under Professional Standards Legislation

Clerk "S"  
Owen Dixon Chambers West  
Level 11, Room 18  
205 William Street  
Melbourne 3000

Telephone: (03) 9225 7703  
Facsimile: (03) 9225 8928  
Ausdoc DX 94 Melbourne  
Email: [g.golvan@vicbar.com.au](mailto:g.golvan@vicbar.com.au)

25 February, 2011

Dear Sirs,

**Re: Project Name – Sydney's Desalination Plant Project**

**Nomination Category:**

**Australian Construction Achievement Award**

I have been advised that John Holland Pty Ltd and Veolia Pty Ltd Joint Venture ("Blue Water") propose to nominate Sydney's Desalination Plant Project ("the Project") for the 2011 Australian Construction Achievement Award.

As the Independent Chairperson of Sydney's Desalination Plant Project Dispute Resolution Board I wish to add my support to the nomination based on my close involvement with and knowledge of the Project.

At the commencement of the Project in 2007, the Principal, Sydney Water and the Contractor, Blue Water, established a three member Dispute Resolution Board ("DRB") consisting of one Independent Member nominated by the Principal and approved by the Contractor (Graeme Peck), one Independent Member nominated by the Contractor and approved by the Principal (Ronald Finlay) and a third Member to act as the Chairperson, nominated by the first two Members and approved by the Principal and the Contractor. I was the appointed Chairperson of the DRB.

The DRB met on site over the duration of the Project, between 2007 and 2010, generally at three monthly intervals, with both key site representatives and non-involved senior off site management personnel. The purpose of the DRB was to assist the parties to the Project to identify, discuss and resolve potential issues of concern between themselves, at the earliest possible stage, in a frank and open environment to avoid potentially acrimonious disputes. With the cooperation of the parties a range of potential issues were raised and discussed in a frank and open environment at DRB Meetings with the focus on successful Project delivery and dispute avoidance. The discussions invariably resulted in rapid and



## 2

pragmatic solutions to all problems or potential problems within a relatively short time after they were identified.

The DRB acted in a facilitation capacity, by encouraging, with the complete cooperation of the parties, a range of creative dispute avoidance procedures, including:

- Identification of potential issues and open discussions;
- Meetings of designated individuals (such as persons responsible for Project coordination) to discuss such matters as improving delays in design approval;
- Exchanging detailed written Position Papers on technical issues;
- Establishing a joint Subcommittee to deal with potential concerns;
- Creation of a joint workshop to deal with the possible scenarios available to address potential complex issues.

The DRB set timelines for discussions to take place and reporting obligations back to the DRB on the progress of the discussions. In every case, the processes encouraged by the DRB with the full support of the parties resulted in a pragmatic lateral solution, or in an ongoing process to deal with problems or potential problems before the parties positions were permitted to become entrenched. As a result, all issues of concern were able to be dealt with successfully by the parties themselves, and no issues were required to be referred to the DRB for recommendation, or were the subject of any dispute resolution procedure.

The Members of the DRB on a number of occasions in the DRB Minutes praised the excellent working relationship and cooperative approach adopted by the parties to ensure the success of the Project without disputation. In particular, I note the comments of the DRB at DRB Meeting No. 10 conducted on site on Friday 11 December, 2009 which reflect the unanimous position of the DRB Members:

***“Project Success***

*The DRB recorded as the Project was nearing completion that the outstanding attitude and cooperation that had existed between the parties from the outset had significantly contributed to the success of this large and complex Project and to the maintenance of a dispute free relationship.”*

The DRB also recorded that the safety record on the Project was exemplary and was a credit to the whole team, and observed that as an excellent innovation a full time doctor had been engaged on site for the last nine months of the Project.

The Project is a large and complex Project which had the potential for significant disputation at various time throughout the Project. I am able to say that from the outset and consistently throughout the Project both Blue Water and Sydney Water displayed a commitment to creating a pro-active mutual problem solving environment to facilitate the success of the Project. The Project issues were identified at an early stage and discussed between the parties in an informal, frank and open manner with the considerable assistance of senior personnel and

## 3

the facilitation of the DRB. The cooperative approach and joint commitment to project delivery by the parties, which extended until the completion of the Project, has been a key factor, in my opinion, in ensuring the outstanding success of this critical infrastructure Project.

I offer my strongest support, and I do so on behalf of the other Members of the DRB, to the nomination by John Holland and Veolia Joint Venture for this prestigious Award for their performance on this Project.

I note that the Project won the 2010 Government Partnership Excellence Award in the 2010 National Infrastructure Partnerships Australia *"Project of the Year"* Awards and was a finalist for the *"Project of the Year"* Award.

Yours sincerely,

**George H. Golvan QC**  
Chairperson  
Sydney's Desalination Plant Project  
Dispute Resolution Board



28 May 2010

SWC Letter Ref 53018

Mr Malachy Breslin  
Contractor's Representative  
Blue Water JV  
Building 1  
Sir Joseph Banks Drive  
KURNELL NSW 2231

Dear Malachy,

**Re: Sydney Desalination Plant – Design and Construct Contract No. 24507  
Letter of Support**

When Sydney Water engaged the Joint Venture of John Holland and Veolia Water to undertake the design and construction of the desalination plant we were confident that we had a team with the right skills, experience and approach to deliver this critical infrastructure project.

This was an immense project with numerous work faces, each with their own technical, timing and human challenges. We set a challenging scope technically and a very short target completion.

The Joint Venture met these challenges and have achieved or exceeded almost all of Sydney Water's performance requirements. They have worked with us to resolve issues in an open constructive way to the benefit of all parties and the final product.

Sydney Water's Chairman, Tom Parry and Managing Director, Kerry Schott are both on the record with their thanks and appreciation for a job well done.

I have worked very closely with the Joint Venture since the very start and would like to add my congratulations and sincere thanks for the professional and cooperative way the Joint Venture team have worked to deliver this iconic project.

Yours faithfully

A handwritten signature in black ink, appearing to read "Mike Watts", written over a light blue circular background.

Mike Watts  
Company's Representative  
Sydney's Desalination Project, Design and Construct Contract

---

100528\_Ltr\_53018\_Letter of Support\_MW  
28/05/10 12:02 PM

Sydney Desalination Plant Pty Limited (ABN 50 125 095 177)  
Sydney's Desalination Project 1 Smith Street Parramatta NSW 2150  
PO Box 399 Parramatta NSW 2124  
[www.sydneywater.com.au](http://www.sydneywater.com.au)

