William McCormack Place Stage 2

Engineers Australia Cairns Region
Engineering Excellence Awards 2010

Category: Project of the Year
October 2010

ARUP

MGF

GILBOY HYDRAULIC SOLUTIONS
Building Hydraulic Services Design

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Project participants

Client:
Queensland Government Accommodation Office, Department of Public Works

Procurement agent:
Project Services

Managing contractor:
Laing O'Rourke Australia Construction

Principal consultant:
Cox Rayner/CA Architects

Mechanical, electrical, lighting, acoustics consultant:
MGF Consultants (NQ) Pty Ltd

Hydraulic consultant:

Gilboy Hydraulic Services

Structural, civil, fire, traffic engineering consultant:
Arup

Project description

In mid-2007 the Queensland Government, Department of Public Works, commissioned a second stage of the William McCormack Place (WMP) office building. The client's brief placed particular emphasis on long-term ownership – lifecycle costing, resource efficiency, and durability.

The requirement was for approximately 10,000m² of Grade A office accommodation and supporting infrastructure. The project was to be delivered on the constrained and odd-shaped existing site, and without disruption to the Stage 1 building's operation.

WMP Stage 1 was Australia's first 5-Star energy (ABGR) rated building. The Stage 2 development was to build on this by also delivering a 5 Star Green Star Office Design, Office As-Built, and Office Interiors ratings.

The project's engineering team – civil, structural, fire safety (Arup), mechanical, electrical, lighting, acoustic (MGF Consultants NQ) and hydraulic (Gilboy Hydraulic Solutions) – was entirely local to Cairns.

In addition to a wealth of local knowledge and experience, the team brought to the table proven expertise in sustainable engineering to produce creative and viable strategies that enabled the client to reach its sustainability outcomes.

Design / engineering process

The design process for William McCormack Place Stage 2 is characterised by an unusually high degree of integration and collaboration. The client, architects, and engineers cut across traditional boundaries of responsibility in a series of design charrettes to ensure a structure within which all disciplines could excel – and continued this interaction throughout design and construction.

Many of the project's key features involved collaboration between multiple disciplines to produce mutually-beneficial designs.

- The structures and architectural team worked to develop a **post-tensioned (PT) slab** system for the office floors – reducing material, time, and cost. They also worked closely with the services disciplines to develop workable and future-proof riser arrangements.
- The structures and architectural team also completely eliminated **transfer structures.** In addition to reducing materials, this minimised constraints on services allowing the mechanical team to provide oversized ductwork for improved efficiency.
- Expert wind engineering advice allowed the architects to reduce **facade** costs and materials, without the need for expensive and time-consuming wind tunnel testing.
- **Safety in Design** principles were applied to allow safe and convenient access to clean windows at height without the need for abseiling or hire of specialist access equipment. The resulting slab projections were coordinated between the structures and architectural team and formed an intrinsic part of the facade shading strategy.
- Structures, mechanical, and hydraulic engineers collaborated on a clever 'stacked' solution to the large amount of **water storage** (including 1.5ML of chilled water storage) using an otherwise dead corner of the site, saving on space as well as structure.
- Civil engineers and architects effectively dealt with **stormwater** on a difficult (very flat) site and were able to utilise existing infrastructure avoiding new build; while hydraulic engineers contributed with rainwater collection and storage.
- Fire safety advice allowed the architects to externalise of two of the three main **fire stairs,** reducing costs and services.
- Fire safety, mechanical, and structural engineers also worked together to realise an open-sided naturally-ventilated **carpark** which would not otherwise have been allowable – reducing materials and services costs.
- Mechanical, lighting, and electrical engineers proposed an **interior form** and servicing arrangement which the architect accepted and developed. High ceilings and window-heads throughout an 8m deep open-plan perimeter zone provide excellent daylight while 'rib' bulkheads provide air distribution and services access, and dropped ceilings through the 'spine' provide main services and a **built zone.**
- The structures team worked with the architect and client to avoid excessive structure for **compactus zones** in the spine by bringing recognised global best practice to the office design loadings, while maintaining a high flexibility of use.
- Mechanical and electrical engineers utilised high-efficiency low-noise **ceiling fans** to assist air conditioning in cooling building occupants, and improve air mixing. This also enabled simplified zoning of air-conditioning which reduced ductwork quantities. Lighting specialists worked with manufacturers to develop a flexible control solution which integrates these fans to both lighting and air conditioning systems.
- Lighting specialists worked with the architect to optimise shading, glazing, and finishes to provide effective **daylighting** for all open-plan office areas. An innovative approach to daylight-harvesting controls was developed, designed to be more effective and acceptable than traditional systems.

Design / engineering process

- Electrical engineers in collaboration with the structures and architectural team designed 64kW **solar photovoltaic** generation and accommodated telecommunications services on the rooftop with a minimum number of roof penetrations, while also providing safe access to these and withstanding cyclonic conditions. Hydraulic engineers provided a contingency design for a 'smart' rainwater roof wash-down system (under the solar panels – though this was ultimately not needed).
- Hydraulic engineers worked with manufacturers to develop flow-control solutions for **water fixtures** which exceeded water efficiency labelling schemes.
- The hydraulic team worked with local council to obtain approval for a tropical-optimised solution re-using **rainwater and grey water** for use in toilet flushing and irrigation respectively (the opposite of a typical non-tropical system) maximising water re-use and minimising treatment requirements.
- Hydraulic and mechanical engineers collaborated with landscapers to develop a 'smart' **irrigation control system** which uses landscape irrigation as a method of disposing of treated grey water – significantly reducing water to sewer. Grey water collection includes around 170,000 litres per year of condensate water from air-conditioning.
- All services consultants coordinated a large number of interfaces between the **Building Management System (BMS)** and various sub-systems for centralised control and management via the BMS. This includes all time scheduling, sub-metering of all energy and water; and fault reporting on all systems.

At the centre of the building's lifecycle cost and energy / emissions savings are two key mechanical services engineering initiatives. The effectiveness of each engineering initiative enhances, and is enhanced by, the others – a true example of 'whole system design' in practice.

- A 1.5ML **thermal energy storage** system and associated air cooled chiller. This system provides for all cooling needs of both the Stage 1 and Stage 2 buildings entirely via overnight chilling – 90% of which occurs during the off-peak tariff period. This system radically reduces energy costs, avoids more than 5ML/y of water use, and reduces the peak demand of the building by half; while still using around 10% less energy than a conventional chiller system. At the same time, the design allowed the installation of only one chiller (rather than three) while the existing Stage 1 chillers provide full redundancy.
- A **pre-conditioning outside air** system with **rotary heat exchange** recovers approximately 75% of the waste energy from the exhaust air stream and uses it to pre-cool incoming fresh air. This provides around a quarter of the building's cooling needs essentially 'for free', while also providing improved indoor air quality and comfort control.

Engineering and sustainability innovations and outcomes

The key design and engineering solutions implemeneted on this project along with other engineering initiatives have assisted in delivering the WMP Stage 2 project on budget and ahead of schedule.

The building's energy saving initiatives are expected to deliver approximately $450,000 per year in cost savings. The design is also predicted to deliver an impressive suite of environmental outcomes.

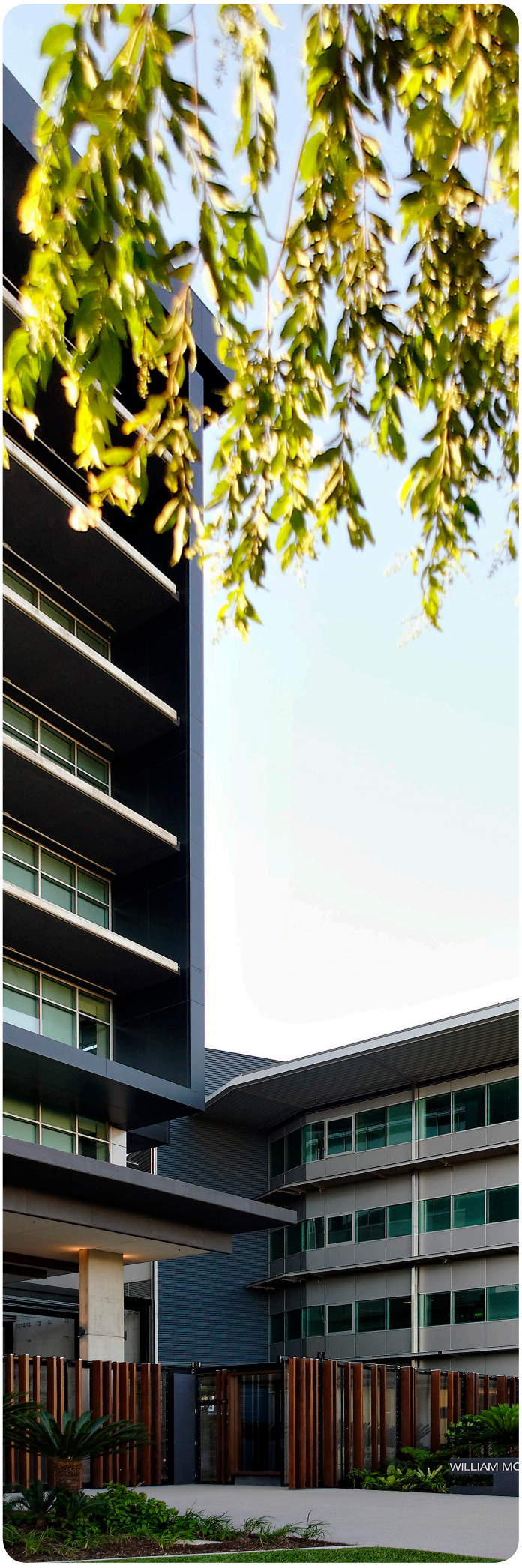
- 60% (1,000 tonnes/y) reduction in CO^2 emissions, compared to a median (2.5 Star) building, including:
  - 110MWh/y generation from 64kW Solar PV
  - 25% reduction in chiller requirements due to heat exchange
  - 20% reduction in cooling requirements due to ceiling fans
- 40% reduction in whole-building demand on the electricity grid,
  - with 90% chiller work in the network off-peak period
- 75% (17 ML/y) reduction in potable water use, compared to a median (2.5 Star) building, including:
  - 5ML/y saving due to the air-cooled chiller
  - 55% reduction in toilets portable water use (due to rainwater re-use)
- 25% (2 ML/y) reduction in flow to stormwater system
- 20% (1 ML/y) diversion of greywater to landscape instead of sewer
- 600 lux annual average daylight in open-plan zones (with >200 lux for 99% of working hours),
  - with 62% lighting energy reduction in open-plan zones
- 70% reduction in reinforcing steel used
- 30% reduction in air conditioning ductwork
- 50% increase in fresh air to office areas,
  - with significant further reduction in indoor air pollution6 Star Green Star Office Design v2 rating, with
  - targeted 6 Star Green Star Office As-Built v2 rating
  - targeted 5 Star Green Star Office Interiors v1.1 rating
- Anticipated 5 Star NABERS Energy ratings (whole building, base building, and tenancy)
- Anticipated 4 Star NABERS Water rating (whole building)

Community benefits

The completion of William McCormack Place Stage 2 in July 2010 has raised the bar for office accommodation in Cairns. It has demonstrated that world leadership in sustainable design is not only possible in the tropics, but is also possible with a local team of engineers. The engineering team brought intelligent and responsive design to the table to exceed client expectations, and the success of the project has placed Cairns on the sustainability map on a national and international level.

In the process of completing the design and construction, the local marketplace including builders, sub-contractors and suppliers have also learnt the benefits of sustainable design and in some cases raised their performance to help the project succeed.

The engineering team look forward to future opportunities within Cairns and further afield to help clients realise the real value of their commercial space by applying proven techniques to help realise long term environmental performance and reduced life-cycle costs.



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