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Technical Note

Project title	Project Duke
Job number	298537-00
File reference	Rev B - SSDA Amendment
cc	
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Date	May 2025 Cooling
Subject	Option Study

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1. Project Description

This memo summarises the results of cooling solution options reviewed for this proposed data centre development.

Following technical requirements were considered when conducting the analysis:

- A data hall supply air temperature of 23°C
- A low Power Usage Effectiveness (PUE)
- Ability to be adapted to suit various tenants
- Flexibility for design to be modified by operators to suit customer needs

The current design trends faced by the data centre industry is the adoption of direct-to-chip cooling. Liquid to chip cooling has gradually been deployed in some data centres in Australia. Another noticeable trend in data centre technology is the rise in temperature within cold aisles which allows the chilled water temperature to be raised and potentially the removal of chillers if water cooled solutions are used. The cooling solution chosen must be flexible in taking on these trends.

1.1 Site constraints

The project is located on land known as 2 and 10-22 Kent Road, and 685 Gardeners Road, Mascot, legally referred to as Lot 1 DP529177, Lot 1 DP1009083 and Lot 2 DP529177. The site is located on Country of the Gadigal people within the local government area of Bayside Council.

It has a land area of approximately 23,470m2 with frontages to Ricketty Street, Kent Road, and Gardeners Road, all of which are classified roads.

The cooling solution also needs to take into consideration the following site specific constraints:

- The project is in the Mascot West Employment area, with commercial/industrial premises to the north, south and west. To the east and southeast of the site is a high-density residential apartment towers up to 14 storeys in height. With the nearest sensitive receivers to be residential buildings 30-40m in distance to the site.

- The building will reach a total building height of 40m (from natural ground) with plant space on the roof level.

- There are 9 data halls in the building, with one data hall on ground level and three (3) data halls on level 1 and 2, and two (2), on level 3.

- The site is very close to Sydney Airport and the runways so the air quality of the site will be affected by emissions from aircrafts as well as road traffic near the site.

2. Cooling Options

The following cooling options have been reviewed during the concept design:

- Option 1: Air-cooled chillers + Fan Wall Units (FWUs)
- Option 2: Adiabatic air-cooled chillers + FWUs
- Option 3: Open circuit cooling towers (CTs) + water cooled chillers + FWUs
- Option 4: Hybrid towers + water cooled chillers + FWUs
- Option 5: Open circuit CTs + direct expansion (DX) FWU/Computer Room Air Conditioning (CRAC) units

These systems represent the most common cooling solutions used in Australia for data centre applications. Each listed option includes a description of its operational functionality.

2.1 Option 1: Air-cooled chillers + FWUs

Air cooled chillers produce chilled water and reject heat to ambient air. The chilled water produced is pumped to serve fan wall units which supply cool air into data halls and remove heat from the data halls. This option does not require water for heat rejection, but all chillers need be placed in the roof plant space as enclosed areas restrict the airflow intake into the chillers.

2.2 Option 2: Adiabatic air-cooled chillers + FWUs

Adiabatic air cooled chillers use evaporative pads to cool down the outside air before the air passing through condenser water coils. This makes the chillers more efficient as evaporative pads provide the first stage of cooling. The chilled water produced is pumped to serve fan wall units which supply cool air into the data halls and remove heat from the data halls. This option does require water for heat rejection and all chillers need be placed in the roof plant space as enclosed areas restrict the airflow intake into the chillers.

2.3 Option 3: Open circuit CTs + water cooled chillers + FWUs

Chilled water is produced by water-cooled chillers and heat is rejected via open circuit cooling towers to the atmosphere. The chilled water produced is pumped to serve fan wall units which supply cool air into the data halls and remove heat from the data halls. Water side free cooling is possible using plate heat exchangers and this will reduce the operation hours of the chiller resulting in improved annualised PUE. Water is required for the cooling tower operation.

2.4 Option 4: Hybrid towers + water cooled chillers + FWUs

The option is the same as Option 3 with cooling towers replaced by hybrid coolers. When ambient temperature drops, hybrid coolers will switch from wet mode to dry mode. This reduces the annual water consumption of the site.

2.5 Option 5: Open circuit CTs + DX FWU/CRAC units

Open Circuit Cooling Towers reject heat to the atmosphere and condenser water is pumped to serve direct expansion (DX) FWU/CRAC units, which have local condensers and evaporators. Water side free cooling is possible when the outdoor wet bulb temperatures drop below the condenser water supply temperature. No central chillers are required, and the local compressors are smaller but also less efficient.

3. Comparison of cooling options

To evaluate the efficiency of various options against the technical requirements as well as feasibility against the site restrictions, a comparative study was conducted. The results of the comparison study are summarised in Tabl1 below:

Cooling Option	Peak PUE	Annualised PUE	Water usage	Acoustic	Plant space	Future proofing
Option 1. **Air-cooled chillers + FWUs**	1.43-1.48	1.37-1.40	No water is required	89-95 dBA Significantly louder fans than water options.	Takes up more external plant space and will fit on the roof	Can be adopted for high supply air temperatures and liquid to chip. Still requires mechanical cooling
Option 2. Adiabatic air-cooled chillers + FWUs	1.37-1.42	1.30-1.36	Higher peak water usage. Overall annual water use is less.	89-95 dBA Significantly louder fans than water options.	Takes up more external plant space and will not fit on the roof	Can be adopted for high supply air temperatures and liquid to chip. Still requires mechanical cooling
Option 3. Open circuit CTs + water cooled chillers + FWUs	1.30-1.35	1.27-1.32	High peak water usage. High annual water usage	79-88 dBA	Can utilise both external and internal plantrooms	If higher cooling water temperature is acceptable to customers, chillers can be removed to provide better efficiency Can accommodate higher supply air temperatures and liquid to chip solution.
Option 4. Hybrid towers + water cooled chillers + FWUs	1.32-1.38	1.29-1.35	High peak water usage. Lower annual water usage	85-90 dBA	Can utilise both external and internal plantrooms	If higher cooling water temperature is acceptable to customers, chillers can be removed to provide better efficiency Can accommodate higher supply air temperatures and liquid to chip solution.
Option 5. Open circuit CTs + DX FWU/CRAC units	1.40-1.45	1.36-1.39	High peak water usage. Higher annual water usage	79-88 dBA	Can utilise both external and internal plantrooms	Can be adopted for higher supply air temperatures Cannot accommodate Direct liquid to chip solution.

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4. Results

Both air cooled chiller options having the highest peak and annualised PUEs. These two options also take up more external plant space and thus do not fit within the available roof area.

In terms of water usage, Option 3 has a higher annual consumption compared to the other options. However, it demonstrates greater efficiency during peak conditions, which reduces the need for water storage in the data centre. The data centre is designed at its peak conditions this means that less water storage space is required in design. Recycled water is available to this site and rainwater is also captured from the large roof area. Both measures will reduce portable water consumption of the site significantly.

Due to the proximity of residential receivers to the site, noise criteria are crucial in evaluating which cooling option is better suited for this data centre development. Both air cooled chiller options produce the loudest noise emission of all options. Option 3 and 5 emit the lowest noise of all equipment, hence are considered the most suitable solution for this site.

The lowest PUEs of all options analysed is Option 3 with open circuit CTs and water-cooled chillers, and this cooling solution is used in the design. This cooling solution also has the potential of removing water-cooled chillers if customers can utilise higher cooling water temperatures due to the adoption of liquid to chip cooling technology and/or raised supply air temperatures. This will further improve the energy efficiency of the system and provide even lower PUEs.

5. Conclusion

In conclusion, Option 3 with its used of open circuit cooling towers and water-cooled chillers to provide cooling to the data centre is shown to be the most efficient solution. The option is flexible in its design, it can also be adapted to liquid to chip cooling which will make the cooling solution even more efficient. It has lowest noise emission which is important for site close to residential towers. The availability of recycled water to the site also makes water cooled chillers and cooling towers the most appropriate solution as the reliance on portable water is significantly reduced.

DOCUMENT CHECKING

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