9.10 Engineering responses to DGRs

Engineering Response to Director Generals Requirements
Sydney 2
Global Switch

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aurecon

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Contents

1. General

This report describes the systems intended to be provided within the proposed Sydney 2 development for Global Switch. This is a very heavily serviced building due to the need to support high amounts of Information and Communications Technology (ICT) equipment, thereby making its power consumption relatively high. This report also forms a response to the engineering queries that were raised in the Director Generals' Requirements and is to be read in conjunction with the responses from DEM, Global Switch and in particular the following additional engineering reports:

- Acoustic Report by Aurecon
- Plume Study by Parsons Brinckerhoff

The overall technical objective of Global Switch is to provide a world-class, best-practice, mission-critical internet data centre on the site adjacent to their current facility in Ultimo.

The intent for the new building is to provide a technical facility with real delivery of power to IT space of 1500W/m² plus power for cooling and ancillary systems.

The electricity supply will be available on a 24 hours per day 7 days per week basis (24×7), by the provision of on site gas engines to generate electricity, electrical feeders by the supply authority, and diesel-backed electrical generators. The computer equipment loads will also be supported by UPS (Uninterruptable Power Supply) equipment. This equipment will provide continuous (no-break) and short-break power equating to 100% of power requirements and providing 100% backup of the mains and on site gas generators. The heat generated by the gas engines will be used in absorption chillers, providing chilled water to cool the computer equipment in a scheme known as trigeneration. All of the central plant and associated reticulation systems will be arranged with redundancy so that the facility will remain operational upon failure or outage for maintenance of plant or reticulation systems.

The design philosophy can be summarised as providing the following:

- To world industry standards for mission critical facilities.
- Energy efficient with reduced Carbon Dioxide emissions.
- Water recycling.
- Reliable electricity supply fully supported by UPS systems.
- Reliable cooling systems able to provide controlled environment for full technical equipment heat load capacity.
- Redundancy of all critical plant and systems.
- Modular plant and reticulation systems for ease of expansion for load growth and with provision for seamless addition of plant at later stages.
- High presence of security with 24×7 security operation and extensive detection, access control and surveillance devices.
- High level fire protection and detection systems.

1.1 Trigeneration

This development departs from a traditional commercial building or data centre in that it will use trigeneration as the primary energy source. Although the plant scale is not large compared with a power station, it is large compared to other commercial buildings where cogeneration or trigeneration has been used. Trigeneration consists of on site gas engines generating electricity. The heat generated by these engines from both the exhaust and the engine jacket will be used to drive absorption chillers. The heat will also be used to heat hot water.

The reasons why providing trigeneration plant is better for the environment include:

- Much lower carbon dioxide emissions than using electricity sourced from the NSW grid. This is because the majority of the grid sourced electricity is produced by burning coal. The electricity generated on site is from burning natural gas which has lower emissions than coal.
- Higher usage of energy contained in the gas than using grid electricity because the heat from the electricity generation is used within the building in the absorption chillers.
- No energy is lost in the electrical transmission associated with transporting electricity across the grid because the electricity is generated on site.

The high energy consumption of this building amplifies the advantages of trigeneration compared with a more typical commercial development.

1.2 Utility Providers

The following utility providers have been contacted and have confirmed that suitable connections for this building are available.

Utility	Provider
Electricity	Energy Australia Refer to the letter included in Appendix A
Water Stormwater/Sewer	Sydney Water Discussions held, Sydney Water Servicing Coordinator appointed. Section 73 will be lodged to suite construction programme. Refer to the letter included in Appendix B.
Natural gas	Jemena Discussions have been held with Jemena. The contract for the supply of gas and installation of the required pipes is currently being tendered.
Telecommunications Carriers	Space allocated in building for carrier equipment.

2. Electrical

2.1 Electrical Design Objectives

The electrical design objectives are as follows:

- Provide real delivery of power to IT space of 1500 W/m² for transformer cable and circuit breaker sizing of plus power for cooling and ancillary systems.
- Provide a reliable electricity supply based on 24×7 operation, with gas powered generators and electricity authority mains fully backed up by diesel generators.
- Provide redundancy of major items of plant and alternative reticulation paths to minimise single points of failure and enable maintenance and replacement of equipment and switchboards.
- Provide major equipment in appropriate modules to enable expansion of facility.
- Provide dual output power supplies to the ICT equipment.
- Provide the lowest possible running, maintenance and capital costs

2.2 Regulations and Authorities

The installation will be designed in accordance with:

- AS3000 –2007 Wiring Rules
- NSW Service and Installation Rules
- Building Code of Australia (BCA)
- Relevant Australian Standards

2.3 Network Power Supply

The facility will be a high voltage customer and will take supply at 33kV via one 33kV underground cable supply (20+MVA rating), likely from Energy Australia's Pyrmont Subtransmission Bus. A 33kV cable connection will also be made to the existing Global Switch Sydney 1 facility.

Two 33/11kV transformers will be installed. These transformers will be rated so that in fan forced mode they can supply the entire building load. In normal mode, when the building is operating on trigeneration mode a single transformer would provide the link to the electricity grid.

A 33kV Switchboard will be installed on the site. This switchboard will incorporate circuit breakers for the incoming and link cable protection as well as protection of the 33/11kV transformers. This switchboard will be bus separated so that the bus is not a single point of failure.

2.4 On-Site Gas Generator Supply

The primary source of electricity for the site will be the on-site reciprocating gas engines. These will be installed on an n+1 basis to allow for one machine to be in maintenance. Additional redundancy will be provided by the electricity grid and the on-site diesel generators.

These engines will be rated to approximately 4MW each.

The exhaust for these engines will be treated to reduce Nitrate Oxides as required by the DECCW. Refer to separate report from Parsons Brinckerhoff.

2.5 Backup Diesel Supply

In case of failure of the external energy networks, on site diesel generators will be installed so that building operations can be maintained.

2.5.1 Fuel Storage

Bulk fuel storage will be provided for the diesel generators to provide 48 hours running time at full load (nominally 400,000 litres).

This system will be designed and installed in accordance with AS1940, The storage and handling of flammable and combustible liquids.

2.5.2 Machine Room Ventilation

The machine rooms for the gas and diesel engines will be provided with attenuated inlet and outlet air plenums. During operation of the engines fans will provide the ventilation of the room.

2.6 Internal Reticulation

The internal power reticulation will be at 11kV. All of the diesel and gas engines will be connected at this voltage. The electricity will be reticulated to multiple locations on each floor where the supply will be stepped down to 400V.

11,000/400 volt transformers will be located within the building in accordance with load requirements. Transformers will be cast epoxy resin type, naturally cooled.

Each technical space will be provided with 2 supplies.

2.7 Earthing Systems

Three earthing systems will be provided. A combined power earth system in accordance with AS3000, a technical earth system and a lightning earth system.

The technical earth system will be separately distributed from the main earth bars to each technical floor with earthing connection cubicles distributed around the floors for connection of equipment earth cables. The resistance to earth at any point in the technical earth system will be no greater than 3 ohms.

The lightning protection connection to earth will be separate from the power/technical earth systems.

2.8 Lighting

Lighting will be provided in accordance with AS1680. In office areas the maintenance illuminance will be a minimum of 320 lux on an open plan basis. Office luminaries will be provided with low brightness direct/indirect diffusers to provide lighting suitable for screen based tasks.

In the shell of tenancy areas minimum lighting will be provided with maintenance illuminance of 40 lux.

Technical areas will be provided with lighting to 200lux on the vertical face of the ICT cabinets.

The lighting control will be designed to achieve the maximum Greenstar/ABGR points. All luminaires will be fitted with addressable control gear.

2.9 Emergency & Exit Lighting

Emergency and exit lighting will be provided in accordance with AS 2293.

2.10 System Control and Data Acquisition System (SCADA)

A PLC based SCADA system will be provided to monitor and control the entire electrical system and measure the energy consumption at numerous locations throughout the building.

3. Telecommunications

3.1 Telecommunications Providers

Provision will be made within the building to accommodate in excess of ten fibre optic cable and copper network providers.

3.2 Cable Entry Rooms

Two entry rooms will be provided adjacent to the initial Meet Me Rooms.

Redundant pathways with multiple conduits will be provided from the cable entry rooms to pits within the footpath for cable access for the cable providers.

3.3 “Meet-Me” Rooms

Two initially, with provision for a future 2, fully serviced “meet-me” rooms (MMRs) will be provided for installation of the cable providers’ termination and distribution equipment racks.

3.4 Floor Distributors

Floor Distributors (FDs) will be established on each floor. Each of these will be provided with dedicated cable pathways to one of the MMRs. These provide space at each level for the structured cabling system to be connected.

3.5 Building Cabling Reticulation

Dedicated cable routes without cable tray systems will be provided between the “meet-me” rooms, Floor distributors and the computer halls. Redundant pathways will be provided.

4. Security

4.1 General

The security measures, subject to detailed risk analysis and subsequent completion of a detailed security brief, will include the following items.

4.2 Access Control

All points of access into the building and all movement within the building will be controlled by a computer based security and access control system. This will include access control at the following locations:

- Main pedestrian entry.
- Ground level vehicle entry.
- All passenger lifts and goods lift (car call and hall call).
- All plant rooms, switch rooms and communications rooms.
- All technical spaces.
- All tenancy areas, office and technical.

4.3 Physical Security

Security guards will be in occupation in the building with guards present at all entry points and the security room. Guards with electronic checkpoints and continuous communication with the security room will carry out frequent security patrols through the building.

All perimeter elements of the building will be installed so that they cannot be opened/removed without an authorised key or damaged sufficiently to permit access without setting off an alarm.

4.4 Intrusion Detection Alarms

Intrusion detection alarms will include the following:

- Perimeter and internal door sensors
- Glass breakage sensors
- Motion detectors
- Other sensors as determined by risk analysis

4.5 CCTV Surveillance

A comprehensive CCTV surveillance system will be provided with high-resolution cameras located to monitor the following:

- The extended building perimeter including:
  - Pedestrian and vehicular approaches to the building
  - All points of entry and exit to/from the building
- All lift lobbies and lift cars
- Carpark and loading dock
- Plant room entry/exit doors
- Communications room entry/exit doors
- Access corridors
- Fire stair entry doors
- Security room
- Other locations as determined by the risk analysis.

The CCTV system will be provided with digital recording with minimum 30 days of archiving and remote retrieval and play back of archived video.

5. Mechanical

5.1 Cooling Plant

5.1.1 General

The central cooling plant and systems arrangements will be integrated with the electrical supply and electric plant. The design and arrangement of how the cooling is achieved is fundamental to the operation and optimisation of energy consumed for this Data Centre.

The design of the cooling plant is fully dependant on how the electrical design is configured. Therefore energy savings are a paramount consideration for the design of the cooling systems in conjunction with the electrical systems.

5.1.2 Cogeneration Plant

The cogeneration plant for the four stages will comprise of gas engines which will provide 4MW nominally each.

5.1.3 Consideration Items for Cooling Plant selection

The following items will be considered in order to reach the best option to provide cooling for the Data Centre:

- N+2 redundancy
- Eliminating single points of failure to maximise reliability.
- Starting time from cold
- Starting time from emergency stop
- Interface operation with electrical plant
- Mitigation of risk issues
- Minimise replacement times
- Lowest running costs
- Maintenance costs
- Capital cost
- Design for 24 hour, 7 day per week operation
- Modules to allow for ease of expansion

5.1.4 Absorption Chillers

Multistage absorption chillers utilising waste heat from the jacket water and flue gas from the associated gas engine.

Cooling towers for the absorption chiller will also operate to reject jacket water heat from engine when the chiller is not running. A heat exchanger and pump will be arranged to allow for this changeover to occur.

5.1.5 Electric Chillers

Electric chillers utilising low voltage (LV) motors at 400 volts of approximately 4000kWR will allow quick start-up for the back-up operation.

5.1.6 Low load electric chillers

A small chiller is considered essential for this facility which will be optimised in use during the initial stage of this project. As the project grows in demand, the reliance on the low load chiller will diminish.

Water cooled type is recommended in lieu of air cooled type because of higher efficiency and greater life expectancy with compressor accommodated inside the plantroom.

5.1.7 Chilled water reticulation

Chilled water will be reticulated throughout the building by secondary chilled water pumps.

Redundancy will be incorporated with dual pipework sized at a higher velocity.

5.1.8 Cooling Towers

Heat rejection from the chillers will be via cooling towers mounted on the roof level over. Condenser water pumps will circulate condenser water from a chiller to the cooling towers. A water treatment facility for the system will be provided to maintain close control of the condenser water to limit corrosion and bacterial build–up in the system.

Water storage will be provided for the cooling towers and humidifiers to allow operation for up to 12 hours, in the event of failure of the towns main water supply.

5.2 Technical Spaces

5.2.1 General

Air conditioning of technical spaces will be carried out by tenants as tenancy fitout. It is intended that the technical spaces will be air conditioned by means of chilled water, down blow computer room type process coolers (CRAC units).

5.2.2 Hot/Cold Aisle Arrangement

The industry standard is to arrange the racks within the data space in a hot aisle/ cold aisle arrangement where cold air is delivered from the underfloor void to the front of the equipment racks only. The hot air from the back of the racks is then allowed to return from the hot aisles back to the CRAC units.

It is common in such an arrangement that the hot return air will mix with cold aisle air therefore reducing the overall efficiency of the system. This is because some of the cold air is only cooling the hot return air, not cooling the actual equipment contained within the racks.

The efficiency of a hot/cold aisle arrangement can be improved further by containing the hot or cold aisle to avoid mixing of the two air paths. This can be by either sealing the end of the aisle or by providing an air path within the rack.

It is proposed to seal the hot aisles and return the hot air back to the CRAC units via a ceiling plenum or ductwork at high level. This creates the following advantages:

- Increased capacity from CRAC unit due to higher air on temperature
- Enables an increased supply air temperature thus reducing the level of de-humidification from the coil and therefore the amount of humidification required from the humidifiers. (19degC as opposed to the normal 13degC).
- Increased supply air temperature enables a higher chilled water temperature to be used, resulting in increased efficiency at the chiller.
- Reduced mixing between hot and cold aisles

Unless racks with built in hot aisle plenums are used, the hot aisles will need to be contained via baffles installed from the top of the racks to the ceiling over. The ends of the aisles will also need to be contained with a door or similar. Technicians will be required to work within this higher temperature space (> 30degC) when working on the rear of the racks.

5.3 Office Areas

The office area will be air conditioned by means of individual fan coil units (FCU) located within floor plantrooms. Air will be distributed throughout the office areas by means of sheet metal ductwork and ceiling diffusers.

Dedicated fan coil units will be provided for conference room, board rooms etc.

5.4 Electrical Service Plant Rooms

The electrical services plant rooms will be air conditioned by means of chilled water fan coil units located in the rooms.

Routes for condensate drains will be arranged outside of the technical space.

5.5 Meet-Me-Rooms

The meet-me-rooms (MMR) will be air conditioned by CRAC units.

5.6 Ventilation Systems

The following ventilation systems will be provided to meet Building Code of Australia and Authority requirements:

- Combined outside air supply and building pressurisation system
- Plantroom ventilation
- Toilet exhaust
- Zone Smoke control system
- General exhaust system to serve future tenant needs regarding gas suppression systems.

The technical spaces will be positively pressurised to limit the entry of dust-laden air. High efficiency filters will be provided to the outside air systems to maintain clean conditions within the technical spaces.

Outside air and exhaust ventilation will be provided to all non-technical areas in accordance with AS1668.2

5.7 Building Management System

A Building Management System (BMS) will be provided to monitor and control the operation of the building services and to provide status and performance information to allow assessment of overall facility readiness.

The BMS will monitor the status of the following services:

- Central mechanical plant
- All air-conditioning systems
- Hydraulic plant interface
- Fire services interface

6. Fire

6.1 Engineering

Aurecon will provide a fire engineering report, with fire engineer's certification, addressing fire safety issues relating to the entire "Global Switch 2" development. In particular, the report will include assessment of potential fire spread from the new development to existing RTA structures. The report will confirm through design of appropriate passive structures and active fire protection systems, spread of fire to existing RTA structures will not occur.

6.2 Automatic Fire Sprinkler System

The building will be protected with an automatic fire sprinkler system in accordance with AS2118 – 1999.

To prevent water damage from leaking pipes and accidental damage to sprinkler heads, the technical floors will be protected by double interlocked pre-action sprinkler systems with solenoid-operated valves holding the water in the sprinkler valve room. The pipe-work to the technical spaces will be dry. When dual interlock smoke detection activates (detector and MASD) and a sprinkler bulb fuses, the pre-action sprinkler system solenoid valve operates and the sprinkler pipe-work will be charged with water. The sprinkler system then operates in a normal fashion.

The building will be provided with a grade 1 water supply.

Dual connections to town mains are proposed.

The installation control valve assemblies will be located in the sprinkler valve room on ground floor.

The sprinkler booster pumps to AS2941 will boost the water through the sprinkler system maintaining the required pressure at the highest sprinkler head.

6.3 Gas Based Fire Suppression System

The building will be provided with the infrastructure for a gaseous fire suppression system comprising:

- A central cylinder store.
- An array of directional valves to direct gas to specific areas.
- Risers to allow a future main to each floor. The extension of the main to the tenants is by the tenant.

Tenants requiring gaseous fire suppression will be able to connect to the respective reticulation to each technical space.

The gas cylinders will be sized to provide sufficient gas to release gas twice to the largest initial fit out area of maximum space of 1500m². This gas system will require dual detector logic for system activation.

6.4 Fire Detection and Warning Systems

The building will be provided with a distributed addressable Automatic Fire Detection system compliant with Australian Standards, incorporating discriminating logic to minimise false alarms, to provide:

- Early warning of fire
- Early evacuation of staff and visitors.
- Control and initiation of ancillary devices and systems.

- Indication of location of the fire.

The fire detection and BOWS (Building Occupant Warning) systems will be zoned to suit the separation and compartmentation requirements of the building and suit the smoke control system.

The main addressable Fire Indicating Panel (FIP) will be located in the Fire Control Valve room with a mimic panel located at building entrance.

The gas and diesel generator rooms shall be provided with point type flame detection

The system will be interfaced with the following:
- The BOWS
- Other building services such as smoke exhaust systems
- Technical area suppression system
- The Building Management System (BMS)

6.5 Building Occupant Warning System

The building will be provided with a Building Occupant Warning System complying with AS1670.4 and 5.

The Master Emergency Control Panel will be located in the Building Control Room.

Generally, 100mm diameter recessed ceiling speakers with 100V line variable tap transformers will be used throughout the building where false ceilings are fitted and horn type speakers will be installed throughout such areas as plantrooms and technical floors, where there are no false ceilings.

6.6 Portable Fire Extinguishers

The building will be provided with portable fire extinguishers and fire blankets to AS2444 and the BCA. Water mist, CO_2 and dry chemical extinguishers will be provided to the technical areas.

Trolley mounted CO_2 extinguishers and floor tile lifters will be provided to each technical space loading dock area.

6.7 Water Mist System

A water mist system shall be provided within the gas and diesel generator rooms.

The arrangement of the water mist pipework and nozzles shall be in accordance with the manufacturer's data sheets, shall be Underwriters Laboratories (UL) approved and shall comply with NFPA750 and AS4587.

The water mist system shall activate by a double interlock detection arrangement on a signal from ob the MASD and point type flame detection within the gas and diesel generator rooms.

7. Hydraulic

7.1 Generally

The Hydraulic Services will be in accordance with the requirements of all the relevant authorities and of a high commercial standard.

7.2 Sewer Drainage & Sanitary Plumbing

The sewer drainage and sanitary plumbing system will collect the discharge from the various sanitary fixtures, air conditioning plant and drainage points and will gravitate to the water treatment plant on the lowest level. A pump out to Sydney Water's sewer main will be provided.

The sewer drainage and sanitary plumbing will be designed and arranged so that maintenance of the system can be minimised and carried out with no disruption to the technical areas.

The system will be designed in accordance with AS3500 the National Drainage and Plumbing Code.

7.3 Stormwater Drainage & Downpipes

A new system of downpipes and stormwater drainage will be provided from the roof area to cater for a 1:100 year storm event, in accordance with the guidelines of Australian Rainfall and Runoff.

The downpipe system will also be provided with external overflow that can cater for the full 1:100 year discharge as a fail-safe system.

7.4 Access Floor Drainage

To minimise the risk of water damage caused by a burst pipe or from the fire protection system being activated an access floor drainage system is to be incorporated into the development.

The system will consist of a network of drains, which will gravitate to discharge over a sewer gully. The access floor drainage provide at the ground level may require discharge to a separate waste water pump pit and pumped to discharge over the sewer connection gully, to prevent surcharge of the sewer system into the proposed computer flooring space.

The drains will incorporate water seals, to ensure there is no leakage of conditioned air or of the gas based fire suppression system.

The access floor drainage will also handle condensate discharge from the process coolers.

The system generally will be designed to prevent backflows. Boundary backflow penetration will be provided to prevent network sewer from back flowing into site sewer system.

7.5 Cold Water Service

The cold water service will be pressurised mains feed system from a Sydney Water's main as the primary supply.

This storage tank will also be provided with a connection from the primary water supply.

The cold water service will be reticulated to all fixtures, taps, cooling towers, mechanical plant and points of connection. The reticulation will be provided with a pressure range of 200 kPa to a maximum of 500kPa with a maximum velocity of 1.95m/s with a diversity of 40% for the amenities and full flow for cooling tower make up and process coolers.

The pumping units on the primary cold water services and the cooling tower water supply will be provided with variable speed drive units and arranged for n+1 redundancy.

The cold water service will also incorporate water filtration plant on each of the connections to Sydney Water's mains. This filtration plant will have a minimum 50 micro screening and incorporate automatic backwashing.

7.6 Domestic Hot Water Service

The domestic hot water system will serve all fixtures and taps requiring hot water.

The hot water plant will consist of heat recovery from the gas engines.

The hot water reticulation will be a circulating system with dual hot water circulating pumps. The system will comply with AS 3666*.*

Taps, which incorporate temperature stops for general amenities and thermostatic mixing valves for disabled person's amenities, will provide warm water, to basins.

7.7 Fire Hydrant & Hose Reel Service

The fire hydrant and hose reel service will be separate mains feed systems in accordance with the BCA requirements.

The systems will be a ring main type, which incorporates dual pressure sets, hydrant booster valve, a connection to the 300mm Harris Street water main and all required hydrants and hose reels.

In line with the (n+1) redundancy, the ring main will be provided with a central interconnection riser and will incorporate control valves to allow any section of the main to be isolated for regulatory maintenance. This interconnected ring main system allows for a section of the main to be shut down without the necessity for total closure of the system.

7.8 Sanitary Fixtures & Faucets

The sanitary fixtures and faucets will be of a high commercial standard.

Sanitary fixtures will generally be vitreous china wall mounted type to facilitate ease of maintenance.

Electronic beam activated flushing will be incorporated for urinal flushing, with water closet suites being close coupled cisterns.

Faucets will be mixing valve type, which incorporate temperature limiting and flow control devices.

7.9 Water Recycling / Re-use

The facility intends to capture and reuse water from the following sources:

- Stormwater capture and treatment from Sydney 1
- Stormwater capture and treatment from Sydney 2
- Sewer water capture and treatment from Sydney 1
- Sewer water capture and treatment from Sydney 2
- Potentially sewer mining from the street sewer mains and then treatment of the sewer.

Options for water treatment for use in building services cooling systems are being considered by the design team, however are subject to further analysis.

Rainwater is to be harvested from the roof structure and fed into the existing building services for site irrigation and toilet flushing.

The tank locations are shown on architectural site plans, with relevant controls located within designated plantrooms. This will allow the building manager to monitor the usage, rainwater levels and possible reuse volumes that have been captured at the site. Control systems and monitoring functions are subject to further detailed design.

8. Environmental

8.1 Mandatory Compliance

8.1.1 Section J Building Fabric Assessment

The facility has will be designed in accordance with the energy efficiency provisions of Building Code of Australia (BCA) Part J for building constructions and services. The BCA requires a minimum R1.8 value for external walls and R3.2 value for roofs / ceilings where conditioned for Climate zone 5. The building fabric will be detailed to exceed these values for all conditioned spaces. The typical external wall construction for the building is to be metal cladding and precast systems with internal linings. The proposed roof and main structural frame to be in-situ concrete construction.

Wall Constructions

The general wall and roof constructions for the building are to achieve the following minimum R-values as defined in the following tables:

Table 1: Typical Wall constructions detail

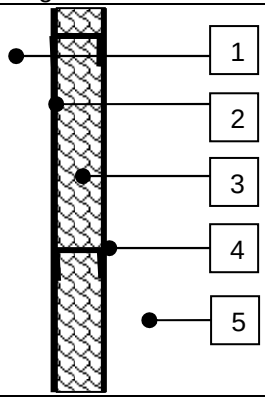
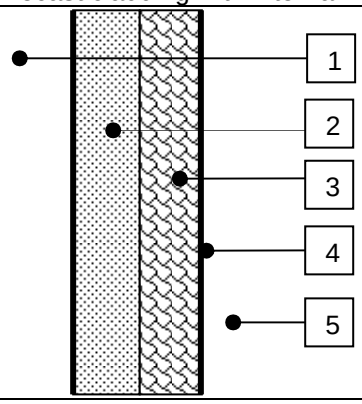
Steel framing with metal sheet cladding	Item	Description	R-value
	1.	Outdoor air film (7m/s)	0.03
	2.	Metal sheet cladding or similar (1.2mm thk)	0.00
	3.	R1.66 Insulation (64mm thk, low density 16kg/m^3 or similar)	1.66
	4.	Internal lining (12mm thk)	0.06
	5.	Indoor air film (still air)	0.12
	Total R-value		1.81

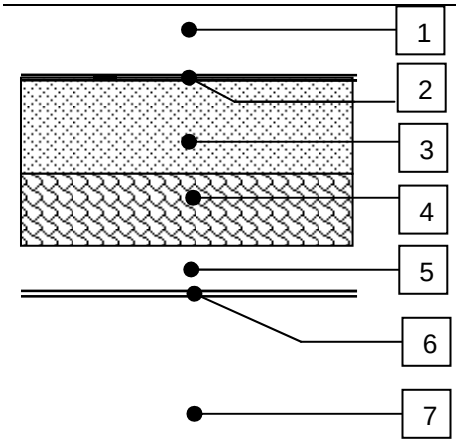
Table 2: Typical Wall constructions detail

Precast cladding with internal lining	Item	Description	R-value
	1.	Outdoor air film (7m/s)	0.03
	2.	Precast cladding or similar (90mm thk, 2400kg/m^3)	0.07
	3.	R1.66 Insulation (64mm thk, low density 16kg/m^3 or similar)	1.66
	4.	Internal lining (12mm thk)	0.06
	5.	Indoor air film (still air)	0.12
	Total R-value		1.94

Roof / Ceiling Constructions

The roof construction proposed is concrete with internal ceiling linings. All roof constructions are to achieve the minimum following constructions to satisfy BCA Part J1 energy efficiency requirements.

Table 3: Roof / ceiling constructions for steel frame without ceiling lining

Steel frame with metal roof sheeting no ceiling	Item	Description	R-Value (down)
	1.	Outdoor air film (7m/s)	0.03
	2.	Membrane	0.00
	3.	Concrete slab (200 thk, 2450 kgm^3)	0.07
	4.	Insulation R2.84 (163mm thk, low density 6.25kg/m^3 or similar)	2.84
	5.	Air space (Unventilated non-reflective 200-500mm)	0.17
	6.	Ceiling lining	0.08
	7.	Indoor air film (still air)	0.16
	Total R-Value		3.35

In summary the performance criteria for the building constructions is as follows:

Element	Minimum Requirement	R-value to be achieved	Typical Insulation Requirements
Typical wall constructions	R1.80	R1.81	R1.66
Roof to conditioned spaces	R3.20	R3.35	R2.84
Floors that separate conditioned and unconditioned spaces	R1.60	R1.69	R1.18

8.2 Ecological Sustainable Development (ESD)

The new Global Switch development has considered the elements of Ecologically Sustainable Design in the planning of this new data centre. The development incorporates a number of sustainable design initiatives that address the whole life of the building from conception through to construction and operation. The team has considered environmental impacts in energy, water, materials

The elements of sustainability hat have been addressed include:

- Local planning provisions where applicable to the development type
- Energy & water efficiency measures and benchmarks
- Materials and waste minimisation
- Operational monitoring and reporting

8.2.1 Energy Efficiency

The design team has utilised existing Global Switch Data Centres to benchmark this facility. The facility will include a number of initiatives to facilitate as outlined below.

Energy benchmarking exercise is to be undertaken using appropriate energy assessment tools. NABERS Office Energy tool is not appropriate for use due to protocol limitations. Project team is to set the energy benchmark for the development using an appropriate measurement tool and compare the benchmark to the proposed energy consumption for the development. Investigations into the NABERS Data Centre tool will be undertaken in association with NSW Department of Environment Climate Change & Water NABERS Energy Data Centre rating could be achieved in operation.

Mechanical design (Trigeneration)

The mechanical system for the centre is to incorporate trigeneration plant. The trigeneration plant is to assist in the reduction of greenhouse gas emission of the building through the use of a cleaner fuel source and use of waste heat to produce chilled water. The engines / turbines (generator) converts rotary engine power to electricity and simultaneously captures the heat from the exhaust gases and cooling water (heat exchangers). This heat is directed into absorption chillers. Therefore the total energy demand of the building services in operation of this facility will be reduced through the use of absorption chillers.

Monitoring & reporting

Sub-metering of major plant, equipment and tenant rooms is to be implemented within the building to facilitate effective recording and measurement of the electricity consumption of different energy uses within the facility. A comprehensive metering system will allow the facility manager to monitor energy usage attributed to the different spaces such as major plant, back of house areas, major and minor tenants etc.

Ongoing reporting will allow Global Switch to monitor energy targets and set ongoing goals for energy consumption reductions in operation. By monitoring energy usage, losses and tariff exchanges can be identified, therefore improving the overall performance of the building in operation. This initiative is subject to further design development and in association with the NABERS Data Centre tool development.

Lighting specification and design

Lighting efficiency is to be implemented in the facility. A lighting density of around 6-7 W/m^2 with efficient ballasts is to be targeted for the building with minimal specialised lighting. Lighting controls (with time switches) is to be implemented to ensure lights are turned off when areas are unoccupied. This will ensure that no interior lights are operating during unoccupied times. Lighting controls will be zoned such that the areas can be lit according to needs of occupants.

8.2.2 Water Efficiency

The development will incorporate a number of water initiatives and consider the recycling options. NABERS Office Water tool is not appropriate to this development type due to the expected usage, which is not considered comparable to a typical office environment. The project team is to develop NABERS Water benchmark for the project.

Investigations into the NABERS Data Centre tool will be undertaken in association with NSW Department of Environment Climate Change & Water to determine if a NABERS Water Data Centre rating could be achieved in operation.

On-site recovery

Rainwater is to be harvested from the roof structure and fed into the existing building services for site irrigation and toilet flushing. Initial feasibility assessments have determined that rainwater capture and reuse options would provide very limited benefit to building services systems due to the disparity between cooling tower usage and rainwater availability. Options for tertiary water treatment and sewer mining are being investigated with relevant authorities, however feasibility of this option is subject to further design investigations.

The tank locations are shown on architectural site plans, with relevant controls located within designated plantrooms. This will allow the building manager to monitor the usage, rainwater levels and possible reuse volumes that have been captured at the site. Control systems and monitoring functions are subject to further detailed design.

Specification of Fixtures

Potable water usage for the site will be attributed to showers, basins in toilet areas, WC's, urinals, kitchen sinks and some external works for irrigation. The on-site rainwater tank has been sized to meet the demand for toilet flushing with allowances for external landscaping and irrigation. To reduce the overall demand attributed from these uses, fixtures are to be specified to achieve a minimum 4 WELS rating or better where feasible for the proposed use. Each basin fitting is to include automatic shut-off to further reduce potable water demand.

8.2.3 Materials Management

Waste Management in Construction

Management of waste streams in construction through appropriate application and implementation of Waste Management Plan. Minimum waste recycling target of 80% has been set for the project. All opportunities to re-use materials from the excavation phase are to be investigated for the project and are to be limited to materials deemed non-hazardous. The Waste Management Plan for the development is to include as a minimum:

- Documentation of the proposed waste management strategies for the construction stages from excavation through to commissioning
- Provision for on-site materials sorting and collection area. Materials to be sort include timber, blocks, bricks, glass, metals, insulation, pallets, cardboard concrete & associated construction materials.
- Provision for on-site monitoring of wastes generated with details of weights (quantities) for each material, disposal destinations (tracking) and receipts.
- Identification of materials that pose environmental risk to be used on site
- Define the appropriate waste disposal measures to be undertaken for materials that pose an environmental risk such as soils, concrete, contaminated water, paints etc

Waste Management in Operation

Typical waste streams for data centres are limited to general office wastes and IT wastes. A waste management plan is to be developed for tenants that include appropriate recycling and disposal of all waste streams. It is expected that tenants will manage their own wastes. General office wastes produced by the Facilities Management staff will include appropriate office recycling and sorting facilities.

Specification of Materials

Interior finishes will consider the concentration of Volatile Organic Compounds with products for adhesives, paints, carpets and floor sealants. The design team will work with suppliers and contractors to identify opportunities to reduce the level of VOC's within products and finishes. This initiative is subject to further design development of the project team.

8.3 Operational Risks

The following is a list of potential environmental risks and their proposed mitigation method that have been identified as part of the operation of this facility.

Diesel contamination

The diesel handling and storage system will be provided in accordance with AS1940. This stipulates methods for control of spill and safe handling.

Natural gas

The gas transportation pipework will be provided in accordance with the Australian Gas Code AS5601. This adequately deals with the risks associated with gas reticulation.

Gas engine emissions

The major emissions from the gas engines are the Oxides of Nitrogen (NOx) gases. Refer to the separate report from Parsons Brinckerhoff for the treatment of these.

Diesel engine emissions

The emissions from the diesel engines will only occur when the engines are running. This is during testing or when both the gas network and electricity grids have failed.

Testing is envisaged to involve a single engine running at a time once per month and therefore will not significantly add to the emissions.

Noise breakout from the building

The noise generated by the equipment within the building will be mitigated in accordance with the acoustic requirements nominated within the acoustic report.

9. Structural

The structure for this building will be designed in accordance with relevant provisions of the standard building codes listed below and in accordance with accepted engineering practice and principles.

- Building Code of Australia
- AS1170 Part 0 General Principles
- AS1170 Part 1 Permanent, imposed and other actions
- AS1170 Part 2 Wind Actions
- AS1170 Part 4 Earthquake Actions
- AS3600 Concrete Structures
- AS4100 Steel Structures

The structural engineering consultant for the project will carry our periodic inspections of the construction of this building for those elements and phases for which it is commissioned. The intent of these inspections is to endeavour, to the best of knowledge and belief, to confirm the as-inspected works are in accordance with the intent of the structural engineering design and that compliance by the Builder has been achieved.

9.1 RTA Structural Coordination

We are aware of the RTA (Roads and Traffic Authority) owned structure that crosses part of the site. The design will take this in to account so that there is no affect on the RTA structure. Specifically, the existing piers and their footings that support the motorway cannot be affected by the structural design. This forms an additional consideration for the structural design that would not exist if the motorway were not there. We will, likely, require information on these structures when we commence more detailed design.

10. Façade

At the current design stage of the building, a reflectivity study to assess the impact of solar reflections off the proposed development on surrounding drivers in terms of reduced visibility of visual tasks is yet to be undertaken. However it is anticipated that this assessment is performed by following the methodology of David N.H. Hassall of the University of New South Wales. A cursory inspection of the building layouts, site plan and 3D perspectives indicate that the proposed building will generally perform well in terms of solar reflectivity, and glare is unlikely to exceed the limits of acceptability of the Hassall methodology that could affect drivers on surroundings streets in most of the cases.

The only exception would be for the north- west façade facing the elevated Western Distributor highway. Experience on adjacent buildings have proven that for any available glazing reflectance (even below 20%), luminance may exceed the limit of 500 Cd/m² for drivers driving towards the building on the elevated highway adjacent to that façade aspect during late summer afternoons. A driver's view should be unaffected by Disability Glare as this has the potential to cause road accidents. Risks mitigation actions involve replacing glass with opaque elements, or in case of keeping the glass, ensuring it is provided with external shading devices to ensure that potential sources of glare are shaded, eliminating any Disability Glare reflections. It is suggested by the City of Sydney Council "visible light reflectivity from building materials used on the facades of new buildings should not exceed 20%". Therefore a maximum of 20% reflectivity for the glazing is suggested to address general reflectivity issues such as reflections towards other buildings and pedestrians that represent discomfort but not safety problems as the ones addressed for motorists.

Therefore, a detailed report on the reflectivity of the façade, particularly in relation to the Western Distributer, will be conducted during the latter stages of the project to mitigate any Disability Glare risks.

Appendix A
Energy Australia Letter

145 Newcastle Road
Wallsend NSW 2287

Address all mail to
PO Box 487 Newcastle
NSW 2300 Australia

Telephone (+61) 13 1525

EnergyAustralia™
We're on it

5 February 2010

Mr Andrew Macdonald
Aurecon Australia Pty Ltd
PO Box 538
NEUTRAL BAY NSW 2089

Dear Andrew

Global Switch Sydney 2, Pyrmont

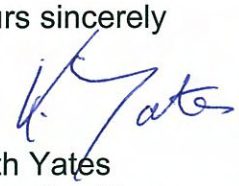
Thank you for your letter dated 15 December 2009 requesting information on electricity supply to the above proposal. To assist with consideration of the feasibility of scenarios it is advised the forecast maximum 33kV fault level at Pyrmont substation is 24kA. The current 33kV fault level at Pyrmont substation is 19kA. The ability to increase the fault level beyond this level will depend on other customers connected to this network, planned transmission developments and any contribution to fault level by Global Switch Sydney 2 and other generation in the area. It should be noted that fault levels on the 132kV system supplying Pyrmont substation are approaching the system design limits. Resolving the fault level issues associated with the proposed level of generation will require detailed investigation.

In response to the two issues raised in your letter, for Sydney 1 a spare circuit breaker exists at Pyrmont to connect a third feeder to this site and supply the maximum demand of 35MVA. This additional feeder would still be subject to further technical, commercial and environmental evaluation. For the planned Global Switch Sydney 2 a maximum demand of up to 30MVA will be able to be supplied on a non firm basis depending on system conditions at the time. Again this would still be subject to further technical, commercial and environmental evaluation. As Global Switch Sydney 2 is a large generator connection we would be looking to process this connection in line with the National Electricity Rules. Finally, EnergyAustralia is able to provide in principle agreement to export energy from Global Switch Sydney 2 into the system.

The transferring of load between the adjacent Global Switch Sydney 1 and Sydney 2 installations appears acceptable but further evaluation may be required during the detail design stage.

If you require further information or assistance, please do not hesitate to contact me on 4951 9359.

Yours sincerely



Keith Yates
Executive Manager – Major Customer Connection and Metering

Appendix B
Sydney Water Feasibility Letter

Sydney WATER

Case Number: 114988

17 April 2009

Global Switch Sydney
c/- MGP Building & Infrastructure Services Pty Ltd

FEASIBILITY LETTER

Developer: **Global Switch Sydney**
Your reference: **20090012**
Development: **Pyrmont Street Pyrmont**
Development Description: **Five Storey Commercial Building**
Your application date: **20 March 2009**

Dear Applicant

This Feasibility Letter (Letter) is a guide only. It provides general information about what Sydney Water's requirements could be if you applied to us for a Section 73 Certificate (Certificate) for your proposed development. **The information is accurate at today's date only.**

If you obtain development consent for that development from your consent authority (this is usually your local Council) they will require you to apply to us for a Section 73 Certificate. You will need to submit a new application (and pay another application fee) to us for that Certificate by using your current or another Water Servicing Coordinator (Coordinator).

Sydney Water will then send you either a:
- Notice of Requirements (Notice) and Works Agreement (Agreement); or
- Certificate.

These documents will be the definitive statement of Sydney Water's requirements.

There may be changes in Sydney Water's requirements between the issue dates of this Letter and the Notice or Certificate. The changes may be:

1. Developer Charges

(a) Adjustment of charges due to the Consumer Price Index (CPI);

(b) Adjustment of charges because of a scheduled review by the Independent Pricing and Review Tribunal (IPART). After that review and registration of the new charges, Sydney Water has to apply those charges; or

(c) If there is rezoning of any land within the development proposal then new charges will apply.

2. Reticulation Recovery Charges

These charges recover part of the cost of works that have been paid for by Sydney Water or other developers and that benefit your development. This charge has been made before your points of connection have been determined. If your completed designs show that your development will be connected to other main/s, the charge may be changed and/or you may need to construct other works.

3. Changing the Proposed Development

If you change your proposed development, e.g. the development description or the plan/site layout, after today, the requirements in this Letter could change when you submit your new application.

Also, if you decide to do your development in stages then you must submit a new application (and pay another application fee) for each stage.

No warranties or assurances can be given about the suitability of this document or any of its provisions for any specific transaction. It does not constitute an approval from Sydney Water and to the extent that it is able, Sydney Water limits its liability to the reissue of this Letter or the return of your application fee. You should rely on your own independent professional advice.

4. What You Must Do To Get A Section 73 Certificate

To get a Section 73 Certificate you must do the following things. You can also find out about this process by visiting www.sydneywater.com.au ➢ Building and Developing ➢ Developing Your Land.

1. **Obtain Development Consent from the consent authority for your development proposal.**

2. **Engage a Water Servicing Coordinator (Coordinator).**

   You must engage your current or another authorised Coordinator to manage the design and construction of works that you must provide, at your cost, to service your development. Before you engage another Coordinator you must write and tell Sydney Water.

   For a list of authorised Coordinators, either visit www.sydneywater.com.au ➢ Building and Developing ➢ Developing Your Land or call **13 20 92.**

   The Coordinator will be your point of contact with Sydney Water. They can answer most questions that you might have about the process and developer charges and can give you a quote or information about costs for services/works (including Sydney Water costs).

3. **Works Agreement**

   After the Coordinator has submitted your new application, they will receive the Sydney Water Notice and Works Agreement. You will need to sign and lodge **both originals** of that Agreement with your nominated Coordinator.

   The agreement sets out for this development:
   - your responsibilities;
   - Sydney Water's responsibilities; and
   - the Coordinator's responsibilities.

   You must do all the things that we ask you to do in that Agreement. This is because your development requires the existing sewer to be deviated and you must construct and pay for the following works extensions under this Agreement to provide these services.

   After Sydney Water has signed the documents, one of them will be returned to your Coordinator.

   Note: The Coordinator must be fully authorised by us for the whole time of the Agreement.

4. **Water and Sewer Works and Sewer Mining.**

   4.1 Water

   Your development must have a frontage to a water main that is the right size and can be used for connection.

   Your development must have:

- a frontage to a water main that is the right size and can be used for connection; and
- its own connection to that water main and a property service (main to meter) that is available for the fitting of a meter.

Sydney Water has assessed your application and found that:

- Either of the existing 200 mm DICL water mains in Quarry or Fig Streets are available to serve the development.

NOTE:

Sydney Water does not consider whether a water main is adequate for fire fighting purposes for your development. We cannot guarantee that this water supply will meet your Council's fire fighting requirements. The Council and your hydraulic consultant can help.

Large Water Service Connection

A water main is available to provide your development with a domestic supply. The size of your development means that you will need a connection larger than the standard domestic 20 mm size.

To get approval for your connection, you will need to lodge an application with a Quick Check Agent or at a Sydney Water Customer Centre. You, or your hydraulic consultant, may need to supply the following:

- A plan of the hydraulic layout;
- A list of all the fixtures/fittings within the property;
- A copy of the fire flow pressure inquiry issued by Sydney Water;
- A pump application form (if a pump is required);
- All pump details (if a pump is required).

You will have to pay an application fee.

Sydney Water does not consider whether a water main is adequate for fire fighting purposes for your development. We cannot guarantee that this water supply will meet your Council's fire fighting requirements. The Council and your hydraulic consultant can help.

Water pressure may be encountered in periods of high demand at the subject site below the minimum pressure for most normal domestic and commercial uses. The applicant should be advised that Sydney Water recommends that a hydraulic consultant be engaged (by the applicant) to ensure the needs of the proposed development are met.

Assessment of any fire fighting capability of Sydney Water main is not part of the Section 73 Certificate system capability assessment which is for predicted normal domestic supply only. Fire fighting capability assessment is the responsibility of the applicant. Sydney Water can assist only by indicating modelled pressures at flows nominated by the applicant (provided that such flows do not exceed water supply capability) on a standard pressure enquiry form submitted with the scheduled fee.

4.2 Sewer

Your development must have a sewer main that is the right size and can be used for connection. That sewer must also have a connection point within your development's boundaries.

Sydney Water has assessed your application and found that:

- **The existing 225 mm VC sewer main in the site will serve the development after the deviation is completed.**

The preferred point of connection is on the deviated 225 mm sewer in Pyrmont Street.
However the 300mm sewers in Pyrmont and Harris Streets are suitable but will require a sewer extension to bring the connection point to the property boundary.

4.3 Sewer Mining

Advice has previously been sent to Global Switch by Mr Frank Vidovic detailing Sydney Waters' requirements for the mining of sewers. Should the mining of sewer be used for this site then our requirements as detailed in Mr. Vidovics' letter will need to be followed.

Please note that both Sewer Mining and a Trade Waste Agreement will need to be signed.

4.4 Ancillary Matters

4.4.1 Asset adjustments.

After Sydney Water issues this Notice (and more detailed designs are available), Sydney Water may require that the water main/sewer main/stormwater located in the footway/your property needs to be adjusted/deviated. If this happens, you will need to do this work as well as the extension we have detailed above at your cost. The work must meet the conditions of this Notice and you will need to complete it **before we can issue the Certificate**. Sydney Water will need to see the completed designs for the work and we will require you to lodge a security. The security will be refunded once the work is completed.

4.4.2 Entry onto neighbouring property

If you need to enter a neighbouring property, you must have the written permission of the relevant property owners and tenants. You must use Sydney Water's **Permission to Enter** form(s) for this. You can get copies of these forms from your Coordinator or the Sydney Water website. Your Coordinator can also negotiate on your behalf. Please make sure that you address all the items on the form(s) including payment of compensation and whether there are other ways of designing and constructing that could avoid or reduce their impacts. You will be responsible for all costs of mediation involved in resolving any disputes. Please allow enough time for entry issues to be resolved.

4.4.3 Costs

Construction of these works will require you to pay project management, survey, design and construction costs **directly to your suppliers**. Additional costs payable to Sydney Water may include:

- water main shutdown and disinfection;
- connection of new water mains to Sydney Water system(s);
- design and construction audit fees;
- contract administration, Operations Area Charge & Customer Redress prior to project finalisation;
- creation or alteration of easements etc.; and
- water usage charges where water has been supplied for building activity purposes prior to disinfection of a newly constructed water main.

Note: Payment for any Goods and Services (including Customer Redress) provided by Sydney Water will be required prior to the issue of the Section 73 Certificate or release of the Bank Guarantee or Cash Bond.

5 Stamping and Approval of your Building Plans.

You must have your building plans stamped and approved **before the Certificate can be issued. In any case, building construction work MUST NOT commence until Sydney Water has granted approval.** Approval is needed because construction/building works may affect Sydney Water's assets (e.g. water and sewer mains).

Your Coordinator can tell you about the approval process including:

- Your provision, if required, of a "Services Protection Report" (also known as a "pegout"). This is needed to check whether the building and engineering plans show accurately where Sydney Water's assets are located in relation to your proposed building work. Your Coordinator will then either approve the plans or make requirements to protect those assets before approving the plans;
- Possible requirements;
- Costs; and
- Timeframes.

Your can also find information about this process (including technical specifications) if you either:

- visit www.sydneywater.com.au ➢ Building and Developing ➢ Building and Renovating. Here you can find Sydney Water's *Guidelines for Building Over/Adjacent to Sydney Water Assets;* or
- call 13 20 92.

Notes:

- **The Certificate will not be issued until the plans have been approved and, if required, Sydney Water's assets are altered or deviated;**
- **You can only remove, deviate or replace any of Sydney Water's pipes using temporary pipework if you have written approval from Sydney Water's Development Operations Branch. You must engage your Coordinator to arrange this approval; and**
- **You must obtain our written approval before you do any work on Sydney Water's systems. Sydney Water will take action to have work stopped on the site if you do not have that approval. We will apply Section 44 of the *Sydney Water Act 1994*.**

OTHER THINGS YOU NEED TO DO.

Shown below are other things you need to do that are NOT a requirement for the Certificate. They may well be a requirement of Sydney Water in the future because of the impact of your development on our assets. You must read them before you go any further.

(1) Trade Waste Information

Should this development generate trade wastewater, this notice of requirements does not guarantee the applicant that Sydney Water will accept the trade wastewater to its sewerage system**.** A boundary trap will be required where arrestors and special units are installed for trade waste pre-treatment. For further information please visit the Sydney Water website at:
http://www.sydneywater.com.au/OurSystemsAndOperations/Tradewaste/
or contact a Trade Waste Customer Service Representative on (02) 9622 2244.

Prospective Purchasers should be made aware of the above situation under the requirements of vendor disclosure.

(2) Backflow Prevention Information

In accordance with Sydney Water's Backflow Prevention Containment Policy, you may be required to install a backflow prevention containment device immediately downstream of each master water meter/s servicing the property. In circumstances where there is no master meter/s the containment device shall be installed on the water supply entering the property boundary.

Separate hydrant and sprinkler fire services on non-residential properties, require the installation of a testable double check detector assembly. The device is to be located at the boundary of the property.

If required, the device must be installed as a condition of continued use of the water supply. Failure to install and maintain the device may result in disconnection of the water service. A copy of Sydney Water's Backflow Prevention Policy is available on the Sydney Water Website at:
http://www.sydneywater.com.au/BuildingDevelopingandPlumbing/BackflowPrevention/

(3) Soffit requirements

Please be aware that floor levels must meet Sydney Water's soffit requirements for property connection and drainage.

(4) Possible future costs.

The requirements in this Notice relate to your Certificate application only. Sydney Water may be involved with other aspects of your development and there may be other fees or requirements. These include:

- construction/building plan stamping fees;
- plumbing and drainage inspection costs;
- the installation of backflow prevention devices;
- trade waste requirements;
- large water connections; and
- council fire fighting requirements. (It will help you to know what the fire fighting requirements are for your development as soon as possible. Your hydraulic consultant can help you here.)

No warranties or assurances can be given about the suitability of this document or any of its provisions for any specific transaction. It does not constitute an approval from Sydney Water and to the extent that it is able, Sydney Water limits its liability to the reissue of this Letter or the return of your application fee. You should rely on your own independent professional advice.

END