HEALTH INFRASTRUCTURE

TAMWORTH MENTAL HEALTH ELECTRICAL AND MECHANICAL SERVICES

SCHEMATIC DESIGN REPORT

NOVEMBER 2022

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Tamworth Mental Health
Electrical and Mechanical Services
Schematic Design Report

Health Infrastructure

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REV	DATE	DETAILS
A	18.11.2022	SCHEMATIC DESIGN ISSUE

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Reviewed by:	Sandeep Kodoth	16th Nov 2022	
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1 PROJECT BACKGROUND

1.1 THE PROJECT

WSP Australia Pty Limited have been engaged by Health Infrastructure (HI) to provide Multi-Discipline Design Services including Mechanical and Electrical for the Project.

We understand that STH is proceeding the design based on 'Option 3' which has been selected as a preferred scheme. This includes 4200m² of GFA.

The proposed location for the new Tamworth Mental Health is directly adjacent to the existing Acute Services building (ASB) and connected to the ASB building via a link bridge. The works will involve demolition of the existing Rotary Hostel, Rotary Lodge and Staff Accommodation. Our understanding is that all existing buildings will be decanted as part of the re-development works. As such the project is limited to demolition and new works only.

1.2 PURPOSE OF THIS REPORT

This report will provide a high-level approach to the services design and will form part of the Schematic design submission for the project. Plant and infrastructure upgrades required to support the development of the site will be described within the report.

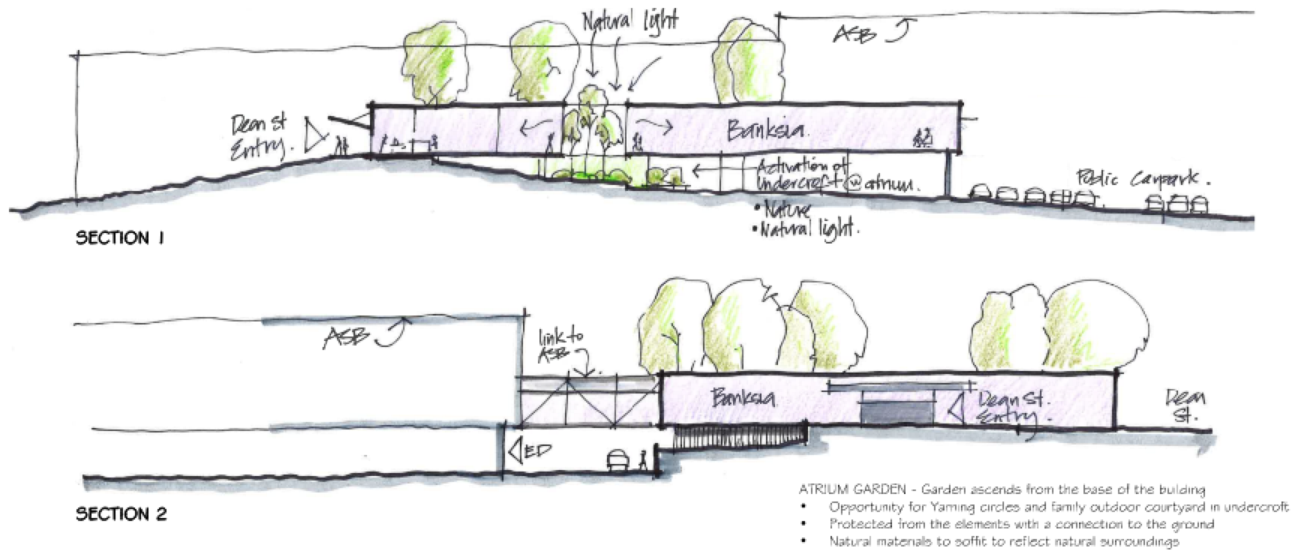

FIGURE 1: PROPOSED NEW TAMWORTH MENTAL HEALTH BUILDING SECTION

2 MECHANICAL AND MEDICAL GAS

2.1 MECHANICAL AND MEDICAL GAS

2.1.1 GENERAL

The mechanical services works will comprise the following systems:

- Space heating and space cooling
- General ventilation systems
- Building management and controls systems (BMCS) and energy management system (EMS)

The proposed mechanical services systems are detailed within Section 2.3.1.1 of this report.

2.1.2 REFERENCE DOCUMENTS

The mechanical services system will be designed in accordance with the building code, applicable Australian Standards and other relevant guidelines, including the following:

- National Construction Code (NCC) 2019
- National Construction Code (NCC) 2019 Section J
- Australian Standard AS 1668.2 (2012)
- Australian Standard AS 1668.1 (2015)
- NSW Government Health Engineering Services Guide (ESG) 2016

Other references:

- Architectural drawings numbered *TAMWORTH HOSPITAL MENTAL HEALTH UNIT 10500.1 A00-001* WSP are awaiting the revised architectural layouts to perform a detailed load analysis
- Best engineering practice, guidance and recommendations published by professional institutions such as the Australian Institute of Refrigeration, Air conditioning and Heating (AIRAH), Chartered Institution of Building Services Engineers (CIBSE) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

2.1.3 SERVICES

- Full Mechanical Services Design
- Chilled water VAV (Variable Air Volume) heat recovery AHU (Air Handling Units) will be located at roof level serving individual zones.
- Internal reheat VAV (Variable Air Volume) boxes supplying internal zones
- Centralised toilet exhaust fans located at roof level
- Internal chilled water FCU's (Fan Coil Units) serving staff office spaces
- An analysis of the mechanical central plant systems has been developed, Refer to Appendix D – Mechanical System life Cycle analysis and Options report. WSP are awaiting direction on prefer main thermal plant option
- Refer to Appendix A for main mechanical heating & Cooling plant options
- Fire stair pressurisation & relief air system to roof level plant rooms
- Electrical works to make fully operating system
- BMS (Building Management System)
- General exhaust systems with extract fan at roof level
- Dedicated 24/7 DX FCU (Fan Coil Units) will serve the comms rooms in a N+1 arrangement
- All internal services are to be install for anti-ligature

2.1.4 DESIGN CRITERIA

PARAMETER	DESIGN CRITERIA
External ambient conditions	As per The Australian Bureau of Meteorology (Tamworth Airport), the external ambient conditions to be utilised are as follows: Summer — 36.8°C dry bulb temperature — 22.0°C wet bulb temperature Winter — 0.4°C dry bulb temperature
Internal conditions (Patient Rooms, Consult Rooms, Interview Rooms, Meeting Rooms, Dining Room, Recreational Area, Treatment Rooms, Workstations & Num)	Summer 24.0°C dry bulb temperature Relative humidity will not be actively controlled. However, will be controlled by virtue of dry bulb temperature only. Winter 21.0°C dry bulb temperature Relative humidity will not be actively controlled. However, will be controlled by virtue of dry bulb temperature only.
Internal conditions (Medication Storage room)	Confirmation of medications Storage setpoint temperature to be confirmed by HI
Building fabric and glazing	Based on the architectural package provided and Section J requirements.
Infiltration	0.5 ACH for perimeter zones 0 ACH for centre zones
Internal loads	Occupancy densities: Based on the number shown on architectural layouts. In lieu of this, in line with AS1668.2 (2012). Lighting: NCC 2019 and any lighting designer selections made available. Equipment: The ESG 2016
Ventilation	Outside air: Rates to be the higher of AS1668.2 (2012) and the ESG 2016 Exhaust air: Rates as per AS1668.2 (2012)

Hours of operation	Bedrooms and staff areas including meeting rooms, sensory and kitchenette: 24 hours/day All other spaces: 12 hours/day

2.2 SIZING OF EQUIPMENT

Equipment will be selected incorporating a 10% safety margin on capacity unless specified otherwise.

All pipework will be designed in accordance the following criteria:

Parameter	Design Criteria
Max Pressure Drop	240 Pa/m
Maximum Velocity	2.4 m/s
Headers	80 Pa/m

All ductwork will be designed in accordance the following criteria unless otherwise advised by the Acoustic Consultant:

Parameter	Design Criteria
Max Pressure Drop	0.8 Pa/m
Maximum Riser Velocity	10 m/s
Maximum Main Velocity	8 m/s
Maximum Branch Velocity	4.5 m/s
Maximum Runout Velocity	2.5 m/s

2.3 SYSTEM DESCRIPTIONS

2.3.1 SYSTEM SELECTIONS

The ESG 2016 states that "the purpose of HVAC systems in healthcare projects is to satisfy internal environmental conditions for comfort, safety and infection control."

In considering appropriate space heating and space cooling options for the proposed development, we have reviewed several types of air conditioning systems that are capable of meeting the building cooling and heating requirement. As part of our review of the heating and cooling options, we have based our assessment on the following design factors –

- The location of the building and surrounding environment
- The estimated heating and cooling load
- Require plant room area requirements
- Cost
- Internal design condition that must be maintained
- Operating hours
- Population occupying the conditioned space at any one time
- Floor area
- Constraints imposed by the proposed building structure
- The intended use of the proposed development
- Expected life of equipment

Based on these design factors, WSP is assisting 2 mechanical system options:

- Option 1: Air-Cooled Chiller, 4-Pipe Chiller & Heat Pump
- Option 2: Air-Cooled Reverse Cycle Heat Pump

Refer to Appendix D for further detail.

2.3.1.1 PROPOSED MECHANICAL SERVICES DESCRIPTIONS

ENERGY EFFICENY AND THERMAL MODELLING

The mechanical systems shall be designed in accordance with the relevant sections of Australian Standards and NCC (BCA) Section J, utilising energy savings initiatives where possible. Some of the measures for minimizing energy consumption shall include the use of Energy efficient main plant, chilled water and heating hot water temperature resets, heat recovery AHU's, EC plug fans, increased duct and pipe dimensions to minimise system resistance and thus reduce fan & pump pressures and also the interface of central plant with the solar array to supplement electrical demand. Further coordination with the ESD consultant will be conducted in the next phase to refine the sustainability initiatives.

Energy and thermal modelling have been completed using Camel modelling software to determine the buildings heating and cooling load demands, this software has also been used to refine the buildings energy consumption and to determine the simultaneous heating & cooling demand which enables a more accrue sizing of central thermal plant.

CHILLED WATER & HEATING HOT WATER SYSTEM

An analysis of the mechanical central plant systems has been developed, Refer to Appendix D – Mechanical System life Cycle analysis and Options report. WSP are awaiting direction on prefer main thermal plant option

MEDICATION STORAGE ROOM

The Medication storage room will be provided with a dedicated chilled & heating hot water ceiling concealed FCU which dedicated outside air ducted from the adjacent courtyard.

COMMS ROOM COOLING

The level 1 comms room shall be supplied via dedicated 24/7 DX FCU (Fan Coil Units) in a N+1 arrangement i.e. 2 independent condensers and FCUs will be supplied to condition the comms room, each sized for the full conditioning load.

The external condenser will be installed directly outside of the comms room and enclosed within a vandal / vermin proof enclosure.

The level 2 & 3 comms room shall be supplied via a dedicated 24/7 DX FCU (Fan Coil Units)

The external condenser will be installed within the roof level plantroom.

MAIN SWITCH ROOM COOLING

The level 1 main switch room shall be supplied via a dedicated 24/7 DX FCU (Fan Coil Units) in a N+1 arrangement, i.e. 2 independent condensers and FCUs will be supplied to condition the switch room, each sized for the full conditioning load.

The external condenser will we installed directly outside of the comms room and enclosed within a vandal / vermin proof enclosure.

SPECIFIC ROOMS RECEIVING DEDICATED FCU'S

Specific spaces which required independent temperature control such as offices, interview rooms, medication storage rooms, etc will be conditioned via independent ceiling concealed FCU's complete with wall mounted controller, outside air will be supplied directly to the units from the façade or roof level.

GENERAL VENTILATION SYSTEMS

Outside air systems

The internal space will be separated into internal and perimeter zones with conditioned outdoor air supplied to the zones via supply VAV AHU's located at roof level complete with heat recovery via a mixing box (subject to further design development) to assist in control of potential relative humidity issues that may occur in region.

The perimeter zones mostly consist of patient accommodate rooms, conditioned outside air will be supplied to internal reheat (where required) VAV boxes located within the ceiling void, each VAV box will serve multiple rooms within the zone.

The internal zones will consist a variety of rooms such as interview rooms, multi-purpose rooms, dining, etc. Conditioned outside air will be supplied to internal reheat (where required) VAV boxes located within the ceiling void, each VAV box will serve multiple rooms within the zone.

All supply air distribution will be supplied via ceiling flush anti-ligature air diffusers.

All internal access to units where required will be via ceiling flush anti-ligature access panels.

Return Air System

Return air from each of the internal zones will return to the central AHUs via ceiling transfer ducts from each of the individual room to the corridors where it will be directly ducted from the corridor return air grilles back to the AHU, the relief air will past through the AHU mixing box to provide both heat recovery and to manage the relative humidity of the outside air.

Return air from each of the perimeter patient room zones will return to the central AHUs via ceiling transfer ducts from each of the individual room to the patient corridors where it will be directly ducted from the corridor return air grilles back to the AHU, the relief air will past through the AHU mixing box to provide both heat recovery and to manage the relative humidity of the outside air.

All return air distribution will be supplied via ceiling flush anti-ligature air diffusers.

Toilet Extract

Patient bathrooms will be exhausted via a dedicated centralised exhaust with make-up air from the conditioned supply from the adjacent bedroom via door undercuts.

Internal zone bathrooms will be exhausted via a dedicated centralised exhaust with make-up air from the conditioned supply from the adjacent corridors via door grilles / door undercuts.

A laundry extract system will be provided complete with extract hard ductwork system direct to Dryer units (subject to specific dryer unit selection, general extract from room may only be required) and central extract fan located at roof level. Makeup air to the laundry may be from the adjacent space depending on the specification of laundry units and the ventilation requirements. Larger Laundry units may require a dedicated supply air system.

The garbage room and storage spaces will have dedicated exhaust which will discharge to atmosphere at roof level

Exhaust air systems will be utilised to extract air from all required spaces in line with AS1668.2 (2012) and THE ESG 2016. This includes bedroom, other toilet WC exhaust air systems, general exhaust air system, kitchen exhaust air system and laundry systems.

Kitchen exhaust have been designed based on a non-commercial grade kitchen with the provision of a general exhaust only.

Relief air systems

Relief air systems will be provided based on a review of the air balance of the proposed development, undertaken during design development.

AREAS REQUIRING FURTHER DEVELOPMENT

The following space require further coordination with the wider design team to better understand their ventilation requirements based on the internal unit's design and ventilation requirements:

- Mechanical Plantroom
- Sprinkler Alarm Valve Room
- Gen PT PR Room
- Hot Water Storage Room
- Hydraulic Heat pump Room
- Fire Pump Room

Meeting required with design team to discuss the specific requirements of each of the above spaces.

BMCS AND EMS

WSP proposes utilising a standalone BMCS for control of this development. The proposed automatic control system will comprise of standalone DDC panels. The DDC panels will have the ability to control and operate the plant autonomously with the ability to be connected to a centralised BMCS for remote monitoring and control.

TEMPERATURE CONTROL

Patient bedrooms

Three to four patient bedrooms will be supplied via a single VAV box, there will temperature sensor within the return duct of each room, the conditioned supply will be based on the average temperature reading across the temperature sensors. No temperature controllers will be displayed, control of temperature and set points will be via the BMS with password access granted to designated personnel

General Internal Spaces

A VAV box may supply multiple internal spaces with the temperature sensor within the return duct of each room, the conditioned supply will be based on the average temperature reading across the temperature sensors. No temperature controllers will be displayed, control of temperature and set points will be via the BMS with password access granted to designated personnel

Individual Spaces Containing FCU's

Spaces containing dedicated FCU's will have combined wall mounted temperatures sensors and controllers providing direct control to the occupants to alter the room setpoint temperatures.

OTHER SYSTEMS CONSIDERED

Smoke hazard management systems

Smoke hazard management systems, where required, will be utilised throughout the project to all required spaces in line with NCC 2019, the BCA report and the fire engineering report. Based on our review of the reference documents and the advice made available to us, Stair pressurisation & relief will be required for each of the main stair wells .

Medical gases

WSP understand that there are no requirements for central reticulation of medical gas systems such as oxygen, medical air and vacuum systems for this type of development. Should medical gas be required, this will be administered by portable bottle gas, under supervision by staff.

3 ELECTRICAL, ICT AND SECURITY

3.1 ELECTRICAL

3.1.1 SCOPE INTENT

The electrical services will be designed to comply with the NSW Health Policy Directives and guidelines such as of guidelines such as Engineering Services and Sustainable Development Guidelines.

WSP Electrical services for will include but not limited to the following:

- → Liaison with supply authority
- → Early works associated with new car parks
- → New substation and associated works
- → Decommissioning and removal of existing Electrical, ICT and Security services from buildings to be demolished
- → Diversion and relocation works of existing underground power and ICT cabling
- → Provision of new underground power and ICT cabling and associated works
- → New external ring road Main distribution board
- → Main distribution board for new Tamworth Mental Health building
- → Essential and non-essential Distribution boards
- → Standby diesel generator system complete with fuel tanks
- → Submain cabling
- → New backbone cabling from Campus distributor to new Tamworth Mental Health building distributor via diverse paths
- → Provision of new general power (Non-essential)
- → Provision of new emergency power (Essential)
- → Provision of new UPS power (Essential)
- → Provision of new RJ45 data outlets and horizontal cabling
- → Data outlets for Wireless Access Points
- → New nurse call system points and connection to existing Nurse call system
- → Provision of new general lighting
- → MATV /Patient Entertainment system
- → Intercom system
- → Duress alarms
- → Provision of new exit and emergency lighting
- → Liaison with specialist equipment supplier
- → Power supply continuity during the works
- → Review and co-ordination with the staging
- → Electronic access control and CCTV

3.1.2 DESIGN CRITERIA

ITEM	REFERENCE DOCUMENT	DESIGN CRITERIA
Electrical supply parameters	AS 3000 Engineering services guidelines	Electrical voltage 415/240V in accordance with SIR +10%/-6%.
Harmonics	AS 3000 Engineering services guidelines	Maximum total current harmonic distortion of 5% (THDi). This will be designed for at the point of common coupling for the facility.
Meters	AS 3000 ES1 Service Installation Rules NSW	New metering shall be provided for outgoing supply
Circuit fault impedance levels	AS 3000 Engineering services guidelines	Provide reactors and/or other modules/equipment to the energy distribution network to in accordance with supply authority requirements.
Distribution boards	AS 3000 Engineering services guidelines	Non-essential and Essential DB
Bonding	AS 3000 AS 3003	All metallic elements will be equipotential bonded to earth.
Earthing systems		Sized in accordance with AS 3000. Shall be designed in accordance with reference documents. M.E.N boards shall be provided for each individual building. Every submain to be provided with its own earthing conductor. Earth impedance in accordance with AS 3000 Ability to connect an additional 20% earthing medium anywhere into the network.
Patient Area Earthing	AS3003	Equipotential earthing to body protected areas in accordance with AS 3003. Equipotential earthing systems shall be wired in all new cardiac – protected electrical areas. Equipotential junctions shall be installed as per AS 3003.
Communications earthing System		Communications earthing to ACIF/S008 and ACIF/S009.
Electromagnetic Interference		Major submains cabling and boards will be located to avoid high levels of EMI adjacent to patient areas.
Light and power Submain	AS 3000 Engineering services guidelines	Maximum demand as set out in AS 3000 plus 20% spare. Neutral sized the same as the active conductors

Submains to mechanical plant	AS 3000	Maximum full connected load plus 20% spare capacity. Neutral sized the same as the active conductors
Fire rated services	AS 3013	Fire rated to WS53W AS3013 and full size neutral where identified as required.
Cable trays/ladders	AS 3000	Sized for all submain cables in accordance with AS 3008 plus 25% spare space minimum. Trays and ladders will be provided to carry all overhead runs for Mains and Submains Cables. Final sub circuits will run on trays located above circulation spaces and branch out from these trays on catenary wires.
Final sub-circuits	AS 3000 AS 3008 AS 3003	General Power Circuits: Minimum 2.5mm2 Cu. General Indoor Lighting Circuit: Minimum 1.5mm2 Cu. General Outdoor Lighting Circuit: Minimum 10mm2 Cu. Specific Equipment and other installations: Will be in accordance with reference documents.
System Voltage Drop	AS 3000 AS 3008	Maximum voltage drop of 7% from point of supply to final outlet Generally, this will be distributed through the network as follows: Point of Supply to Main Switchboard: 1 % Main Switchboard to Final Distribution Board: 1.5% Final Distribution Boards to Final Outlets: 2.5%
Riser accommodation	AS 3000	Existing riser R3 will be used
Essential loads to be connected to standby power		All essential loads to connected to essential DB.
Non-essential loads		All non-essential loads will be connected to existing non-essential DB
UPS Electrical output supply parameters		Electrical voltage 400/243V +10%/-6%.

3.1.3 GENERAL

The Tamworth Hospital campus consists of several buildings, all varying in size, height, shape and age. The spread of the buildings is such that it covers large land area, enclosed by Dean street and Johnston street.

FIGURE 3 - TAMWORTH HOSPITAL CAMPUS

The following are the main buildings on site

- Brudelin Building
- 1883 Building
- ASB Building
- Cancer centre
- Exiting Tamworth Mental Health building
- Roland Mcdonald house
- Helipad and Lift
- Patient carer's accommodation
- Hilltop Lodge
- Several car parks
- Other small building

The data in this report has been collected from the sources as listed below.

- Dial before you dig plans

— Site survey documentation

— Available As-built drawings

— Visual site inspections and discussion with LHD during site walkaround

— Discussions with LHD ICT

3.1.4 STANDARDS AND GUIDELINES

The following are the main standards and guidelines will be applicable throughout the project:

→ NCC BCA 2019

→ Local government and municipal council regulations

→ Occupation / workplace health and safety legislation

→ NSW Service Rules and Installation rules

→ Engineering Services guidelines

→ LHD Structured cabling guidelines

→ LHD Security services guidelines

→ Service Rules and Regulations of the local Supply Authority

→ AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)

→ AS/NZS 3008.1 Electrical Installations - Selection of cables.ac

→ AS/NZS 1680 Interior Lighting

→ AS/NZS 2293 Emergency Evacuation Lighting.

→ AS/NZS 3439 Low-voltage switchgear and control gear assemblies

→ AS 4674 Design, Construction and Fit-out of food premises

→ The requirements of the Australian Telecommunications Authority

→ Essential energy Network Standards

3.1.5 EXISTING SYSTEMS

3.1.5.1 POWER SUPPLY

The current Tamworth Hospital campus is serviced by multiple Essential energy substations located around the site. The campus has the following substations:

— Brudelin building Chamber substation

— Kiosk substation for Cancer centre

— Kiosk substation for the ASB building

During the redevelopment of the Tamworth Hospital in 2013-16 phase, new 2 x 1500 KVA kiosk essential energy substations were installed to service the development including the new ASB services building. It is understood that the current substations are loaded to capacity and will not have spare capacity to service additional major loads. The existing Tamworth Mental Health building is serviced from the Brudelin building Chamber substation via an external MSB located in the Northern side of the site. Underground cabling is reticulated from this MSB to the Tamworth Mental Health building local switchboard to service the building. Currently there are two standby diesel generator systems on site:

— A 350 KVA generator system for the Brudelin building supplies

— A 1100 KVA generator system for the ASB building

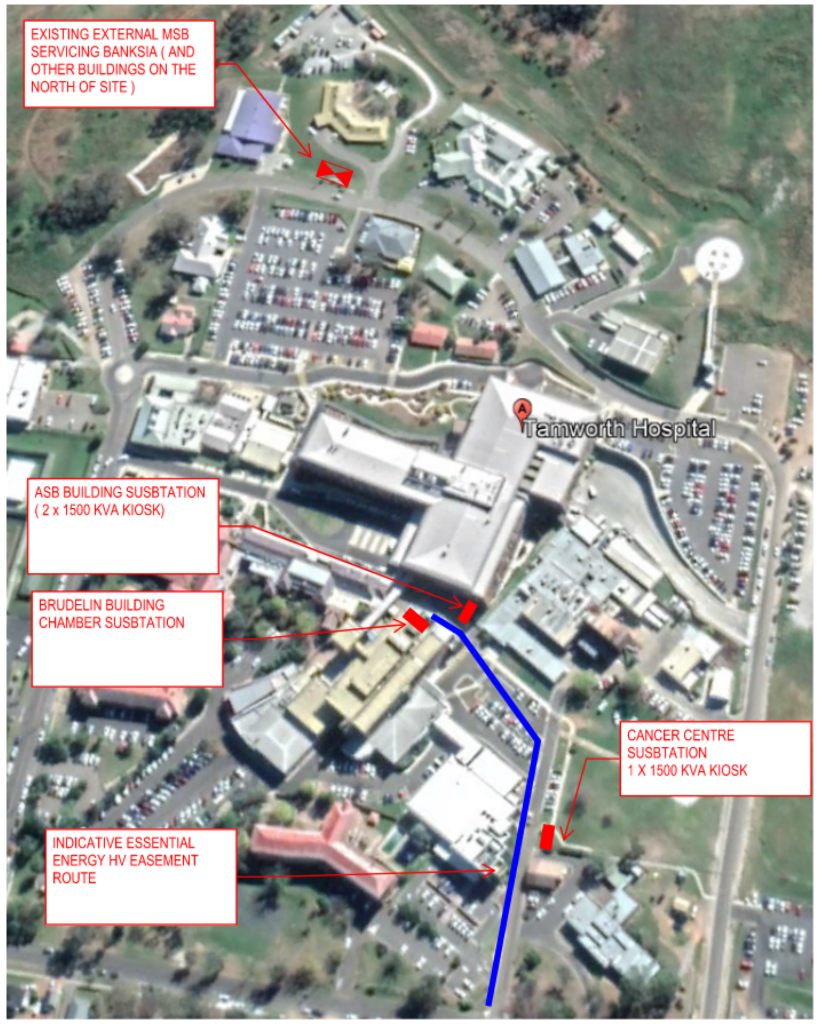

FIG 4 – EXISTING POWER SUPPLY ARRANGEMENT

In addition to the above there is an existing overhead HV supply and a pole mount substation opposite the Northern car park car park. The Utility company responsible for the electrical power supply to the site is Essential Energy.

FIG 4 – EXISTING HV NETWORK ON NORTH SIDE

3.1.6 PROPOSED NEW WORKS

3.1.6.1 MAIN WORKS ENABLING WORKS

The enabling works required can be classified under the following Categories

Demolition and Decommissioning Works

The area on which the proposed Tamworth Mental Health building facility will be build has existing buildings and underground services. The buildings that are to be demolished as part of the works are

- Rotary Hostel
- Rotary Lodge
- Staff Accommodation
- Removal of existing car park areas

These buildings are to be made redundant, vacant and demolished to allow for new site. These enabling works will involve the following

- Disconnection and removal of all power connection to the above-mentioned buildings
- Disconnection and removal of all CT links to the above-mentioned buildings

  These buildings are individually connected removing power and ICT links to above building will not impact any other existing services on site.

- Disconnection and removal of light poles and power from existing car park

Relocation Works

The following are services existing on the proposed new Mental Health building site

- Ring Road DB
- Underground conduits and submain cabling from DB ring road to Ambulance workshop and Helipad DB
- Underground conduits and ICT cabling from Campus distributors forming a ring connection around the site
- Pole lighting and associated underground cabling
- Car Park pole lighting and associated underground cabling

The services mentioned above services areas of the Hospital campus which are to be retained including services. As such as part of main works enabling works mitigation works which involves relocation / duplication shall be undertaken to ensure services to other area of Hospital campus are kept intact and uninterrupted. There will be some downtime related to the works and this will be requiring close co-ordination with LHD during the works. The key works are

- Installation of new ring road MDB outside the zone of proposed Tamworth Mental Health works
- Disconnection of submain cabling to Ambulance workshop and Helipad DB from ring road DB and reconnection to new ring road MDB
- New ICT conduit outside the zone of works and relocation of fibre cabling to maintain the ring road ICT network connection
- Relocation of the pole lights to the opposite side of the road or provision of new temporary lighting on construction hoarding
- Disconnection and removal of existing car park pole lighting on area where new building will be built.

The enabling works shall be completed including commissioning prior to the commencement of main works.

The schematic design drawings issued along with this report identifies the scope of works associated

FIG 5 – EXISTING RING ROAD DB SERVICING BUILDINGS ON NORTH SIDE

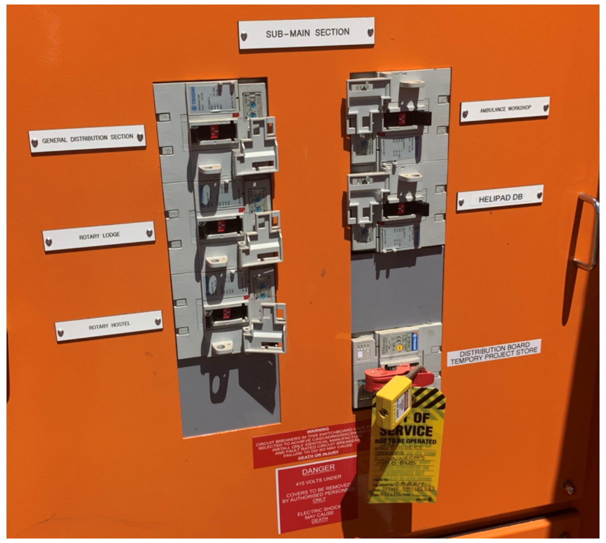

FIG 6 – OUTGOING FEEDS FROM RING ROAD DB

FIG 7 – EXISTING CARPARK LIGHTS TO REMOVED

3.1.6.2 INCOMING POWER SUPPLY

The new Tamworth Mental Health building is proposed to be 4200 sq.m. Based on assessment of the maximum demand for the building we envisage to see a 600 A supply. This calculation is based on VA/sq.m methodology. As part of the detail design when the actual loads from services such as Mechanical, Fire, Hydraulics, general power and lighting is finalised the final maximum demand calculation will be undertaken based on actual loads.

In the early stages of the project during the concept phase, based on review of existing information it was identified that the existing ASB building is running at full capacity with regards to Electrical loading.

In the original scheme for Tamworth Mental Health building it was proposed service the new Tamworth Mental Health building from the Brudelin Building main switchboard-1. However with the increased size of the new Mental Health building and hence the Electrical load the facility can no longer be serviced from the Brudelin building board. A new substation will be required to service the proposed Mental Health building with future expansion.

3.1.6.3 SUBSTATION

The power supply authority responsible for HV network in the area is Essential energy. Based on the maximum demand calculations it is expected that a new 1 x 750 KVA Pad mount substation will be required to be installed. This will power the new Tamworth Mental Health along with adequate capacity for future expansion.

At the time of this issue of this eport, WSP has submitted application to connection with project details to Essential energy. A response from supply authority is expected in 2-3 weeks time. Based on this response further work related to substation such as location will be co-ordinated.

It is proposed to install a substation in two locations subject to Essential Energy's approval and LV MSB location. Please refer to the below two options showing indicative substation location.

Option 1: Option 1 is only acceptable to Essential Energy, provided the road is private. Usually, Public Road crossing service cables are not permitted in the case of Essential Energy. The proposal is to extend the HV cable from the pole substation and terminate into the proposed substation. LV Service cable to cross the road and terminate into MSB.

Option 2: If the road is public, it is proposed to install a substation in a different location near the Car Park

3.1.6.4 EXTERNAL MAIN SWITCHBOARD

An external grade Main switchboard will be installed next to the substation. The location of the MSB will be co-ordinated after confirmation of location of the substation. The MSB will include the following

- SPD and metering
- Outgoing circuit breaker for new Tamworth Mental Health building
- Spare circuit breaker for future connections

New underground consumer mains cabling will be installed from the substation to the Main switchboard. The outgoing main cabling from the site switchboard to the Tamworth Mental Health building will be reticulated via underground onduits.

3.1.6.5 MAIN DISTRIBUTION BOARD SWITCHBOARD

A main distribution board will be provided in the Level 1 of the building in the new main switch room.

The MDB will be floor mounted, front connected, Form 3b modular construction, IP42 rated enclosure. The switchboard shall contain 3 internally separate sections for the supply of:

- Non-essential supply section
- Essential supply section
- Life Safety services section

The MDB includes:

- Incoming Main circuit breaker
- Outgoing Circuit Breakers
- Distribution Board Sections for Common Area Light and Power
- Metering

Circuit breakers are used throughout to achieve discrimination with upstream and downstream protection. Spare circuit breakers will be provided to each section of the Main Switchboard for the future connection of additional building loads. Provision for 25% load current growth in the main busbars in relation to the building design load will also be provided.

3.1.6.6 DISTRIBUTION BOARD

The facility will be provided with distribution boards General light and power distribution board is located within the electrical cupboard in all the floors.

Distribution Board (DB) is sheet metal construction, hinged lockable doors, front connected, and DIN circuit breaker type, min 10kA rated, IP42 dead front escutcheon type, surface mounted designed in accordance with AS/NZS 3000 Wiring rules.

DB incorporates step down transformers, interposing relays and contactors to allow scheduled switching by the lighting control system. Pole capacity is determined based on electrical circuitry (lighting and power circuits) plus 25% spare capacity. All circuits supplying lighting and power outlets are fitted with 30mA RCD protection as required by the regulations.

The distribution boards will be provided with split chassis with separate metering for power and lighting sections.

Following distribution boards will be provided

- 1 x non-essential distribution for Level 1
- 2 x non-essential and 2 x essential DB for level 2
- 1 x non-essential for level 3

1.1.1.1 POWER RETICULATION

The power reticulation will be mainly provided by the following means

- Underground conduits and cabling for main power supply from Brudelin building main switchroom to new Tamworth Mental Health building MDB. Existing conduits to be used if possible. This is to be further investigated in detail design.
- Cable tray for reticulation of submain cabling from MDB to DB and MSSB
- Main Cable tray and catenary system for reticulation of final sub-circuit cabling for power and lighting

New Distribution boards will be provided throughout the new building. The requirement for a Main switchboard, power correction and metering arrangements will be determined once the power supply options are determined.

Power supplies will be provided to Mechanical Services Switchboards, power to hydraulic plant, joinery and specialist equipment;

3.1.6.7 STANDBY GENERATION

The standby diesel generator system will be provided for the building to services the essential and life safety load of the building.

During the early discussion phase LHD has identified a requirement to provide full back up power supply to service the HVAC for the building. Based on further review by HI it was decided that this is not required and only HVAC for critical areas will be provided with back-up power supply.

Generator size to be calculated further as part of detail design development.

3.1.6.8 UPS

UPS system will be provided for back-up power to critical equipments. The UPS will provide back-up power to critical equipment during the time when main power supply is off and generator is yet to kick in.

UPS supply could be a central supply or rack mounted UPS depending on the load and location. The UPS power will be provided for the following

- All ICT active equipment
- Security head end
- Nurse call head end
- BMS head end
- UPS power for any power outlet designed as UPS power by users

3.1.6.9 POWER OUTLET PROVISIONS

Provisions for power outlets will be designed in accordance with the AHFG with input from the Architect.
These will be developed through the user group process in conjunction with the architect creating the room data sheets and room layout sheets.
Within patient areas Body Protection will generally be provided in accordance with AS3003 with RCD protection provided locally at the bedhead protecting all outlets within the patient area.

Medical Service Panels will be considered for the bed locations where multiple services are to be installed such as power, comms, medical gases & nurse call.

3.2 LIGHTING AND LIGHTING CONTROL

3.2.1.1 OVERVIEW

Lighting influences the perception of a space, the visual performance as well as comfort of its occupants. Research shows that lighting can have a significant impact of the visual comfort, health and productivity for people working and or occupying the space.

In hospitals and health care environments, optimising natural daylight and electric lighting is crucial for performance and comfort of patients, staff and visitors where appropriate. In mental health care environments, more detail care needs to be given to the overall lighting design to create a comfortable day and night environment for the patients and staff while ensuring that the equipment selection is suitable and robust for the given environment and its use.

The lighting design shall be fully integrated with the architecture at Tamworth Mental Health Mental Health Unit. The design shall consider energy efficient and high-quality lighting equipment for a low energy, sustainable and maintainable lighting design solution. Internal lighting to the, Level 1 and Level 2 shall be designed to provide a comfortable environment which is inviting and appropriately illuminated to support the various tasks being undertaken in each area. Lighting shall be designed in accordance with the most current versions of the relevant sections of Australian Standards AS/NZS 1680 and NCC (BCA) Section J6, utilising energy savings initiatives where possible as well as AusHFGs.

The exterior lighting shall be designed in accordance with Australian Standards AS/NZS 1158 Road Lighting and AS 4282 Control of the Obtrusive Effect of Outdoor Lighting. External lighting to the perimeter of the building and any outdoor spaces including the courtyards shall be coordinated with security and CCTV camera requirements within these areas.

All lighting shall utilise LED technology. Some of the measures for minimizing energy consumption shall include selection of efficient LED luminaires for energy efficiency and minimisation of maintenance requirements with LEDs due to extended lamp life and control strategies to use lighting control system with automated and timed settings as well as use of motion sensor controls for less frequently used areas.

The correlated colour temperature (CCT) of all LED light sources for external areas shall be 3000K and match existing site wide exterior lighting. All exterior luminaires are selected with direct downward light distribution and full cut-off and with the appropriate optics and accessories to minimise glare and light spill. All external luminaires shall be double insulated. Refer also to wiring requirements for external lighting.

3.2.1.2 KEY LIGHTING CONSIDERATIONS

Some of the key lighting techniques that shall be integrated within the lighting design include the following:

- **Overall Considerations**

- Access to daylight – connection to the outside, circadian rhythms
- Patient and staff comfort - comfortable glare free lighting to create a calm and relaxed environment
- Task appropriate lighting – flexibility, modulation for various modes/ scenes
- General day/ examination/ reading/ night-time
- Well-lit task areas and surfaces
- Vertical illumination for sculpting/ modelling of the faces
- Uniform, diffused lighting
- Soft, comfortable lighting for patient areas
- Shadowless lighting for treatment areas
- Glare control - limit visibility of light sources in the field of view
- Lighting to support shift work including safety and well being
- Anti-ligature, vandal proof and fully sealed light fittings
- Sealed IP rated luminaries in areas subject to ingress of dust or where space pressure regimes are to be maintained
- Use of night lights in circulation spaces and patient bedrooms
- Infection Control – Examination lights, other medical equipment, switches and controls
- Lighting controls - Flexible Control settings including dimmability, local and centralised controls for staff, easily accessible locations for staff with limited access for patients, intuitive with ease of use without training and instructions

- **Light quality considerations:**

- Use of latest technologies such as LED lighting
- Colour Rendering Index, CRI >90 in all patient areas
- Colour Temperature (CCT) – 3000K or 4000 K(kelvin) or
- Circadian/ Tunable White lighting (2200K – 6500K) in selected spaces for patients and staff. Recommended areas include:
  - Priority 1 Spaces to include Circaadian Lighting (areas to be reviewed with client and stakeholders)
    - 1 Bed MH
    - 1 Bed Special
    - Seclusion
    - De-Escalation
    - Staff Base
    - Clinical Workroom
    - Tribunal
  - Priority 2 Spaces to include Circadian Lighting (areas to be reviewed with client and stakeholders)
    - Corridor/ Circulation outside 1 Bed MH
    - Lounge/ Dining
    - Recreation Day Area
    - Family Lounge
- Use of colour changing RGBW lighting with set scenes in Sensory Rooms. Lighting to support other interior and acoustic treatment within the spaces
- Use of Cyanosis lighting to Treatment and Observation Rooms
- Night lights – warm colour temperature 2200-2700K
- Location of luminaires to enable ready access for maintenance. Where possible access to luminaires from below within the room for maintenance.

Refer to Appendix C for further details on recommendations for proposed areas with Circadian/ Tunable White lighting in patient and staff areas, Cyanosis lighting to treatment rooms and coloured lighting to sensory rooms. Client to confirm preferences around the with these recommendations and direction to procced with the design in the next stage on this basis.

- **Natural Illuminance and Tunable White Artificial Lighting**

A naturally illuminated environment with supplementary artificial lighting to create a comfortable, well illuminated visual environment. Areas with prolonged use by patients and staff during day and night-time to incorporate Human Centric, tunable white lighting to support the circadian rhythms of the occupants.

The following considerations are recommended to be integrated within the overall lighting design approach:

- Use of windows and skylights to provide connection to nature/ outside as well as access to daylight as natural light impacts on health and well-being of staff, doctors, patients, including faster recovery rate
- Integration of daylight into the electric lighting and architectural design
- Uplighting of ceiling/ indirect lighting to increase overall ambient lighting within interior spaces
- Where tunable-white lighting is utilised, correlated colour temperature range ranging from 2200-6500K to be tailored to suit each space colour temperatures in some cases depending on the task and needs of the occupant
- Seamlessly adjusted colour temperatures from cool white to warm white –create natural lighting effects (daylight) and considers circadian rhythms
- Daylighting is to be utilised where possible. Integration of daylight and electric lighting shall be developed through the Schematic and Detail design phases of the project in conjunction with Health Infrastructure and the Architect.

- **Lighting Integration**

Utilising light as an integrated luminaire as an alternative to "feature luminaires" This will allow for more secure decorative lighting elements while assisting in creating soft ambient light levels in selected areas.

- Concealed light sources minimising visibility of light sources, especially in the field of vision of patients
- Visual interest created using feature lighting or illuminating artwork on the walls
- Integrated joinery lighting
- Use of integrated night lights to architectural joinery

▪ **Finishes and Textures**

Designing interest and enhancing the light and atmosphere with consideration of the material finish in spaces. Lighting vertical surfaces where possible to increase ambient indirect illumination within a space while reducing the overall number of luminaires. Architectural consideration for use of matte, textured and lighter coloured surfaces to increase inter-reflected light within the interiors. Use of specular surfaces to be carefully considered alongside the positioning of luminaires for glare.

- Control of reflectance can assist with control of glare – from daylight and artificial lighting
- Wall lighting/ vertical illumination to increase ambient brightness of spaces

▪ **Way finding**

Utilising light as a tool to assist with navigation throughout the building. Consideration is required to ensure that all fixtures are not able to be accessed without the appropriate maintenance tools to ensure safety of patients and staff.

- Integration into walls and architectural joinery
- Nightlights - low level lighting
- Night lighting to be controlled at nurse station
- Ambient light to support way finding

3.2.1.3 LIGHTING CONTROL

A centrally controlled intelligent DALI lighting control system, Dynalite or approved equivalent for the control of all the internal and external lighting complete with interface to the head end PC and software is to be located in the restricted access location confirmed by the client. Client to confirm if there is a preference for this lighting control to interface with any other buildings or network systems across the site.

All internal lighting to front of house and patient areas to be DALI dimmable. Circulation areas to be centrally controlled via timer with override controls at staff station or Reception. Motion Sensors to be provided to circulation areas, workspaces, offices, meeting rooms, toilets, BOH areas such as store-rooms with intermittent use for presence and absence detection.

Lighting control system shall have a high-level interface with the BMS for monitoring purposes only providing information such as lighting is operational or not as well as fault reporting for each of the zones. Client to confirm if this requires interface with a site wide BMS/ BAS system. Any control of the lighting and modifications to the lighting control settings, zoning or programming shall be undertaken at the lighting control head end installed on a new PC. Client to confirm if this is required to be new or existing PC.

The system shall be supplied with all equipment, hardware, software, cabling and ancillary services as required to provide an integrated system complete and functional in all respects. The system head end and network shall be a fully IP based system operating over a Microsoft Windows based platform which integrates with other systems. Network components shall operate at Megabit speed as a minimum.

The lighting control system consists of time clock, dimmers, DALI gateways, modular controllers, relay controllers, PIR's, LCP's and PE cells.

The system shall be capable of providing manual control, pre-programmed scene control, and automated time controls of functional areas through localised control panels in designated areas, as well as programming of hardware controls.

3.2.1.4 EXIT AND EMERGENCY LIGHTING

The emergency and evacuation lighting system to be a stand-alone computer monitored system, Legrand Axiom or approved equivalent and will be provided with a head end PC. Location of the head end on a PC or a rack location within a comms rack and remote access provided to a computer to be confirmed by the client. Client to confirm if there is preference to connect the emergency and exit lighting within the new Tamworth Mental Health building to the Tamworth ASB building.

All emergency and exit signs to have a self-contained battery for power supply. Luminaires used for general lighting and emergency will be maintained emergency. All emergency lights and exit signs will have a 2-hour battery back-up power. Meters will have communication modules to allow connections to the network in the future where required.

The computer monitored single-point emergency and evacuation lighting system shall have provision to carry-out monitoring and testing of emergency lighting and associated batteries (within the luminaires and exit signs) as per AS2293.

New emergency and exit lighting shall be in accordance with NCC Section E and AS2293 Emergency lighting standards.

Emergency lighting system to have a high-level interface with the BMS to provide the following data:

- If the Emergency and exit lighting is operational or no to provide fault reports
- Emergency luminaires will be self-contained, non-maintained.
- Exit luminaires will be self-contained maintained type. Each fitting will have an individual battery pack.
- Additional key design features are as follows;
- Luminaires are to be sourced from proven production runs with demonstrated performance levels.
- System to contain a cable based communication network
- System will be capable of accommodating additional luminaires anywhere within the systems network.
- Emergency and exit luminaires to contain a localised battery source of a minimum 5 year manufacturer's life.
- Battery and control circuitry to be modular in design to enable quick replacement techniques

Specifics of these require input from the users, as well as more detailed layout drawings of the proposed buildings.

3.3 COMMUNICATION SERVICES

1.1.2 GENERAL

The ICT services shall be designed and constructed in accordance with the following standards and guidelines

- NCC 2019
- Local government and municipal council regulations
- Occupation / workplace health and safety legislation
- NSW Service Rules and Installation rules
- Engineering Services guidelines
- NSW Health ICT Cabling Standard Version 3.2 – May 2021
- LHD Security services guidelines
- AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)
- AS/NZS 3008.1 Electrical Installations - Selection of cables.ac
- The requirements of the Australian Telecommunications Authority

1.1.3 EXISTING ICT ARRANGEMENT

The key element of the ICT services for the Tamworth Campus consists of the following:

— Campus distributor-1 located in 1883 building

— Campus distributor-2 located in Brudelin building

All the other buildings located on the campus are directly serviced from these two campus distributors. The backbone cabling runs directly via diverse paths from each of the campus distributor to building distributors located in individual building. The backbone cabling from each of the campus distributor comprises of 12 Core Multimode + 12 Core Multimode and 100 pair copper. Prior to the redevelopment, the communications backbone cabling was reticulated via a daisy chain system. However, as part of enabling works of the Tamworth Hospital rural redevelopment project in 2013-16, the daisy system was discarded and individual backbone cabling reticulation system was adopted to improve redundancy and reliance of the ICT campus wide system. The existing Tamworth Mental Health building is also serviced by backbone cabling from these campus distributors.

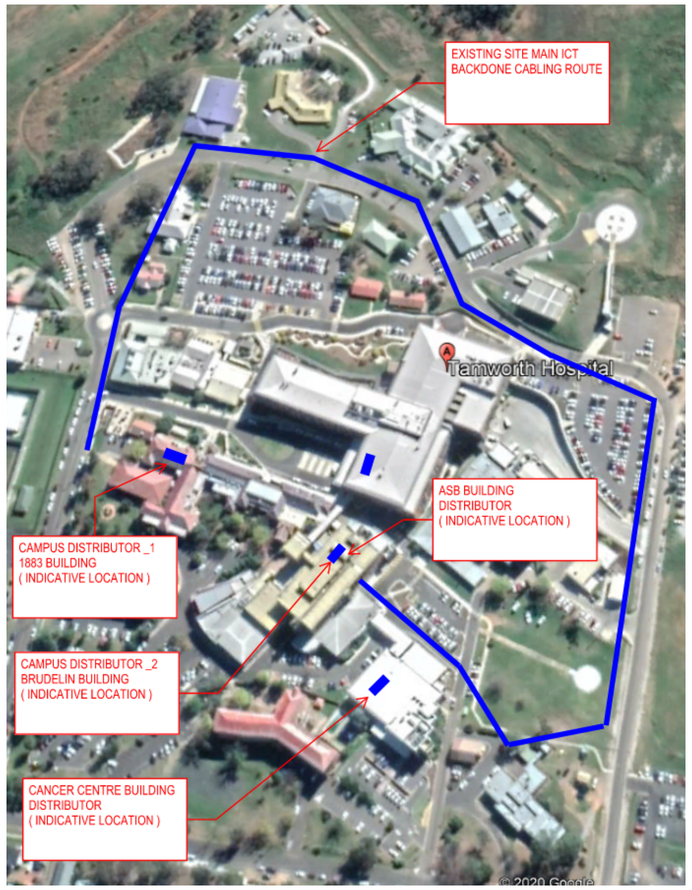

FIG 8 – EXISTING INDICATIVE ICT INFRASTRUCTURE ARRANGEMENT

1.1.4 ENABLING WORKS – ICT

Refer to section 3.1.6.1 for details associated with enabling works for ICT.

1.1.5 NEW WORKS – ICT NETWORK CONNECTION

The communications services for the new Tamworth Mental Health building shall be provided by connecting to the existing Tamworth Hospital campus ICT network. Backbone copper and fibre cabling will be provided by connecting to the campus distributors via diverse paths.
The following were the options considered during the early phase of the project.

→ 1883 Campus distributor

→ Brudelin Campus distributor

→ ASB building main communications room

Further to focus group meeting undertaken with LHD ICT the following strategy was adopted to service new Tamworth Mental Health building

→ 1 x fibre link from existing Brudelin Campus distributor to be provided to new Tamworth Mental Health building. Existing conduits to be used for the majority portion of the route and new conduit to be provided as required

→ Existing fibre link to doctors accommodation to be spliced and then routed to connected to new Tamworth Mental Health building. Existing conduits to be used where possible and new conduits to be provided as required

The design development will focus on using existing underground conduits and pathway for reticulation of backbone cabling.

1.1.6 NEW WORKS – ICT IN NEW TAMWORTH MENTAL HEALTH BUILDING

The new Tamworth Mental Health building consists of 3 level – Level 1, 2 and 3. The largest area is in level 2 and comprises of the clinical space.

Typically, the ICT system would be arranged in the following way

- Main communications room in Level 1

  This will be the building distributor and floor distributor for level 1

- Floor communications room in level 2 and 3

  This will be floor distributors for level 2 and 3

However due to the limitation of floor space on level 2 and limit LHD ICT team to clinical level the following alternate solution was proposed and accepted

- Main communications room in level 1

  This will be building distributor and floor distributor for level 1 and 2

- Floor communications room in level 3

  This will be floor distributors for level 3

A key challenge us to ensure 90m horizontal cabling length is maintained from the comms room to all the data outlets. This will be undertaken through efficient cable reticulation system.

1.1.6.1.1 MAIN COMMUNCATIONS ROOM

The main communication room will be established in level 1 of the building as indicated above.

The key factors associated with the communications room to be as follows

— Maximum permitted cabling length of 90m is not exceeded from the patch panel to the farthest outlet

— Not be adjacent to washrooms, toilets or kitchens where the room and its equipment could be damaged due to rising damp, seepage or a flooding event

- No pipes containing water or liquid material to be installed below or within 1200mm of any pipes containing water or liquid material
- Shall be located away from sources of excessive electromagnetic interference
- Shall provide the required clear working spacing around the communication cabinets
- Shall have essential power to supply the communications rack, security system, nurse call, air conditioning and a minimum of 50% of the lights.
- Lighting in the room shall be activated by a motion sensor
- Door to be secured with card reader

The communications rack shall be provided with 45 RU racks. The actual quantity of the racks to be determined in the detail design phase. The key factors associated with the racks are as follows;

- 45RU, 800mm wide x 1000mm deep
- Perforated single front and split rear doors
- Removable doors and side panels (side panels to each have two removable sections, top and bottom)
- All doors and panels to be key lockable
- Vertical cable management
- Local UPS with bypass switch connected to the Essential supply with captive plug
- Vertical power rail captive power plug

1.1.6.1.2 STRUCTURED CABLING SYSTEM

- The structured cabling system shall be provided in accordance with NSW Health ICT Cabling Standard Version 3.2 – May 2021
- Horizontal cabling is to be supported by an approved method (for example, cable tray, catenary cable, J hook) from the cabinet to within 3m horizontally of the vertical channels used to deliver the ICT cables to their telecommunications outlets.
- Horizontal cable trays shall be installed in all locations where there are more than 24 cables being run together in the same general direction.
- Catenary cables may be used where there are 24 or less cables being run together in the same general direction.
- Cable trays shall be run from the data cabinet outwards and are to be installed above the main passageways to enable easy access
- Cabling to be Category 6A, Class EA F/UTP (shielded)
- Structured cabling system to be tested to the “ISO11801 PL2 Class Ea” test limits
- The maximum length of the structured cabling shall be 90m from the patch panel to the data outlet
- All new cabling within a specific site shall be of a single brand with manufacturer’s warranty.
- The number and location of data outlets should be determined by AusHfg as the starting point, overlayed by the NSW Health ICT Cabling Standard which takes precedence in regard to the number of outlets per location, and then finally supplemented by requirements determined through the user group process.

3.4 SECURITY SYSTEMS

The Electronic security for the Tamworth Mental Health building will comprise of provision of the following systems

- Electronic Access Control
- CCTV system
- Intercom
- Duress Alarm System

The key factors associated with each system are as follows

1.1.6.1.3 ELECTRONIC ACCESS CONTROL SYSTEM

The Electronic access control system for the new building will be consistent with the system provided across the campus

The system shall comprise but not limited to the following

- Reed switches
- Electrical access control card readers
- Electric strikes
- Electromagnetic locks
- Exit to push button
- PIRs
- Security equipment panel
- Head end system
- Cabling and associated works
- Fixed duress buttons

The head end system will be located in the main communications room to be located in level 1. Essential power supply will be provided for the system to keep it operational during mains power failure situation.

The actual location of the various access control device will be finalised as part of the detail design process.

1.1.6.1.4 CCTV SYSTEM

The CCTV system for the new building will be integrated with the site wide surveillance system.

The CCTV system for the building will be provided with the following

- Work with NMBLHD Security to identify specific locations where ongoing video surveillance is required
- Install new IP based CCTV cameras
- Cameras to be cabled back to the main communications room in level
- Cameras to be cabled using Category 6a F/UTP network cabling
- Cameras required to have the appropriate ingress protection (IP) and impact protection (IK) ratings

The actual location of the various access control device will be finalised as part of the detail design process.

1.1.6.1.5 INTERCOM

A video intercom system will be provided for controlling and streamlining the access to the building.

The type of system to be provided will be consistent with the existing system across the campus. A video intercom system is proposed at main entry. This will enable the staff to review the visitor and provide access as required. The operational time of the system to be confirmed as part of the detail design stage in consultation with LHD.

3.5 NURSE CALL SYSTEM

A dedicated standalone Nurse call system will be provided for the new building. No integration of this system with the AMHU facility or any other buildings is currently proposed.

Key factors associated with the nurse call system are as follows

- Austco or Hills system will be used
- Nurse call system will be an IP based system
- Essential power to be provided

3.6 OTHER SYSTEMS

Various ancillary systems will be proposed for the facility and will be discussed in more detail during the detail design stages, these include such systems as listed below.

- Duress systems. comprise of both mobile and fixed duress call stations.
- The emergency / exit system will be interfaced with any campus manufacture system.
- If the Emergency and exit lighting is operational or no to provide fault reports
- Emergency luminaires will be self-contained, non-maintained.
- Exit luminaires will be self-contained maintained type. Each fitting will have an individual battery pack.
- Additional key design features are as follows;
- Luminaires are to be sourced from proven production runs with demonstrated performance levels.
- System to contain a cable based communication network
- System will be capable of accommodating additional luminaires anywhere within the systems network.
- Emergency and exit luminaires to contain a localised battery source of a minimum 5 year manufacturer's life.
- Battery and control circuitry to be modular in design to enable quick replacement techniques

Specifics of these require input from the users, as well as more detailed layout drawings of the proposed buildings.

4 APPENDIX A – SCHEMATIC DESIGN DRAWNGS

Refer to separate attachment

Refer to separate attachment

5 APPENDIX D – MECHANICAL SYSTEM LIFE CYCLE ANALYSIS AND OPTIONS REPORT

HEALTH INFRASTRUCTURE

TAMWORTH MENTAL HEALTH UNIT

MECHANICAL SYSTEM LIFE CYCLE ANALYSIS

NOVEMBER 2022

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Question today
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Tamworth Mental Health Unit
Mechanical System Life Cycle Analysis & Sytem Options

Health Infrastructure

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TABLE OF CONTENTS

1 CONSULTANT'S ADVICE

1.1 INTRODUCTION

The following consultant's advice provides a comparison and recommendation for the mechanical services cooling and heating system options for the Tamworth Mental Health Unit.

The report is based on the available concept floor plan layouts. Note that equipment and maintenance cost prices are estimates only and subject to change.

The purpose of this report is to provide an estimated cost comparison between 2 system configurations as follows:

- **Option 1: Air-Cooled Chiller, 4-Pipe Chiller & Heat Pump**
- **Option 2: Reverse Cycle Heat Pump w/ Reverse Cycle**

2 SYSTEM COMPARISON

2.1 OPTION 1: AIR COOLED CHILLER, 4-PIPE CHILLER & HEAT PUMP

This option comprises of an all-electric air-cooled chilled/heating hot water system using water as a working medium to transfer energy (heat) from the conditioned space for rejection into the atmosphere. The system consists of one large outdoor 4-pipe chiller (with heating recovery), 1 large cooling only chiller and a heat pump. The 4-pipe unit can generate both heating hot water and chilled water both independently and simultaneously via a heat recovery method supported with the conventional chiller generating chilled water when demand requires. A 4-pipe system requires a larger quantity of water storage to prevent the unit from cycling via the use of thermal inertia, which results in the requirement for buffer tanks on both the heating and chilled water systems. When heating only is required, the heat pump will operate to meet the peak heating demand

The system comprises the following:

Roof Plant Room: Dedicated plant room required for main equipment, including a 4-pipe chiller, air-cooled chiller, reverse cycle heat pump, pumps, buffer tanks and dosing tanks, mechanical services switchboard, pipework reticulation and controls.

On-Floor: Pipework reticulation, valves and fittings, ceiling concealed fan coil units, Variable air volume boxes, electrical and control units.

Risers: Pipework riser (consisting of common flow and return pipework).

2.1.1 INDICATIVE CONCEPT DIAGRAM

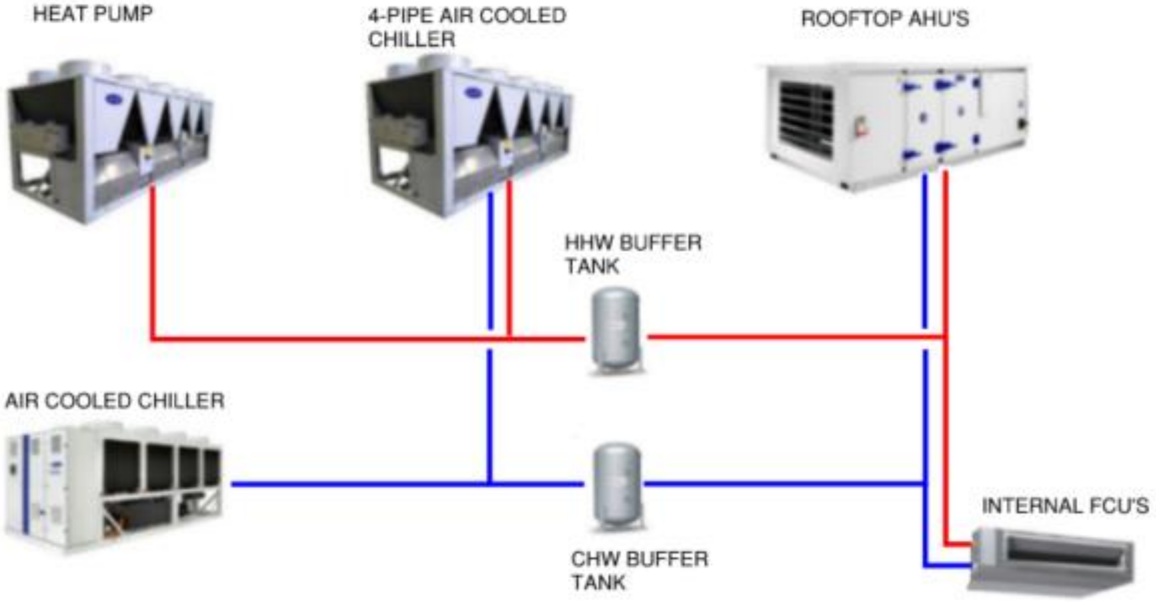


Figure 1. Option 1 Schematic

2.1.2 ADVANTAGES

- ✓ Redundancy for both cooling & heating system
- ✓ Net zero carbon
- ✓ Spatially fits within current plant room
- ✓ Lower operational Cost
- ✓ Most efficient system to operate
- ✓ Compatible with solar array
- ✓ Ability for payback

2.1.3 DISADVANTAGES

- ✗ More complicated to install and maintain
- ✗ Higher capital cost
- ✗ More complicated to control
- ✗ Possible acoustic treatment of units

2.1.4 SYSTEM PARTICULARS

System impact: 4-pipe chillers are required to be designed at a different heating hot water temperature than a conventional gas fired boiler system. This will result in an increase in the system flow rate which will have an impact on the heating hot water pipe sizing, pump size and FCU/AHU coil sizes. These requirements will need to be reviewed and confirmed during design development.

As 4-pipe chillers require a larger quantity of water storage to prevent the unit from cycling, water buffer tanks will be required on both the heating hot water and chilled water systems.

Sustainability: The use of a fully electric heating and cooling system enables the buildings to achieve net zero carbon footprint which better aligns with future projections for sustainability. These chiller units can also utilise renewable energy sources such as photovoltaic array to operate.

4-Pipe chillers typically have a slightly lower operational COP and part load efficiency when compared to dedicated chillers and heat pumps, however these systems have the ability to recover rejected heat, enabling free heating during transitional seasons. The cooling only chiller typically has a higher peak load COP compared to the heat pump and higher part load efficiencies. Combining the two features provide overall improved operational efficiency.

System Redundancy: The 4-pipe chiller & dedicated air cooled chiller is sized based on the buildings 60% base heating demand which produces close to equal cooling output. The cooling only chiller provides support to the 4-pipe. This results in a cooling system redundancy. The heating is supplied by the 4-pipe chiller and heat pump, which also provides redundancy on the heating hot water system.

Controllability: The units both operate with independent pipework systems (i.e. no mixing of hot and cold system) eliminating the need for a complicated external valving arrangement. The chiller units have inbuilt controllers which control their internal operation and heat recovery systems (where applicable). The unit's operational sequence can be programmed into the BMS (As per the current design intent), or the unit suppliers can provide a standalone management controller to carry out this function. The management controller receives a heating or cooling demand from the filed devices via HLI input to the BMS which is used to manage the unit's operation via a pre-programmed staging sequence.

Maintainability: Conventional cooling only chillers are simpler than heat pumps regarding maintenance, most contractors would have had exposure to these types of units with parts readily available from suppliers. 4-pipe chillers are more specialised, their ability to recover heat means their internal operation is more complex than that of a conventional cooling only chiller and heat pump, and therefore more complicated to maintain. Replacement parts are readily available from suppliers, but not all contractors may have had experience working with this style of chiller. This is expected to change over time.

2.2 OPTION 2: REVERSE CYCLE AIR-COOLED CHILLERS

This option follows a similar approach utilising 4 x Heat pumps with reverse cycle (inclusive of 1 standby unit) which can also operate in a reverse cycle to provide heating. Following an N+1 configuration, these units can be set-up to provide cooling in the summer (2 Units Cooling & 1 Unit Heating) where the heat extracted from the conditioned space is rejected to the atmosphere. In the winter, this operation is reversed where refrigerant is used to extract heat from the atmosphere and transfer this energy to water for circulation to the AHU's & FCU's (2 Units Heating & 1 Units Cooling). Unlike Option 1 (where a 4-Pipe Chiller is utilised), this chiller cannot provide simultaneous cooling & heating via heat recovered from the conditioned space. Modular heat pumps w/ reverse cycles allow capital cost savings as well as minimising plant footprint. Alternatively, the need for inactive & dedicated heat pumps for heating and chillers for cooling would be required.

The system comprises the following:

Roof Plant Room: Dedicated plant room required for main equipment, including 4 x Heat Pumps w/ Reverse Cycle (1 unit will be standby), Water pumps, Buffer tank, Dosing tanks, Mechanical Services Switchboard, Pipework Reticulation and Controls.

On-Floor: Pipework reticulation, valves and fittings, ceiling concealed fan coil units, variable air volume boxes, electrical and control units.

Risers: Pipework riser (consisting of common main flow and return pipework).

2.2.1 INDICATIVE CONCEPT DIAGRAM

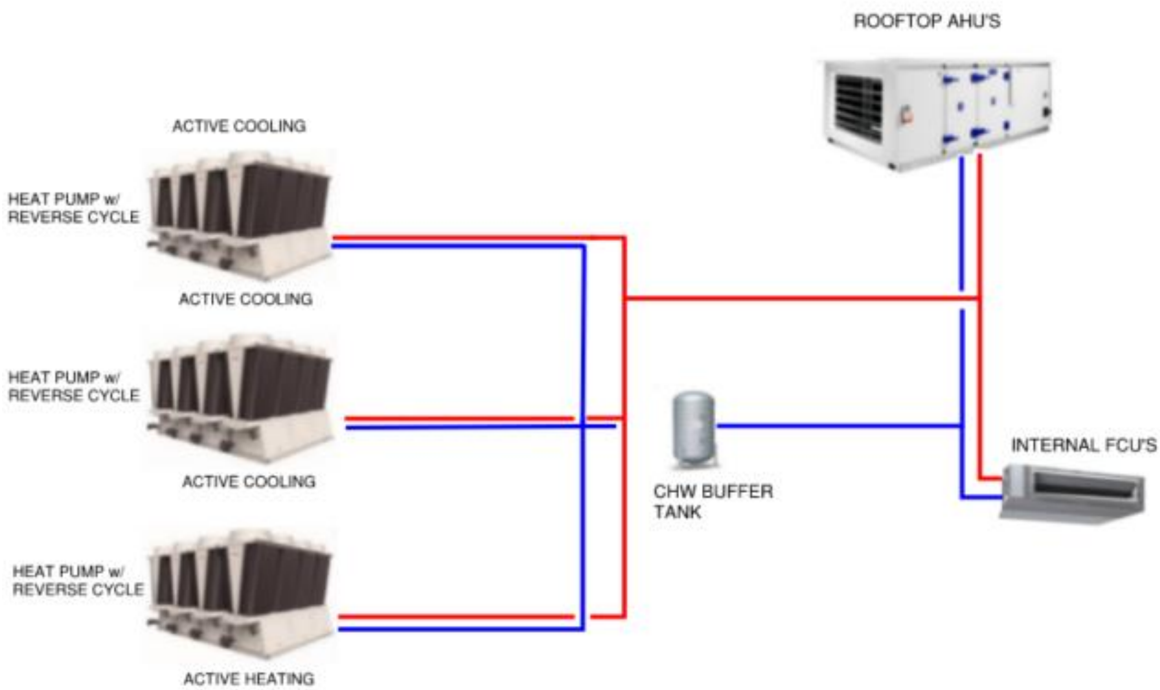


Figure 2. Option 2 Schematic

2.2.2 ADVANTAGES

- ✓ Redundancy for both cooling & heating system
- ✓ Easy to install and maintain
- ✓ Lower capital cost
- ✓ Lower maintenance cost
- ✓ Lower operation cooling cost
- ✓ Compatible with solar array
- ✓ Simpler to control

2.2.3 DISADVANTAGES

- ✗ No ability for payback as a result of no energy recovery
- ✗ Less efficient system due to inability for energy recovery
- ✗ Higher on-going operational Cost

2.2.4 SYSTEM PARTICULARS

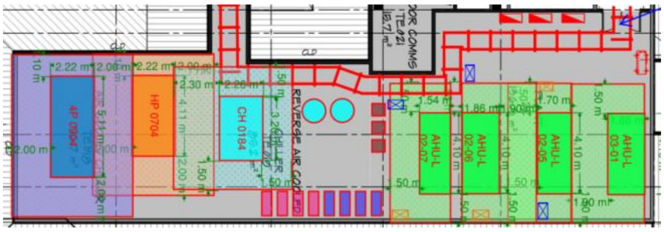
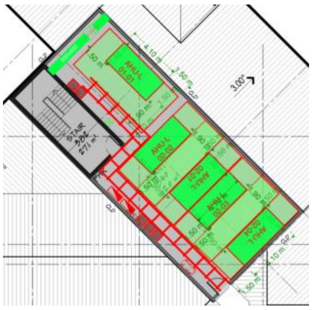
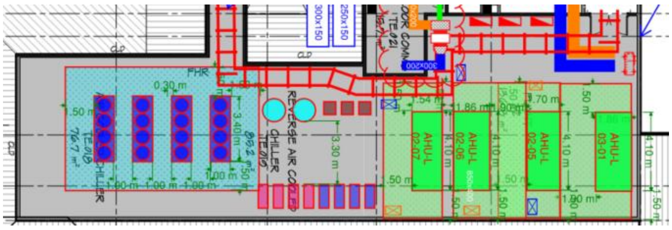
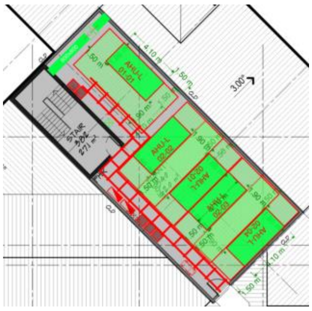
This system operates in a similar manner to Option 1 with the following key differences:

System impact: Reduced spatial requirements due to the removal of the 4-pipe chiller and thus enabling a reduction in volume of water storage requirements within the plant room when compared to Option 1 aswe

Sustainability: No potential for energy recovery during simultaneous heating and cooling demand due to the removal of the 4-pipe chiller.

System Redundancy: The inclusion of additional heat pump w/ reverse cycle capability provides redundancy for both the heating and cooling system.

2.3 AREA FOOTPRINT COMPARISON

PLANTROOM 1 (OPTION 1)	PLANTROOM 2 (OPTION 1)	AREA
		PLANTROOM 1 = **286 SQM** PLANTROOM 2 = **185 SQM**
PLANTROOM 1 (OPTION 2)	**PLANTROOM 2 (OPTION 2)**	**OPTION 2:**
		PLANTROOM 1 = **267 SQM** PLANTROOM 2 = **185 SQM**

2.4 REQUIRED PLANT REPLACEMENT

Below outlines the key elements that will require replacement for each system option over a 30-year life cycle.

Option 1

The plant outlined below would require a Single replacement within a 30-year life cycle for a chilled water system:

- Air Cooled Chiller Unit
- 4 Pipe Chiller Unit
- Heat Pump

Option 2

The plant outlined below would require a Single replacement within a 30-year life cycle for a chilled water system:

- Heat Pumps w/ Reverse Cycle

3 COST COMPARISON

3.1 GENERAL

The following provides the 30-year life-cycle comparison between Option 1 & Option 2 Cooling and Heating Water Plant Systems. The figures represent the system's estimate of cost for all equipment and maintenance throughout a 30-year life span cycle.

The provided estimate costs are for comparative purposes only and to assist in the decision making regarding which mechanical option is most viable.

3.2 SYSTEM PARAMETERS

The following general and specific system parameters have been applied.

3.2.1 COMMON PARAMETERS

Operating Time	Total System: 8,904 Hrs/P.A.
Air Side Systems	Fans & AHU's have not been considered as they are generally common between each of the options
Indoor Units	Indoor units, i.e. fan coil units, will be required for both CHW/HHW
Rates (1st Year)	Electricity: 20.21 c/kWh
Rates (30th Year)	Electricity: 20.21 c/kWh
Ancillary Items	Pressurisation Units, Buffer Tanks, etc.
Maintenance costs	Chillers & Heat Pumps
Electrical and Controls	BMS
Other items	Valves, Fittings, Filters, Controls, etc. included in equipment cost and ancillary items

3.2.2 UNCOMMON PARAMETERS

Mechanical Equipment	4-pipe chiller, Heat Pump & Heat Pump w/ Reverse Cycle
COP (Coefficient of Performance)	Varies for each system and load
Maintenance costs	4-pipe chiller, Heat Pump & Heat Pump w/ Reverse Cycle

3.3 LIFE-CYCLE RESULTS

Based on a period of 30 years, the following life-cycle assessment can be presented (Table 1 and Figure 1) for the chillers/heat pumps for the 2 options presented:

	OPTION 1 W/ 4-PIPE	OPTION 2 HEAT PUMP W/ REVERSE CYCLE
Initial Capital cost of Units	$ 2,738,881.07	$ 2,687,266.54
Replacement Capital over 25-year period	$ 478,500.00	$ 442,498.00
Maintenance cost over 30-year period	$ 360,000.00	$ 234,000.00
Running cost of cooling over 30-year period	$ 3,040,735.20	$ 3,662,995.68
Running cost of heating over 30-year period	$ 861,183.17	$ 1,764,756.97
30-Year Lifecycle Accumulated Cost	$ 7,479,299.45	$ 8,791,517.69

Table 1. Estimated capital cost over a 30-year lifecycle

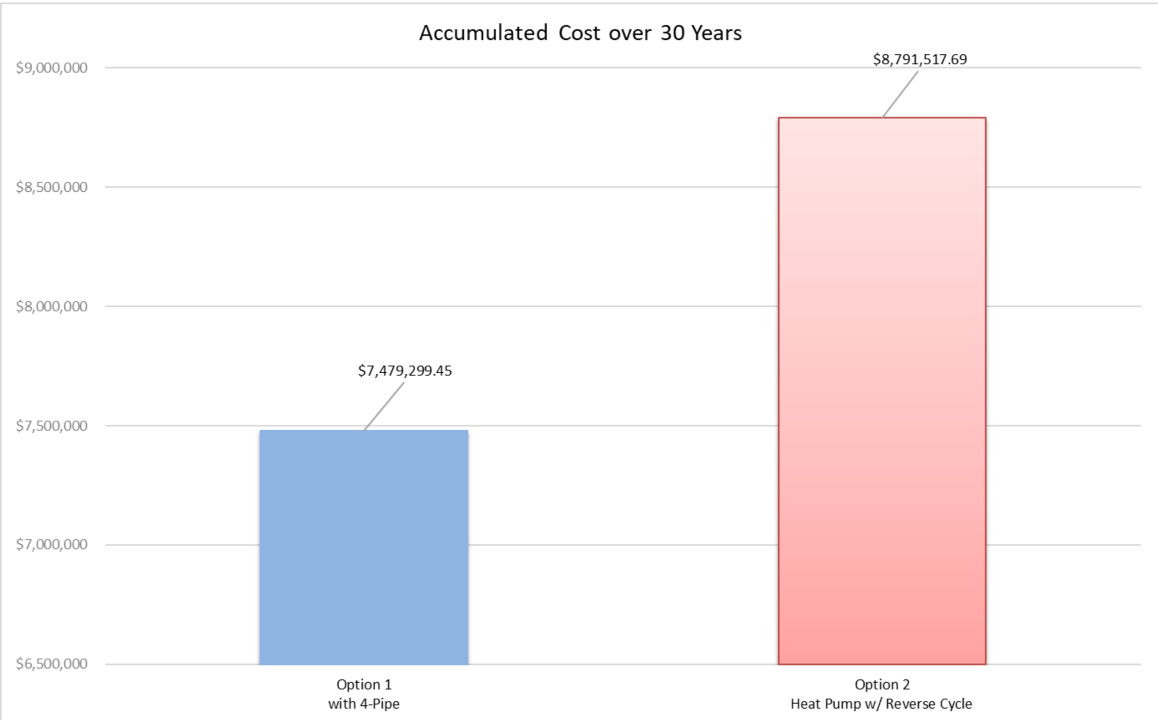


Figure 3. Cost Comparison

Over time, it is expected that Option 1 will have a lower operational cost as a result of the savings obtained via the 4-pipe chillers ability to avail of free heating (despite a higher on-going annual maintenance cost).

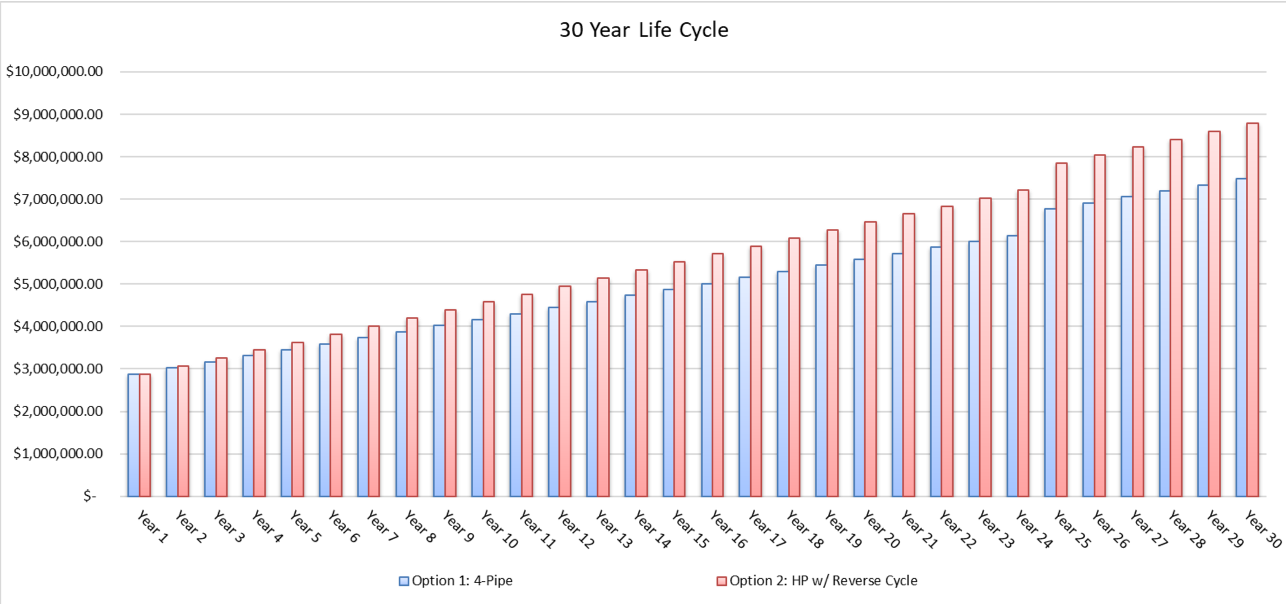


Figure 4. Accumulated costs in 30-year lifecycle.

3.4 CLARIFICATIONS AND ASSUMPTIONS

The design is in early schematic design stage therefore high level selections have been made based on calculations derived from CAMEL +. These selections are subject to change following design development.

- Equipment and maintenance costs are estimates based on available information
- A 50% addition cost has been added to all plant items quotes from manufacturers and account for the procurement and installation by contractors
- Unit costs have been determined using a combination of Rawlinson Construction Cost Guide, supply selection quotes and industry experience.
- Assumed installed systems receive regular maintenance throughout their life span
- Plant Economic Life spans have been determined using AIRAH handbook 2007

3.4.1 ELECTRICITY PRICE FORECAST

The electrical tariff rate has been taken on from the electrical bills provided by Hunter New England hospital, the rate is based on the yearly average of the hospital electrical consumption which to 20.21 c/kWh , WSP have elected to maintain a steady-state price at 20.21 c/kWh.

4 RECOMMENDATION

It is expected that the initial capital expenditure for Option 1 will be greater than that of Option 2. Furthermore, the on-going maintenance cost for Option 1 is greater as it is a more complex system. Despite this, Option 1 provides a greater payback off-set via heat recovery resulting in an overall saving of $1,312,218.24 over 30 years.

The payback above also includes a replacement capital cost for both Options after 25 years. In terms of plant footprint, the standard air-cooled system (Option 2) occupies less area that could be used for future provision or potentially given back as workspace.

Taking into consideration the various system factors outlined above and the consideration of a more sustainable and low carbon future, our recommendation would be Option 1. Although the initial A/C capital cost is higher for this Option, this solution better achieves net zero carbon targets, provides the best opportunity of energy recovery (heating recovery) and has an overall lower system cost compared to Option 2 over the intended life of the plant.