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Consultant Advice Note

Project Name:	Wallacia Memorial Park	**Document No**	177127 CAN S01
Project No:	177127	**Revision**	00
Subject	Environmentally Sustainable Design (ESD) Strategies		

Sydney October 16th, 2017
Project No. 15814

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1.0 Sustainability Strategies

For the development of the sustainability strategy for the Wallacia Golf Course Cemetery and Crematorium, Steensen Varming have been appointed to provide Sustainability advice for the development of the park and buildings.

Having worked with the Catholic Cemeteries Metropolitan Trust for the Macarthur Memorial Park, Steensen Varming understands that the sustainability aspirations include the following:

- Strong focus on energy saving;
- Focus on productivity benefits that can flow from sustainable design and an energy efficient building;
- Incorporate sustainability initiatives to provide benefits in both the living environment of individual spaces and long term operational cost savings;
- Consideration of solar energy generation;
- Maximise natural lighting, heating and cooling;
- Stormwater capture and grey water re-use;
- Other relevant strategies that could help enhance the overall sustainability of the project.

The sustainability strategies presented below follow a similar approach to that developed for the Macarthur site, and focus on low impact, mainly passive design features. This will help improve the overall efficiency of the buildings, and provide a narrative for how the development responds to its surroundings and the climatic conditions of the site.

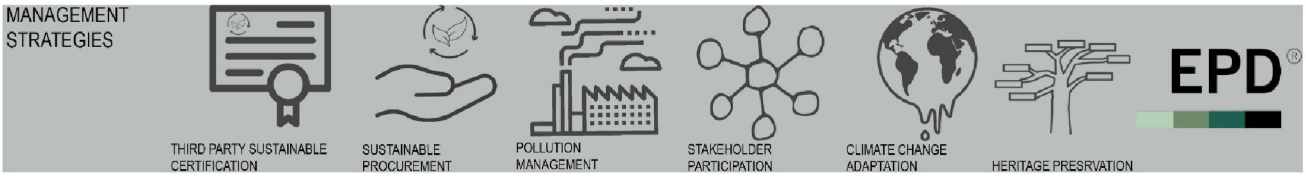
This sustainability report reviews the following areas:

- Sustainability Management:
  - Sustainability regulations effecting the site;
  - Sustainability certification requirements and options;
- Site Assessment – including:
  - Climate conditions such as temperature, solar radiation, wind and humidity;
  - Landscape features such as topography;
- Energy Strategy measures – including:
  - Micro-climate analysis – ensuring the design is appropriate for the local climate conditions;
  - Building fabric considerations;
  - Systems efficiency recommendations;
  - Cogeneration and Trigeneration;
  - Renewable energy opportunities;
- Water efficiency measures:
  - Efficient indoor water use measures;
  - Efficient irrigation and planting;

  - Water storage and re-use;
- Indoor Environment:
  - Acoustics;
  - Lighting;
  - Air quality;
- Materials considerations:
  - Sustainably sourced materials;
- Waste considerations:
  - Operational waste management;
  - Spoil management;
- Climate Change impacts;
- Flexibility and Durability;
- Transport considerations;

2.0 Sustainability Management / Regulatory Requirements

Given the broad range of areas that are covered within sustainability management, it is important to develop a clear set of principles and targets to guide the development of a sustainable project. This includes incorporation of client requirements and goals, local and government regulations, and the possible targeting of third party sustainability certification. It is necessary to consider the environmental impact of a development at all stages of the project life, from concept design through to construction and operation. Some of the sustainability management considerations are shown in the diagram below.



To develop a suitable sustainability framework for the Wallacia Golf Course Cemetery and Crematorium, a review has been carried out for the following local / state / federal environmental policies:

2.1 National / Local Government Sustainability Regulations

2.1.1 Section-J of the National Construction Code.

Section J of the National Construction Code (NCC, previously known as the Building Code of Australia) relates to energy efficiency of buildings, and stipulates the minimum performance values for building fabric and services. Code compliance to this standard is required in this project.

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2.1.2 Penrith Policies

The following local plans are applicable to the development in the suburb of Wallacia:

- Sustainability strategy 2015 – 2021
- Sustainable Penrith Action Plan
- "Penrith Development Control Plan 2014" (Key Precincts – E9 Mulgoa Valley

The Penrith DCP applies to all land within the Penrith Local Government Area. The Penrith City Council has made a firm commitment to building a Sustainable City. This commitment has been clearly articulated in 'Penrith's Principles for a Sustainable City.'

- Principle 1: Provide a long term vision for cities, based on sustainability; intergenerational, social, economic and political equity; and their individuality.
- Principle 2: Achieve long term economic and social security.
- Principle 3: Recognise the intrinsic value of biodiversity and natural ecosystems, and protect and restore them.
- Principle 4: Enable communities to minimise their ecological footprint.
- Principle 5: Build on the characteristics of ecosystems in the development and nurturing of healthy and sustainable cities.
- Principle 6: Recognise and build on the distinctive characteristics of cities, including their human and cultural values, history and natural systems.
- Principle 7: Empower people and foster participation.
- Principle 8: Expand and enable cooperative networks to work towards a common, sustainable future.
- Principle 9: Promote sustainable production and consumption, through appropriate use of environmentally sound technologies and effective demand management.
- Principle 10: Enable continual improvement, based on accountability, transparency and good governance.

Environmental Certification

Non-residential developments, including mixed-use developments, with a construction cost of $1 million or more are to demonstrate a commitment to achieving **no less than 4 stars under Green Star** or **4.5 stars under the Australian Building Greenhouse Rating system**, now part of the National Australian Built Environment Rating System (**NABERS**).

Built Form - Energy Efficiency and Conservation

- The selection criteria for construction materials, including internal fit-out work, should include detailed documentation of their energy efficiency properties.
- Buildings should be designed on passive solar design principles which:
  - Respond to orientation to maximise the northerly aspect and solar access in the cooler periods;
  - Reduce overheating in summer and promote solar gain in winter; and

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- Ensure there is adequate cross flow of air by utilising natural ventilation, resulting in a reduction in the use of mechanical ventilation and/or air-conditioning systems.

- The future use and occupants of the building should be considered in the design and location of building services/equipment to ensure that:
  - The thermal comfort of occupants is optimised through zoning sections of the floor area to ii) of building services is provided enable individual control of heating and cooling;
  - Lighting systems and fittings have reduced energy consumption that are also appropriate for the use/activity located in that part of the building;
  - The equipment or service will be used and its future use will not affect other elements of sustainability; and
  - Sub-metering to individual tenancies within the development to enable individual monitoring of consumption performance.
- Common and service areas in the building should incorporate energy and water efficiency/conservation measures in their design and location.

Building Façade Treatment:

- Promote a high architectural quality commensurate with the type of building and land use;
- Adopt façade treatments which define, activate and enhance the public domain and street character;
- Ensure that building elements are integrated into the overall building form and façade design;
- Compose façades with an appropriate scale, rhythm and proportion that responds to the building's desired contextual character;
- Design façades to reflect the orientation of the site using elements such as sun shading, light shelves and appropriate glazing as environmental controls;
- Express important corners by giving visual prominence to parts of the façade, for example, a change in building articulation, material or colour, roof expression or building height, and
- Co-ordinate and integrate building services to improve the visual presentation.

2.1.3 Panther's Gold Course Project Site

In addition to the Penrith Council policies and plans, there are specific requirements for the Penrith Panthers Golf Club site as part of the Penrith Local Environmental Plan 2010.

Some of the sustainability requirements listed as part of the Development control plan for this land include:

- Development consent must not be granted for development on land to which this Part applies unless a development control plan that provides for the following matters has been prepared for the land:

Copenhagen
London
Sydney
Hong Kong
New York

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- An overall transport movement hierarchy showing the major circulation routes and connections to achieve a simple and safe movement system for private vehicles, public transport, pedestrians and cyclists,
- An overall landscaping strategy for the protection and enhancement of riparian areas and remnant vegetation, including visually prominent locations, and detailed landscaping requirements for both the public and private domain,
- A network of active and passive recreation areas,
- Stormwater and water quality management controls,
- Amelioration of natural and environmental hazards, including bush fire, flooding and site contamination and, in relation to natural hazards, the safe occupation of, and the evacuation from, any land so affected,
- Suitably located public facilities and services, including provision for appropriate traffic management facilities and parking,
- The protection and enhancement of the amenity of residents in the vicinity of the development.

2.2 Client Targets

As mentioned above, a high level of sustainability performance is desired by the client for the project, including high energy performance and environmentally sensitive design considerations. This report therefore proposes an approach to developing a sustainability strategy and framework for the development, and recommends potential third-party sustainability certification systems that could be targeted.

2.3 Formal Sustainability Certification

As mentioned above, Penrith council requires formal sustainability certification of either Green Star (4 Stars or above) or NABERS (4.5 Stars or above). In addition to these 2 systems, an assessment of possible additional rating systems has been carried out below, which may be of interest to the client, and recommendations are made for which system(s) may be most appropriate for the project. Rating systems assessed include:

For the overall site infrastructure:

- Infrastructure Sustainability Rating Scheme (operated by the Infrastructure Sustainability Council of Australia (ISCA);
- CEEQUAL (operated by the BRE Group);
- Other international infrastructure sustainability rating systems.

For the buildings within the site:

- Green Star (operated by the Green Building Council of Australia (GBCA);
- LEED (operated by the US Green Building Council (USGBC);
- WELL Building Standard (operated by the International Well Building Institute (IWBI));
- Other international certification schemes.

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2.3.1 Sustainability Rating System Comparison

The following table provides an overview of the sustainability rating systems discussed above. The table is split into 3 sections:

- Local / National government sustainability requirements;
- Site / Infrastructure scale third party sustainability rating systems;
- Building scale third party sustainability rating systems.

The table reviews the extent of each system, and the level of detail attributed to each category.

✓ represents coverage but without much detail.

✓✓✓ or more represents greater coverage and more stringent targets / requirements.

⊗ means that the category is not assessed by that standard or rating system.

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Scheme / Assessment body	Country	Integration / Management	Management	Site / Location	Transport	Ecology	Energy	Water	Materials / Waste	Air	Light	Emissions	Health / Wellbeing	Beauty	Pros	Cons	Application to Wallacia project
Local Government / Council Sustainability Requirements																	
PENRITH CITY COUNCIL Penrith Sustainable Strategies	AUS	✓✓	✓✓	✓	✓	✓	✓✓	✓	✓	✗	✓	✗	✓✓	✗	Specific goals linked to priorities of local council		As the project site is located within Penrith, it must comply with the requirements, including targeting either Green Star or NABERS.
NSW Government Resource Efficiency Policy	AUS	✗	✗	✗	✗	✗	✓✓✓	✓✓✓	✓	✓✓	✗	✗	✗	✗			Some sections are related to all new constructions, while other are obligatory to agencies only.
NABERS / Office of environment and Heritage NABERS	AUS	✗	✗	✗	✗	✗	✓✓✓	✓✓	✓✓	✓✓	✓✓	✗	✓	✗	The rating reflects the operational environmental performance of buildings.		The NABERS rating can be used for the offices within the project.

Scheme / Assessment body	Country	Integration / Management	Management	Site / Location	Transport	Ecology	Energy	Water	Materials / Waste	Air	Light	Emissions	Health / Wellbeing	Beauty	Pros	Cons	Application to Wallacia project
Site / Infrastructure Assessment Schemes																	
IS / Infrastructure Sustainability Council of Australia	AUS	✓✓	✓✓✓	✓	✓	✓✓	✓	✓	✓✓	✓	✓	✓	✓	✗	Australia based system that could apply to the site infrastructure	Focused on large infrastructure	Could be beneficial system to the project as it assesses the whole site, not just buildings. Although, it is focused on large infrastructure projects.
CEEQUAL / BRE (Building Research Establishment)	UK	✓✓	✓✓✓✓	✓	✓	✓✓	✓✓	✓	✓✓	✓✓	✓	✓	✓	✗	Well established / International projects	Large number of credits to manage	CEEQUAL was used as a reference to develop the IS rating tool. Therefore, it makes more sense to use IS, which is tailored for Australian projects.
Envision / Institute for Sustainable Infrustructure	USA	✓	✓✓	✓	✓	✓✓✓✓	✓	✓	✓	✓	✗	✓	✓✓✓	✗	Links with LEED	Focused on large infrastructure	System is focused on large infrastructure projects and based outside of Australia.
Green Star Communities Green Building Council of Australia	AUS	✓	✓	✓	✓	✓	✗	✓	✓	✗	✓	✗	✓	✗	Cross claim between GS Communities and GS DAB.	A lot of documentation	System is better suited to larger scale communities with greater density and mix of uses.
Sustainable Sites Initiative (US GBC)	USA	✓	✓	✓✓	✓	✓✓✓	✓	✓	✓✓✓✓	✓	✓	✗	✓✓	✗	Landscape focused system; Linked with LEED	US based	The system aligns fairly well with the project as a public park development, but for now it is only US based program.

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Scheme / Assessment body	Country	Integration / Management	Management	Site / Location	Transport	Ecology	Energy	Water	Materials / Waste	Air	Light	Emissions	Health / Wellbeing	Beauty	Pros	Cons	Application to Wallacia project
Building Assessment Schemes																	
Green Building Council of Australia	AUS	✓	✓	✓	✓	✓	✓✓✓✓	✓✓	✓✓✓	✓	✓	✓	✗	✗	Australia based; Australian analogy to LEED	A lot of documentation	Each of the main buildings within the project could be eligible for building level sustainability certification. Recommended that the chapel considers targeting Green Star certification.
International WELL Building Institute	USA	✓	✗	✗	✓	✗	✗	✓✓	✓	✓✓✓	✓	✓	✓✓✓✓	✓	WELL support; Flexible credits definition; Links with GS.	Some credits are very prescriptive; US based	Could be a worthwhile additional to GS standard to target, which is focused on the health and wellbeing of building occupants.
LEED (Leadership in Energy and Environmental Design) / United States Green Building Council	USA	✓	✓	✓✓✓	✓	✓	✓✓✓✓	✓	✓✓	✓	✓	✓	✗	✗	Internationally recognised; A lot of information online	Expensive; Very US directed credits requirements	LEED cover a very similar range of categories to GS, as they are trying to achieve a similar overall goal for building sustainability, it is more challenging as it is US system. LEED would not necessarily add additional value for the project if GS is targeting.
Living Building Challenge / International Living Future Institute	USA	✗	✓	✓✓✓	✗	✓	✓	✓	✓✓✓✓	✗	✗	✓	✓✓	✓	Impressive achievement for a project.	Very hard to achieve.	Possibly the most challenging sustainability rating system, and therefore demonstrates sustainability excellence, although very difficult to achieve.

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Following from the assessment table above, it is recommended that the following tools are used for the project:

- All relevant Penrith sustainability policies will be followed;
- For wider governmental tools, it is recommended that a third party rating tool such as **Green Star** is used for the **Chapel**, and **Green Star and/or NABERS** for the **admin building**, as this will cover the local and national government targets;
- **IS** is recommended for the site and infrastructure portions of the site if desired;
- A bespoke system could also be considered / developed to compliment the official ratings and provide specific measures and targets for the development. This would benefit from being focused on the specifics of the site.

2.3.2 Site Infrastructure Assessment

IS is recommended for assessing the site wide development and infrastructure. The tool was established for assessing the sustainability of infrastructure projects, covering aspects such as:

- Management and Governance;
- Use of Resources (Energy, Water, Materials);
- Emissions, Pollution and Waste;
- Ecology;
- People and Place (Community Health and Wellbeing, Heritage, Stakeholder participation, urban and landscape design);
- Innovation.

The process requires all project team members (including client, designers and contractors) to achieve high performance in the design, construction and operation of the development. Given the extent of landscaped park land, walkways, roads and infrastructure being installed, it is recommended that such a scheme is considered. Steensen Varming can help guide the selection of an appropriate rating system, and help manage the process of certification if required.

2.3.3 Building Level Rating Systems

Each of the main buildings within the project could be eligible for building level sustainability certification. It is recommended that **Green Star** is considered in the first instance, as this has been developed for Australian projects. However, other internationally recognised rating systems such as LEED could be considered. Green Star covers the following areas of performance for the building:

- Management (Commissioning, Building adaptation, Information, Metering and Monitoring, Construction environmental management, Waste management);
- Indoor Environmental Quality (Air Quality, Acoustic, lighting and visual comfort, Pollutant emissions);
- Energy (Greenhouse Gas reduction and Peak demand reduction);
- Transport (Sustainable transport);

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- Materials (Life cycle impacts, Responsible sourcing of materials and products, Construction Waste management);
- Land Use & Ecology (Ecological value, sustainable sites and heat island effect);
- Emissions (Stormwater, Light pollution, Microbial control and Refrigerant management);
- Innovation.

LEED and other international rating systems cover a very similar range of categories, as they are trying to achieve a similar overall goal for building sustainability.

The WELL Building Standard could be a worthwhile additional standard to target, which is focused on the health and wellbeing of building occupants. The standard is still relatively new, and its applicability for this project would need to be reviewed for each building. However, achieving WELL would be complimentary to Green Star, whereas LEED would not necessarily add additional value for the project.

Steensen Varming can help work with the Client team to establish which rating systems to target, which credits could be targeted, possible award levels that could be achieved, and any risks associated with achieving each certification.

It should be noted that targeting a third party certification will require extensive work to develop the necessary evidence to demonstrate compliance against each target. This will incur additional cost for each design consultant, sustainability management fees, plus registration and certification fees to the official review body.

2.3.4 Bespoke Sustainability Framework

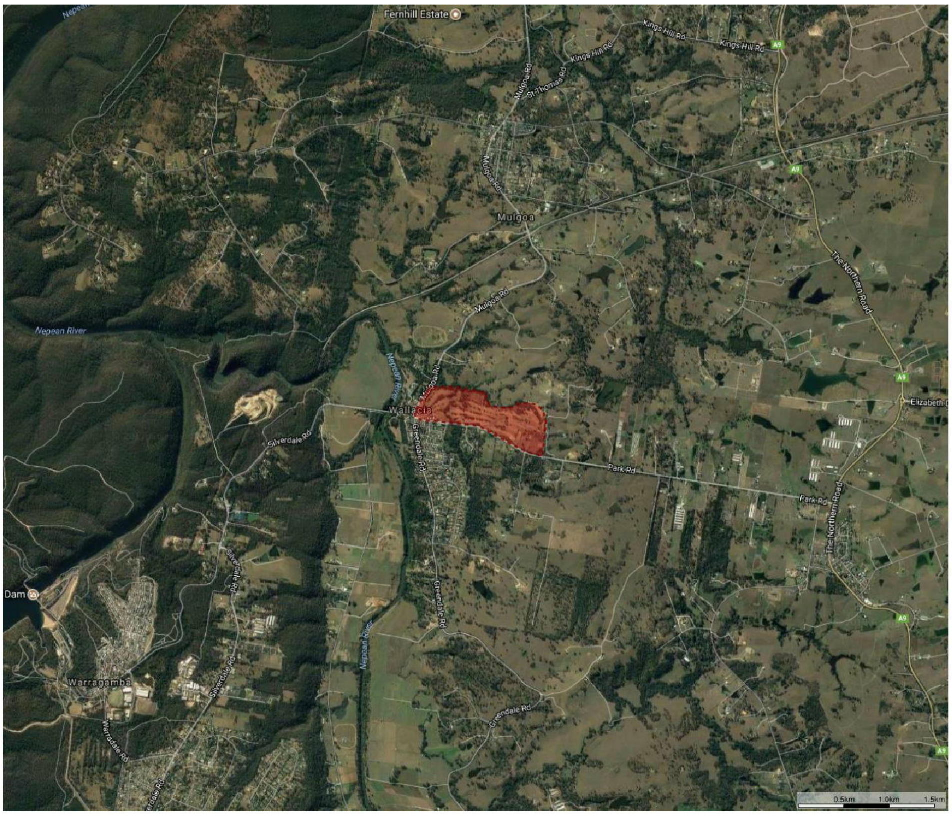
Either in addition, or separately from targeting an official sustainability rating(s), Steensen Varming could help produce a bespoke sustainability framework specific to the project aspirations. The framework could incorporate sustainability targets for the buildings, infrastructure and landscape areas, and provide an overarching tool for achieving high level sustainability performance for the project.

A bespoke framework has the benefit of being tailored to the site, buildings and specific functions of the development. However, by targeting an official rating system, the project will have the approval of an independent, third party organisation, which could be beneficial from a marketing perspective.

3.0 Site Assessment

3.1 Site Location

The Wallacia Golf Course Cemetery and Crematorium site is in Wallacia, to the South West of Sydney, approx. 18km south of Penrith CBD, as shown on the plan below (site highlighted in red):



Wallacia Golf Course Cemetery and Crematorium comprises a 42 hectare purchased by the Catholic Cemeteries Metropolitan Trust with a view to providing a community landscape cemetery within Western Sydney. The facility will comprise the following developments:

- Crematorium, chapel and condolence room, complex with a seating capacity around 75;
- Admin Office – General Office area for 4 staff, managers office, lunch room, male and female toilets, store room, photo copy room, reception area, public pace, 2 interview rooms;
- Public Toilet facility.

The plan below shows the arrangement of the Chapel and Admin offices

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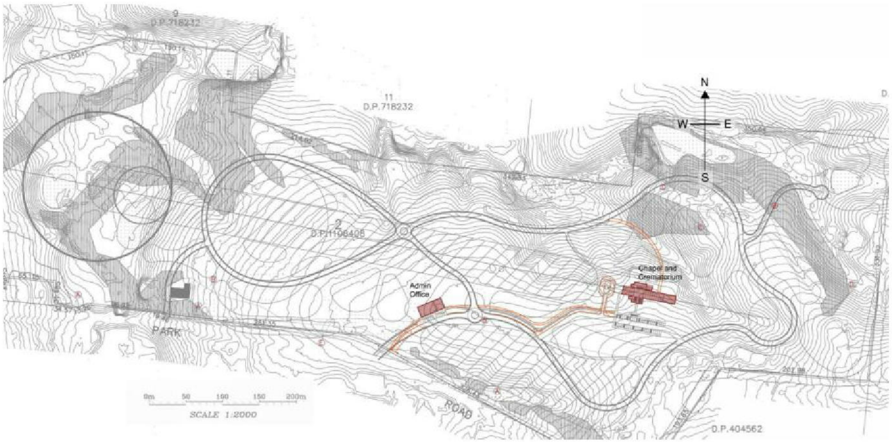
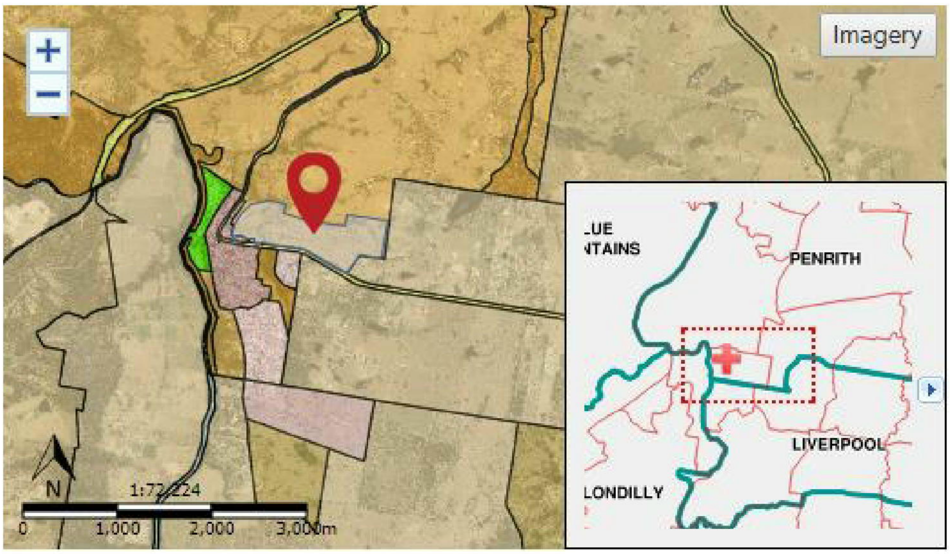


3.2 Environmental Considerations

The site is currently zoned E3 Environmental Land under the Penrith Local Environmental Plan 2010. The objectives of the E3 zone are stated as:

- To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values;
- To provide for a limited range of development that does not have an adverse effect on those values;
- To minimise conflict between land uses within the zone and land uses within adjoining zones;
- To ensure development is compatible with the environmental capabilities of the land and does not unreasonably increase the demand for public services or public facilities;
- To preserve and improve natural resources through appropriate land management practices.



Imagery from NSW Planning Portal for the development site (source: https://www.planningportal.nsw.gov.au/find-a-property/property/poi_517467146/wallacia_panthers_golf_and_country_club_(club),_wallacia*)*

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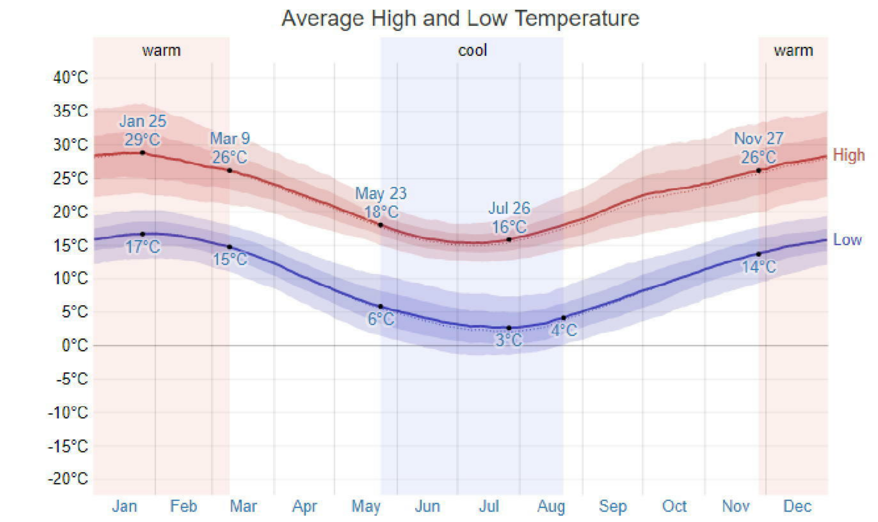
Therefore, enhancement of the environmental and ecological value of the land and maintaining the rural character of the land will be an important consideration.

3.3 Site Climate

As mentioned, the site is located to the South West of Sydney. The site is located approximately 25km inland, which leads to summer high temperatures around 4°C higher and winter low temperatures around 4°C lower than central Sydney.

3.3.1 Temperature:

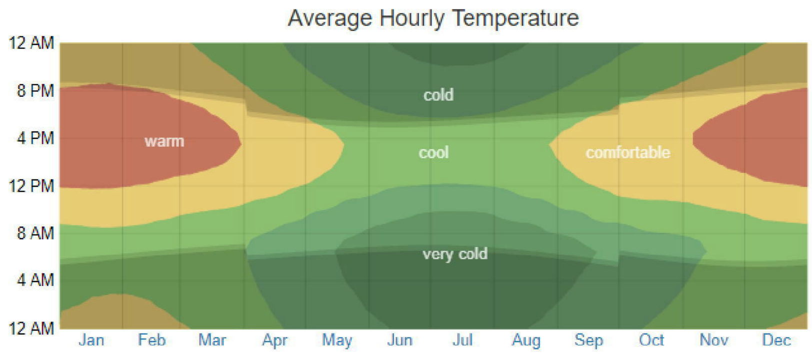
The following graph shows the average temperature fluctuations throughout the year for the site:



The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures.

Daily high and low temperatures (Source: https://weatherspark.com/y/144507/Average-Weather-in-Glenbrook-Australia-Year-Round*)*

The comfort zones for the site are shown below for each month of the year:



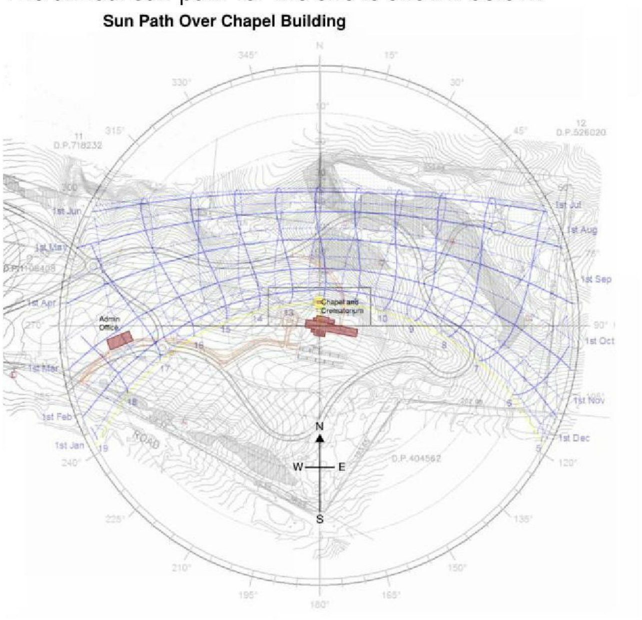
The average hourly temperature, color coded into bands: frigid < -9°C < freezing < 0°C < very cold < 7°C < cold < 13°C < cool < 18°C < comfortable < 24°C < warm < 29°C < hot < 35°C < sweltering. The shaded overlays indicate night and civil twilight.

Time spent within external comfort zones throughout the year (Source: https://weatherspark.com/y/144507/Average-Weather-in-Glenbrook-Australia-Year-Round*)*

While temperatures can get hot in summer and cool in winter, the overall temperature range is fairly comfortable, and careful consideration of passive design strategies can help reduce overall energy demands.

3.3.2 Sun Path:

The annual sun path for the site is shown below:



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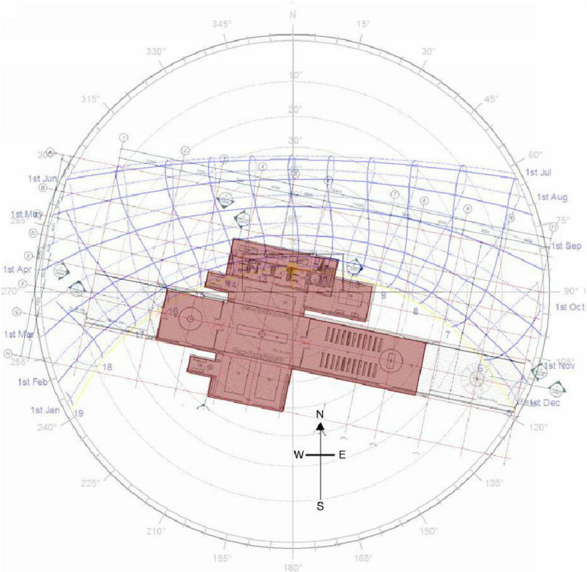
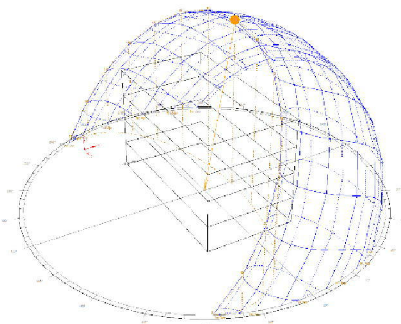
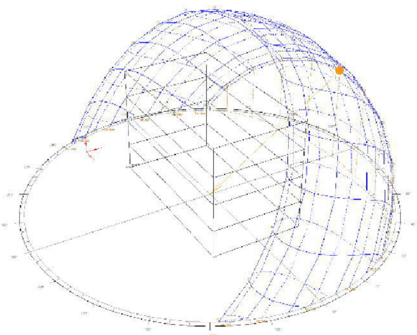


Seasonal sun positions:

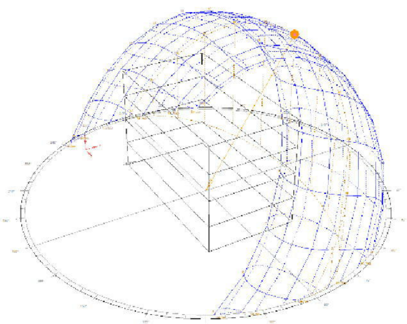
Summer sun angle (1st January)



Winter sun angle (1st July)



Equinox (20th March)



The following diagram shows key summer and winter sun positions at different times of the day:

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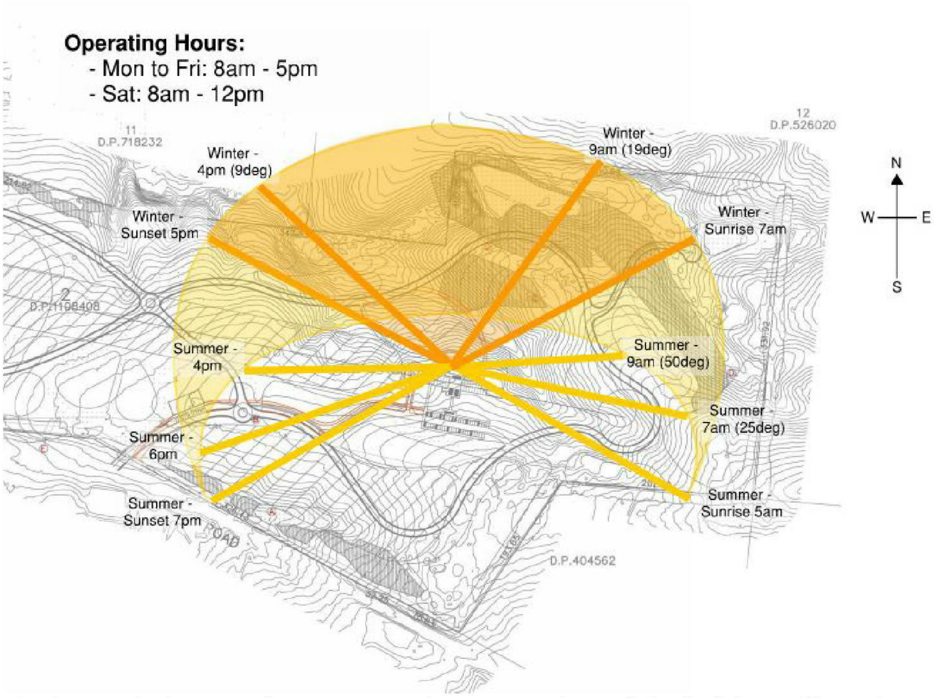

The large windows on the eastern and western edges of the building will need careful consideration to reduce solar gains and glare. Glare could well be a problem for the main chapel for morning services throughout the year. Afternoon solar gains could also be a problem from the Western windows, and the skylight will need to be designed to reduce summer heat gains.

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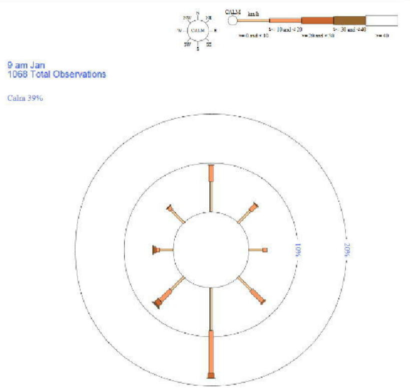
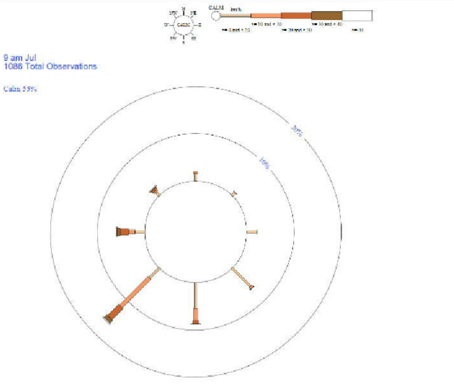
3.3.3 Wind Speed & Direction:

Wind speeds for the site have been taken from the Bureau of Meteorology (BOM) website, using Camden Airport AWS weather station data, as this station is fairly near the site, and should be representative. A sample of the results are shown below for summer and winter conditions, with reports from 9am and 3pm:

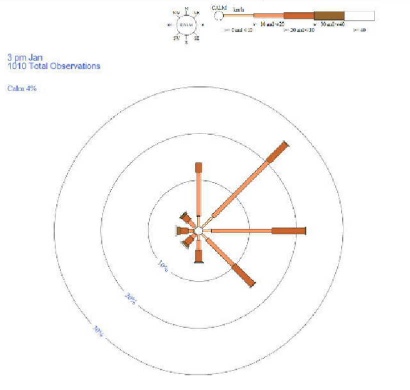
Summer 9am



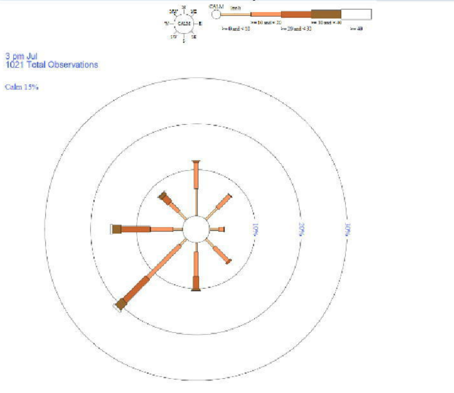
Winter 9am



Summer 3pm



Winter 3pm



The results show that while winter wind direction is consistent throughout the day, from the SW, the summer profile fluctuates far more throughout the day, from a southerly prevailing morning wind to North Easterly and Easterly in the afternoon.

For passive design considerations, protection should be provided where possible from strong winter winds from the SW, while summer winds, especially in the afternoon from the NE when temperatures are hotter, should be encouraged.

3.3.4 Site Topography:

The following diagram shows the site contours. The chapel is situated toward the east of the site, and relatively high up. The elevation will help improve air movement past the building for natural ventilation, and will be a consideration for designing the exhaust for the crematorium furnaces.

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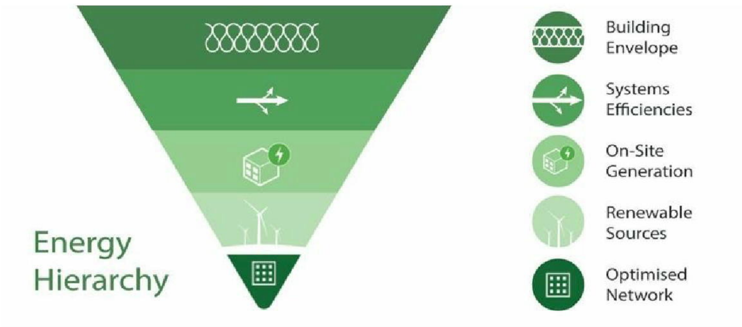
4.0 Energy Strategy

For the design of the buildings within the development, the following energy hierarchy is recommended to optimize cost effective energy efficiency measures:



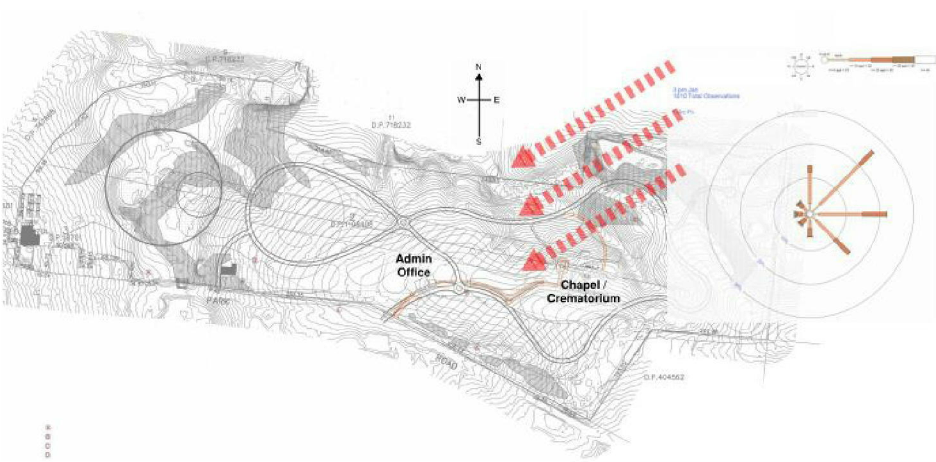
This energy hierarchy considers passive reduction of energy use as its first priority, and then seeks to meet the remaining energy demand by systems efficiency measures and then renewable energy sources.

4.1 Passive Design Measures

The façade design, including shading, openings and window ratios should be designed based on the climatic conditions discussed above.

As the admin office and chapel buildings are relatively small scale and isolated from each other, there is little scope for sharing systems such as cooling, heating or hot water. It is therefore recommended that each building energy performance is optimised as follows:

4.1.1 Promote natural ventilation:



- Orientate buildings towards prevailing summer winds (NE and E);

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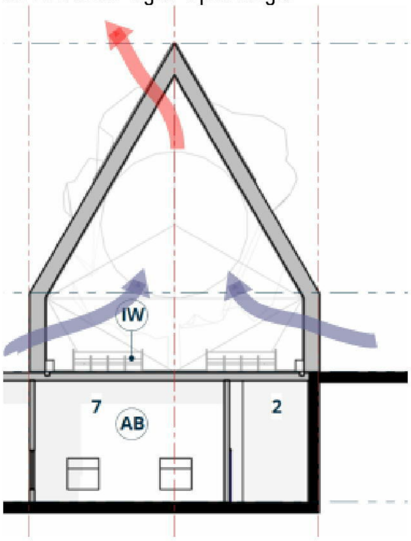
  - Openings on the eastern and western facades will help promote the stronger afternoon summer winds through the buildings.

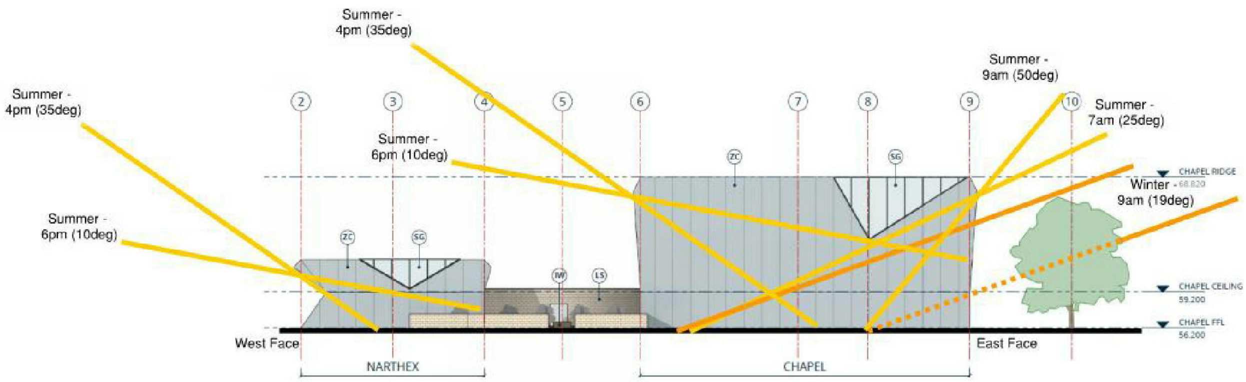
The building height and rooflight could also be utilised to promote natural ventilation through the building through the stack effect. Through careful design of openings, air movement could be drawn in from the low level openings and up out of the roof light openings.



4.1.2 Optimize solar exposure:

- Reduce solar gains during summer, both internally and externally;
- Promote shading of internal and external spaces;
- Allow some winter sun to enter buildings to provide passive heating.

Chapel Considerations:
The following diagram show the sun angles in relation to the main chapel building, showing the sun angles in the morning and afternoon entering the Eastern and Western facades.



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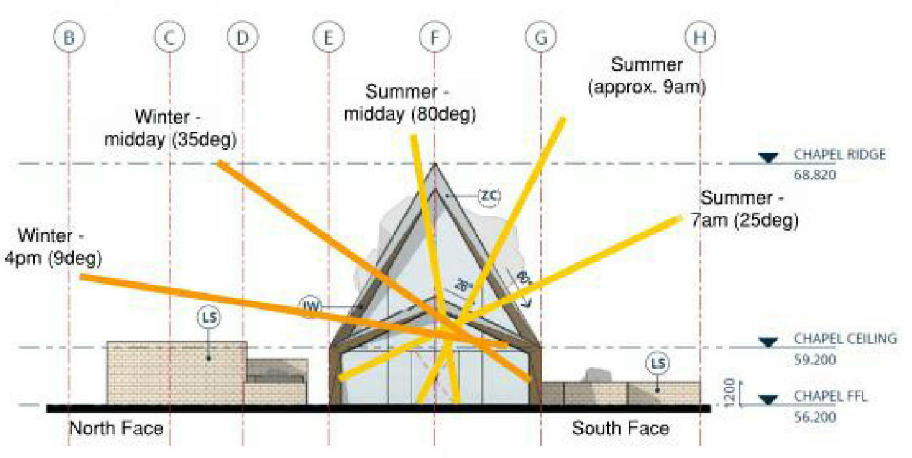
The eastern and western facades have large amounts of glazing, and there is a large rooflight within the Chapel and Narthex buildings. Therefore, the following recommendations could be considered:

- Provide shading for the rooflight to cut out high angle summer sunlight penetration, while enabling low angle sunlight during the winter;
- Consider extending the overhang of the Eastern and Western facades, and providing either vertical shading fins or increased vegetation to block low angle sunlight and reduce possible impacts of glare;
- Consider internal blinds to be used for the critical periods;
- Reduce overall glazing area on the eastern and western facades;
- Reduce the solar heat gain coefficient of the glazing.



For the rooflight design, it is understood that some daylight is desired in the space, but this needs to be balanced with reducing solar heat gains. In summer, the sun angles are high, and therefore a series of horizontal strips or louvres could be used to reduce summer sun penetration, while allowing winter sun to enter and heat the space.

Fritting and translucency could also be considered to reduce the heat gains in the space while allowing daylight in.

4.1.3 Building Façade Optimisation

Thermal insulation –

- Insulation is important for maintaining internal temperatures and reducing unwanted heat transfer between outdoor and indoor conditions (heating and/or cooling);

Thermal mass and night time purging –

- Thermal mass can help reduce variations in internal temperatures, by absorbing heat during hotter daytime conditions, and releasing heat once the temperature cools;

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- It is recommended that exposed thermal mass is considered wherever possible within the main buildings on the site to help reduce the cooling demand of the building.

Performance glazing –
- Glazing should be selected to optimise performance, admitting good daylight levels, while controlling the transmission of solar heat and thermal conduction;
- Double glazing and low Solar Heat Gain Coefficient (SHGC) glazing is recommended for the glazed walls and roof lights within the buildings;
- Glazing performance will also help reduce diffuse radiant heat gains.

Glazing ratio –
- Glazing ratios need to achieve an equilibrium between allowing daylight to enter buildings while reducing solar and conductive heat gains;
- While it is understood that the main Chapel has large glazing areas, it is recommended to reduce these where possible to limit conductive and radiative heat gains.

Building air tightness –
- Doors should be designed to close automatically to reduce unwanted heat transfer during peak summer and winter conditions. Consider revolving doors for the main entrance to maintain air tightness.

Landscaping:
- As mentioned above, providing trees can add additional shading, especially on the eastern and western edges of the buildings;
- Trees can also reduce heat island effect, buffer of cool winds, and promote biodiversity;
- Water bodies or features – Strategic location of water bodies can encourage evaporative cooling externally or within building areas;
- Green roofs – Help reduce overall building heating and cooling loads by providing better thermal insulation. They also help reduce external temperatures and relative humidity and encourage biodiversity;
    - While the chapel building may not be able to accommodate a green roof, this could be considered for the Admin building roof, given the large flat surface area of this building.

4.2 Active Energy Strategies

Having reduced the overall energy demand through passive measures, the next focus is on how to supply the cooling, heating and electrical loads efficiently. The strategies mentioned below are discussed in more detail in the Mechanical CAN (177127_can002 - Mechanical Strategies_Rev00), but an overview is provided below:

Free Cooling:
- Run mechanical cooling plant in economy cycle when conditions are appropriate;
- Use evaporative cooling options;
- Use labyrinths, earth ducts, night purge and other strategies;

Pre-temper outside air:
- Use of heat recovery systems to lower outside air temperatures;

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- Use of geothermal energy, using ground source heating and cooling;
- A thermal labyrinth could also be considered, along with displacement ventilation. Air could be pre-tempered using a labyrinth or ground source pipes, with air either provided directly or cooled further if required.

It is worth noting that due to the cost of ground source pipe work installation, and given the relatively low energy demand and potentially short operating hours of the chapel, a financial assessment of a geothermal system would need to be carried out to determine the possible return on investment.

For external spaces, in peak summer days, to promote thermal comfort either before or after a service, evaporative cooling through mist sprays could be considered.

Use of heat energy from crematory furnace –
- Given the large heat energy required for the crematory, the exhaust heat could be captured and used for either heating or cooling throughout the year;
- Consider timing of cremations to align with peak heating and cooling loads of the space;
- Incorporate energy storage to use heating or cooling energy throughout the day and reduce overall peak loads.

Ceiling Fans –
- Consider installation of ceiling fans to circulate air, promote evaporative cooling and reduce air conditioning requirements.

Automated openings –
- Consider automation of windows, doors and rooflights to utilise passive heating and cooling when external conditions are suitable.

Relax internal set points –
- Allowing a greater range of thermal conditions can reduce heating and cooling plant loads.

Seasonal temperature and humidity set points –
- Set-points could be varied throughout the year based on expected comfort ranges of the building occupants.

Reduce Hot Water usage –
- Consider providing cold water only wash basins for the public.

High Efficiency plant –
- Provide high efficiency heating, cooling, hot water and ventilation systems.

Efficient lighting and lighting controls –
- Use of LEDs, occupancy and daylight sensors.

Metering and Monitoring –
- Consider installation of energy, water and air quality metering and monitoring to promote healthy environment and save energy energy and resources.

Building Management Systems (BMS) –
- Installation of a BMS to link to sensors and meters throughout the park, with the ability to control lighting, hydraulic and mechanical systems could

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help reduce energy and water usage throughout the buildings and the park itself.

System Commissioning –

- Comprehensive commissioning of the buildings is essential to ensure the buildings function as planned.

5.0 Renewable Energy Review

Given the sensitivity and open nature of the site, the options for renewable energy are limited. However, an overview of renewable energy options that could be could be considered for the site is discussed below:

5.1 Solar PV

Photovoltaic (PV) panels convert solar energy directly into electricity. PV is the most likely technology to be applicable for the site, given the expected low heat demand for the site buildings. Possible locations for PV could include:

- Building roofs;
- Site landscaped areas;
- Roads / Walkways.

Building Roof PV:

Given the design of the Chapel and Narthex roofs, it could be possible to integrate PV panels effectively onto the north facing roof of both buildings. Depending on the desired aesthetic, it may be possible to include PV integrated roof tiles, thin film PV panels or standard PV panels onto this face.

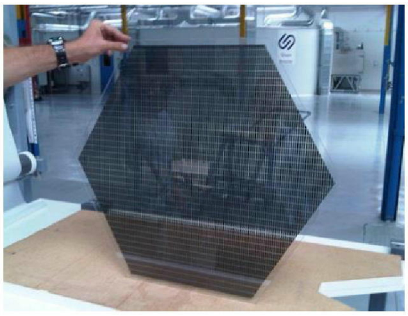
PV cells could also be integrated into the roof light to produce electricity while reducing solar gains in the internal spaces.

Standard Roof Mounted PV Panels

PV Cells integrated into Glass Pane

Thin Film flexible PV panel

PV cells within glazed roof shading system



PV panels could also be mounted onto the Admin building roof. It is possible to include both a green roof and a PV array to promote better insulation, biodiversity, reduce heat island effect and energy production at the same time.

Site Roads and Walkways:

There are PV applications that can be integrated into roadways or walkways. Applications have included a cycleway in the Netherlands, and a recent commitment in France to build large scale PV roadways.

Common arguments against the technology include durability concerns plus cost and efficiency concerns when compared more standard PV applications. An image of the PV walkway installed in the Netherlands is shown below:

Due to the visual constraints of this site, and the low expected vehicle movements, there may be scope to integrate PVs into the roadways to help power both the buildings and any street lighting that might be considered for the site.

5.2 Solar Thermal

Solar thermal panels convert solar energy into heat for use as hot water or heating. The panels are relatively cheap and have good efficiency. It is recommended that they could be considered for the admin office building, to serve any showers or hot water demand within those buildings.

Solar thermal panels could also be used at night for cooling, through radiant cooling, to cool thermal mass.

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Solar Thermal Panel

5.3 Wind Power

Due to the size and visual impact of wind turbines, wind power is not considered a viable option for the site.

5.4 Cogeneration / Trigeneration

As mentioned above, the crematory furnace could be considered for the use of co-gen or tri-gen energy production.

6.0 Water Efficiency Measures

The following initiatives are considered viable for the buildings within the site:

- Rainwater Collection from Roof for reuse as grey water for toilet flushing and irrigation;
- Efficient Fixtures and Fittings can be installed throughout the buildings: WELS rated 3/6 litre flush; Five (5) star rated mixer taps; Five (5) star rated shower heads and tapware water outlets will be provided.
- Landscape Irrigation: Aim for low or zero water demand planting throughout landscaped areas. Where irrigation is required, install efficient irrigation systems (bubblers / drip irrigation) and re-use rainwater or treated grey water;
- Solar Hot Water: As mentioned above, Solar Hot Water could also be considered for the staff facilities;
- Water meters should be provided to record and monitor water consumption, and meters to be linked to the BMS system.

7.0 Healthy Environment

7.1 Human Environment

Good indoor environmental quality (IEQ) is one of the key priorities to ensure comfort, health and well-being of the building occupants.

IEQ is of particular importance for the admin and workspace areas as poor IEQ is the principal cause of sick building syndrome, which can reduce productivity of staff and have detrimental health impacts.

7.1.1 Key factors affecting IEQ

The indoor environment of a building is influenced by the following factors, which should be carefully considered during design and operation:

Thermal comfort:

- This includes temperature, humidity and air speed;

Acoustic comfort

- This includes the ability of a building to minimise external noise as well as the noise levels within the occupied space;
- Acoustic performance is of particular importance for the chapel, to ensure that services can be heard by all guests.

Indoor air quality:
Following are some of the key strategies that should be considered for the performance of the buildings:

- Ventilation rates and outdoor air opportunities should be considered to reduce the build-up of internal pollutants such as carbon dioxide (from respiration) and odours.
- Low Volatile Organic Compound (VOC) finishes should be considered for the project. Low VOC finishes include paints, adhesives and sealants, carpets and other flooring i.e. vinyl and fit out items.
- Low formaldehyde products should be specified for the project.
- CO2 / pollutant sensors should be used on mechanical services to monitor and control the indoor air quality.
- General outdoor air supply should be maximised where possible.

Any sensitive spaces within the buildings, or areas where pollutants are regularly emitted (such as cleaning cupboards, waste storage, printer rooms) are clearly separated from other spaces and separately ventilated / exhausted.

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8.0 Materials

Consideration should be given to materials of low embodied energy content, high recycled content and/or highly recyclable. Construction techniques should also be assessed to promote sustainable practices and reduce waste materials.

Embodied energy is the energy consumed by all the processes associated with the making of a product, from the mining and processing of natural resources to manufacturing, transport and product delivery. To minimize embodied energy the design should, wherever possible:

- Use locally sourced materials to reduce transportation;
- Re-use materials from the demolition of onsite or nearby buildings;
- Select low embodied energy materials (which may include re-used materials or those with a high recycled content);
- Select materials that can be re-used or recycled easily at the end of their lives using existing recycling systems;
- Give preference to materials manufactured using renewable energy sources.

Choice of materials is a crucial factor for a long-life span project such as the Memorial Park. To achieve the long-term requirements, one option is to follow the most durable and long-lasting materials, while another option is to make the spaces / buildings easily maintainable and repairable. Life cycle cost should be assessed for all options to determine the optimum selection.

9.0 Waste

All efforts will be made to reduce the production of waste within the Wallacia Golf Course Cemetery and Crematorium site. While it is not possible to eliminate all waste, a waste hierarchy approach will be used to reduce, re-use and recycle waste where possible.

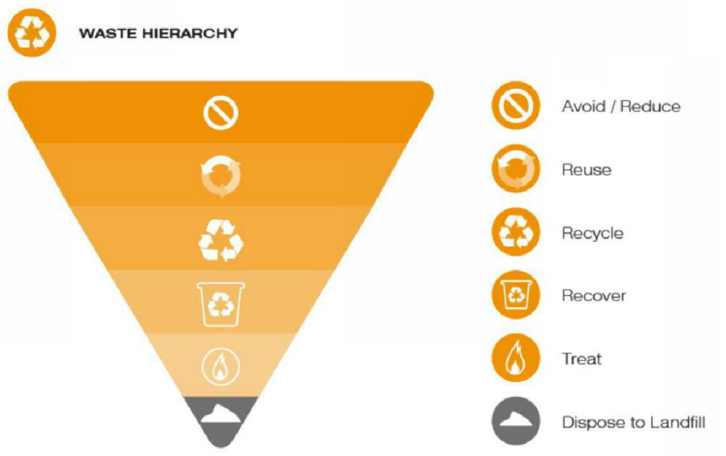

Fig S31 Waste Strategy Hierarchy

Key principles to be included in the design include:

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- For all landscape and building management, look to reduce creation of waste where possible to minimise the size of waste storage areas and the number of waste vehicle trips for collecting and disposing of waste;
- Protect the visual amenity of the landscape through well designed waste collection, storage and disposal strategies;
- Allocation of an area within the site for composting of organic waste, which can then be used for soil mulch to provide nutrients for the soil within the landscape;
- Consideration for a centralised waste storage area to reduce waste vehicle movements around the site, and provide opportunities for segregation of waste streams to improve recycling rates.

Spoil management:

Due to the nature of the project site and use as a cemetery, there will be a need to transport large volumes of spoil associated with the digging of graves. In addition to removal of excess spoil from the grave, there is often a need for temporary transport of spoil away from the grave site during the ceremony, and then return of spoil for back fill once the ceremony has ended. This requires vehicle transportation that leads to fuel/electricity use and potential damage of green areas of the site.

To reduce vehicle travel distances, it is proposed to have multiple temporary spoil storage areas across the site, and allow vehicles to travel to the closest one. To reduce damage to the vehicle movement routes during this process, it is recommended to reinforce certain routes to protect the ground and reduce the overall impact.
Consideration is also made for location of excess spoil from this process. Due to the potential poor quality of the spoil, there is little value associated with the material. However, options should be explored for use as backfill material in nearby sites.

10.0 Flexibility / Durability

To ensure long term durability of the site and buildings, design decisions need to be made to promote the need for adaptation and flexibility of space. Functions and demands of spaces may change with time, and therefore the buildings should be designed to accommodate these changes. Flexibility is defined within three types:

- Adaptability;
- Transformability;
- Convertibility.

Each type of flexibility not only refers to the amount of change which occurs in the built environment, but addresses the degree of permanence of that change as well. For example, plant rooms should be designed to allow for alterations and changes, so in the future the original equipment can be easily adapted or replaced.

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11.0 Flood Risk / Stormwater Management

Flood risk should be considered for all buildings and areas within the development. The topography around the site and the location of buildings adjacent should consider the risks associated with flooding in large storm events.

Consideration should also be given to storage and potential reuse of storm water, and any potential impacts of run-off from the site to adjacent areas. This could be within the landscaping or within storage tanks located within or adjacent to the buildings.

Possible uses for collected rainwater include:

- Roof water collection water reuse for building's needs;
- Run-off collection for irrigation;
- Bio-swales for passive runoff water treatment.

Also, to reduce water demand of the buildings and site, native plants should be selected where possible with the minimum demand in irrigation water consumption.

12.0 Climate Adaptation

Consideration should be given to potential of climate change impacts on the buildings and landscape. Climatic changes could include:

- Increased periods of high and low temperatures;
- Extreme weather events such as heat waves, storms, etc;
- Prolonged periods of heavy rain or drought;
- Shifts in wind patterns and velocities.

An assessment should be made regarding the impact of such changes on the design of the development, and mitigation measures should be considered to reduce the overall impacts.

13.0 Transport

Sustainable transport measures should be considered for all site users, including:

- Visitors / Ceremony attendees;
- Visitors to the park;
- Staff members.

For Visitors to the park and facilities, it is recommended that the focus should be on access to public transport, such as buses, trains and / or shuttle buses to and from nearby public transport stations / stops.

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For staff, in addition to public transport access, consideration should be given to cycle facilities such as bike storage, cycle paths, and showers and lockers within staff buildings.