HEGGIES

REPORT 10-5947-R2

Revision 0

Dwyer-Oxford Site Re-Development - Concept Design

31 Crown Street, Wollongong

Ecologically Sustainable Development (ESD) Review

PREPARED FOR

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8 OCTOBER 2007

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
10-5947-R2	Revision 0	8 October 2007	Raymond Sim	Peter Georgiou	Peter Georgiou

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1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been engaged by Belmorgan Property Development Pty Ltd to assess the environmental impact of the proposed Dwyer-Oxford Site Re-Development, Concept Design, with respect to the Ecologically Sustainable Design (ESD) principles.

1.1 Development Site

The development consists of two sites (refer **Figure 1**) that are separated by Corrimal Street. The site to the east of Corrimal Street is the Dwyer Site and the site to the west of Corrimal Street is the Oxford Tavern (Oxford) Site.

The Dwyer development site (refer **Figure 1**) is located at the eastern end of Burelli Street, approximately 500 m from Wollongong City Beach and over 1 km east of Wollongong train station. The site is bounded by Crown Street (north), Corrimal Street (west) and Burelli Street (south). The main pedestrian entries to the building are from the Corrimal Street corners of the site and vehicular entry will be from Crown and Burelli Streets. The site is surrounded by a mix of retail and residential developments of the Wollongong CBD.

The Oxford site (refer **Figure 1**) is bounded by Corrimal Street to the east, Crown Street to the north and Burelli Street to the south. The site is located just to the east of the central Wollongong CBD area and is surrounded by a mix of mainly low to medium rise retail and residential developments.

Figure 1 Site Location Map for the Dwyer and Oxford Development Sites

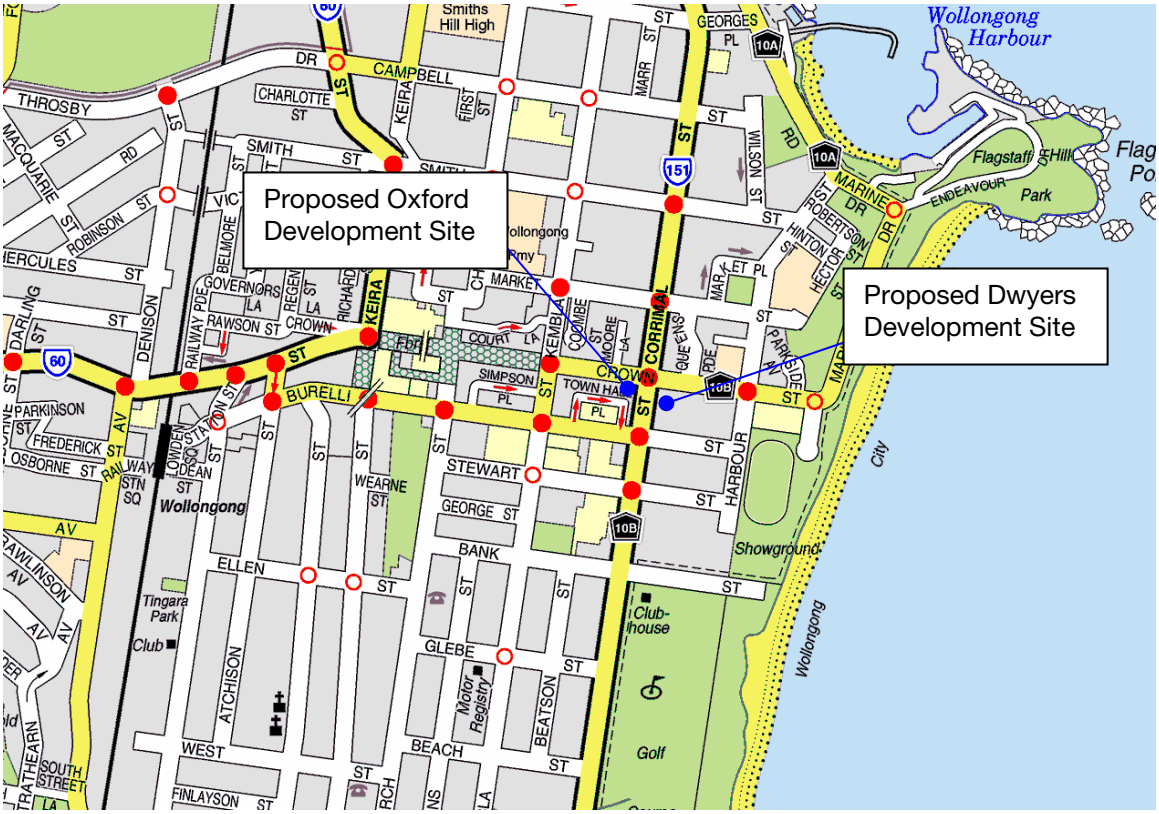

Image Source: UBD on disc

1.2 Development Description

The construction and development of the project will be conducted in three stages. The development stages of the project are as follow:

- **Stage 1** - consists of the development of the retail, entertainment and commercial areas of the Dwyer Site. The retail, entertainment and commercial areas are proposed to be located in a 4 storey podium in the Dwyer Site.
- **Stage 2** - consists of the development of a 9 storey Hotel building to be built on top of the podium of the Stage 1 development. The proposed hotel building will consists of conference facilities, the main hotel pool, rainwater/stormwater collection tank, cooling tower for hotel, HVAC system, lawn terrace, other landscaping and reflection pool on the podium level, followed by 7 levels of hotel rooms and a restaurant on the top level.
- **Stage 3** - consists of the entire Oxford site development.

  Based upon architectural drawings supplied by DBI Design, the proposed redevelopment of the Oxford Site consists of a Podium rising 3 storeys about ground level. This component includes:

  - Retail areas (min-major, food court and small retail shops) and a tavern on Level 1. Commercial areas on Levels 1, 2 and 3.
  - Four sub-ground basement floors for carparking.

  An 11-storey residential tower and an 8-storey commercial building are located above the podium surrounded by landscaped roof terrace.

  - Rooftop podium terrace level will include a lawn area, perimeter native planting, a lap pool and BBQ facilities.
  - The residential tower is located to the north of the Level 4 podium and rises to Level 14. The commercial building is located to the south of the Level 4 podium and rises to Level 11.

2 ESD GUIDELINES FOR RETAIL, COMMERCIAL AND RESIDENTIAL DEVELOPMENTS

2.1 Wollongong City Council Development Control Plan DCP 2007

Various controls have been embodied in Wollongong City Council's DCP 2007 and the Wollongong City Centre LEP 2007 aimed at assisting developers in creating sustainable residential, commercial and retail developments which have enhanced environmental impacts and feature innovative energy efficient design solutions.

- New Residential developments need to demonstrate compliance with NSW's BASIX (Building Sustainability Index) protocol.
- New Commercial developments (over $5million) need to be accompanied by an Energy Efficiency Report which shows that the development will achieve a minimum ABGR 4-Star Rating (Australian Building Greenhouse Rating Scheme) and comply with BCA Section J requirements for Class 3 to 9 buildings. Non-residential buildings must also show compliance with minimum ratings for water usage systems, eg 3-Stars for water fixtures (shower heads, taps, toilets, urinals, etc) and appliances such as dishwashers.

In relation to ESD, Wollongong Council's LEP 2007 notes the following areas of interest:

- Greenhouse Gas Reduction.
- Embodied Energy in Materials and Building Processes.
- Building Design and Orientation.
- Passive Solar Design and Day Lighting.
- Natural Ventilation.
- Energy Efficiency and Energy Conservation.
- Water Conservation and Water Re-Use.
- Waste Minimisation and Recycling.
- Reduction of Car dependence.
- Potential for Adaptive Re-Use.

The proposed re-development contains features which have positive impacts in all of these areas; these are discussed in detail in subsequent sections. Some of these features are also documented in the Concept Design Reports prepared by Erbas & Associates Pty Ltd, Hughes Trueman Pty Ltd and Jim Hatz & Associates for Mechanical Services, Hydraulic and Fire Services and Electrical and Communication Services respectively.

2.2 Retail and Commercial Components

The energy efficiency of retail and commercial developments is determined to a large extent by the choice and design of active building features, ie heating, ventilation and air conditioning (HVAC) systems designed to meet the heating and cooling loads as well as other building services (lighting, equipment and other processes). This qualitative ESD Report investigates the potential for these components to have low energy consumption once operational through careful design of passive building elements such as building fabric and insulation, external shading, thermal mass, use of natural ventilation etc. Other ESD initiatives including minimisation of waste and pollution and life cycle considerations are also considered.

Design initiatives explored in the current report can be later quantified with computer simulation to provide indicative performance of passive and active energy design features and can help inform the design, commissioning and operation of a new building and provide an estimate that can be converted into an Australian Building Greenhouse Rating score.

2.3 Residential Component

Aspects of residential apartment amenity have acquired a new importance in NSW, due to the influence of State Environmental Planning Policy 65 - Design of Residential Flat Buildings. SEPP 65 relates to the passive and operational energy efficiency of a building, as well as water efficiency, waste production and low environmental impact material selection. Items under Principle 7 - Amenity of the RFDC relate to the factors affecting resident comfort such as daylight access and natural ventilation, and also have strong ties to the energy efficiency of the building.

A BASIX certificate has been previously prepared for the residential component of this development by Heggies as part of a previous DA submission. The submission of a BASIX certificate requires the apartments to achieve a minimal level of thermal comfort and the achievement of a 20% reduction in operational energy usage and 40% water usage reduction within Wollongong compared to the "average NSW dwelling". Hence BASIX compliance has already provided a quantitative confirmation that SEPP 65 Amenity issues will be met for this development.

This qualitative report will demonstrate ESD attributes of the proposed residential apartments will comply with SEPP 65 and highlight those design aspects providing compliance with the mandatory BASIX scheme.

The residential building design has been revised since the submission of the BASIX certificate for the Dwyer-Oxford development. Therefore, Heggies will re-assess the new residential building design for compliance with the BASIX scheme. Thermal comfort modelling using NatHERS will be carried out on the new residential building design to achieve BASIX compliance.

3 PASSIVE ENERGY DESIGN

Passive energy efficiency refers the choice of building materials, the placement of external facades and fenestration to effectively utilise solar energy for heating when required, and minimise solar gains when appropriate, thus 'passively' reducing the artificial heating and cooling requirements of the building. In the temperate coastal Wollongong climate a good balance of heating and cooling load reduction techniques is required to produce a development with efficient passive design.

3.1 Siting and Overall Concept

One of the objectives of SEPP 65 is to minimise car dependency for commuting and recreational transport use and to promote alternative means of transport-public transport, bicycling, and walking."

The following points are noted with respect to the gross siting of the retail, commercial and residential component of the Dwyer and Oxford developments:

- The development is situated close to road and bus arterial routes and is just over 1 km from Wollongong train station.
- Importantly, the development of this site will continue to provide immediate retail support for surrounding residential areas of Wollongong.
- As opposed to new developments on the outer fringes of the city which require great investment in new roads, sewage, lighting, power, etc, the proposed development will have immediate access to all of these at very little additional infrastructure investment to the Wollongong city area.
- A mix of recreational uses (gym, cinema, pool, surf beach, etc) and shops are easily accessible to the residents without the need for motorised transport.
- Storerooms will be made available for bicycles requiring secure storage.

There are also a number of design benefits with regard to the location of the residential, commercial and hotel towers on the development sites. The towers are located to the south and west of the site, which allows beneficial northerly aspects to many residential units and maintains solar access to the podium area while protecting it from winter southerly winds.

3.2 Solar Access and Shading

Retail and Commercial Components

Shadow Diagrams for the sites have been prepared by DBI Design as part of the DA submission. Shadow diagrams have been produced for the summer and winter solstice as well as equinox for the following times throughout the day:

- 9.00 am; 10.30 am; 12.00 noon; 1.30 pm; 3.00 pm and 5.00 pm.

It can be inferred that the whole of the north and large portions of the east façades will not be overshadowed at any period of the day throughout the year with the existing surrounding built environment. Extended periods of direct daylight access will therefore be available to these facades over the same periods.

Continuous daylight access to the podium facades can potentially provide a reduction in the energy consumed by the development through two modes:

- Air conditioning winter heating loads in zones adjacent the north and east facades can be reduced through additional solar heat gain, i.e. direct radiant heat loading through glazing in the winter months can be used to offset thermal conduction losses through the facade.
- Retail stores adjacent the north and east facades can utilise available sunlight to reduce artificial lighting demand during daylight hours.

Whilst the design of the perimeter retail and commercial zones should take advantage of the winter sun, there is an equal need to provide protection from the severity of the summer sun to prevent overheating of the building. To this end the Crown Street and Corrimal perimeter footpath will include horizontal shading in the form of awning elements at Level 1 along the length of the northern and eastern façades. Awnings will be positioned to provide shading form high altitude summer sun and associated cooling loads. At the same time the same northern glazing can still act as highly efficient solar collectors or "sun spaces" during winter months when the sun altitude is lower.

Using trees for shading can also be very effective. Existing tree planting on Crown Street will provide shading during the hot summer months. Perimeter planting will also shade surrounding paved areas that can reflect heat and light onto the building. Planting provides added cooling during the summer months through the leaf transpiration process.

Residential Component

A review of the shadow diagrams described above indicate that the north, east and the west facades of the tower will not be overshadowed between 9.00 am and 5.00 pm on the winter solstice. The height and spacing of surrounding developments to the north, east and west of the site will allow excellent solar exposure to almost all apartments throughout the day, year round.

The form dictated by the site has been used to advantage by the designers to maximise the solar access of units by:

- Designing all residential apartments to have at least one north, east or west façade. Most apartments have multiple aspects which help to ensure solar access at different times of day, and different times of the year.
- Importantly, all apartments have their primary facade glazing, windows and sliding doors to balconies attached to "living zone" rooms (i.e. living room, bedrooms etc) and not to bathrooms or unconditioned zones. With appropriate attention to design details (eg glazing seals, etc) these areas can act as highly efficient solar collectors during winter months. Kitchens are part of the open-plan living/dining areas, which connect directly to at least one external wall with operable windows/balcony doors for natural ventilation and light.
- No apartments will have only a southerly aspect thereby exceeding the "Rule of Thumb" set in the Residential Flat Design Code, to ensure that no more than 10% of apartments have a sole southerly aspect.

While the design of the apartments has taken advantage of the winter sun, there is an equal need to provide protection from the severity of the summer sun so as to prevent overheating of the building.

- Horizontal shading is incorporated to all apartments in the form of balcony spaces to north facing glazing. This will selectively shield glazing from high altitude summer sun, and admit low altitude winter sun.
- Use will be made of vertical fin shading blades attached to the east and west façade glazing in the form of 300 mm reveals spaced at 300 mm centres. Reveals will be angled by 45 degrees toward the north to provide afternoon summer shading for solar azimuth angles approaching due west. The same blades will allow full penetration of afternoon winter sun with a more northerly azimuth.

- Toned glazing having a shading coefficient of approximately 0.6 will be used on the north east and west façade glazing to limit summer heat gain. For southern façade glazing advantage will be gained by using low-e treated glass, which will reduce heat flow across the glazing surface.

The suitability of the apartment form and shading design above has been confirmed by the achievement of thermal comfort compliance under the BASIX scheme for the previous residential design.

3.3 Wind Impact and Natural Ventilation

Interaction of the proposed development with the local Wollongong wind environment has been described in a separate detailed Wind Impact Assessment prepared by Heggies Australia and submitted with this application. The focus of the Wind Impact Assessment focuses upon the impact of extreme winds (synoptic gales, storm fronts and seasonally strong winds) on users of the facility with a reduced emphasis upon the day-to-day serviceability conditions associated with regular breezes and availability of natural ventilation.

Retail and Commercial Components

Natural ventilation is the most efficient mechanism in summer for replacing hot air inside an apartment with cooler outside air. The site has good exposure to coastal sea breezes providing a potential heat purge mechanism to the centre and a highly effective means for reducing cooling loads in summer. Initiatives should therefore be considered where such cooling breezes can be utilised.

Residential Component

SEPP 65, Principle 7 - Amenity - refers to “natural ventilation” and supporting Residential Flat Design Code ‘rule of thumb’ states that 60% of apartments in a development should be cross ventilated.

The revised design of the residential tower within the re-development has dual façade operable windows and/or doors for virtually all floors except for the lowest (Level 4) just above the podium. The building will therefore significantly exceed SEPP’65 cross-ventilation requirements.

In winter it is important to close off heated areas that need warming. The opportunity to open and close balcony doors will allow adequate control to moderate the impact of any higher than comfortable winds, particularly towards design limit wind speeds. The following initiatives will also be incorporated to minimise heat leakage from the building:

- Particular attention will be paid to design detailing of the glazing interface to the window framing system and the provision of adequate weather stripping.
- Doors leading to hallways and stairwells from the dwellings will be provided with draught excluders to limit heat losses during winter months. Pressure seals around doorways should be compatible with fire rating requirements.
- Doors located throughout the development in general-use areas, such as access ways to/from the building, will be fitted with door closers where it is deemed that their opening will have an adverse effect on heat loss during winter.

Attention will be paid to design detailing of connections and sealing details to ensure that the good thermal properties of the individual elements being used are not ‘diluted’ by poor thermal leakage paths.

3.4 Insulation

Retail and Commercial Components

It has been proposed that the development will use standard concrete slab construction over the level 4 terrace roof of the Dwyer Site, the Level 3 terrace roof of the Oxford Site, the Level 13 roof of the Hotel tower and the Level 14 roof of the Office tower. It has been estimated that the overall roof construction R-value of the four roofs will be approximately R 3.0. This takes into account the waterproofing membrane, concrete slab, foil, false ceiling cavity below and plasterboard ceiling with including R 2.5 bulk insulation. This level of insulation is deemed to be more than adequate for winter heat retention and radiant heat reflection.

It has been proposed that the external walls will include a large proportion of glazing, precast concrete and Alucabond panelling. Foil and bulk insulation will be included in all non-glazed external walls for improved thermal performance.

Residential Component

The top level of the residential tower will comprise unconditioned plant room space with a metal deck roof. It is proposed to include a foil blanket directly below the metal sheeting inclusive of a bulk insulation layer to R 2.0. Although the top plant room will be uninhabitable, this level of insulation meets the "*Rule of Thumb"* set in the Residential Flat Design Code of roof/ceiling insulation to R 2.0.

It has been proposed that the external walls will be precast 200 mm concrete panels. East and west curtain wall glazing will include insulated infill panels in order to meet heating and cooling load caps under BASIX. At these locations plasterboard will be installed on furring channels to allow space for foil and bulk insulation, to increase the total system insulation value to at least R 2.0.

The suitability of apartment insulation above has been confirmed by the achievement of thermal comfort compliance under the BASIX scheme for the previous residential design and will be confirmed again with the revised NatHERS/BASIX assessment of the current design.

Finally, internal walls are to be lightweight plasterboard on stud construction with acoustic insulation. This is advantageous from a building life-cycle perspective, as it maximises the adaptive reuse potential when the building reaches the end of its intended use.

3.5 Windows

Retail and Commercial Components

There is plentiful exposure of the retail, hotel and commercial buildings' north and east facades to solar heat gain as discussed in **Section 3.2**. Performance enhancing glazing is being considered to be used on the retail podium to further optimise solar gain throughout the year.

Residential Component

There is a good level of exposure of the building's north, east and west facades to solar heat gain as discussed in **Section 3.2**. Toned glazing having a shading coefficient of approximately 0.6 will be used on the north east and west façade glazing to limit summer heat gain. For southern façade glazing advantage will be gained by using low-e treated glass, which will reduce heat flow across the glazing surface.

It is proposed to install curtains or blinds on all windows in residential apartments. It is recommended that these be closed weave material (and not venetian blinds) to eliminate air flow through the curtain surface. Pelmets should be installed above the curtain rail or blinds and should be well-fitted within the reveals to stop convective air currents from making contact with the top of the window surface, resulting in winter heating load savings.

3.6 Thermal Mass

It has been proposed that all floors throughout the development will be 200mm concrete slab construction, which has amongst the highest thermal mass capacity of a range of common building products, as seen in **Table 1**. External walls, structural internal walls and slabs of the proposed development will be predominantly concrete.

Generally the more dense the material, the higher the thermal mass and therefore the more heat energy, that can be stored. Hence the development can provide heat storage capacity to smooth out daily temperature variations within conditioned spaces with corresponding reductions in heating and cooling loads.

Table 1 Indicative Thermal Mass Values of Some Common Building and Reference Materials

Material	Material Thickness (mm)	Thermal Mass (kJ/m^2.K)
Dolerite (Rock / Stone)	200	433
10-31 Solid Brick	190	410
Concrete	100	221
Concrete block	90	194
10.01 regular brick	90	151
Clay brick (3.5 kg solid + 0.5 kg mortar)	110	142
Aerated concrete block	100	50
Fibre cement sheet (compressed)	18	32
Wood flooring (hardwood)	19	25
Weatherboard (softwood)	15	16
Fibre cement sheet	6	8
Plasterboard	10	8
Glass	3	6
Expanded polystyrene (EPS-class SL)	50	1.8
Cork	6	1.6
Rockwool (batts)	50	1.5
Fibreglass (batts)	50	0.5
Air	50	0.5

4 OPERATIONAL ENERGY EFFICIENCY DESIGN

4.1 Australian Building Greenhouse Rating (ABGR)

As the commercial component cost of the Dwyer-Oxford development is more than $5 million, it is a requirement set out by Wollongong Council that a minimum ABGR 4 star be achieved. Heggies will assist the developer and architect in attaining a minimum ABGR 4 star accreditation for the commercial component of the development.

Heggies will conduct energy simulation, using ESP II software, of the commercial component. This will assist in incorporating energy efficiency building services into the re-development, thereby attaining the required ABGR rating. We will also assist the developer in the signing of a Commitment Agreement with the Department of Environment and Climate Change (DECC) and the preparation of documentations required for attaining the ABGR 4 star accreditation.

4.2 Heating/Cooling and Ventilation

Retail and Commercial Components

At this stage in the design process it has been decided in principle to use centralised gas fired boilers for heating and chilled water plant for cooling. Centralised plant normally provides superior energy performance than packaged units by providing better matching to heating and cooling loads. Outside Air Economy cycles will be incorporated into the design for improved energy efficiency.

It has also proposed that the retail, hotel and commercial buildings' air conditioning systems will be designed on the basis of reasonable maximum loads. This is efficient as it avoids the problem of over-specifying plant in the building.

At the time of reporting, the design control setpoint, deadband and throttling range were not known. It is recommended that the range of the deadband be as large as possible, without compromising thermal comfort, thereby avoiding unnecessary switching of the HVAC system. It is also recommended that these components should not be able to be adjusted by occupants of the building.

It is recommended that temperature sensors used with the system be located to avoid direct solar gain, heat transfer through external walls and interference between zones, and that pipework and ductwork is proposed to be adequately insulated. All of these actions represent good energy efficiency practice.

Details of the (in-principle) HVAC systems proposed for the re-development can be found in the Mechanical Services Report prepared by Erbas & Associates Pty Ltd, outlining a series of energy-efficient features such as the use of gas-fired boilers, heat exchangers, VAV type AHU's, etc, coupled with individual controls for temperature and air-conditioning operation for commercial tenants which will allow efficient energy use throughout the development and zone controls for air supply to suit the specific office layout chosen for office areas.

Residential Component

It is proposed to use water-cooled packaged units to individual apartments using a rooftop cooling tower for heat rejection and centralised gas fired boilers for heating. Individual control systems will be provided to each apartment to enable separate control of air conditioning so that heating and cooling are only used when required, particularly when rooms or apartments are unoccupied. It is recommended that a variable speed drive cooling fan be considered in the design of the cooling tower. Pipework and ductwork will also be adequately insulated, which represents good energy efficiency practice.

The suitability of the apartment HVAC design above has been confirmed through the achievement of a 20% reduction in residential energy consumption under the BASIX scheme for the previous residential design.

4.3 Mechanical Ventilation

Energy efficiency measures on mechanical ventilation will be incorporated including linking residential mechanical ventilation to manual switching where allowable under the BCA and using individual fans rather than a common ducted ventilation system with constant operation. Variable speed drive fans will be used for carpark ventilation with carbon monoxide sensor so that the fan only runs when required. These initiatives will provide significant savings in energy use and associated operational energy costs of the development as reflected in a 20% reduction in energy consumption under BASIX.

4.4 Domestic Hot Water

It has been proposed that domestic hot water to the entire development will be provided using separately metered centralised gas boilers. The overall size of the site will allow relatively efficient gas-fired hot water boilers to be used in the central plant facilities of the building.

It is anticipated that losses from pipework will constitute a significant base load on the domestic hot water system. Consideration will also be given to the use of solar panels to supplement reticulation heat losses.

No heating is currently planned for the outdoor pool on the podium level.

The suitability of the apartment domestic hot water design above has been confirmed through the achievement of a 20% reduction in residential energy consumption under the BASIX scheme for the previous residential design.

4.5 Appliances

Dishwashers, clothes dryers and fridges will be installed in every residential apartment and energy efficient models will be chosen to at least 5 stars on the Energy labelling list provided by the Australian Greenhouse Office (AGO) (www.energyrating.com.au).

Gas cook tops and ovens will also be provided which is environmentally favourable as gas is much less greenhouse intensive than electricity. Clothes dryers will be gas heated.

Fridge spaces will not be fully enclosed to allow ventilation to refrigerator coil, thereby improving the efficiency of the installed equipment.

4.6 Lighting

Retail and Commercial Components

Improvements in the energy efficiency of lighting systems can be achieved in various ways:

- Use of the most energy efficient luminaries. The efficiency of available lamps, ranges from approximately 10 lumens per watt for a typical incandescent lamp to almost 200 lumens per watt for a high capacity low pressure sodium lamp.
- Installation of an effective lighting control system so that unwanted lighting can be switched off either manually or automatically. A building management system can operate both lighting and air conditioning. Automatic switch controls will be timed for when staff and shoppers are not normally present.

- Integration of electric lighting and daylight utilising daylighting sensors which can automatically adjust illumination to changing natural light conditions. These would be appropriate for the perimeter retail stores.

External lighting used for security purposes in car park areas and building perimeter zones can use high pressure sodium or metal halide fittings and can be turned on by a photo-electric cell and turned off using a time switch or light sensor.

In addition the following general recommendations are made:

- Lighting levels should be established using the guidelines set out in Australian Standard AS 1680.1-1990.
- Internal wall colouring should be made as light as possible to maximise the use of natural daylight.

Residential Components

Compact fluorescent downlighting will be used in all apartments in place of standard halogen downlighting. These globes use as little as an eighth the energy of halogen downlights, are available in warm white or crisp white, fit the same recessed fitting but do not require a transformer and last for 15,000 hours compared to 1,000 to 2,000 hours for standard halogen units, thus saving on maintenance costs for the building owner.

The following will also be incorporated:

- Lighting control devices such as light sensors, time-clock switching and lift-lighting linked to lift-call buttons will be used in the development for basement carparking, common use areas, externally lit doorways or entrances and for any outdoor security lighting. This will minimise unnecessary lighting of extended duration.
- Common area lighting consumes a large amount of energy in multi-storey residential apartments. This project will favour the use of energy efficient fluorescent or compact fluorescent fittings in these zones.
- Light switches will be located at room exits to encourage switching lights off when leaving a room. Separate switches will be installed for special purpose lighting.

The suitability of the apartment and common area lighting design above has been confirmed through the achievement of a 20% reduction in residential energy consumption under the BASIX scheme for the previous residential design.

In-Principle Lighting Concept Design Features

The Electrical and Communication Services Report prepared for the Concept Design by Jim Hatz & Associates outlines numerous ESD initiatives associated with the planned lighting design of the project, including:

- Introduction of bulk power correction factor.
- Use of fluorescent linear T5 and compact fluorescent lamps throughout internal areas.
- Use of electronic (high frequency) ballasts.
- Light dimming and photo-cell system options where appropriate.
- Smaller motors with VRV where appropriate.

These address many of the recommendations made above for both the residential and commercial / office components of the re-development.

4.7 Construction and Commissioning

Construction has the potential to result in significant environmental disturbance including pollution, construction waste, and water and energy use. The adoption of an environmental management system during construction can significantly minimise these impacts. It is therefore recommended that an environmental management system (or equivalent) be used by the successful Contractor for the project in accordance with:

- Section 4 of the NSW Environmental Management System guidelines (1998).

It is possible to significantly improve building services performance and energy efficiency by incorporating comprehensive pre-commissioning, commissioning, building tuning and quality monitoring into a project. A number of internationally recognised codes are available to assist in this process:

- ASHRAE Guideline 1 - 1996 - The HVAC Commissioning Process.
- CIBSE Commissioning Code M - Commissioning Management.

It is recommended that design and documentation quality assurance checks and on-site quality assurance be adopted to ensure that energy efficient design features are preserved throughout the construction process to the commissioning stage.

It is also recommended that energy efficient features of the building be documented in individual trade Operation and Maintenance manuals to be compiled by Belmorgan Property Development Pty Ltd. Training can then be provided to future users of the building, as required, and a long term energy management plan for the building prepared.

5 WATER EFFICIENCY

Water Efficient Plumbing and Appliances

Excess water usage wastes both the water itself and the energy required to filter, pump and dispose of it. Excess use of hot water also wastes the energy required to heat the water.

All apartments will therefore be fitted with water saving WELS-approved 3-star rated flow restricted showerheads and taps fixtures, fittings and appliances, along with dual flush toilets. It is proposed to incorporate dual flush toilet suites with water efficient cisterns which deliver 4.5 L full flush and 3 L half flush. These products have been given a 4A water conservation rating by the Water Services Association of Australia (WSAA) and provide an estimated 8-9% improvement on AAA rated toilets. These water efficiency options can be further explored during detailed design.

AAA rated water efficiency dishwashers will also be installed in the residential apartments.

Water Efficient Garden Design

The landscape design will focus on using native coastal and other drought resistant species that rely primarily on rainwater for their water needs. All soft garden beds will be mulched and any irrigation supply will be from drip irrigation and soil moisture sensors, helping to minimise water consumption required for irrigation. Furthermore, irrigation water will be sourced from the rainwater tank located on the podium level.

Rainwater / Stormwater Catchment

A 111,000 L tank for Stages 1 (basement level) and two 40,000 Stage 3 (provision for) rainwater /stormwater catchment and re-use tank will be utilised by the development which will be reticulated to the apartments for toilet flushing, to landscaped areas for irrigation, and to the basement levels for car washing and garbage hosing facilities. Fire test water will also be diverted to this tank to minimise wasted water.

The suitability of the apartment and common area water efficiency design above has been confirmed through the achievement of a 40% reduction in residential water consumption under the BASIX scheme for the previous residential design.

6 RECYCLED MATERIAL SELECTION, RECYCLABILITY, AND WASTE MINIMISATION

Complete energy efficient design aims to reduce the energy consumed by a building over its entire lifecycle from "cradle to grave". Construction materials and products will be selected, where feasible and reasonable, based on balancing the following criteria:

- Recyclability.
- Sustainable sourcing.
- Low embodied energy.
- Low pollution from manufacturing.
- Low transport costs.
- Minimal environmental impact.
- Durability and minimal maintenance.
- Non-hazardous.
- Eco-labelling and certification.

Embodied energy is the "up front" capital energy investment at the construction stage associated with the building materials and process used in the production of a building. This includes the mining or harvesting of raw materials, processing these materials into housing fabrics, transport for both raw materials and refined products and the preservation of the energy investment through durability.

The building is designed to be durable providing long term-use with the possibility of later adaptive re-use. Materials to be used extensively throughout the development include concrete, steel, glass, aluminium, and carpet. **Table 2** illustrates the long-term renewable and recyclable properties of these materials. Most materials for use on the project can be recycled, including: aluminium (100% recyclable, 95% embodied energy savings), steel (72% embodied energy savings), gypsum plasterboard, timber, concrete**,** some carpets, glass and plastics.

Table 2 Renewable / Recyclable Properties of Some Common Building Materials

Material	Embodied Energy	Durability	Re-useability /Recyclability	Toxicity	Renewable	Polluting
Aluminium	Very high	High	High	Low	No	Moderate
Steel	High	High	High	Generally Low	No	Moderate
Concrete	Moderate	Moderate-high	High potential, depends on market	Low	No	Moderate-low
Wood	Low	Moderate	High	Low	Yes	Low
Glass	Moderate	Moderate	High	Low	No	Low
Carpet	Moderate-high	Low	Moderate, although market very limited	Low	Partially	Moderate-low

The developer will minimise, where practicable, the use of PVC, particleboard, laminated wood, plywood and treated timber, and exclude all materials containing CFCs or HCFCs. Wherever possible materials with recycled content and materials listed on the "Ecospecifier" database (http://www.ecospecifier.org) of preferable materials will be used.

6.1 Minimisation of Pollution & Waste

Minimisation of Construction Waste

A recycling plan will be developed for construction waste materials. Much of the material generated during construction (excluding packaging and shipping materials) will be recycled, eg: metal (steel & copper), clean dimensional wood & timber off-cuts for reuse, concrete and bricks for crushing, cardboard, glass, asphalt, bricks and beverage containers. Any formwork required for concreting will be recycled and sub-contractors will also be encouraged to make use of recyclable packaging for any materials sent to site.

Operational Waste

The development will be provided with a large garbage/recycling room or area in the basement carparking levels, with the Waste Enclosure having space for hosing, flushing and sanitising the bins with a high pressure gurney.

The garbage room will be provided with individual bins of 240-Litre Plastic Wheeled bins for the separate storage of paper, Glass/PET/Steel/Al, to be available for residents' use and for pick-up by local council recycling services.

Stormwater

Stormwater Management is required to reduce the demand on town stormwater systems during peak stormwater flows, reduce pollution from nutrients, oils, litter and sediment and to ensure that the water does not stagnate. In-ground gross pollution traps and oil/grease arrestors will be included as interceptive devices for trash, debris and sediments (coarse and fine).

Emergency Response During Construction

To minimise the environmental, health and safety risks associated with incidents such as chemical spills, damaged water pipelines, excessive rain run-off or the uncovering of potential contaminated soils, emergency response procedures will be developed by the developer. Procedures will include list of key personnel and emergency services, communication strategies, lists of hazardous materials and their environmental impact and emergency actions.

Noise Pollution

Potential noise pollution problems caused by a range of noise sources associated with the proposed development will be minimised by careful planning and design. A separate acoustic and noise report has been prepared to address this potential impact.

Light Spill

The developer is committed to reducing light pollution from the development onto adjacent residential properties and the local environment. Light spill will be controlled so that minimum light is directed beyond the site boundaries or upwards.

7 CONCLUSION

It is evident that the design of the Dwyers-Oxford Site Re-Development has been mindful of ESD aspects, particularly in relation to the features detailed in Wollongong Council's LEP 2007, covering the following areas of interest:

- Greenhouse Gas Reduction.
- Embodied Energy in Materials and Building Processes.
- Building Design and Orientation.
- Passive Solar Design and Day Lighting.
- Natural Ventilation.
- Energy Efficiency and Energy Conservation
- Water Conservation and Water Re-Use.
- Waste Minimisation and Recycling.
- Reduction of Car dependence.
- Potential for Adaptive Re-Use.

Many energy efficient and sustainable design elements are planned for the re-development, including:

- High levels of cross-ventilation, natural light and solar access exposure.
- Well-recessed glazing to enable horizontal shading to most glass.
- Higher performance glazing in critical areas.
- Incorporation of thermal mass.
- Water efficient bathroom and kitchen fittings.
- Energy efficient lighting options.
- Gas-fired solutions for hot water.
- Individual controls for heating and cooling and thermal zoning design.
- Rainwater /stormwater catchment tanks for water re-use.

These features will help to achieve significant reductions in the energy and water required by the development both in building and operation, as well as ensuring that both the apartments and hotel rooms are more pleasant spaces to reside.

In addition, this ESD assessment recommends a number of measures to be considered with respect to the building envelope, air conditioning and ventilation, lighting and water efficiency, construction and commissioning aspects. These are outlined in **Table 3**.

The adoption of these ESD attributes in the design and delivery of the re-development will further enhance the significant ESD outcomes for the facility and for the local surrounding community already planned.

Table 3 Summary of the ESD Features Already Planned and Recommended for Consideration

ESD Element	Planned Feature / Recommended Feature
Glazing type	Utilise glazing with a shading coefficient of approximately 0.6 on unshaded east facade of the residential tower. Low-e treated glass should also be considered.
	The restaurant should utilise glazing with a shading coefficient of a *maximum* of 0.6, and should be low-e treated
	Curtains or closed weave blinds should have pelmets installed or be well-fitted within the reveals
Building Envelope	R2.5 bulk insulation in all roofs (above the slab if possible)
	R1.4 total roof/ceiling system insulation where habitable rooms are below mechanical plant rooms
	Total wall system insulation to a minimum of R1.4 (including spandrels)
Air conditioning	Variable speed drive fan should be considered in the cooling tower design
Mechanical Ventilation	Consider the use of a variable speed drive fan linked to a carbon monoxide sensor for carpark ventilation
Lighting	Maximise the use of compact fluorescent downlighting in place of halogen downlighting, and sodium, metal halide or fluorescent lighting in communal areas.
Appliances	Fridge spaces should not be fully enclosed where possible
Process Issues	Design and quality assurance checks and on-site quality assurance be put in place
Water Efficiency	The use of 4A 4.5L / 3L dual flush toilets should be investigated
	All available podium level end water uses should be considered as part of the rainwater reticulation system
Water Re-Use	Large Rainwater / Stormwater tanks in both components of the development.