Mainstreaming Net Zero Energy Housing

Design Review Report

Authors	Curtin University: Dr Josh Byrne, Dr Christine Eon, Dr Xin Liu CSIRO: Michael Ambrose
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Executive summary

The Cooperative Research Centre for Low Carbon Living (CRC LCL) research project *Mainstreaming Net Zero Energy Housing* aims to improve industry understanding of Net Zero Energy Homes (NZEH) while addressing cost and consumer interest barriers. The project also provides a unique opportunity to increase collaboration between industry players such as land developers and volume builders.

This report explores cost-efficient approaches for the participating volume builders to transition 'business-as-usual' house design to a 'net zero energy' house design. The methodology involved firstly a workshop, where the concepts of NZEH design were discussed amongst stakeholders and different design and technology scenarios were brainstormed. The second step was to model the chosen scenarios with the use of the CSIRO AusZEH Design Tool, and cost these to identify the most cost-effective solutions. Finally, an adequate PV system was sized to cover the annual energy needs of a typical Australian household in order to achieve NZEH.

The results deriving from the workshop and subsequent modelling were used to inform the house design to be built in four different locations across Australia including Melbourne (Victoria), Townsville (Queensland) and Canberra (Australian Capital Territory) and Perth (Western Australia).The following were some of the key findings

- Major energy efficiency gains were obtained mainly from additional insulation, glazing upgrades and energy efficient appliances (hot water systems and air conditioners in particular);
- Only a relatively small sized PV system (3-4kW) is required to cover the net needs of a typical Australian household provided that the building envelope is designed appropriately for the climate and the appliances are energy efficient;
- A collaborative environment enables builder engagement and win-win solutions to be developed.

Subsequent reports by the authors document the latter stages of the project, including an analysis of the construction costs and estimated payback periods of the NZEH design and technology features of the case study homes, as well the results of visitor surveys being undertaken to identify consumer interests. The results of the three project stages will provide a valuable evidence base for better understanding the upfront cost implications and ongoing operational cost benefits of NZEHs, as well as an insight into market interest in NZEH design and technology features.

Townsville NZEH Design Review Workshop.

Introduction

In 2016 Australia ratified the Paris Agreement committing to reach net zero emissions by 2050 alongside other developed countries (United Nations, 2015). With nearly one quarter of Australian carbon emissions coming from buildings, the building sector plays an essential role in the overall strategic reduction plan (Department of Environment and Energy, 2016). Commercial and residential buildings currently generate approximately the same share of emissions, however it is projected that total residential emissions will rise as a result of trends such as the increase in the number of appliances per household, the decrease of the number of occupants per dwelling and the increase of dwelling habitable area (Moore et al., 2013, Lucon et al., 2014).

Residential building minimum performance standards have remained largely unchanged since 2012. The Nationwide House Energy Rating Scheme (NatHERS) provides a star rating based on the climatic zone and the thermal performance of the residential building being assessed. The National Construction Code (NCC) allows NatHERS to be used to show compliance for residential buildings and currently requires every new residential dwelling to meet a minimum of 6-Star rating on a scale of 0 to 10. 10-Star houses are the most thermally efficient rating on the scale. This rating system, however, is based only on the reduction of the energy requirements for ambient heating and cooling per square meter and does not take into consideration other major domestic energy users such as water heating (21% of total household energy use), fixed appliances and cooking (33% of total household energy use for both appliances and cooking requirements) (McGee, 2013).

Whilst recent reports indicate that residential energy use per square meter decreased following the implementation of NatHERS (ASBEC, 2016), research has also revealed a high rate of underperforming houses, caused in-part by non-compliant construction. Areas of non-compliance include roof colour, insulation, lighting installation, glazing and the sealing of windows and doors (Ambrose and Syme, 2015, DSD, 2015, Eon et al., 2017). However, barriers in the implementation of efficient residential buildings are present in the whole building supply chain and comprise suboptimal knowledge and skills, lack of inspections and quality control and regulatory compliance (DSD, 2016). Limited communication and collaboration between the different parties in the supply chain and lack of cross-trade accountability are also an issue. Workshops with members of the building industry have revealed that compliance is often considered a burden that needs to be overcome, sometimes by cutting corners, as there is no sanction for non-compliance and no consumer protection (DSD, 2016).

From a market perspective, the uptake of energy efficient buildings has been challenged by two factors. The first is a perception that increased efficiency standards results in houses that are more costly to build and therefore less affordable to buyers (DSD, 2014). Yet, there is a growing body of evidence to suggest that high performance houses, and in particular Net Zero Energy Homes (NZEH)[1], are not only economically viable at construction, but also cheaper to run in the long term, resulting in significant savings in utility bills over the building lifecycle and high return on investments (Berry and Davidson, 2015, Szatow, 2012). Simple measures such as the improvement of roof insulation, the installation of ceiling fans and the reduction of air leakage could reduce annual energy bills by up to $150 (ASBEC and ClimateWorks, 2018). Additional benefits of NZEHs include higher levels of comfort for the occupants and better health, also resulting in higher productivity (MacNaughton et al., 2017).

The second challenge is the perception that buyers either do not understand, or do not have interest in energy efficient features and design. This perception includes the belief that if given the choice, consumers would rather invest on building a bigger and modern looking house rather than on energy efficiency (DSD, 2014). When building a house, however, buyers are largely influenced and guided by builders, who do not necessarily possess the required knowledge, skills or supply chain to deliver NZEHs. In contrast, recent research has shown that established houses with sustainable features not only sell faster, but also for 10% more than standard houses, demonstrating that there is a market for more sustainable homes (PRDnationwide and QUT, 2018, Warren-Myers, 2017).

With around 100,000 detached houses built each year (HIA, 2015), and with the average operational greenhouse gas (GHG) emissions in the order of 7 tonnes per year per dwelling (McGee, 2013), total

[1] Net Zero Energy Homes (NZEH) are designed and built to consume the same, or less, energy than they produce on an annual basis. Typically, NZEH buildings are highly energy efficient, through good design and quality construction, and include an appropriately sized roof-top solar power generation system to match their estimated power load during occupancy.

emissions could be reduced by around 700,000 tonnes $CO_{2\text{-eq}}$ year on year if all new homes were built as NZEH. In light of this, addressing the aforementioned industry barriers to facilitate greater uptake of energy efficient housing, and NZEH in particular, is an important pursuit.

The Cooperative Research Centre for Low Carbon Living (CRC LCL) research project *Mainstreaming Net Zero Energy Homes* aims to build industry support for NZEHs amongst major land developers and volume builders while addressing cost and consumer interest barriers, and increasing collaboration between different players. Four NZEH display homes are being built in partnership with land developers in new housing developments in Melbourne (Victoria), Townsville (Queensland), Canberra (Australian Capital Territory) and Perth (Western Australia) and are being used for data gathering as well as industry engagement. The case study in Melbourne has timely synergy with the Zero Net Carbon Homes program led by Sustainability Victoria, which will provide Victorian builders with design expertise in NZEH as well as marketing advice to increase demand and promote sales at a state level (Jewell, 2018). Sustainability Victoria and their collaborators - South East Councils Climate Change Alliance (SECCCA), have been engaged as participants in this project to ensure learnings are shared.

The first steps in the project Mainstreaming Net Zero Energy Homes included:

- The engagement of land developers and volume builders in different Australian housing markets;
- A design review workshop, which aimed to evaluate cost-effective scenarios to improve business-as-usual (BAU) house designs;
- The energy modelling of the scenarios in specialized software, which helped determine the NZEH design to be built in each of the four display sites.

This report is the first of a series of three that have been produced as part of this project and presents the results of the workshop and energy modelling of the NZEH display homes to be built in Melbourne, Townsville, Canberra and Perth. The full set of reports will be:

1. Design Review Report
2. Cost Analysis Report
3. Consumer Interest Report

Subsequent reports document the latter stages of the project, including an analysis of the construction costs and estimated payback periods of the NZEH design and technology features of the case study homes, as well the results of visitor surveys being undertaken to identify consumer interest.

Melbourne NZEH Design Review Workshop.

Methodology

This section describes the methodology employed for the selection of participant industry partners, the design workshop and finally the software used for modelling the predicted energy consumption in the proposed display homes.

Partners selection

The engagement of industry partners and the enablement of a collaborative environment were central to this project, which was initiated by the recruitment of interested parties in different Australian states. Expressions of interest to participate were received from several land developers which were selected according to their geographic distribution and timing of planned residential display villages. Moreover, the land developers were required to assist in identifying a willing builder who would be open to modifying their proposed display home design in line with the NZEH criteria and be open to sharing project costing information.

Design review workshops

Workshops were conducted in each of the four selected cities with representatives of the stakeholders involved in the planning and construction of each display house. Stakeholders consisted of the selected land developer and builder, government and research partners, including CSIRO (Commonwealth Scientific and Industrial Research Organisation) and Curtin University.

Each workshop was conducted over one day and followed the agenda below:

- Outline of the project background and objectives (Curtin University);
- Overview of NZEH definition and design implications (Curtin University);
- Explanation of the software used to model house energy use (CSIRO);
- Presentation of the pre-existing display house design (builder);
- Brainstorming of cost-effective design modifications to achieve a high performance NZEH standard (all stakeholders).

The pre-existing display house design presented by the builder was considered a BAU, or baseline, scenario and proposed energy improvements were allocated into three alternative scenarios according to their cost-effectiveness and ease of implementation for the builders. Principles of passive solar design (e.g. glazing, insulation, ventilation, thermal mass, shading, orientation) guided the first part of the conversation, which was followed by a discussion about energy efficient options for appliances and lighting as well as the installation of solar panels and batteries. This approach was taken as the design of NZEHs should first aim to prioritize improvements to the building fabric, which is primarily responsible for residents' comfort levels (ASBEC and ClimateWorks, 2018), thus reducing heating and cooling energy load. In turn, the solar energy systems required to meet (or offset) energy demand can be smaller and cheaper to install.

Scenario 1 listed the most straight-forward and cost-effective changes. Examples included the modification of roof colour, the addition of insulation (walls, roof and ceiling), the selection of energy efficient appliances and the modification of existing window apertures or glazing type. Scenario 2 included more challenging or costly design changes that might impact the house layout. Examples included the addition of doors, windows or shading structures. Finally, Scenario 3 covered structural modifications such as altering walling materials or adding new walls. Back-of-the-envelope cost estimations were provided by the builders during the brainstorming session, which helped to inform the compilation of scenarios. The detailed costings of the design and fit out modifications, however, were not able to be provided until full cost estimating had been undertaken by the builder. This information is presented in a subsequent report by the authors.

A draft energy model of the improvements suggested in Scenario 1 was prepared in parallel with the discussion and presented at the end of the workshop to demonstrate the process.

Modelling

Further modelling of the agreed Scenarios 1, 2 and 3 were carried out after the completion of the workshops and were used to determine the most cost-effective NZEH to be built at each display village.

The software AusZEH Design Tool (AusZEH) was used to model the three different scenarios. This software combines a thermal energy simulation model; a projection of energy used for lighting, water heating and major household appliances; and house occupancy profiles (Ren et al., 2011a, Ren et al., 2011b). The simulation of the building thermal energy is carried out by the software AccuRate, which is typically employed for NatHERS energy star-rating assessments. This model takes into consideration information about local climate, building orientation, construction materials and conditioned area to determine the required energy for heating and cooling over a one-year period. The simulation of the building thermal energy demand is combined in AusZEH with further predictions of energy used for lighting, water heating and to run high-energy appliances such as fridges, dishwashers and TVs. The model for total annual energy consumption in the home is further refined according to the house occupancy pattern, which can be specified by the modeller. For the purpose of the simulations carried out in this project it was assumed that a family of four occupy the houses. Two occupancy scenarios were further modelled; the first one assumed that the houses are continually occupied seven days per week (worst case scenario); and a second occupancy scenario assumed that the houses are unoccupied during business hours (9am to 5pm, Monday to Friday), when occupants might be attending work or school (other extreme).

While AusZEH is comprehensive and currently considered a leading practice residential energy modelling tool in Australia, some of the appliance/fittings specifications embedded in the software are out-of-date; for example, indicating higher Wattages compared to more recent appliances. In order to overcome this limitation, the builders were asked to provide the specification of appliances being installed as part of the building construction package (e.g. air conditioners and hot water system). These were inserted manually into the software for a more accurate estimation of annual energy consumption.

AusZEH does not account for renewable energy systems such as solar photovoltaic (PV) panels. For houses to be defined as NZEHs, they need to be 'operationally energy neutral', that is they need to generate as much renewable energy as required to meet household energy needs over the year. The software SAM (System Advisor Model), developed by the U.S. National Renewable Energy Laboratory (NREL), was employed to determine adequate PV sizes to cover annual energy demands for each of the three modelled scenarios under specified occupancy patterns. This software predicts hour-by-hour PV electricity production based on variables such as house location and associated solar radiation, the size of the PV system and inverter (NREL, 2014).

The Victorian Residential Efficiency Scorecard tool (the Scorecard) was also used to rate the Melbourne display house in addition to AusZEH and SAM. The Scorecard is a voluntary Victorian rating program that rates houses from 1 to 10 Stars and provides householders with information about ongoing energy costs, house performance in hot and cold weather, appliance performance and options for energy efficiency improvements (Victoria State Government, 2018). The Scorecard assessment was conducted by the South East Councils Climate Change Alliance (SECCCA) and used as an additional tool to verify the energy performance of the selected house design scenario.

Canberra NZEH Design Review Workshop.

Project setup

The four display houses are respectively located in the cities of Melbourne (VIC), Townsville (QLD), Canberra (ACT) and Perth (WA). These locations were chosen partly due to the availability of display villages but also to showcase a variety of climates, markets, construction techniques and supply chains. This section provides an overview of the climatic conditions and design implications for the four project locations.

Climate

Melbourne, Townsville, Canberra and Perth are situated in different climate zones. According to the National Construction Code (NCC), Melbourne's climate is described as 'mild temperate' (Climate zone 6); Townsville's climate is tropical, described as Climate zone 1: 'high humidity summer and warm winter'; Canberra's climate is described as 'cool temperate' (Climate zone 7); and Perth's climate is described as warm temperate (Climate zone 5). Average temperatures, sunshine hours and rainfall differ significantly between these four locations (Table 1).

Table 1 Climate in Townsville, Melbourne, Canberra and Perth.

LOCATION	CLIMATE	SUMMER	WINTER	SUNSHINE (HOURS PER YEAR)	RAINFALL (MM PER YEAR)
Melbourne	Mild temperate	Dry and mild Days of extreme heat Average high temperature: 25.7ºC	Cool and humid Average low temperature: 7.6ºC	2,362	602
Townsville	Tropical	Hot and humid Tropical cyclones Average high temperature: 31.3ºC	Warm days and cool nights South-East winds Average low temperature: 14.4ºC	3,080	1,135
Canberra	Cool temperate	Dry and warm Average high temperature: 27.5ºC	Cool Average low temperature: 1ºC	2,813	615
Perth	Warm temperate	Hot and dry Average high temperature: 31.5ºC	Wet and mild Average low temperature: 8ºC	3,217	733

Building design implications

The most economical and effective way to build a high performance NZEH is to start by designing a building envelope that is adapted to the local environment. Passive solar design takes advantage of the climate to maintain comfortable internal temperatures, reducing the need for mechanical heating and cooling. For instance, houses located in cool climates benefit from access to direct sunlight, while houses situated in warmer climates benefit from natural breezes as well as shade. Building orientation, insulation, glazing and thermal mass are all essential factors to consider when aiming to minimize heat gains and losses.

Passive solar design considerations vary depending on the geography and thermal needs for each location. In Melbourne and Canberra, emphasis is on the cool climate and heat loss prevention. In this case, the optimal house orientation is where living spaces face north to be exposed to sunlight during the winter months but can be protected with external shading devices in warm weather. In Townsville, however, where the climate is warm year-round, shading is essential. The ideal house orientation for sun protection is south, where dining and living areas are kept away from direct sunlight. Moreover, low-e glazing, good cross-ventilation and light-coloured roofs and walls help minimize heat gain. Perth, with warm summers and mild winters benefit from the northern winter sun as well as sun protection and good cross-ventilation. Protected thermal mass and insulation are beneficial in all climates to help stabilize the internal house temperature. Table 2 provides a summary of general design considerations for the three project locations.

Table 2 Passive solar design considerations for Melbourne, Canberra, Townsville and Perth.

LOCATION	PASSIVE SOLAR DESIGN FEATURES
Melbourne and Canberra	North facing orientation of living area Shading in North and West in summer Minimization of air infiltration Cross ventilation in summer Double glazing Reduced glazing in South and West walls Zoning of different areas Insulation High internal thermal mass in Northern areas
Townsville	South facing orientation of living areas Shading in North, East and West windows Cross ventilation Low-e glazing Reduced glazing in North and West walls Light-coloured roof and walls Zoning of different areas Insulation
Perth	North facing orientation of living areas Shading in North, East and West in summer Cross ventilation in summer Low-e glazing Reduced glazing in South and West walls Light-coloured roof and walls Zoning of different areas Insulation High thermal mass in Northern areas

Melbourne NZEH Design Review Workshop.

Results

This section presents the details and outcomes of each case study and workshop, including an overview of the house plans, design and fit out modification options by scenario, and the subsequent energy modelling, the outcome of which informed the final design of each of the NZEH display homes.

Melbourne

Project partners

The project partners involved in the Melbourne NZEH design review case study included Parklea (developer), SJD Homes (builder), the South East Councils Climate Change Alliance (SECCCA) (representing local government), Sustainability Victoria (state government) and CSIRO. A total of six stakeholders representing the above partners were present at the workshop in addition to Curtin University/CRC LCL researchers.

House plan

The display home is in Parklea's Timbertop display village in the suburb of Officer, in South-East Melbourne.

The design was presented was for a 258 m^2 house and includes four bedrooms, two bathrooms, a lounge, an open plan kitchen/living/dining area and a garage in addition to an outdoor living space (Appendix 1). The kitchen/living/dining areas, the lounge, two of the bedrooms and the outdoor living space are facing North, while the remaining two bedrooms, bathroom and garage are oriented South.

Scenarios developed during the workshop

Three scenarios were discussed and agreed upon during the workshop (Table 4). Scenario 1 presents more cost-effective and achievable design modifications, while scenarios 2 and 3 are more costly or deemed more difficult to accomplish. Scenario 2 shows inclusions/modifications in addition to the ones shown in Scenario 1; and Scenario 3 shows inclusions/modifications in addition to the ones shown in Scenarios 1 and 2.

First pass cost estimations for Scenario 1 design modifications totalled AU$15,350 and included:

- AU$ 1,500 for double glazing;
- AU$ 4,000 for added insulation;
- AU$ 700 for the addition of sliding doors for zoning;
- AU$ 1,000 for additional thermal mass;
- AU$ 2,100 for draught sealing;
- AU$ 6,050 for energy efficient appliances.

It should be noted that these figures are estimates only and do not include the cost of the solar PV system or energy savings resulting from the design upgrades. Final costings and savings analysis is provided in a subsequent report by the authors.

Table 3 Design scenarios for Melbourne.

GLAZING	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Double glazing	Double glazing to all windows (Standard)	Add double glazing to all sliding doors (in addition to windows in BAU)		
Thermally broken windows	Thermally broken windows (standard)	Thermally broken to all sliding doors (in addition to windows in BAU)		

INSULATION	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Roof	R2.5 batts to ceiling	R6 roof batts to ceiling cavity		55mm foil board under Colorbond (additional

INSULATION	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
				insulation plus moisture management)
Walls	R2.5 batts to all external walls		Kingspan insulation for internal walls (acoustic and thermal control)	

BUILDING ENVELOPE	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Colours	Medium colour	Light coloured Colorbond - e.g. Surfmist		
Modifying window apertures		Remove entry corner window (East) and reduce size of two front windows <900mm wide Front door - switch from glass to a solid door Southern elevation (laundry) - solid door instead of glass sliding door + small window Northern windows - height change to 1200mm Master bedroom - remove window and keep sliding door		
Additional fixed shading structures		Retractable shading device fixed to the wall	Shading structure (pergola) above sliding door in the master bedroom with retractable/controllable shading device	
Switching walling types/fabric				Dividing wall between family and master bedroom - brick for thermal

BUILDING ENVELOPE	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
				mass/bulk insulation for acoustic control Internal sliding doors for controlled openings - lounge, passage and meals to rear passage
Floor cover	50mm slab coverage over waffle pods for slab Floating timber (family, meals and kitchen) Lounge and bedrooms – carpet	85mm slab coverage over waffle pods for slab Tiles (family, meals and kitchen) Lounge and bedrooms – carpet (standard)		100mm slab coverage over waffle pods for slab
Draught seal	Standard weather seals on doors and windows	Blower door test, thermal imagery and score card test		
Ventilation				Air lock front door; Air recovery system / constant energy air ventilation system

LIGHTING FANS	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Type & wattage	LED	LEDs (standard)		
Penetrations	Exhaust fans in bathroom and ensuite	No downlights		

APPLIANCES	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Fans	None	Ceiling fans in the bedrooms and living areas		

AC	Gas central heating; Split system in lounge, family and bedrooms	Split system reverse cycle AC in lounge and family area	5 Star ducted reverse cycle AC, with advanced zone control and dampeners	
HWS	Gas storage	Solar thermal with electric booster	Air source heat pump	
Stove/Oven	Standard electric stove and oven	Induction stove		
Water	WELS 3 star rated		WELS upgraded tapware (note only)	

Modelling results

The baseline design achieved a NatHERS rating of 6.5 Stars, requiring 70.2 MJ/m^2 per annum to achieve thermal comfort (mostly heating requirements). The total annual energy demand for this house considering a worst-case occupancy scenario (continuous full occupancy by four residents), is 12,448 kWh (Table 4).

Table 4 Preliminary scenario modelling in Melbourne.

SCENARIOS (all full occupancy)	HEATING (kWh/yr)	COOLING (kWh/yr)	HOT WATER (kWh/yr)	APPLIANCES (kWh/yr)	LIGHTING (kWh/yr)	TOTAL ELECTRICITY (kWh/yr)
BASELINE	4,184	120	4,184	3,814	146	12,448
SCENARIO 1	518	81	2,063	3,536	146	6,344
SCENARIO 2	838	98	1,503	3,814	146	6,399
SCENARIO 3	843	97	1,503	3,303	146	5,892

At the end of the workshop, Scenario 1 achieved a rating of 7.6 Stars, which can be considered a high performance house as compared to the current 6-Star NatHERS building standard (Eon and Byrne, 2017). From a building envelope design perspective, the addition of insulation to walls and ceiling made the most difference, improving energy efficiency by 6% (Figure 1) and increasing the NatHERS rating by 0.9 Stars.

The total annual energy demand is 6,344 kWh for this scenario, which is approximately half the demand of the BAU house (Table 4 and Figure 2). Other major energy reductions were achieved in the fields of water heating and ambient heating through the use of electric boosted solar hot water (28% energy reduction) and split systems (23% energy reduction) (Figure 1).

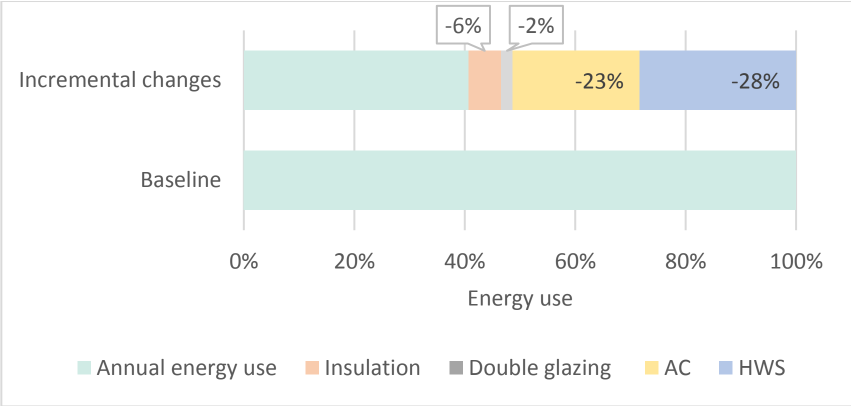


Figure 1 Impact of different design elements on energy efficiency (Melbourne).

Scenario 2 achieved a rating of 7.7 Stars, with a total annual energy demand of 6,399 kWh at full occupancy (Table 4). The addition of wall insulation slightly improved thermal comfort compared to Scenario 1, however, overall energy use for heating and cooling increased with the operation of a ducted reverse cycle air conditioner (Figure 3). Meanwhile, the implementation of a air sourced heat pump reduced hot water energy use by 560 kWh/year (Table 4).

Finally, Scenario 3 also achieved a NatHERS rating of 7.7 Stars, with an annual energy use of 5,892 kWh (Table 4). Despite the addition of air locks and zoned areas to improve the efficiency of internal heating and cooling systems, this did not greatly affect the model (Figure 3).

The range in total energy use between Scenarios 1, 2 and 3 was within 10% (Figure 2) and is therefore considered negligible. Hence, from a cost-effectiveness perspective, Scenario 1 provides the best steps to improve the overall house energy efficiency. Moreover, the inclusion of an air source heat pump for water heating rather than an electric boosted solar hot water system was also advised as the latter consumes significantly more energy over the year (Table 4).

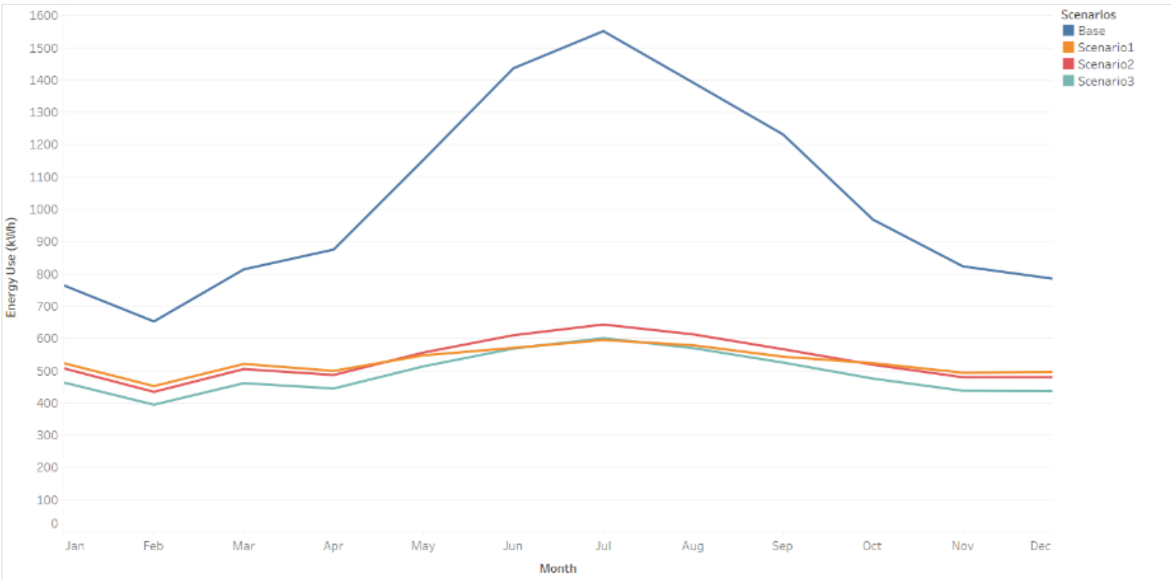


Figure 2 Monthly energy use for each scenario assuming that the house is fully occupied all day (Melbourne).

Figure 3 Modelled scenarios with the assumption that the house is fully occupied all day (Melbourne).

Remodelled results with energy efficient appliances and heat pump

The preliminary results presented above provided an indication as to which scenario would be the most cost effective for implementation. However, in order to design a NZEH, on-site renewable energy needs to be incorporated and sized appropriately for the house and related energy demand, which is largely influenced by appliances. Air conditioners and hot water systems represent respectively 40% and 21% of the total annual residential energy use (Milne et al., 2013) and also need to be adequately considered.

In order to more accurately predict annual energy demand and model a suitable PV system, all scenarios were remodelled taking into consideration detailed appliance specification provided by the builder once their selection had been finalized in the weeks following the workshop (Table 5). While the builder does not have control over most household appliances, the most energy intensive ones, such as air conditioners, hot water system, cooking equipment and dishwashers were included as part of the house building package. A more typical occupancy scenario was also considered in addition to the worst-case scenario. Typical occupancy assumed that the house is unoccupied during business hours, when residents are at work or school (9am to 5pm Monday to Friday).

Table 5 Selected appliances for Melbourne.

APPLIANCE	TYPE	EFFICIENCY COMPARED TO BASELINE
Air conditioner	Multi-split reverse cycle air conditioner	18%
Hot water	Heat pump	40%
Dishwasher	-	60%
Cooktop	Induction	50%

Energy efficient appliances alone reduced annual electricity demand by 17% (Table 6). This improvement was mostly due to the hot water heat pump, which is 40% more efficient than the system originally modelled by the AusZEH software (Table 5).

When keeping the appliances constant for all three scenarios (as per Table 5), the difference between them is negligible (Table 6), which reaffirms the choice of Scenario 1 as the most cost-effective in terms of building envelope design.

Table 6 Scenario modelling with energy efficient appliances and hot water in Melbourne.

SCENARIOS	OCCUPANCY	HEATING (kWh/yr)	COOLING (kWh/yr)	HOT WATER (kWh/yr)	APPLIANCES (kWh/yr)	LIGHTING (kWh/yr)	TOTAL ELECTRICITY (kWh/yr)
SCENARIO 1	Full occupancy	670	92	1141	3360	146	5409
	Unoccupied from 9am to 5pm	609	54	1141	3066	146	5016
SCENARIO 2	Full occupancy	681	80	1141	3360	146	5408
	Unoccupied from 9am to 5pm	617	48	1141	3066	146	5018
SCENARIO 3	Full occupancy	693	77	1141	3360	148	5419

SCENARIOS	OCCUPANCY	HEATING (kWh/yr)	COOLING (kWh/yr)	HOT WATER (kWh/yr)	APPLIANCES (kWh/yr)	LIGHTING (kWh/yr)	TOTAL ELECTRICITY (kWh/yr)
	Unoccupied from 9am to 5pm	626	47	1141	3066	148	5028

PV system

Accordingly, three PV system sizes (3, 5 and 8 kW) were modelled in conjunction with Scenario 1 and energy efficient appliances. For the worst-case occupancy scenario, a 5kW PV system is sufficient to cover the annual electricity demand of a family of 4 (Figure 4). The system produces 20% more electricity than required, making the dwelling not only a NZEH, but net energy positive.

However, the worst-case occupancy scenario is very unlikely to occur. For a more typical occupancy, the model shows that a 5kW PV system is oversized and that a 4kW PV system is sufficient to achieve net zero energy (Figure 5). The 4kW PV system would still generate 4% excess electricity that would feed back into the grid.

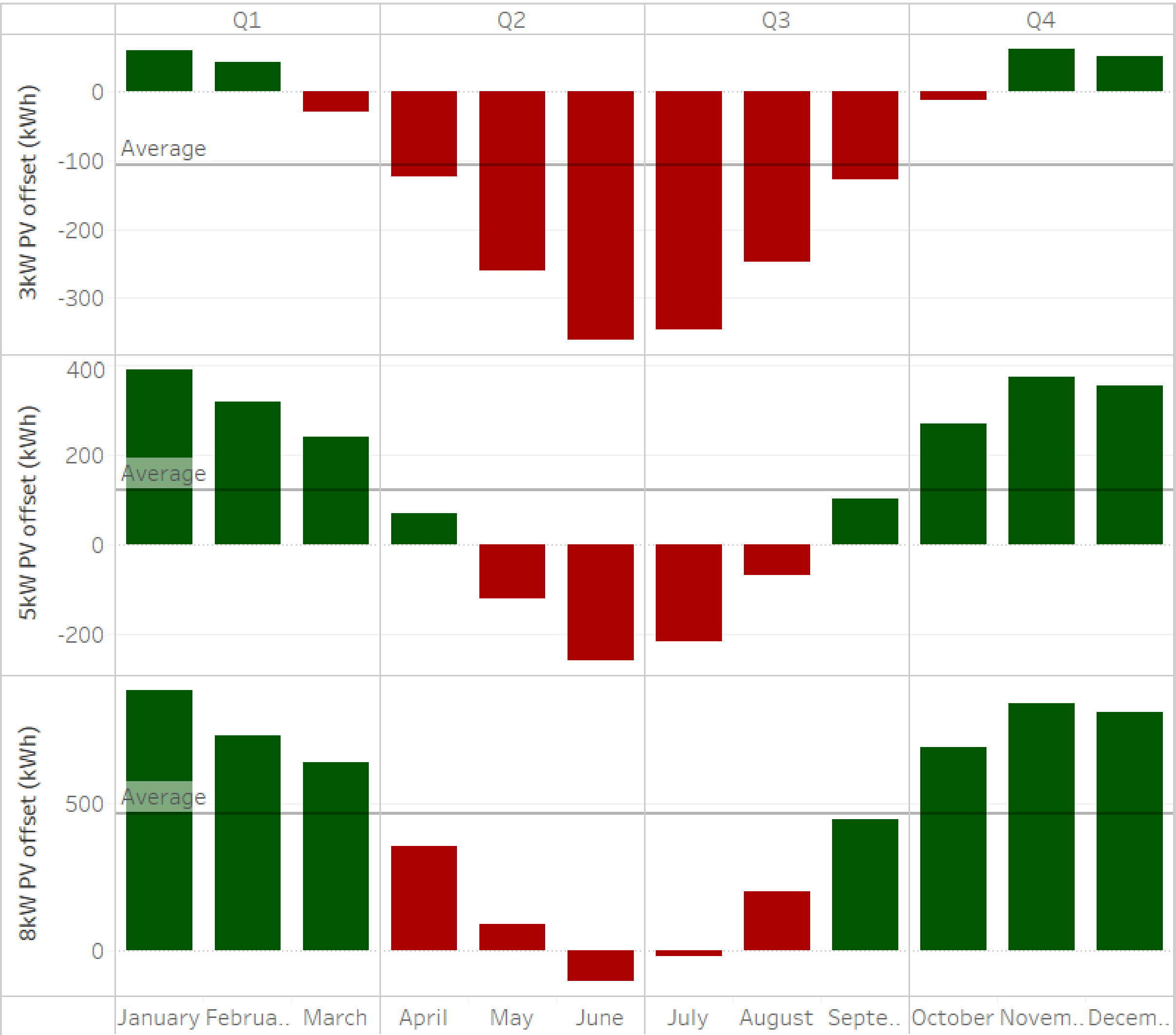


Figure 3 3 kW, 5 kW and 8 kW PV offsets assuming a worst-case occupancy scenario.

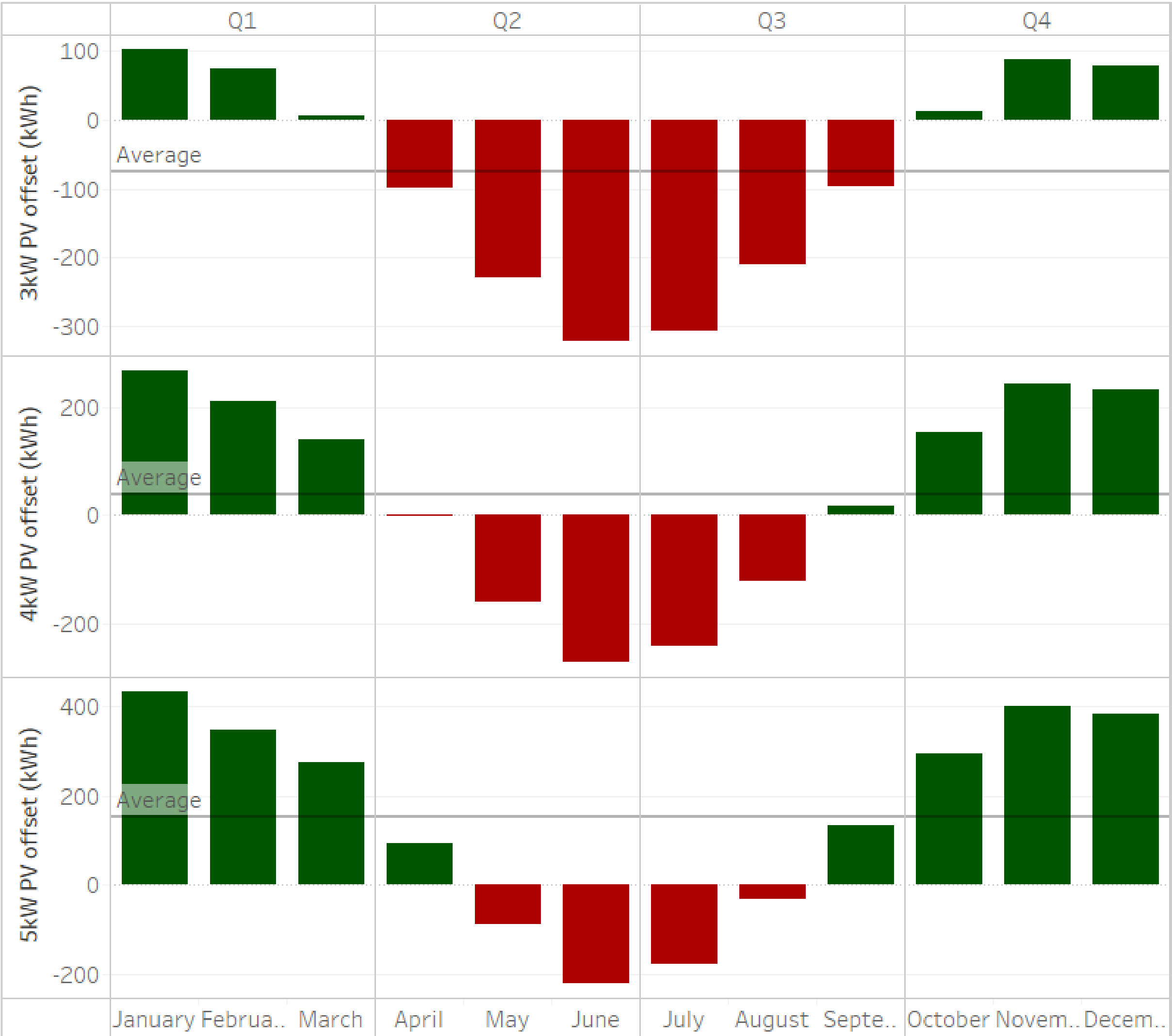


Figure 4 3 kW, 4 kW and 5 kW PV offsets assuming a typical occupancy scenario.

The Victorian Residential Efficiency Scorecard

The energy rating of the chosen Scenario 1 was 10 Stars on the Victorian Residential Efficiency Scorecard. The ratings vary between zero and ten, where ten is 'very energy efficient'. This house scored highly in terms of the building shell, heating system, hot water system and lighting. The only recommendation was to upgrade the cooling system. Cooling in Victoria, however, represents only a small proportion of the house energy use and does not largely impact on the rating.

The scorecard confirms the results obtained through the energy modelling process. This provides high confidence in both the outcomes of the workshop and the new Victorian rating system, which is planned for implementation across the state.

Townsville

Project partners

The project partners in the Townsville NZEH design review case study included Stockland (developer), Innovation House (builder), Jazz Design (designer) and CSIRO. A total of six stakeholders representing the above partners were present at the workshop in addition to Curtin University/CRC LCL researchers.

House plan

The display home is located at the Barramundi Circuit display village at Stockland's North Shore development in Burdell and will initially serve both as a sales office, in addition to a display house. For the purpose of the modelling, however, it was assumed that the building operates as a house.

The home is 239 m^2 and has three bedrooms, two bathrooms, a home theatre, an open plan kitchen/living/dining area and a garage in addition to an alfresco (Appendix 2). The living areas and two of the bedrooms are facing north, while the alfresco, the third bedroom and bathroom have south orientation.

Scenarios developed during the workshop

Three scenarios were discussed and agreed upon during the workshop (Table 7). Scenario 1 presents more cost-effective and achievable design modifications, while scenarios 2 and 3 are more costly or deemed more difficult to accomplish. Scenario 2 shows inclusions/modifications on top of Scenario 1 and Scenario 3 shows inclusions/modifications on top of Scenarios 1 and 2.

First pass cost estimations for Scenario 1 modifications totalled AU $17,800 in addition to a solar PV system and included:

- AU$ 4,300 for improved glazing and louvres;
- AU$ 3,500 for added insulation;
- AU$ 5,000 for energy efficient appliances;
- AU$ 5,000 for high efficiency air conditioning.

It should be noted that these figures are estimates only and do not include the cost of the solar PV system or energy savings resulting from the design upgrades. Final costings and savings analysis is provided in a subsequent report by the authors.

Table 7 Design scenarios for Townsville.

GLAZING	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Low E	None – Standard single glazed	Low-e all windows		
Thermally broken windows	None		Thermally broken window to key windows (as shown on plan)	
Timber louvres for 100% block		Timber or glass louvres (as shown on plan)		

INSULATION	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Ceiling	R2.5 Batts	R4		
Roof	No insulation	Anticon and solar ventilation		
Walls	Foil only	2.5 batts (key walls)	Insulate entry gallery and board room (internal walls to the carport)	

BUILDING ENVELOPE	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Colours	Medium colours	Light coloured walls		Reflective paint

BUILDING ENVELOPE	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Modifying window apertures		Case by case	Inclusion of highlight windows in living area (as shown on plan)	
Additional fixed shading structures			Shading	
Switching walling types/fabric			Isolate kitchen and living area with cavity slide (as shown on plan)	New wall with high thermal mass in kitchen/living room (as shown on plan)

LIGHTING & EXTRACTION FANS	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Type & wattage	CFL	LED lighting - larger format, motion sensor, dimmable		

APPLIANCES	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Fans	1200 (diameter)	1400 (diameter)		
AC	Split systems COP 2.8	Split systems COP 4		
HWS	Standard heat pump	Evacuated tube solar hot water system		
Stove/Oven	Standard electric stove and oven	Induction stove and insulated oven		
Fridge (latent heat)		Fridge ventilation (extraction fan)		
Standby	None	General switch for all ACs		
General		High star rated dishwashers/washing machine		

PV & BATTERIES	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
PV system size and location on roof		Panels on West and East for production all day long		

Modelling results

The baseline design achieved a NatHERS rating of 4.4 Stars (noting that this is below the NCC minimum compliance of 6 Stars), using 168.9 MJ/m^2 per annum for thermal conditioning (cooling requirements only), and a total annual energy demand of 6,339 kWh considering that the house is continuously occupied by four residents (worst case scenario) (Table 8).

Table 8 Preliminary scenario modelling in Townsville.

SCENARIOS	COOLING (kWh/yr)	HOT WATER (kWh/yr)	APPLIANCES (kWh/yr)	LIGHTING (kWh/yr)	TOTAL ELECTRICITY (kWh/yr)
BASELINE	2,076	820	3,263	131	6,339
SCENARIO 1 (full occupancy)	1,008	820	3,263	131	5,221
SCENARIO 2 (full occupancy)	1,036	820	3,263	131	5,249
SCENARIO 2A (without highlight window) (full occupancy)	1,013	820	3,263	131	5,226
SCENARIO 3A (without highlight window) (full occupancy)	875	820	3,263	131	5,088

By the end of the workshop and modelling session, the rating was increased to 6.3 Stars with adoption of the 'glazing', 'insulation' and other 'building envelope' modifications described in Scenario 1 (Table 7). Most of the improvement in thermal efficiency (9%) was due to the addition of insulation to the ceiling and walls (Figure 6). The installation of low-e glazing improved thermal efficiency by 6% (Figure 6). Contrary to Melbourne, the builders in Townsville only provided a general indication of the energy efficient appliances to be installed. For the purpose of the preliminary model, appliances (including AC and HWS) were therefore disregarded. The total annual energy demand at full occupancy is 5,221 kWh for Scenario 1 (Table 8) and the thermal energy demand is 30% lower than BAU (Figure 7).

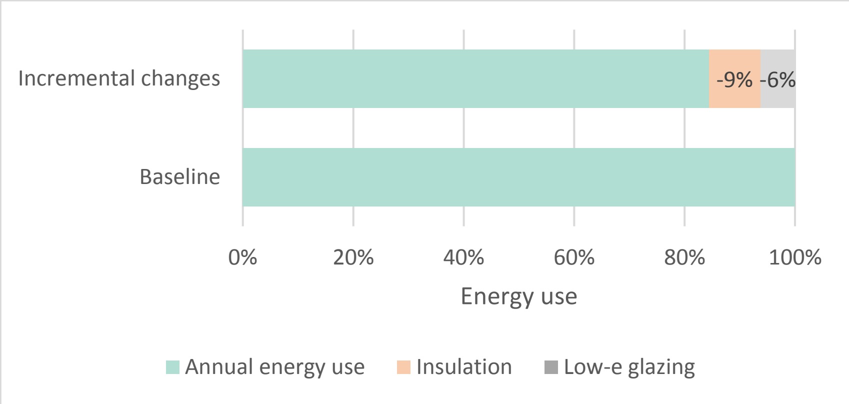


Figure 5 Impact of different design elements on energy efficiency (Townsville).

Scenario 2 achieved a rating of 6.9 Stars, with a total annual energy demand of 5,249 kWh (full occupancy) (Table 8). Despite further upgrades in insulation and glazing, which slightly improved thermal performance, overall energy demand was found to be unexpectedly higher than Scenario 1. An alternative Scenario 2A was modelled without the inclusion of a highlight window in the living area. This version achieved a higher rating of 7 Stars and lower annual energy (Table 8). This indicates that the inclusion of the highlight window was unnecessary, and the benefits of additional cross-ventilation are outweighed by the extra heat gain from the additional glazing, as opposed to an insulated wall.

Following from these findings, Scenario 3 was modelled without the inclusion of the highlight window (Scenario 3A) and achieved a rating of 7.1 Stars and an annual energy demand of 5,088 kWh for a full occupancy scenario (Table 8).

The difference in energy use between Scenarios 1, 2A and 3A (considering building envelope, glazing and insulation only) is less than 3%, which is insignificant compared to additional costs. Scenario 1 was therefore considered the most cost-effective to improve the overall house energy efficiency. The latter can be further reduced with the inclusion of energy efficient appliances, which was remodelled after builder selection.

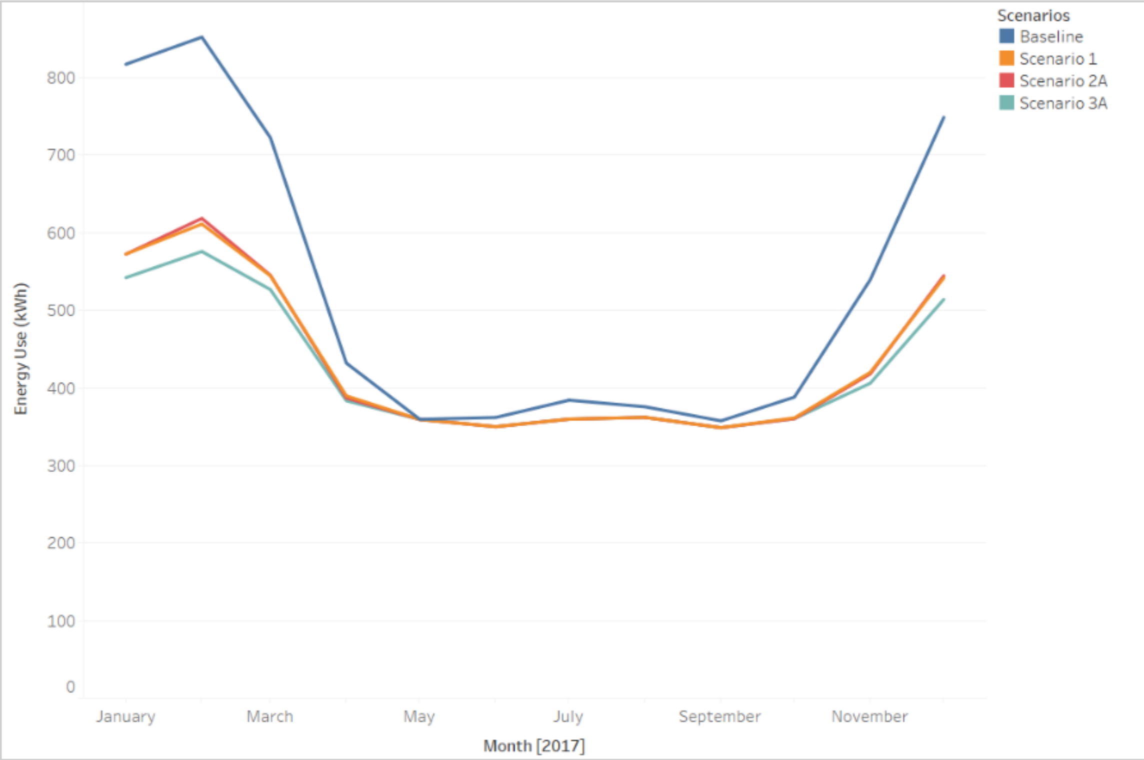


Figure 6 Monthly energy use for each scenario assuming that the house is fully occupied all day (Townsville).

Remodelled results with energy efficient appliances

Scenario 1 was remodelled with the builder specified energy efficient appliances in order to accurately predict annual energy demand and determine an adequate PV system to achieve a NZEH status. The cooktop and hot water system are respectively 50% and 90% more efficient compared to the baseline options that was initially modelled by AusZEH (Table 9). The air conditioner efficiency was estimated at 60% compared to BAU based on a coefficient of performance (COP) of 4, which is a typical value for top of the range air conditioners in the Australian market.

Table 9 Selected appliances for Townsville.

APPLIANCE	TYPE	EFFICIENCY COMPARED TO BAU
Air conditioner	Thermosphere	60%
Hot water	Evacuated Tube	90%
Cooktop	Induction	50%

As for Melbourne, a more typical occupancy scenario was considered in addition to the worst-case scenario. Typical occupancy assumed that the house is unoccupied during business hours, when residents are at work or school (9am to 5pm Monday to Friday).

Energy efficient appliances and hot water system reduced annual energy demand by 21% (Table 10 and Figure 7), mostly due to the inclusion of an evacuated tube hot water technology, which uses solar thermal energy and incurs minimal losses. This technology is around 90% more efficient than the typical system originally modelled by the AusZEH software (Table 9).

Table 10 Modelling of Scenario 1 with energy efficient appliances and hot water in Townsville.

OCCUPANCY	COOLING (kWh/yr)	HOT WATER (kWh/yr)	APPLIANCES (kWh/yr)	LIGHTING (kWh/yr)	TOTAL ELECTRICITY (kWh/yr)
Full occupancy	847	88	3098	131	4,114
Unoccupied from 9am to 5pm	497	88	2837	131	3,506

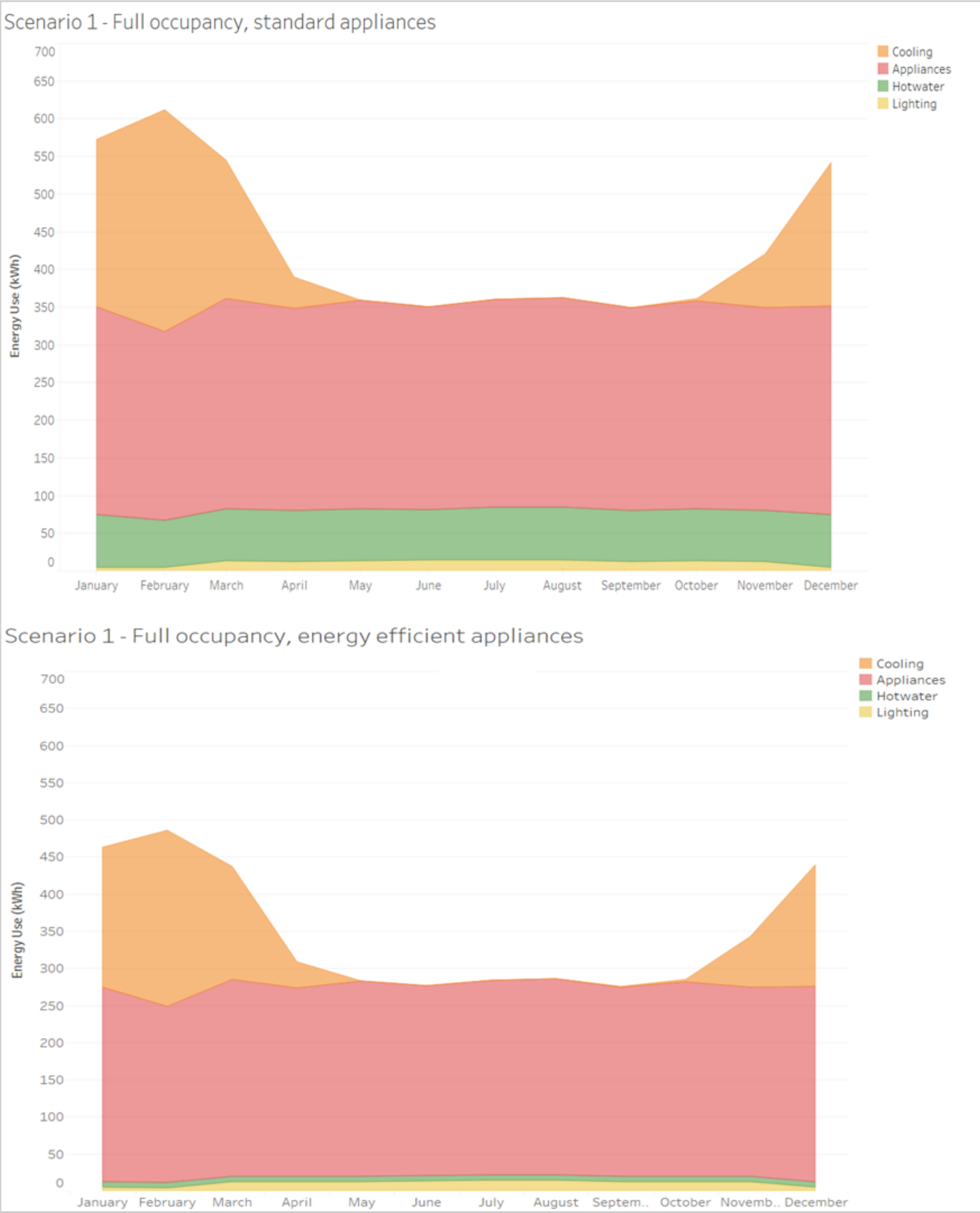


Figure 7 Comparison of scenario 1 modelled at full occupancy with and without energy efficient appliances.

PV system

Three PV system sizes (3, 5 and 8 kW) were modelled in conjunction with Scenario 1 with updated appliances. For both the worst-case scenario and the typical occupancy scenario a 3kW PV system is necessary to cover the annual energy demand of a family of four people. Under typical occupancies, the 3kW system produces on average an excess of 120 kWh/month (Figure 7), which could be stored in a battery or exported to the grid. A 2kW system was modelled as an alternative, however, with an average production of -20 kWh/month, it is not sufficient to enable the house to become zero energy (Figure 8). The deficit of electricity generation occurs mostly in summer, due to the high cooling demands

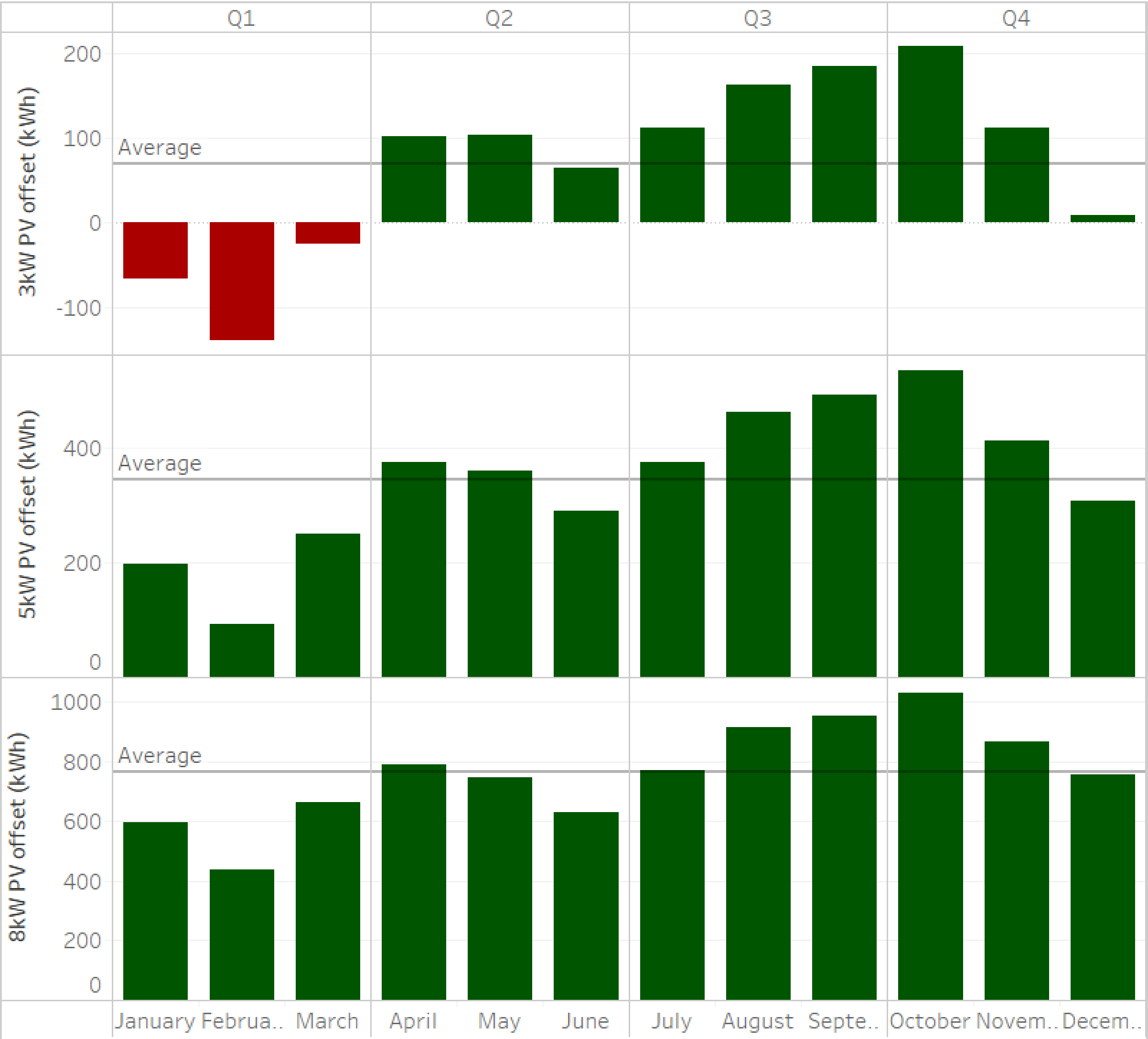


Figure 8 3 kW, 5 kW and 8 kW PV offsets assuming a worst-case occupancy scenario.

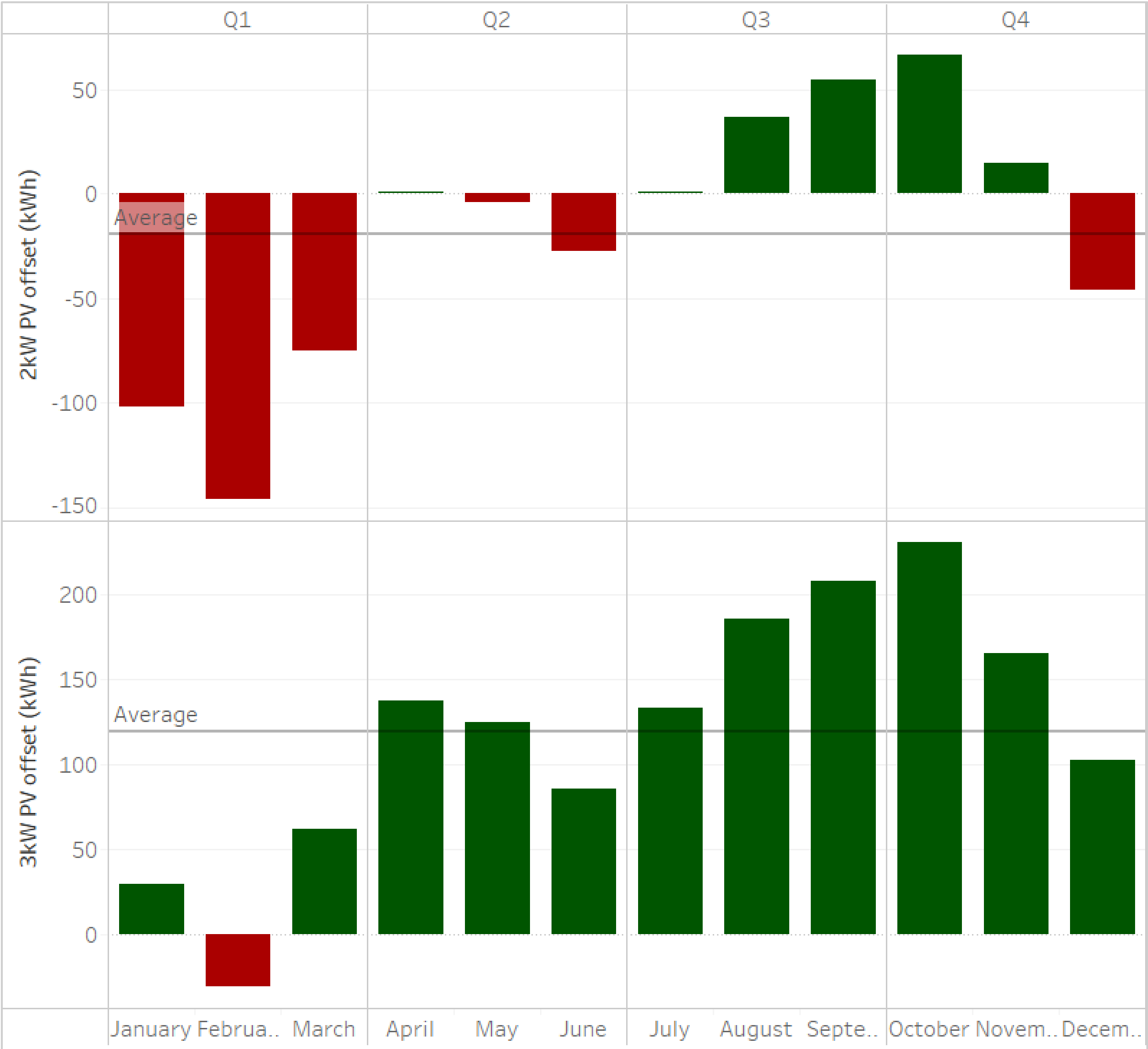


Figure 9 2 kW and 3 kW PV offsets assuming a typical occupancy scenario.

Canberra

Project partners

The project partners involved in the Canberra NZEH design review case study included Riverview Projects (developer), Rawson Homes (builder) and CSIRO. A total of five stakeholders representing the above partners were present at the workshop in addition to Curtin University/CRC LCL researchers.

House plan

The display home will be built in the first stage of the Ginninderry community, in the new suburb of Strathnairn, in Canberra.

The proposed house is 239 m^2 and includes four bedrooms, two bathrooms, a lounge, a laundry, an open plan kitchen/living/dining area and a garage in addition to an outdoor living space (Appendix 3). The kitchen/living/dining areas, laundry, the garage and the alfresco are facing North. The lounge, four bedrooms and two bathrooms are oriented South.

Scenarios developed during the workshop

Three alternative design scenarios were agreed upon as improvements in relation to the baseline design (Table 11). Scenario 1 consists of the adoption of Ginninderry Stage 1 Display Village Guidelines, such as the inclusion of double glazing in all windows, induction cooktop, heat pump hot water system and energy efficient reverse cycle air conditioner. The Ginninderry guidelines also require all display houses to meet a minimum of 7 Stars.

Scenario 2 includes additional minor design changes with the potential of improving energy efficiency, in addition to those required under the

Ginninderry Stage 1 Display Village Guidelines. These include the addition of thermally broken windows, additional window sealing and air leakage testing, and the installation of Anticon as additional roof insulation. Finally, the third scenario includes more challenging and/or costly modifications, such as changing the walling type.

First pass retail cost estimations for Scenario 1 modifications (Table 2) totalled AU$ 26,310 and included:

- AU$ 20,000 for double glazing of all windows;
- AU$ 1,810 for additional ceiling and wall insulation;
- AU$ 4,500 for energy efficiency appliances, including HWS, cooktop and AC upgrade.

It should be noted that these figures are estimates only and do not include the cost of the solar PV system or energy savings resulting from the design upgrades. Final costings and savings analysis is provided in a subsequent report by the authors.

Table 11 Design scenarios for Canberra.

GLAZING	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Double glazing	Single glazing (standard)	Double glazing for all windows and sliding doors No double glazing on laundry door		
Thermally broken windows			Thermally broken windows	

BUILDING ENVELOPE	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Modifying window apertures		Increased glazing apertures in living area - northern windows Additional windows on alfresco		
Switching walling types/fabric				Rendered polystyrene
Floor cover	Carpet in bedrooms and tiles in living area and wet areas			
Draught seal	Dampers on vents Window framing - nil		Additional window sealing Verification testing	
Ventilation			Operable windows on Northern elevations (both levels)	

INSULATION	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Ceiling	R3.5	R5		
Roof	Sarking		Anticon R1.3 (60mm)	
Walls	R2	R2.5		

APPLIANCES	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
AC	Ducted split system - bedrooms and living area (3 COP)	3.5 COP		
HWS	Gas instantaneous	Heat pump (cold climate suitable)		
Stove/Oven	Gas cooktop	Induction cooktop		

Modelling results

The baseline scenario has a NatHERS rating of 6.2 Stars, requiring 156 MJ/m^2 per annum to achieve thermal comfort (mostly heating requirements). The total annual energy demand for this house is 10,875 kWh considering that the house is continuously occupied by four residents (worst case scenario) (Table 12).

Scenario 1 achieved a rating of 6.5 Stars. The total annual energy demand is 6,504 kWh for this scenario if the house is fully occupied (Table 12 and Figure 12). Major energy reductions were achieved in the field of water heating using a heat pump (35%) (Figures 11 and 12). Bulk insulation reduced annual energy use by 7% and double glazing contributed a reduction of 4% (Figure 11), positively affecting heating demand.

On the other hand, larger windows on the Northern elevation slightly increased both heating and cooling loads. It should be noted that this design feature was considered by the builder to be valuable for the additional natural light it provides to the main living area of the house, and it was understood that there may be a trade-off between energy efficiency and other comfort/quality factors.

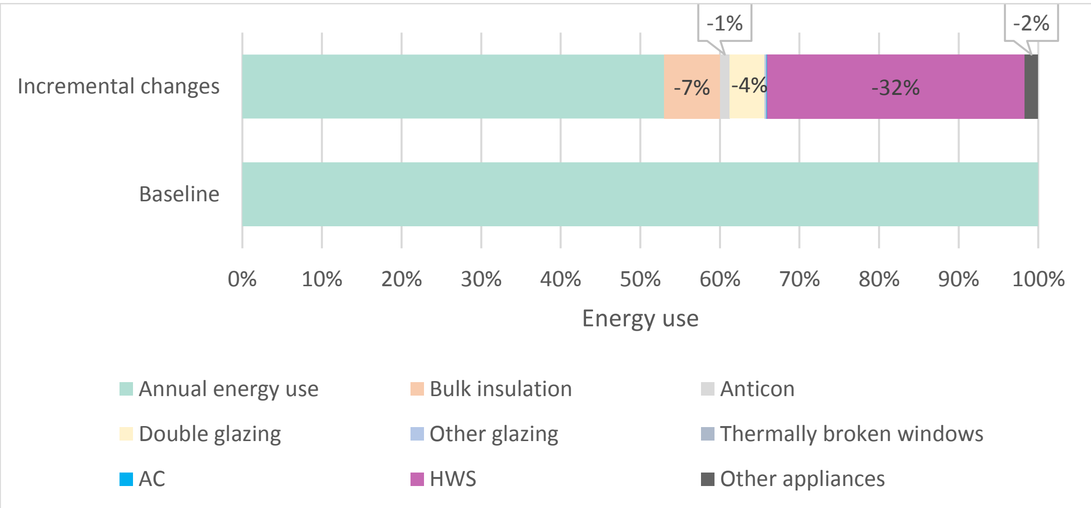


Figure 10 Impact of different design elements on energy efficiency (Canberra).

Since energy efficient appliances were specified as part of the Ginninderry guidelines, they were defined by the builders from the project onset and formed part of the preliminary discussions and energy models (Table 13). Energy efficient appliances, including induction cooktop, reduced annual energy use by a further 2% (Figure 11).

Scenario 2 as described in Table 10 achieved a rating of 7.2 Stars, with a total annual energy demand of 5,905 kWh in a full occupancy scenario (Table 12 and Figure 12). The addition of Anticon and thermally broken windows further decreased energy demand by 1% (Figure 11).

Scenario 3 was almost identical to scenario 2, with only a negligible improvement of 0.5MJ/m^2 per year, which resulted in the same NatHERS rating. This scenario was therefore excluded from further analysis.

Table 12 Scenario modelling in Canberra.

SCENARIOS	HOT WATER (kWh/yr)	HEATING (kWh/yr)	APPLIANCES (kWh/yr)	LIGHTING (kWh/yr)	COOLING (kWh/yr)	TOTAL ENERGY (kWh/yr)
BASELINE	5,282	1,735	3,563	140	155	10,875
SCENARIO 1 (full occupancy)	1,440	1,428	3,169	140	327	6,504
SCENARIO 2 (full occupancy)	1,440	1,001	3,169	140	156	5,905
SCENARIO 1 (unoccupied during business hours)	1,440	1,215	2,903	140	167	5,864
SCENARIO 2 (unoccupied during business hours)	1,440	813	2,903	140	83	5,378

Table 13 Selected appliances for Canberra.

APPLIANCE	TYPE	EFFICIENCY COMPARED TO BAU
Hot water	Heat pump	70%
Cooktop	Induction	50%

Scenario 1, did not achieve the required 7 Stars to meet the Ginninderry Stage 1 display village guidelines, and whilst Scenario 2 did, partially due to the inclusion of thermally broken window, the expected costs of this addition was seen as unattractive by the builders. Further alternatives to the thermally broken window initially suggested in Scenario 2 were therefore tested in combination with Scenario 1 (Table 14). These included:

1) Reduced glazing sizes (as for the baseline scenario) with high gain low-e glazing;
2) High gain low-e glazing to the windows in the north and east walls; thermally broken windows in the living area only; and elimination of a clerestory;
3) High gain low-e glazing throughout and thermally broken windows in the living area and lounge.

Permutation 1, however, affects aesthetics, natural light, and ultimately reduces occupant comfort given the considerable reduction in glazing area. Permutation 2 poses a similar issue as the clerestory window is removed. Finally, permutation 3 enables the glazing size to remain unchanged with the inclusion of thermally broken windows to the living area and lounge room. This is a similar solution to Scenario 2, resulting in a similar annual energy demand; the main difference being that the inclusion of thermally broken windows in alternative 3 is limited to key areas, requiring a lower investment.

Table 14 Scenario 1 permutations and respective impacts on the NatHERS Star rating.

PERMUTATIONS	NatHERS STAR RATING
1	7.1
2	7.1
3	7

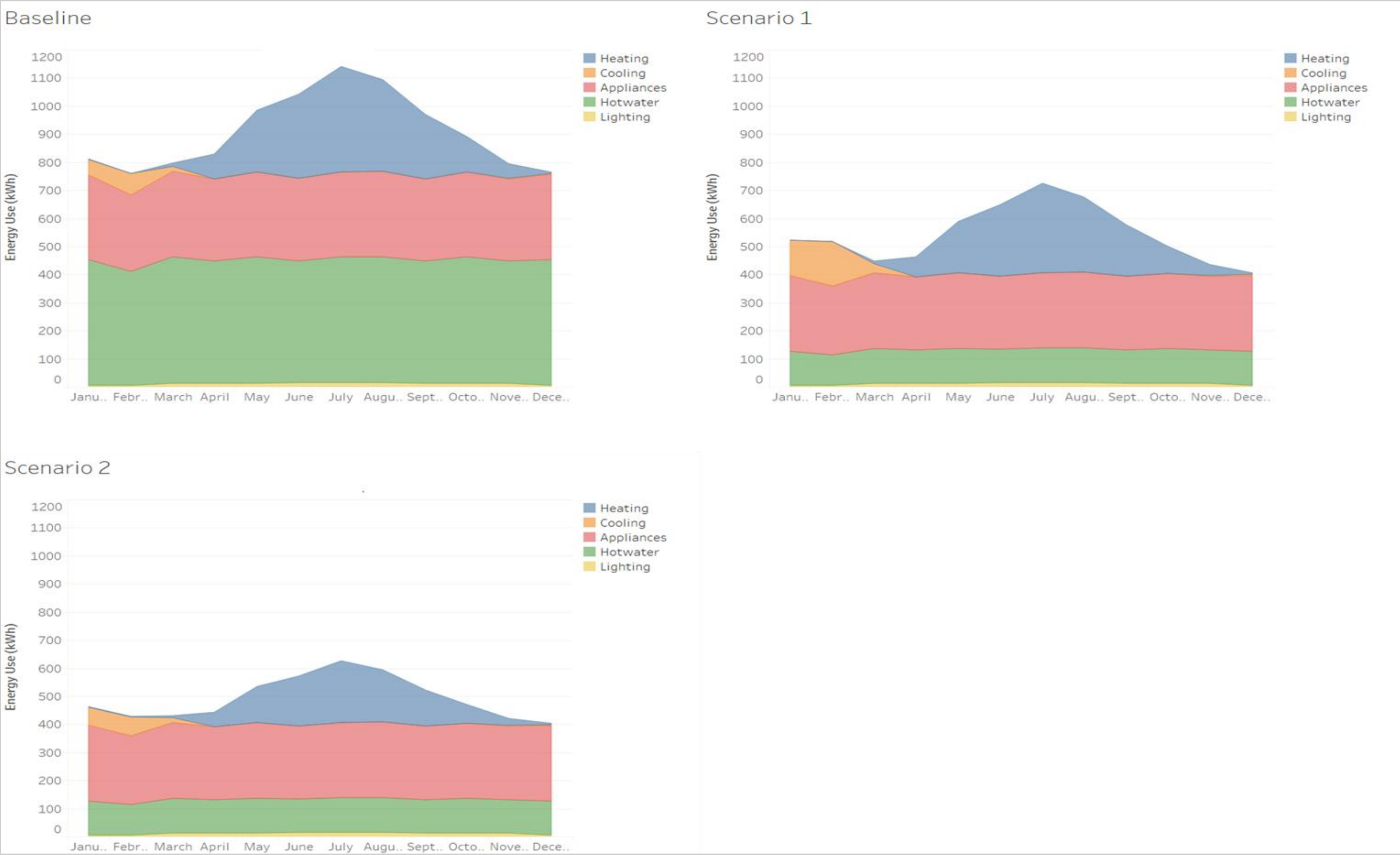


Figure 11 Comparison of scenario 1 modelled at full occupancy with and without energy efficient appliances.

It was therefore recommended that Scenario 1 be chosen with inclusion of low-e windows and thermally broken windows to the living area and lounge for the achievement of the 7 Star rating requirement without compromising occupant comfort.

PV system

Different PV system sizes (3, 4 and 5kW) were modelled to match net energy production with the net demand for design Scenarios 1 (permutation 3) under full time occupancy (worst case) and outside of school/work hours (realistic) for a four-person family.

Under the worst-case occupancy scenario, a 5kW PV system is necessary to achieve a status of net zero energy (Figures 13).

Under the more realistic occupancy scenario, the installation of a 4kW PV system is sufficient to achieve net zero energy for (Figures 15) provided that appliances are installed as specified or have a higher energy efficiency rating.

Figure 12 3 kW, 4 kW and 5 kW PV offsets assuming a worst occupancy scenario for Scenario 1, permutation 3.

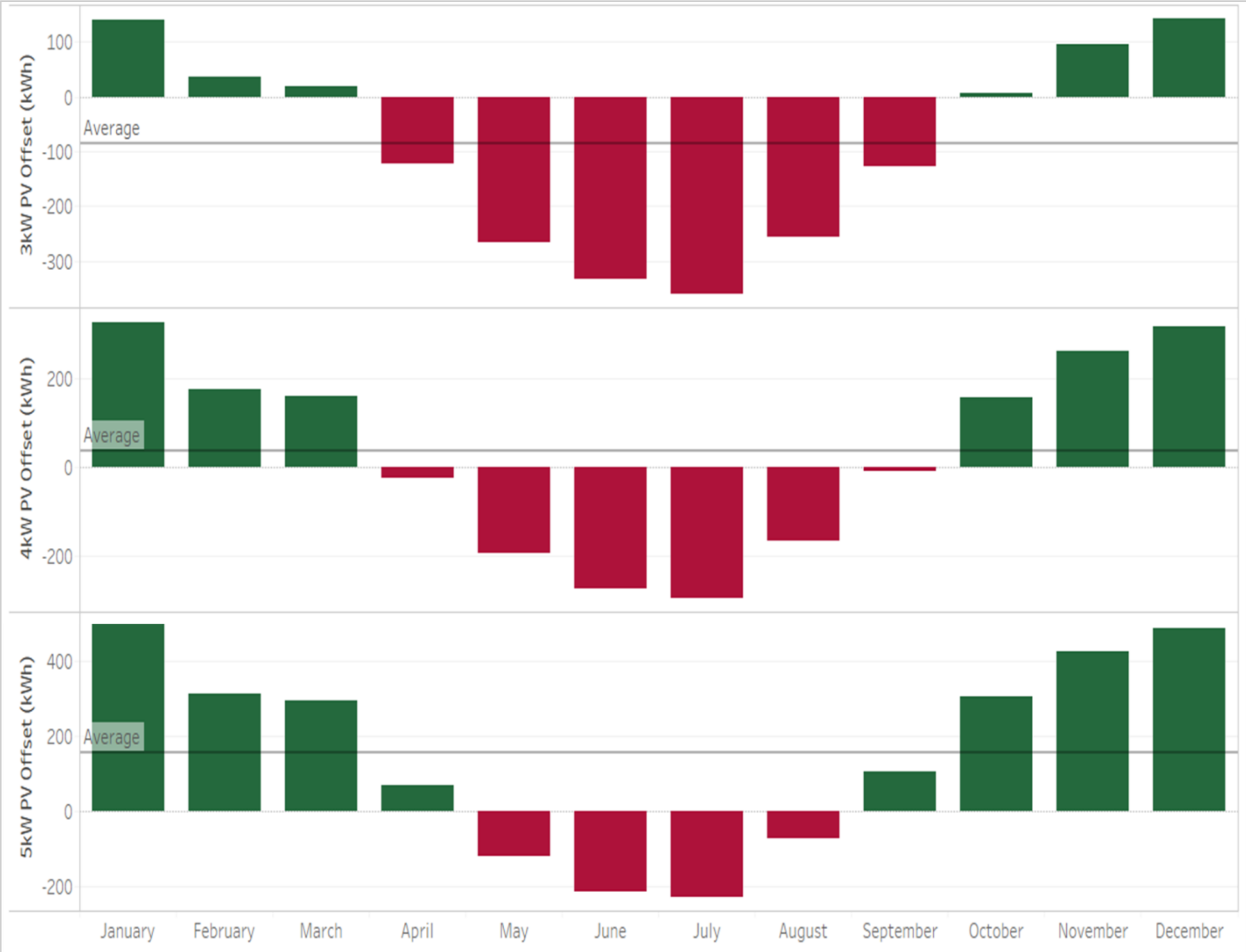


Figure 13 3 kW, 4 kW and 5 kW PV offsets assuming a typical occupancy scenario for Scenario 1, permutation 3.

Perth

Project partners

The project partners involved in the Perth NZEH design review case study included Mirvac (developer), Terrace (builder) and CSIRO. A total of six stakeholders representing the above partners were present at the workshop in addition to Curtin University/CRC LCL researchers.

House plan

The home will be built at the Iluma Private Estate, in the suburb of Bennett Springs, in Perth.

The proposed dwelling is a terraced two-storey, 175 m^2 house. It includes three bedrooms, two bathrooms, a lounge, a laundry, an open plan kitchen/living/dining area and a garage in addition to an outdoor living space and a balcony (Appendix 4). The kitchen/living/dining areas, master suite, ensuite and balcony are located on the second floor; the living, dining area and balcony being oriented North. The laundry, bathroom, two bedrooms and lounge are on the first floor; one of the bedrooms facing North.

Scenarios developed during the workshop

Three scenarios were agreed upon during the workshop (Table 15). Scenario 1 consists of relatively easy and more cost-effective changes, such as changing roof colour, adding insulation and incorporation Low-E glazing. The other two scenarios require further design changes, such as upgrading air conditioning and the addition of double glazing.

First pass cost estimations for Scenario 1 modifications (Table 15) totalled AU$ 22,654 and included:

- AU$ 7,216 to modify window type and add security screens to all ground level windows and doors and balcony, for improved cross ventilation and safety;
- AU$ 1,732 to supply Low E glazing to balcony sliding door and adjacent windows;
- AU$ 2,280 to add Anticon and cavity insulation throughout;
- AU$ 1,185 for ceiling fans in bedrooms;
- AU$ 4,945 for a split system AC;
- AU$ 2,050 for a heat pump hot water system;
- AU$ 1,646 for an induction stove;
- AU$ 1,180 for the installation of LEDs lighting;
- AU$ 1,395 for a kill switch, to turn off appliances on standby;
- AU$ 975 cost savings from removal of gas connection.

It should be noted that these figures are estimates only and do not include the cost of the solar PV system or energy savings resulting from the design upgrades. Final costings and savings analysis is provided in a subsequent report by the authors.

Table 15 Design scenarios for Perth.

GLAZING	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Low E		Upper level balcony glazing		
Double glazing				Double glazing balcony window

BUILDING ENVELOPE	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Colours		Light coloured roofs and external walls		
Ventilation		Sliding windows throughout (security screens on ground level) Security screen on balcony sliding door		

INSULATION	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Roof		Anticon R1.5		
Walls	Permicav on bottom floor only	Permicav on all external walls (top and bottom)		

APPLIANCES	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Fans	No fans	Ceiling fans in 3 bedrooms		
AC	Ducted AC	Split AC in living area/dining room - location TBA	Add second split in lounge/theatre	
HWS	Gas instantaneous	Heat pump		
Stove/Oven	Gas cooktop	Induction - upgrade to 3 phase		

Standby		Kill switch (non-essentials)		
General	Gas connection	Remove gas connection		

LIGHTING	BASELINE	SCENARIO 1	SCENARIO 2	SCENARIO 3
Type & wattage	Compact fluorescent	LEDs - basic	LEDs - display quality	

Modelling results

The baseline design achieved a NatHERS rating of 7.9 Stars requiring 35.5 MJ/m^2 per annum to achieve thermal comfort (24.9 MJ/ m^2 for cooling and 10.6 MJ/m^2 for heating). The total annual energy demand for this house is 9,570 kWh considering that the house is continuously occupied by four residents (worst case scenario) (Table 16).

The rating increased to 8.4 Stars with adoption of modifications described in Scenario 1. The total annual energy demand is 5,216 kWh for this scenario, considering full occupancy (Table 14). From a building design perspective, the use of low-e glazing made the most difference to the house energy rating (5% energy savings). Other major energy reductions as compared to the baseline scenario were achieved in the fields of water heating (37% savings) and ambient heating and cooling (4% savings), respectively through the use of a heat pump rather than an instantaneous gas heater for water heating; and through the use of fans and a split systems for thermal control instead of the ducted AC, which has lower efficiency (Figures 15 and 16).

Affordable energy efficient appliances were specified early on and formed part of the preliminary discussions and energy models (Table 17). These appliances, which included an induction cooktop as well as energy efficient dishwasher, fridge, washing machine and dryer, reduced annual energy use by a further 4% (Figure 15).

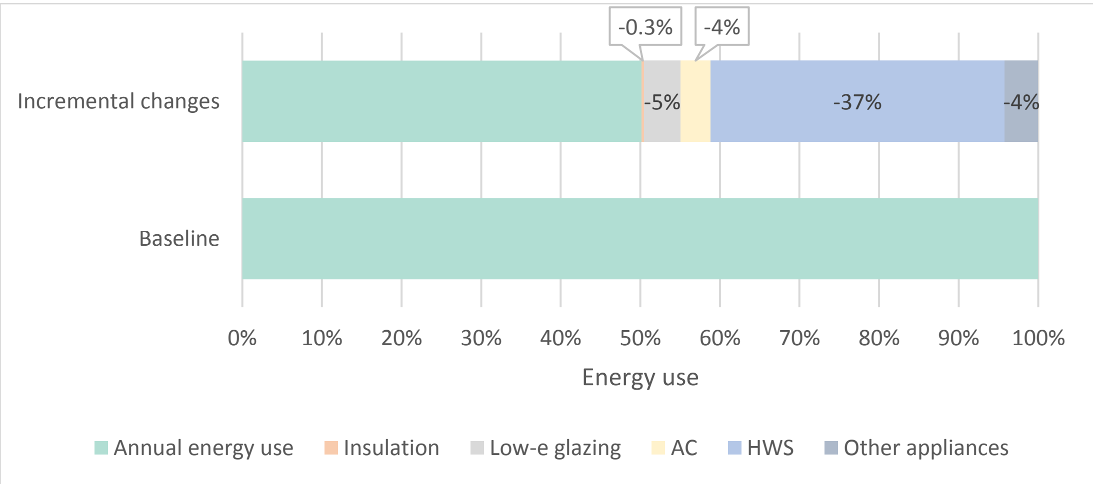


Figure 14 Impact of different design elements on energy efficiency (Perth).

Table 16 Scenario modelling in Perth.

SCENARIOS	HOT WATER (kWh/yr)	HEATING (kWh/yr)	APPLIANCES (kWh/yr)	LIGHTING (kWh/yr)	COOLING (kWh/yr)	TOTAL ENERGY (kWh/yr)
BASELINE (full occupancy)	5,282	105	3,860	92	232	9,570

SCENARIOS	HOT WATER (kWh/yr)	HEATING (kWh/yr)	APPLIANCES (kWh/yr)	LIGHTING (kWh/yr)	COOLING (kWh/yr)	TOTAL ENERGY (kWh/yr)
SCENARIO 1 (full occupancy)	1,440	82	3,466	81	148	5,216
SCENARIO 3 (full occupancy)	1,440	70	3,466	81	140	5,197
SCENARIO 1 (unoccupied during business hours)	1,440	72	3,207	81	111	4,911

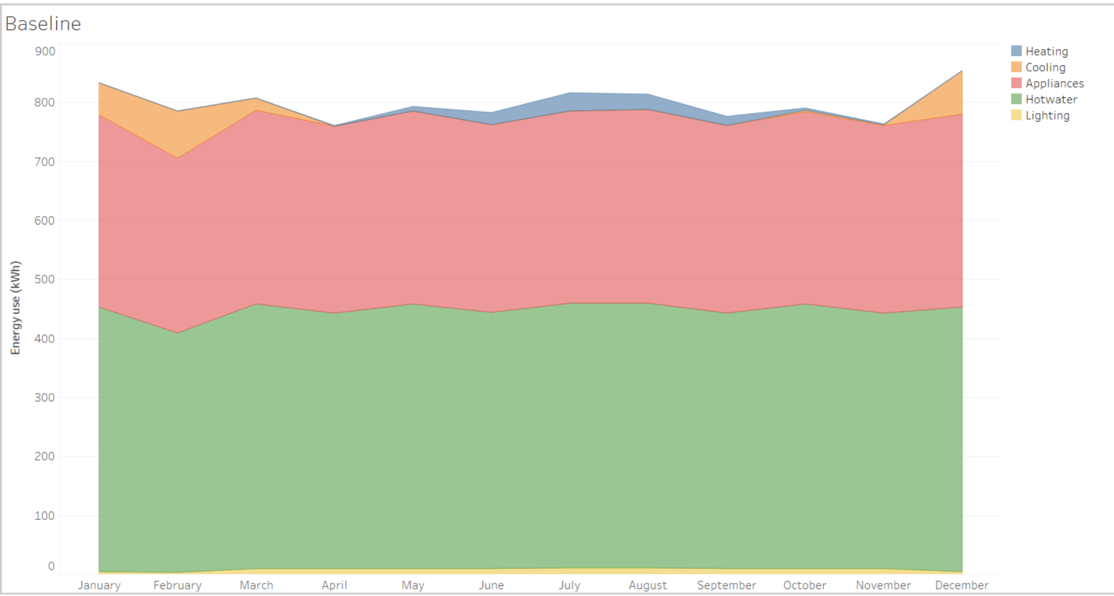
Table 17 Selected appliances for Perth.

APPLIANCE	TYPE	EFF. COMPARED TO BASE CASE
Hot water	Heat pump	70%
Cooktop	Induction	50%
AC	COP3.5	15%

The modifications specified in Scenario 2 (addition of a split system) does not affect the NatHERS star rating and was therefore excluded from further analysis.

Scenario 3 achieved a NatHERS rating of 8.5 Stars, with an annual energy use of 5,197 kWh (Table 16). Heating and cooling loads were reduced by respectively 12 and 8 kWh/year in this scenario thanks to the addition of double glazing to the North facing balcony sliding doors.

The difference in energy rating between Scenarios 1 and 3 was negligible; the most significant change affecting total energy use in 3 being the number of split systems used in the house. From a building design and whole of house energy use perspective, it was therefore recommended Scenario 1 to be chosen.



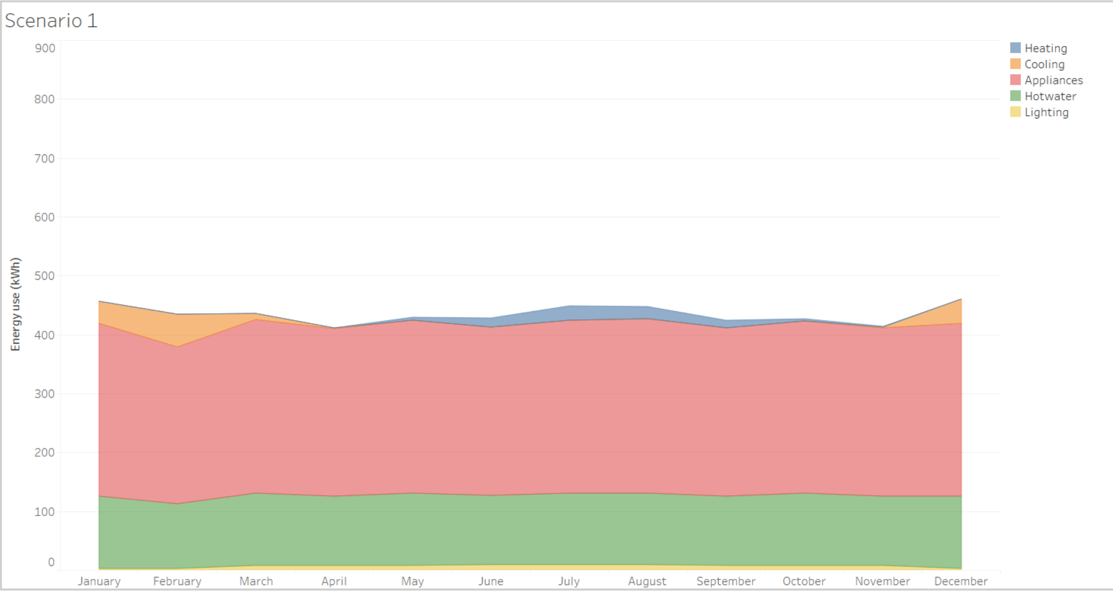


Figure 15 Modelled scenarios with the assumption that the house is fully occupied all day (Perth).

PV system

Different PV system sizes (3, 4 and 5 kW) were modelled (Table 5) to cover energy use for Scenario 1 in the worst-case occupancy as well as under more typical occupancy.

Under the worst occupancy scenario, a 4kW PV system is necessary to achieve a status of net zero energy (Figure 17).

However, the worst-case scenario occupancy is unlikely to occur. Under a typical occupancy scenario, a 3.5kW PV system is sufficient to achieve net zero energy provided that appliances are installed as specified or have a higher energy efficiency rating (Figure 18).

Figure 16 3 kW, 4kW and 5 kW PV offsets assuming a worst-case occupancy scenario for Scenario 1.

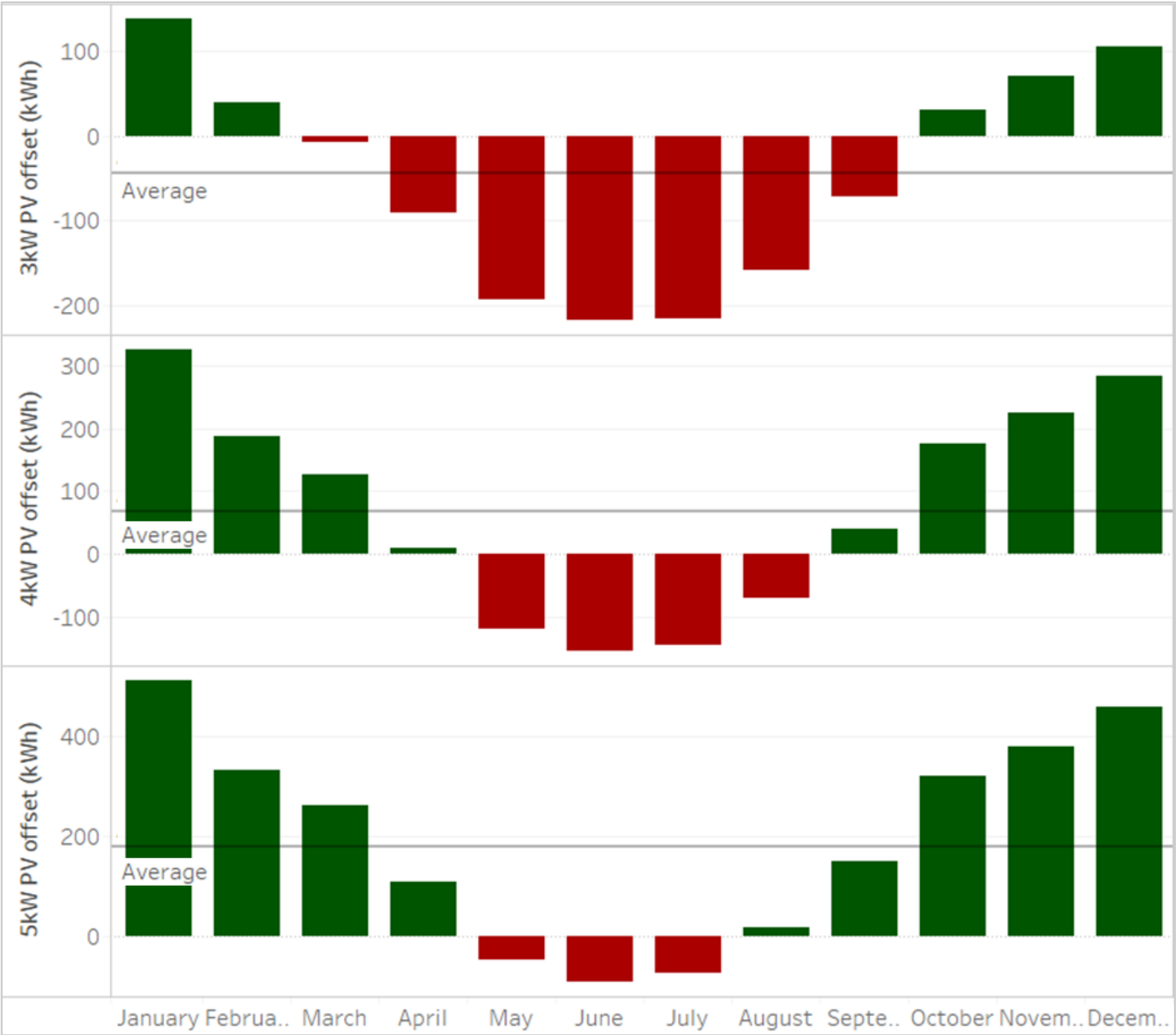


Figure 17 3 kW, 4kW and 5 kW PV offsets assuming a typical occupancy scenario for Scenario 1.

Discussion and conclusion

The aim of the first part of the *Mainstreaming Net Zero Energy Homes* project was to explore cost-efficient approaches for conventional builders to transition from their business-as-usual house design to a net zero energy house design. This involved firstly a workshop, where the concepts of NZEH design were discussed amongst stakeholders and different possible scenarios were brainstormed. The second step was to model the chosen scenarios with the use of the AusZEH tool to identify the most cost-effective design solutions. Finally, the third and final step involved selecting energy efficient appliances and sizing an adequate PV system to cover the annual energy needs of a typical Australian household of four in order to achieve NZEH.

The results of the workshop and modelling session were used to inform the house design to be built in each of the project locations, which are situated in very distinct climates and housing markets. This diversity presents different challenges but also enables the possibility of answering the question as to whether improving the energy efficiency of Australian buildings is feasible and whether NZEHs can be built in a cost-effective manner. Builders, however, need to be engaged in the process. A two-way conversation enables stakeholders' concerns to be heard and win-win solutions to be proposed in a collaborative environment.

The results demonstrated that simple cost-effective changes, such as the addition of insulation or glazing upgrades (*e.g.* low-e glazing and double glazing) can significantly improve thermal performance and that the selection of energy efficient appliances (in particular HWS) can significantly reduce the size of the PV system required to cover the annual net energy needs of an Australian household under typical occupancy.

While costs and market implications were briefly mentioned during the workshop, these were not addressed in depth at this stage of the process. Only high-level costs estimations were projected by the builders to help inform the modelled scenarios in regard to their cost-effectiveness.

A subsequent stage of the *Mainstreaming Net Zero Energy Homes* project involved evaluating the retail costs of building a NZEH as compared to the original builder's Baseline scenario, with costs provided by the builders following completion of design and estimating. In addition to a breakdown of retail costs for key features, the report also includes payback periods and return on investment. Market research is being undertaken once the houses are complete and open to the public for visitation, with potential buyers surveyed to determine their preferences, views on NZEHs and budgets. The results of the three project stages provide a valuable evidence base for better understanding the upfront cost implications and ongoing operational cost benefits of NZEHs, as well as an insight into market interest in NZEH design and technology features.

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Appendix

1. Melbourne Case Study Plans – Base Case

2. Townsville Case Study Plans – Base Case

3. Canberra Case Study Plans – Base Case

4. Perth Case Study Plans – Base Case

GENERAL NOTES (NCC 2016 BCA Vol 2)

- ALL MATERIALS AND WORK PRACTICES SHALL COMPLY WITH, BUT NOT LIMITED TO THE BUILDING REGULATIONS 2017, NATIONAL CONSTRUCTION CODE SERIES 2016, THE BUILDING CODE OF AUSTRALIA VOL 2 AND ALL RELEVANT CURRENT AUSTRALIAN STANDARDS (AS AMENDED) REFERRED TO THEREIN.
- UNLESS OTHERWISE SPECIFIED THE TERM BCA SHALL REFER TO NATIONAL CONSTRUCTION CODE SERIES 2016 BUILDING CODE OF AUSTRALIA VOL 2
- ALL MATERIALS AND CONSTRUCTION PRACTICE SHALL MEET THE PERFORMANCE REQUIREMENTS OF THE BUILDING CODE OF AUSTRALIA. WHERE AN ALTERNATIVE SOLUTION IS PROPOSED THEN, PRIOR TO IMPLEMENTATION OR INSTALLATION, IT FIRST MUST BE ASSESSED AND APPROVED BY THE RELEVANT BUILDING SURVEYOR AS MEETING THE PERFORMANCE REQUIREMENTS OF THE BCA.
- GLAZING INCLUDING SAFETY GLAZING SHALL BE INSTALLED TO A SIZE, TYPE & THICKNESS SO AS TO COMPLY WITH;
- BCA PART 3.6 FOR CLASS 1 AND 10 BUILDINGS WITHIN A DESIGN WIND SPEED OF NOT MORE THAN N3, AND
- BCA VOL 1 PART B1.4 FOR CLASS 2 TO 9 BUILDINGS
- WATERPROOFING OF WET AREAS, BEING BATHROOMS, SHOWERS, SHOWER ROOMS, LAUNDRIES, SANITARY COMPARTMENTS AND THE LIKE SHALL BE PROVIDED IN ACCORDANCE WITH AS 3740-2010: WATERPROOFING OF DOMESTIC WET AREAS.

SUSTAINABILITY MEASURES FOR NEW CLASS 1 BUILDINGS.

THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH ANY HOUSE ENERGY RATING (HERS) REPORT AND SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE STAMPED PLANS ENDORSED BY THE ACCREDITED THERMAL PERFORMANCE ASSESSOR WITHOUT ALTERATION.

SITE BUSHFIRE ATTACK ASSESSMENT.

REFERENCE DOCUMENT AS 3959-2009 CONSTRUCTION OF BUILDINGS IN BUSHFIRE PRONE AREAS.

BUSHFIRE ATTACK LEVEL:- (BAL)

SELECT APPLICABLE (BAL)

ALL HOMES TO COMPLY WITH AS 3959-2009 (BAL)

WIND SPEED ASSESSMENT:

MAXIMUM DESIGN GUST WIND SPEED FOR THIS SITE IS: **SELECT WIND SPEED**

IMPORTANT NOTE:

THE WIND SPEED CALCULATION IS TAKEN FROM THE JOB SPECIFIC SOIL REPORT (FRONT PAGE)

STANDARD HOMES ARE DESIGNED TO SUIT A MINIMUM WIND GUST SPEED OF 33 m/s

ISSUE	AMENDMENT DETAILS
A	INITIAL SKETCH DESIGN 07/09/17 DGH
B	SECOND SKETCH DESIGN 11/09/17 DGH
C	THIRD SKETCH DESIGN 25/09/17 DGH
D	WORKING DRAWINGS 06.10.17 - SR
E	
F	
G	
H	
I	
J	
K	
L	

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433 PRINCES HWY, OFFICER
VICTORIA 3809 (DBU 28104)
PH: 9095 8000 FAX: 9095 8010

STEPS & LANDINGS

- STEP SIZES (OTHER THAN FOR SPIRAL STAIRS) TO BE:
- RISERS (R) 190MM MAXIMUM AND 115MM MINIMUM
- GOING (G) 355MM MAXIMUM AND 240MM MINIMUM
- 2R + 1G = 700MM MAXIMUM AND 550MM MINIMUM
- WITH LESS THAN 125MM MAXIMUM GAP TO OPEN TREADS
- ALL TREADS, LANDINGS AND THE LIKE TO HAVE A SLIP-RESISTANCE CLASSIFICATIONOF P3 OR R10 FOR DRY SURFACE CONDITIONS AND P4 OR R11 FOR WET SURFACE CONDITIONS, OR A NOSING STRIP WITH A SLIP-RESISTANCE CLASSIFICATION OF P3 FOR DRY SURFACE CONDITIONS AND P4 FOR WET SURFACE CONDITIONS.
- PROVIDE BARRIER WHERE CHANGE IN LEVEL EXCEEDS 1000MM ABOVE THE SURFACE BENEATH LANDINGS, RAMPS AND/OR TREADS. BALUSTRADES (OTHER THAN TENSIONED WIRE BALUSTRADES) TO BE:
- 1000MM MIN. ABOVE FINISHED SURFACE LEVEL OF BALCONIES, LANDINGS OR THE LIKE, AND
- 865MM MIN. ABOVE FINISHED SURFACE LEVEL OF STAIR NOSING OR RAMP, AND
- VERTICAL WITH LESS THAN 125MM GAP BETWEEN, AND
- ANY HORIZONTAL ELEMENT WITHIN THE BARRIER BETWEEN 150MM AND 760MM ABOVE THE FLOOR MUST NOT FACILITATE CLIMBING WHERE CHANGES IN LEVEL EXCEEDS 4000MM ABOVE THE SURFACE BENEATH LANDINGS, RAMPS AND/OR TREADS.
- WIRE BALUSTRADE CONSTRUCTION TO COMPLY WITH BCA PART 3.9.2.3 FOR CLASS 1 AND 10 BUILDINGS AND NCC 2016 BCA VOLUME 1 PART D2.16 FOR OTHER CLASSES OF BUILDINGS.
- TOP OF HAND RAILS TO BE 865MM MINIMUM ABOVE STAIR NOSING AND FLOOR SURFACE OF RAMPS.
- WINDOW SIZES NOMINATED ARE NOMINAL ONLY. ACTUAL SIZE MAY VARY ACCORDING TO MANUFACTURER. WINDOWS TO BE FLASHED ALL AROUND.
- WHERE THE BUILDING (EXCLUDES A DETACHED CLASS 10) IS LOCATED IN A TERMITE PRONE AREA THE AREA TO UNDERSIDE OF BUILDING AND PERIMETER IS TO BE TREATED AGAINST TERMITE ATTACK.
- CONCRETE STUMPS: UP TO 1400MM LONG TO BE 100MM X 100MM (1 NO. H.D. WIRE) 1401MM TO 1800MM LONG TO BE 100MM X 100MM (2 NO. H.D. WIRES) 1801MM TO 3000MM LONG TO BE 125MM X 125MM (2 NO. H.D. WIRES)

100MM X 100MM STUMPS EXCEEDING 1200MM ABOVE GROUND LEVEL TO BE BRACED WHERE NO PERIMETER BASE BRICKWORK PROVIDED.

- FOR BUILDINGS IN MARINE OR OTHER EXPOSURE ENVIRONMENTS SHALL HAVE MASONRY UNITS, MORTAR AND ALL BUILT IN COMPONENTS AND THE LIKE COMPLYING WITH THE DURABILITY REQUIREMENTS OF TABLE 4.1 OF AS4773.1-2010 MASONRY IN SMALL BUILDINGS PART 1:DESIGN
- ALL STORMWATER TO BE TAKEN TO THE LEGAL POINT OF DISCHARGE TO THE RELEVANT AUTHORITIES APPROVAL.
- THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL RELEVANT STRUCTURAL AND ALL OTHER CONSULTANTS DRAWINGS/ DETAILS AND WITH ANY OTHER WRITTEN INSTRUCTIONS ISSUED IN THE COURSE OF THE CONTRACT.
- SITE PLAN MEASUREMENTS IN MILLIMETRES - ALL OTHER MEASUREMENTS IN MILLIMETRES U.N.O.
- FIGURED DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS.
- WINDOW & DOOR GLAZING TO BE INSTALLED TO AS 2047 & AS 1288
- PROVIDE CAVITY FLASHING & WEEP HOLES OVER OPENINGS GREATER THAN 1000MM WIDE WITH BRICKWORK OVER
- EAVES WITHIN 900MM OF A BOUNDARY MUST BE LINED WITH NON COMBUSTIBLE MATERIAL

- THE BUILDER SHALL TAKE ALL STEPS NECESSARY TO ENSURE THE STABILITY AND GENERAL WATER TIGHTNESS OF ALL NEW AND/OR EXISTING STRUCTURES DURING ALL WORKS.
- THE BUILDER AND SUBCONTRACTORS SHALL CHECK AND VERIFY ALL DIMENSIONS, SETBACKS, LEVELS AND SPECIFICATIONS AND ALL OTHER RELEVANT DOCUMENTATION PRIOR TO THE COMMENCEMENT OF ANY WORKS. REPORT ALL DISCREPANCIES TO THIS OFFICE FOR CLARIFICATION.
- INSTALLATION OF ALL SERVICES SHALL COMPLY WITH THE RESPECTIVE SUPPLY AUTHORITY REQUIREMENTS.
- THE BUILDER AND SUBCONTRACTOR SHALL ENSURE THAT ALL STORMWATER DRAINS, SEWER PIPES AND THE LIKE ARE LOCATED AT A SUFFICIENT DISTANCE FROM ANY BUILDINGS FOOTING AND/OR SLAB EDGE BEAMS SO AS TO PREVENT GENERAL MOISTURE PENETRATION, DAMPNESS, WEAKENING AND UNDERMINING OF ANY BUILDING AND ITS FOOTING SYSTEM.
- THESE PLANS HAVE BEEN PREPARED FOR THE EXCLUSIVE USE BY THE CLIENT OF HARVAN DESIGN ('THE DESIGNER') FOR THE PURPOSE EXPRESSLY NOTIFIED TO THE DESIGNER. ANY OTHER PERSON WHO USES OR RELIES ON THESE PLANS WITHOUT THE DESIGNER'S WRITTEN CONSENT DOES SO AT THEIR OWN RISK AND NO RESPONSIBILITY IS ACCEPTED BY THE DESIGNER FOR SUCH USE AND/ OR RELIANCE.
- A BUILDING PERMIT IS REQUIRED PRIOR TO THE COMMENCEMENT OF THESE WORKS. THE RELEASE OF THESE DOCUMENTS IS CONDITIONAL TO THE OWNER OBTAINING THE REQUIRED BUILDING PERMIT.
- THE CLIENT AND/OR THE CLIENT'S BUILDER SHALL NOT MODIFY OR AMEND THE PLANS WITHOUT THE KNOWLEDGE AND CONSENT OF HARVAN DESIGN EXCEPT WHERE A REGISTERED BUILDING SURVEYOR MAKES MINOR NECESSARY CHANGES TO FACILITATE THE BUILDING PERMIT APPLICATION AND THAT SUCH CHANGES ARE PROMPTLY REPORTED BACK TO HARVAN DESIGN.
- THE APPROVAL BY THIS OFFICE OF A SUBSTITUTE MATERIAL, WORK PRACTICE, VARIATION OR THE LIKE IS NOT AN AUTHORISATION FOR ITS USE OR A CONTRACT VARIATION. ANY SAID VARIATIONS MUST BE ACCEPTED BY ALL PARTIES TO THE AGREEMENT AND WHERE APPLICABLE THE RELEVANT BUILDING SURVEYOR PRIOR TO IMPLEMENTING THE SAID VARIATION.
- ENSURE SUFFICIENT CLEARANCE PROVIDED B/N BRICK WALL & WINDOW & DOOR FRAMES WHERE ARTICULATION JOINT IS ADJACENT TO WINDOW/DOOR
- SOLAR HOT WATER SYSTEM IS TO BE GAS BOOSTED TYPE & MUST ACHIEVE MINIMUM 60% SOLAR GAIN
- FIXINGS & TIE DOWNS IN ACCORDANCE WITH AS 1684 FOR RELEVANT WIND SPEED CATEGORY (SEE NOTE THIS PAGE)

SITE CLASSIFICATION

SITE CLASSIFICATION AS CLASS:	CLASS
REFER TO SOIL REPORT NO:	NUMBER
BY:	STRUCTERRE

STORMWATER

90MM DIA. CLASS 6 UPVC STORMWATER LINE LAID TO A MINIMUM GRADE OF 1:100 AND CONNECTED TO THE LEGAL POINT OF STORMWATER DISCHARGE. PROVIDE INSPECTION OPENINGS AT 9000MM C/C AND AT EACH CHANGE OF DIRECTION.

THE COVER TO UNDERGROUND STORMWATER DRAINS SHALL BE NOT LESS THAN

- 100MM UNDER SOIL
- 50MM UNDER PAVED OR CONCRETE AREAS
- 100MM UNDER UNREINFORCED CONCRETE OR PAVED DRIVEWAYS
- 75MM UNDER REINFORCED CONCRETE DRIVEWAYS

AUTHORITIES/CONSULTANTS

MUNICIPALITY NAME:	CARDINIA
SEWERAGE AUTHORITY	SOUTH EAST WATER
CONSULTING STRUCTURAL ENGINEER:	STRUCTERRE
GEOTECHNICAL ENGINEER:	STRUCTERRE
THERMAL PERFORMANCE ASSESSOR:	DARYL HARGREAVES

DISPLAY

SITE CUT/FILL LEGEND & NOTES

- DENOTES AREA OF SITE CUT
- DENOTES AREA OF SITE FILL

TERMITE TREATMENT REQUIRED

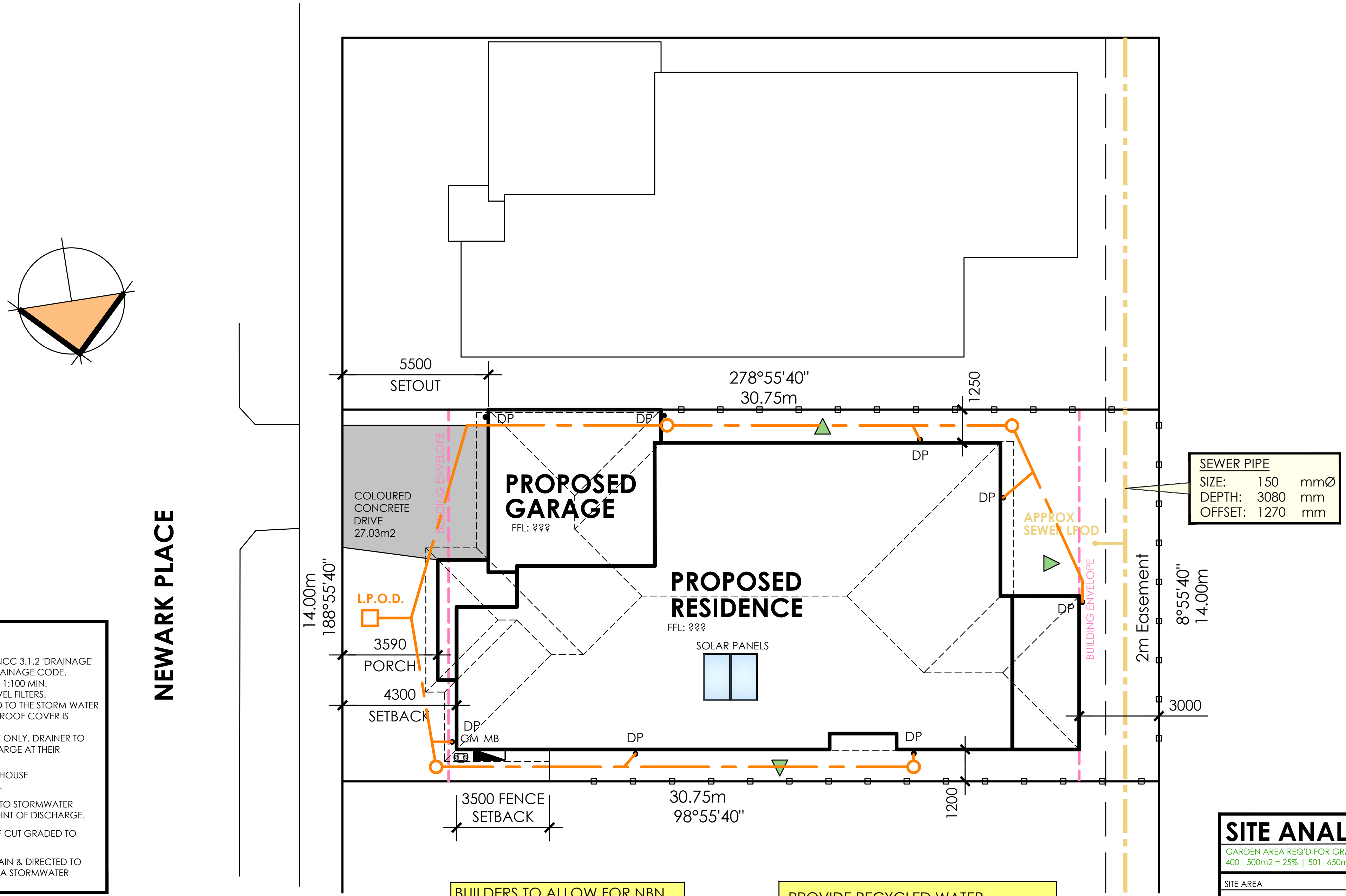
PROVIDE TERMITE TREATMENT IN ACCORDANCE WITH AS 3660

PRELIMINARY SITE PLAN NOTES

THIS SITING IS SUBJECT TO THE FOLLOWING:

- SOIL REPORT & SURVEY
- CLEAR COPY OF TITLE
- EASEMENT DETAILS (IF APPLICABLE)
- FALL OF LAND
- RES-CODE REQUIREMENTS
- DEVELOPER APPROVAL (IF APPLICABLE)
- COUNCIL BUILDING REGULATIONS

IMPORTANT NOTE : SITING MAY ALTER TO SUIT



DRAINAGE NOTES:

- SITE DRAINAGE SHALL COMPLY WITH NCC 3.1.2 'DRAINAGE' AND AS3500 NATIONAL PLUMBING DRAINAGE CODE.
- BASE OF CUT GRADED TO SILT TRAP AT 1:100 MIN. DRAINS SHALL BE PROTECTED BY GRAVEL FILTERS.
- TEMPORARY DOWNPIPES CONNECTED TO THE STORM WATER SYSTEM TO BE INSTALLED AS SOON AS ROOF COVER IS COMPLETED.
- STORMWATER DRAINS ARE INDICATIVE ONLY. DRAINER TO CONNECT TO LEGAL POINT OF DISCHARGE AT THEIR DISCRETION

GRADE SURFACE AWAY FROM HOUSE FOOTINGS(MINIMUM FALL 1:20).

GRATED INLET PIT CONNECTED TO STORMWATER SYSTEM DIRECTED TO LEGAL POINT OF DISCHARGE.

PROVIDE AG DRAIN AT BASE OF CUT GRADED TO SILT PIT AT 1:100 MIN.

SILT PIT CONNECTED TO AG DRAIN & DIRECTED TO LEGAL POINT OF DISCHARGE VIA STORMWATER SYSTEM

BUILDERS TO ALLOW FOR NBN CONNECTION (FIBRE OPTIC)

PROVIDE RECYCLED WATER CONNECTION INCLUDING ALL FLUSHING TOILETS, 2x EXTERNAL TAPS AND WASHING MACHINE STOPS IN ACCORDANCE WITH CLASS 'A' RECYCLED WATER REQUIREMENTS

SITE ANALYSIS

GARDEN AREA REQ'D FOR GRZ & NRZ ZONES ONLY:
400 - 500m2 = 25% | 501- 650m2 = 30% | 650m2+ = 35%

SITE AREA	430.50 m²
BUILT OVER AREA	259.73 m²
NON COMPLIANT GARDEN AREA	0.00 m²
PAVED AREA	27.03 m²
TOTAL HARD COVER	287 m²
SITE COVERAGE	60 %
TOTAL HARD COVER	67 %
PERMEABILITY INDEX	33 %
GARDEN AREA REQ'MT	33 %

SJD homes

433 PRINCES HWY, OFFICER
VICTORIA 3809 (DBU 28104)
PH: 9095 8000 FAX: 9095 8010

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proposed: **HOUSE & GARAGE** for: **SJD HOMES** address: **LOT 290 NEWARK PLACE OFFICER 3809**

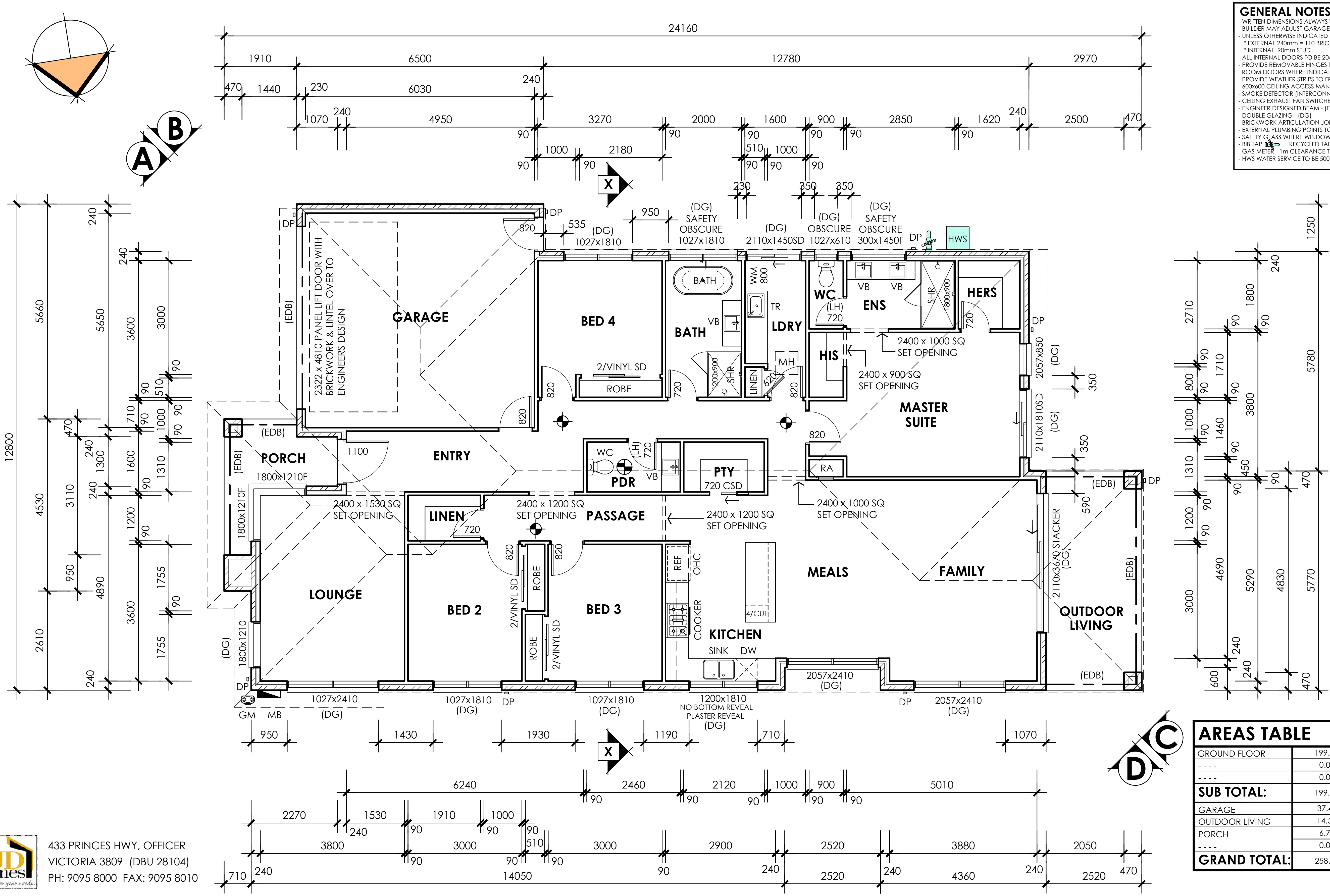
drawing: **SITE PLAN**

drawn : **DGH** date : **07/09/17** scale : **1:200** sheet : **2** of **8** issue : **D** date:**06/10/17** job no. : **17-01240**

DISPLAY

GENERAL NOTES

- WRITTEN DIMENSIONS ALWAYS TAKE PREFERENCE OVER SCALE
- BUILDER MAY ADJUST GARAGE DOOR HEIGHT ON SITE AS REQUIRED
- UNLESS OTHERWISE INDICATED ALL WALL DIMENSIONS ARE:
  * EXTERNAL 240mm = 110 BRICK, 40 CAVITY, 90 STUD
  * INTERNAL 90mm STUD
- ALL INTERNAL DOORS TO BE 2040H (2340H NOTED WITH ASTERISK - 820*)
- PROVIDE REMOVABLE HINGES TO HINGED WC & POWDER ROOM DOORS WHERE INDICATED (LH)
- PROVIDE WEATHER STRIPS TO FRONT ENTRY DOOR
- 600x600 CEILING ACCESS MANHOLE LOCATION (MH)
- SMOKE DETECTOR (INTERCONNECTED WITH BATTERY BACKUP)
- CEILING EXHAUST FAN SWITCHED/COMBINED WITH LIGHT
- ENGINEER DESIGNED BEAM - (EDB)
- DOUBLE GLAZING - (DG)
- BRICKWORK ARTICULATION JOINT
- EXTERNAL PLUMBING POINTS TO PLUMBER'S DISCRETION
- SAFETY GLASS WHERE WINDOW IS WITHIN 2m OF SHR/BATH BASE
- BIB TAP RECYCLED TAP
- GAS METER - 1m CLEARANCE TO OPENINGS & IGNITION SOURCES
- HWS WATER SERVICE TO BE 500mm CLEAR OF BLDG OPENINGS (HWS)



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VICTORIA 3809 (DBU 28104)
PH: 9095 8000 FAX: 9095 8010

AREAS TABLE

GROUND FLOOR	199.48	m^2	21.47	sq
- - - -	0.00	m^2	0.00	sq
- - - -	0.00	m^2	0.00	sq
SUB TOTAL:	199.48	m^2	21.47	sq
GARAGE	37.42	m^2	4.03	sq
OUTDOOR LIVING	14.54	m^2	1.57	sq
PORCH	6.73	m^2	0.72	sq
- - - -	0.00	m^2	0.00	sq
GRAND TOTAL:	258.17	m^2	27.79	sq

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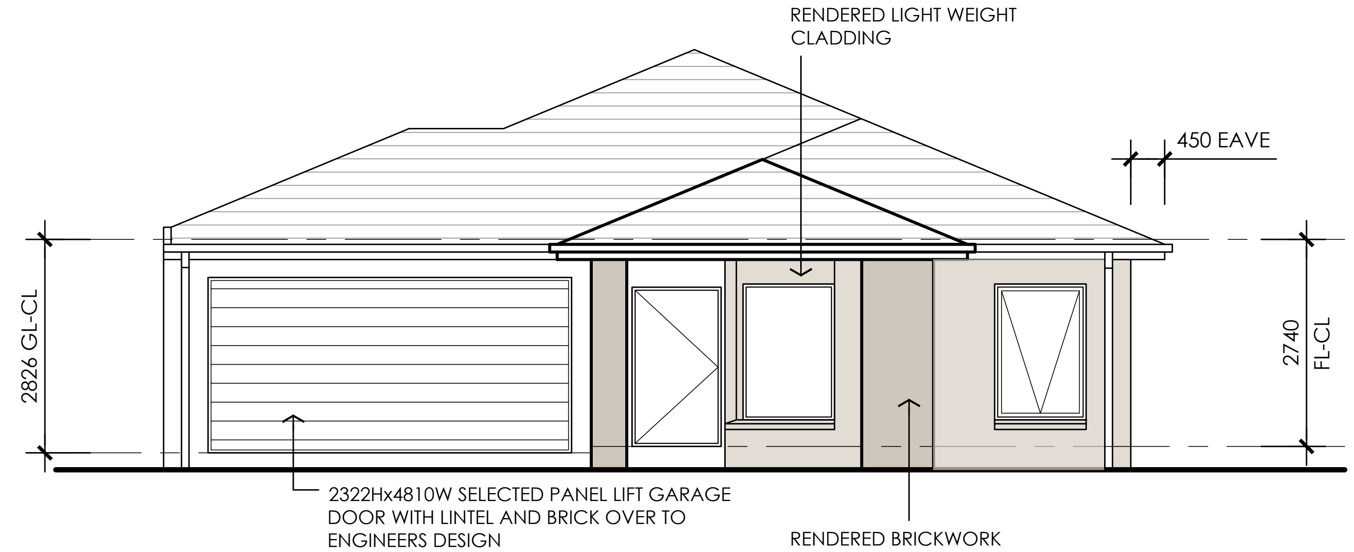
for: **SJD HOMES**

address: **LOT 290 NEWARK PLACE OFFICER 3809**

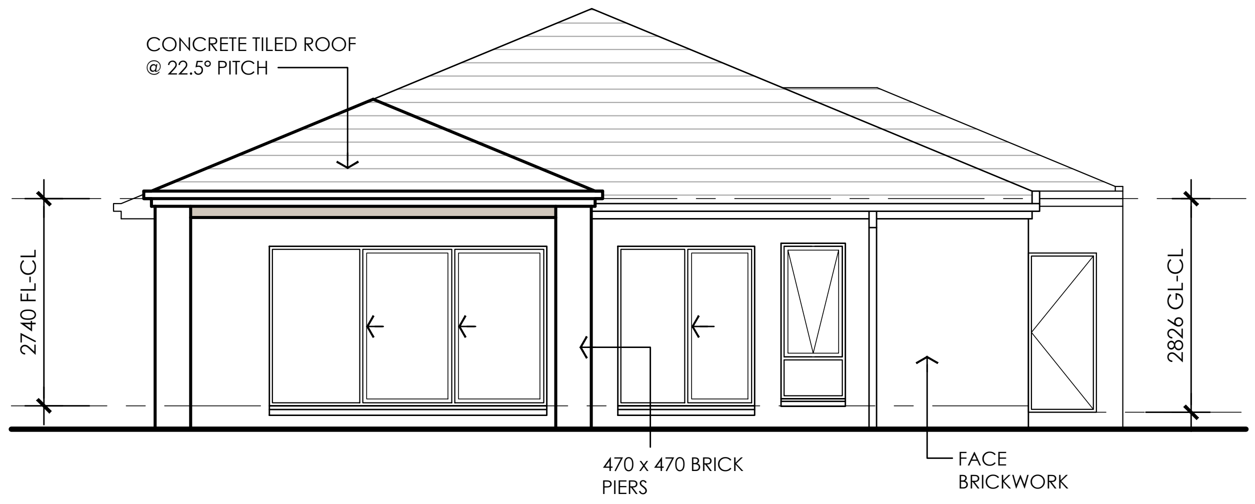
drawing: **GROUND FLOOR PLAN**

drawn: **DGH** date: **07/09/17** scale: **1:100** sheet: **3** of **8** issue: **D** date: **06/10/17** job no.: **17-01240**

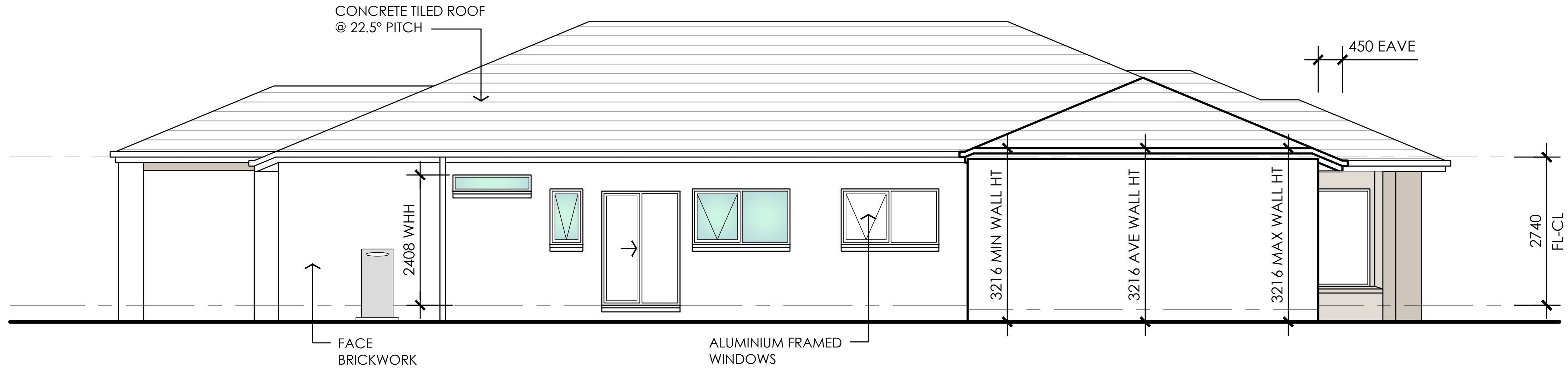
DISPLAY



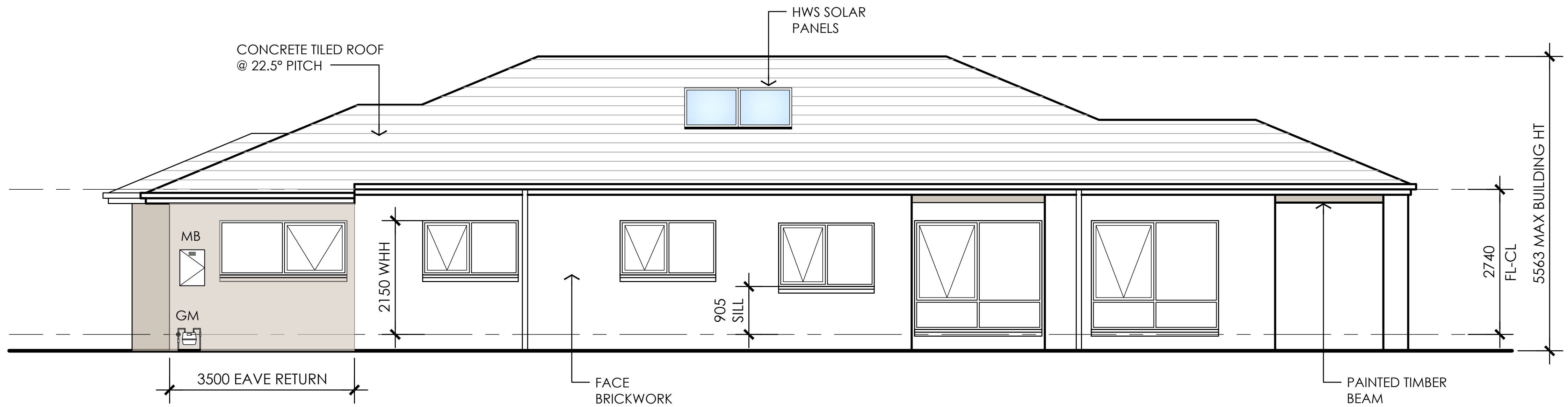
ELEVATION A - (EAST)



ELEVATION C - (WEST)



ELEVATION B - (SOUTH)



ELEVATION D - (NORTH)

EXTERNAL DOOR THRESHOLDS:
THRESHOLDS OF EXTERNAL DOORS TO BE NO GREATER THAN 230MM ABOVE THE ADJOINING SURFACE

433 PRINCES HWY, OFFICER
VICTORIA 3809 (DBU 28104)
PH: 9095 8000 FAX: 9095 8010

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proposed: **HOUSE & GARAGE**

for: **SJD HOMES**

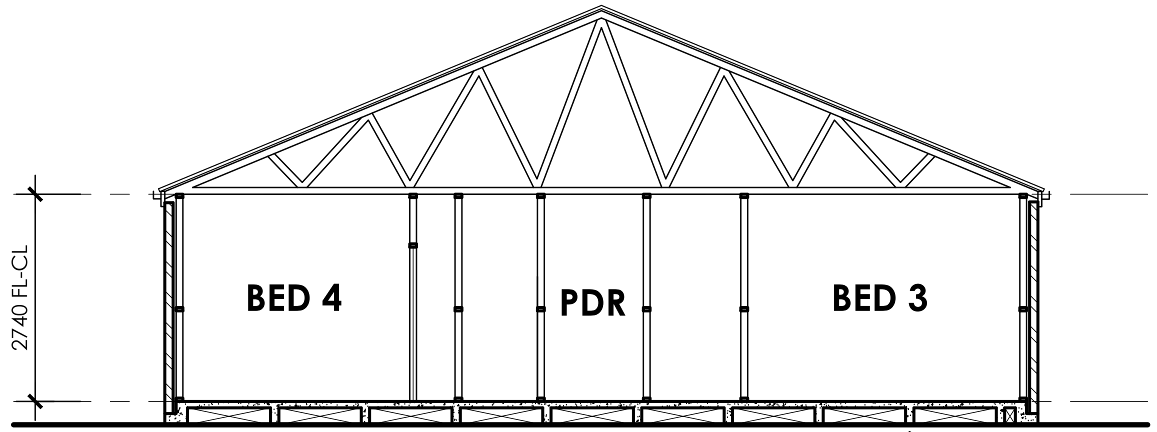
address: **LOT 290 NEWARK PLACE OFFICER 3809**

drawing: **ELEVATIONS**

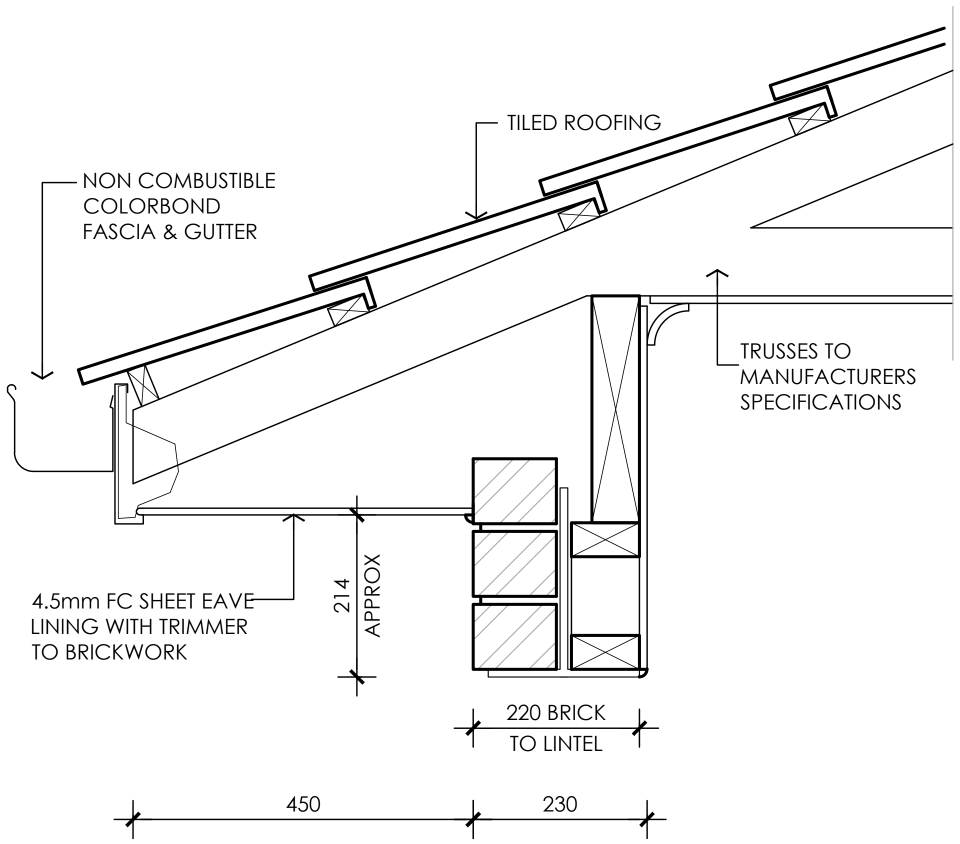
drawn : **DGH** date : **07/09/17** scale : **1:100**

sheet : **4** of **8** issue : **D** date: **06/10/17** job no. : **17-01240**

DISPLAY



SECTION X-X



GARAGE LINTEL DETAIL

2740 CEILING SCALE 1:10

TIMBER FRAMING SCHEDULE RLW : 6000

SINGLE STOREY OR UPPER STOREY LOADBEARING WALLS
CONCRETE TILED ROOF - TRUSSES @ 600 CTS

MEMBER	SIZE	G	SPAN	CTRS
WAFFLE POD CONCRETE SLAB FLOOR				
Btm. plate	90x45	MGP10		
Top plate	2/90x35	MGP10		
Studs	90x35	MGP10		450
Jamb studs 1	90x45	MGP10		1300
Jamb studs 2	2/90x45	MGP10		3100
Wall bracing	IN ACCORDANCE WITH AS 1684-2010			
Noggings	70x35	MGP10		1350
Lintel 1	190x35	LVL15	1850	
Lintel 2	2/200x35	LVL15	2500	
Lintel 3	2/300x35	LVL15	3550	
Porch Beam	AS PER ENG.	-	-	
LINTELS IN LOWER STOREY WALLS OF A TWO STOREY TO ENGINEERS DESIGN				
TRUSSED ROOF				
TIMBER FABRICATED AS PER MANUF. SPECIFICATIONS @ MAX 600 CTS				

* Sizes may be built up using vertical nail lamination

NON LOADBEARING WALLS

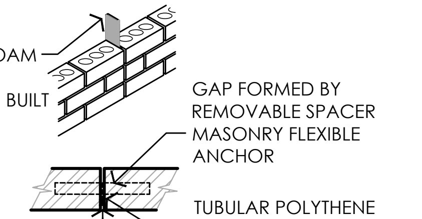
MEMBER	SIZE	G	SPAN	CTRS
WAFFLE POD CONCRETE SLAB FLOOR				
Btm. plate	90x45	MGP10		
Top plate	90x35	MGP10		
Studs	90x35	MGP10		600
Jamb studs 1	90x45	MGP10		1300

6 STAR ENERGY REQ'MENTS:

REQUIREMENTS AS PER 6 STAR ENERGY RATING REPORT.

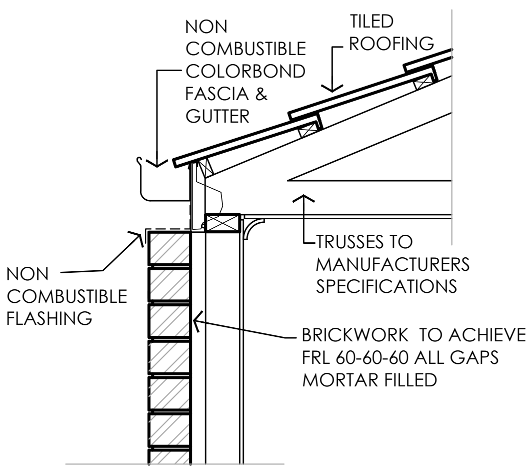
- -INSULATION TO CEILING: R2.5
- -INSULATION TO EXTERNAL WALLS: R1.5
- -INSULATION TO GARAGE INTERNAL WALLS: R1.5
- -SEAL GAPS & CRACKS AROUND ALL EXTERNAL DOOR & WINDOW FRAMES: YES
- -WEATHER SEALS TO ALL EXTERNAL DOORS: YES
- -WEATHER SEALS TO INTERNAL UTILITY DOORS: NO
- -REFER FLOOR PLAN & ELEVATIONS FOR DOUBLE GLAZED WINDOWS IF REQUIRED (DG): YES
- -WEATHER STRIP(S) TO FRONT ENTRY DOOR(S): YES
- -FULLY SEALED CEILING EXHAUST FANS: YES
- - AG SISILATION TO ALL EXTERNAL WALLS - STD INCLUSION
- -100% SEALED ALUM. IMPR WINDOWS - STD INCLUSION
- -WINDOWS & SLIDING DOORS TO DETAILS AS FOLLOWS;

ALUM. A SG CLEAR - U VALUE 6.70 SHGC 0.57
ALUM. A DG AIR FILL CLEAR - U VALUE 3.60 SHGC 0.47



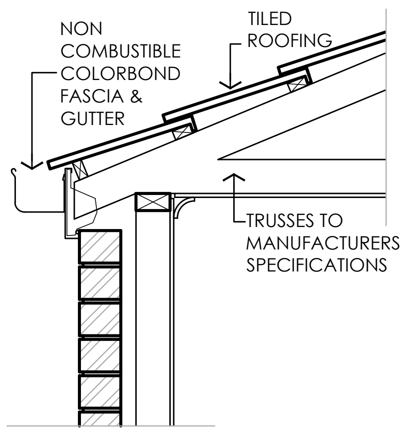
ARTICULATION JOINT

SCALE 1:20



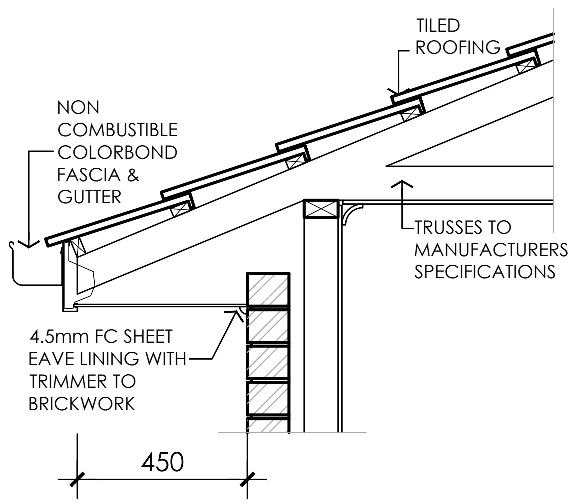
GUTTER ON BRICK

SCALE 1:20



FASCIA GUTTER

SCALE 1:20

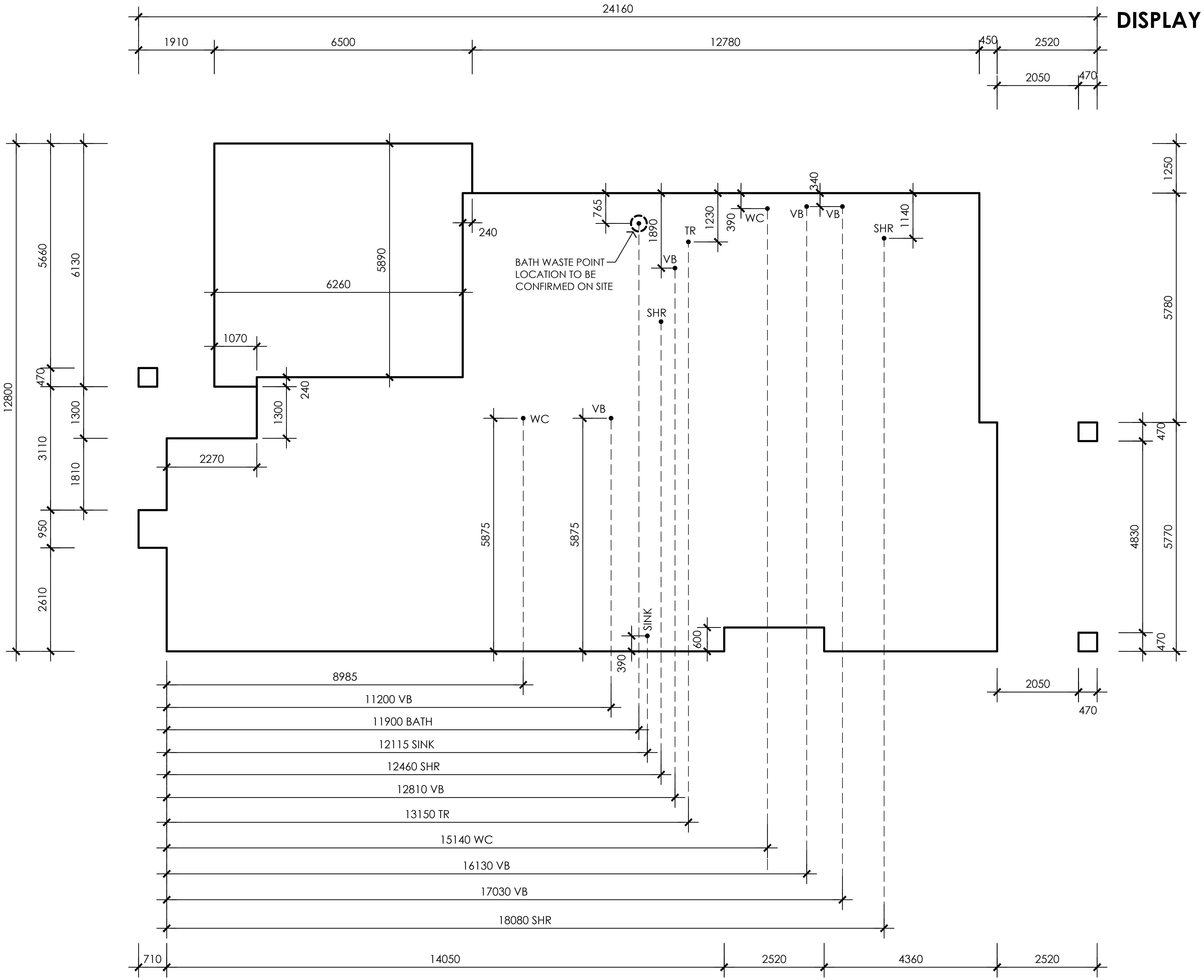


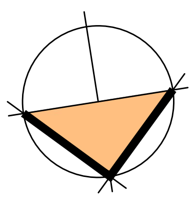
450 EAVE

SCALE 1:20

NOTE: EAVES LINING WITHIN 900mm OF BOUNDARY TO BE NON-COMBUSTIBLE

SJD homes designed for your needs
433 PRINCES HWY, OFFICER
VICTORIA 3809 (DBU 28104)
PH: 9095 8000 FAX: 9095 8010





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VICTORIA 3809 (DBU 28104)
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BUILDING DESIGNERS

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proposed: **HOUSE & GARAGE**

for: **SJD HOMES**

address: **LOT 290 NEWARK PLACE OFFICER 3809**

drawing: **SETOUT PLAN**

drawn: **DGH** date: **07/09/17** scale: **1:100**

sheet: **6** of **8** issue: **D** date: **06/10/17** job no.: **17-01240**

HEATING/COOLING VENTS:
THE LOCATION OF THE HEATER / COOLER AND VENT LOCATION IS UP TO THE DISCRETION OF THE INSTALLER AND MAY VARY PENDING TRUSS LOCATION

ARTIFICIAL LIGHTING TABLE

FLOOR AREA	195.67 m²	WATTAGE ALLOWED	978 w
POR./ OUT. AREA	21.27 m²	WATTAGE ALLOWED	85 w
GARAGE	37.42 m²	WATTAGE ALLOWED	112 w
TOTAL AREA	254.36 m²	**ALLOWABLE WATTS**	1176 w
HOUSE 5 W/m2		NO. OF GLOBES USED	TOTAL WATTS
FLUORESCENT GLOBES	15 w	0	0 w
LED DOWNLIGHTS	9 w	0	0 w
FLUORO TUBES	36 w	0	0 w
		HOUSE TOTAL	0 w
POR./ OUT. 4 W/m2			
FLUORESCENT GLOBES	15 w	0	0 w
LED DOWNLIGHTS	9 w	0	0 w
FLUORO TUBES	36 w	0	0 w
		PORCH TOTAL	0 w
GARAGE 3 W/m2			
FLUORESCENT GLOBES	15 w	0	0 w
LED DOWNLIGHTS	9 w	0	0 w
FLUORO TUBES	36 w	0	0 w
		GARAGE TOTAL	0 w

LIGHTING LEGEND

- CEILING LIGHT BATTEN HOLDER
- 90mm DOWNLIGHT
- 70mm DOWNLIGHT
- 50mm DOWNLIGHT
- EXTERNAL LIGHT POINT
- HEATER/FAN & LIGHT - 2 GLOBE
- HEATER/FAN & LIGHT - 4 GLOBE
- JB JUNCTION BOX
- CEILING FAN
- CEILING FAN WITH LIGHT
- PARA FLOOD LIGHT - SINGLE
- PARA FLOOD LIGHT - DOUBLE
- ROUND FLUORO
- 1200 — 1200 FLUORO - SINGLE
- 1200 — 1200 FLUORO - DOUBLE
- WALL LIGHT BATTEN HOLDER
- MOTION SENSOR
- CEILING EXHAUST FAN
- CEILING EXHAUST FAN SWITCHED WITH LIGHT
- SUSPENDED PENDANT

HEAT/COOL LEGEND

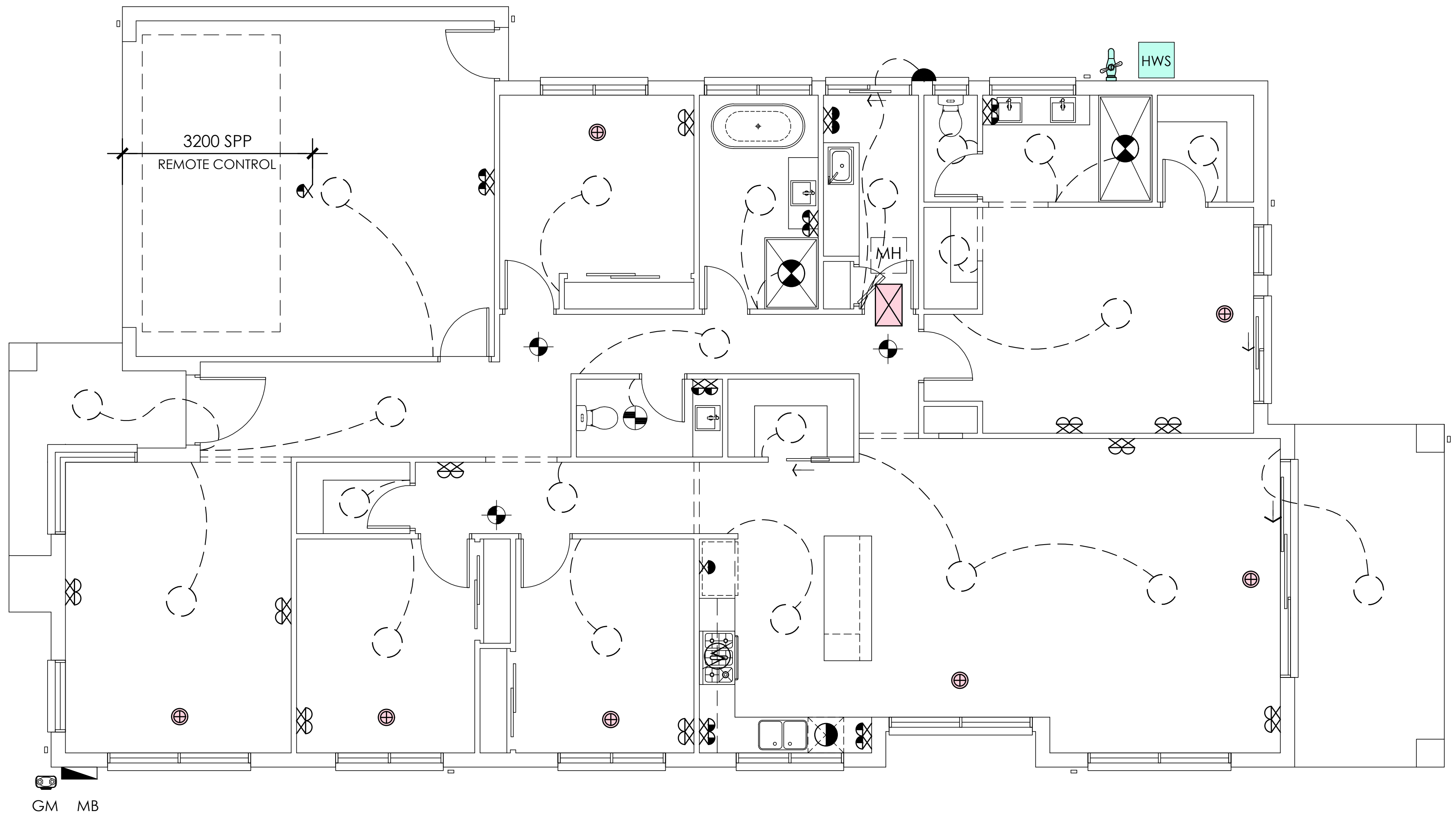
- CEILING HEATING DUCT (APPROX)
- DUCTED HEATING UNIT IN CEILING
- CEILING HEAT/COOL DUCT
- REV CYCLE DUCTED HEAT/COOL UNIT
- TH THERMOSTAT
- RA RETURN AIR
- E EVAPORATIVE COOLING DUCT
- EVAPORATIVE COOLING UNIT
- WP C AC CONDENSOR UNIT
- H AC HEAD UNIT

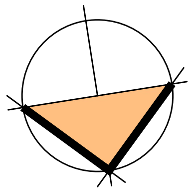
POWER LEGEND

- SINGLE GPO - 300mm
- SINGLE GPO - 1100mm
- SINGLE GPO - 1350mm
- SINGLE GPO - EXTERNAL
- SINGLE GPO - FOR DISHWASHER
- SINGLE GPO - FOR MICROWAVE
- DOUBLE GPO - EXTERNAL
- DOUBLE GPO - 300mm
- DOUBLE GPO - 1100mm
- DOUBLE GPO - 1350mm
- TELEVISION POINT
- TELEPHONE POINT
- METER BOX
- SMOKE DETECTORS (INTERCONNECTED)
- UBO & RHOOD CONNECTIONS
- D DATA POINT WIRED TO NBN
- NBN NBN BOX

DUCTED VACUUM

- DV DUCTED VACUUM UNIT & SGPO
- DUCTED VACUUM OUTLET





DISPLAY

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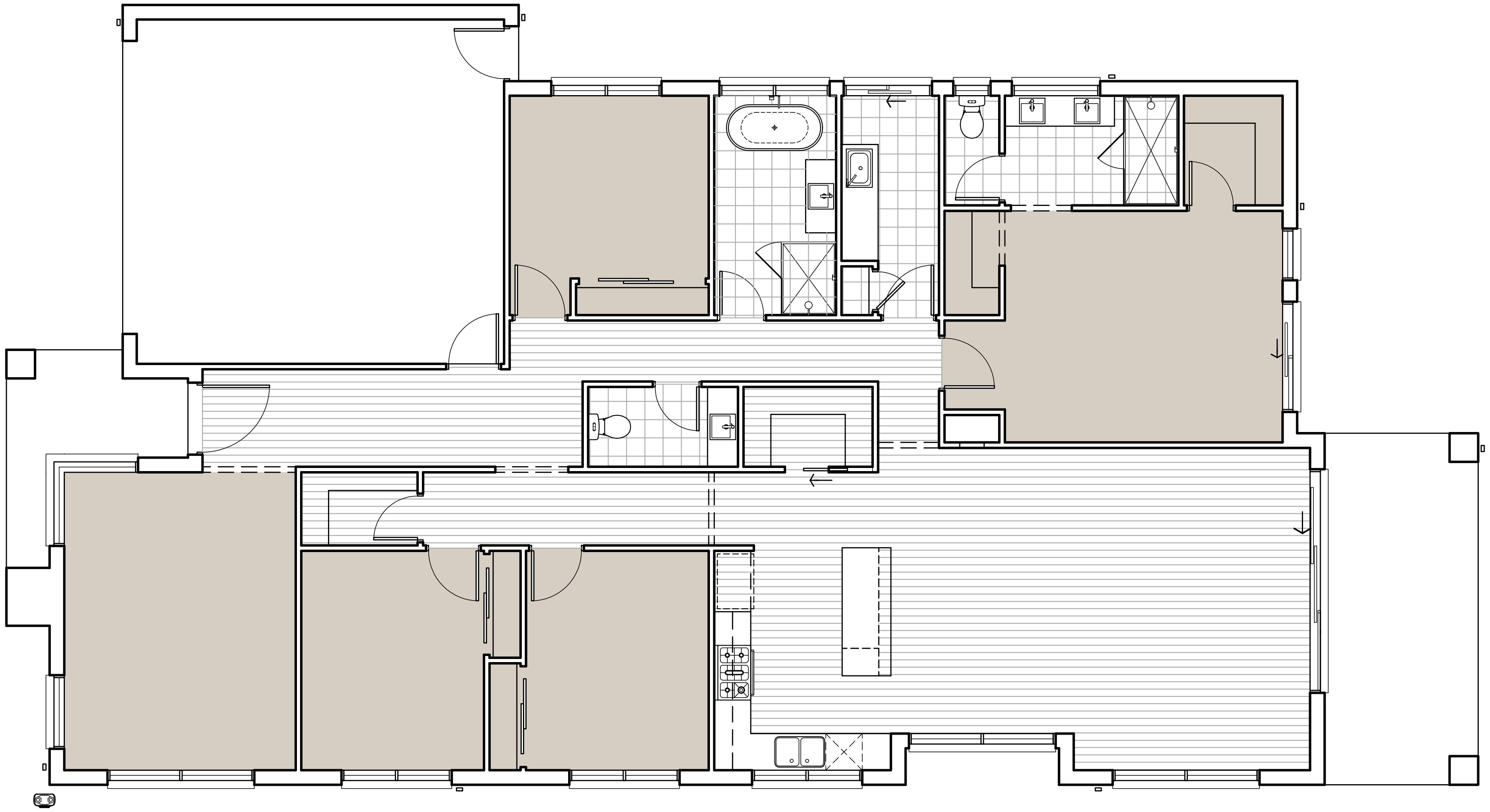
proposed: **HOUSE & GARAGE**
for: **SJD HOMES**
address: **LOT 290 NEWARK PLACE OFFICER 3809**
drawing: **ELECTRICAL PLAN**
drawn : **DGH** date : **07/09/17** scale : **1:100**
sheet : **7** of **8** issue : **D** date: **06/10/17** job no. : **17-01240**

DISPLAY

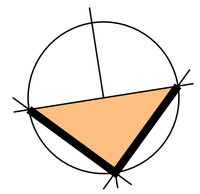


FLOOR COVERINGS

FLOOR TILES
AREA:23.4 M2

CARPET
AREA:77.1 M2

TIMBER FLOORING
AREA:72.9 M2



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proposed: **HOUSE & GARAGE**

for: **SJD HOMES**

address : **LOT 290 NEWARK PLACE**
OFFICER 3809

drawing: **FLOOR COVERINGS PLAN**

drawn : **DGH** date : **07/09/17** scale : **1:100**

sheet : **8** of **8** issue : **D** date:**06/10/17** job no. : **17-01240**

Illustration of Design

FINLAY

FINLAY HOMES

CLIENTS SIGNATURE:____________________ CLIENTS SIGNATURE:____________________

JOB ADDRESS: LOT 7036 NORTH SHORE BURDELL QLD	DESIGN: PROPOSED RESIDENCE			JOB NO: 16 00295		
				SCALE:	ISSUE: G	
CLIENT: FINLAY HOMES	DATE: 20.06.17	DRAWN: ADM	CHECKED: NV	DWG NO: 002		

PROPERTY DETAILS
S.P: 000
PARISH: AAA
COUNTY: AAA
LAND AREA: 000

STAGED PLAN: CONCEPT

USE FIGURED DIMENSIONS AT ALL TIMES. REFER ANY ENQUIRES TO **BUILDING CONTRACTOR**. ALL DIMENSIONS TO BE VERIFIED ON SITE PRIOR TO CONSTRUCTION. ALL WORK TO COMPLY WITH LOCAL AUTHORITY REGULATIONS AND BCA.

Illustration of Design

FINLAY
FINLAY HOMES

CLIENTS SIGNATURE:________________ CLIENTS SIGNATURE:________________

JOB ADDRESS: LOT 7036 NORTH SHORE BURDELL QLD	DESIGN: PROPOSED RESIDENCE			JOB NO: 16 00295	
				SCALE:	ISSUE: G
CLIENT: FINLAY HOMES	DATE: 20.06.17	DRAWN: ADM	CHECKED: NV	DWG NO: 003	

PROPERTY DETAILS	
S.P: 000	STAGED PLAN: CONCEPT
PARISH: AAA	
COUNTY: AAA	
LAND AREA: 000	

USE FIGURED DIMENSIONS AT ALL TIMES. REFER ANY ENQUIRES TO **BUILDING CONTRACTOR**. ALL DIMENSIONS TO BE VERIFIED ON SITE PRIOR TO CONSTRUCTION. ALL WORK TO COMPLY WITH LOCAL AUTHORITY REGULATIONS AND BCA.

AREA SCHEDULE	
ALFRESCO	19.52 m²
GARAGE	40.12 m²
LIVING	174.17 m²
PORCH	5.17 m²
Grand total	238.96 m²

PATHS BY OTHERS

WINDOW SCHEDULE				
No.	Type	Height	Width	Description
03	WL2106	2140	610	A&L_Louvre - Single
04	WL2106	2140	610	A&L_Louvre - Single
07	WL2106	2140	610	A&L_Louvre - Single
08	WL2109	2140	910	A&L_Louvre - Single
09	WL2103	2100	300	A&L_Louvre - Single
10	WL2103	2100	300	A&L_Louvre - Single
12	WL2106	2140	610	A&L_Louvre - Single
14	SW-2124	2100	2410	Sliding Window - XOX-OOO
15	WL2106	2140	610	A&L_Louvre - Single
16	WL2106	2140	610	A&L_Louvre - Single
18	WL2118	2140	610	A&L_Louvre - Single
19	WL2118	2140	610	A&L_Louvre - Single
20	SW-1218	1200	1810	Sliding Window - XO
23	WL2118	2140	610	A&L_Louvre - Single
24	SW-0918	900	1810	Sliding Window - XO
25	DH-2106	2100	610	Double Hung X
26	DH-2106	2100	610	Double Hung X

Floor Plan - Overall

FINLAY

FINLAY HOMES

CLIENTS SIGNATURE:______________________ CLIENTS SIGNATURE:______________________

JOB ADDRESS: LOT 7036 NORTH SHORE BURDELL QLD

DESIGN: PROPOSED RESIDENCE

JOB NO: 16 00295

SCALE: 1 : 150

ISSUE: G

CLIENT: FINLAY HOMES

DATE: 20.06.17

DRAWN: ADM

CHECKED: NV

DWG NO: 200

PROPERTY DETAILS

S.P: 000

PARISH: AAA

COUNTY: AAA

LAND AREA: 000

STAGED PLAN: CONCEPT

USE FIGURED DIMENSIONS AT ALL TIMES. REFER ANY ENQUIRES TO **BUILDING CONTRACTOR**. ALL DIMENSIONS TO BE VERIFIED ON SITE PRIOR TO CONSTRUCTION. ALL WORK TO COMPLY WITH LOCAL AUTHORITY REGULATIONS AND BCA.

AREA SCHEDULE	
ALFRESCO	19.52 m²
GARAGE	40.12 m²
LIVING	174.17 m²
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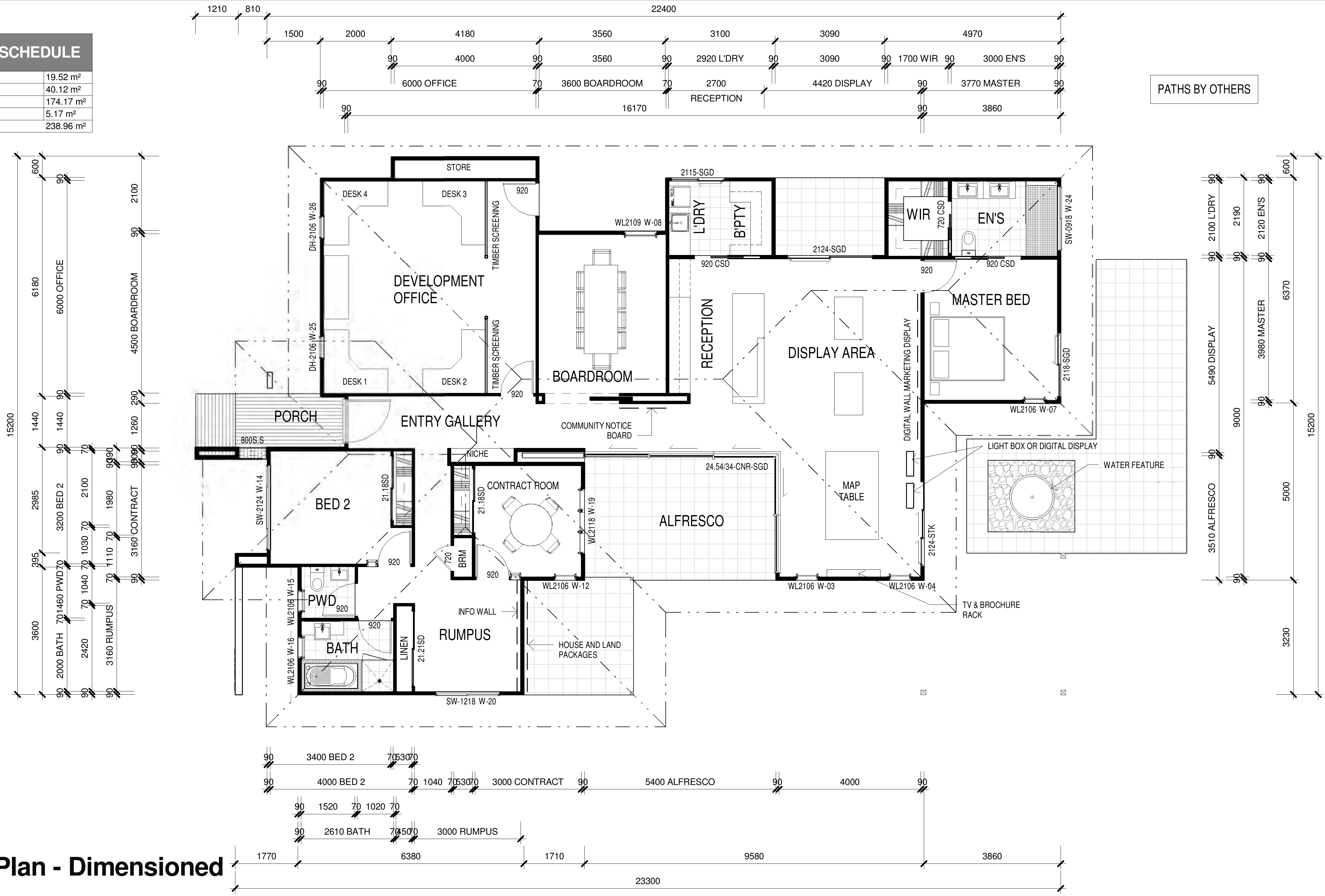
Grand total	238.96 m²



Floor Plan - Dimensioned

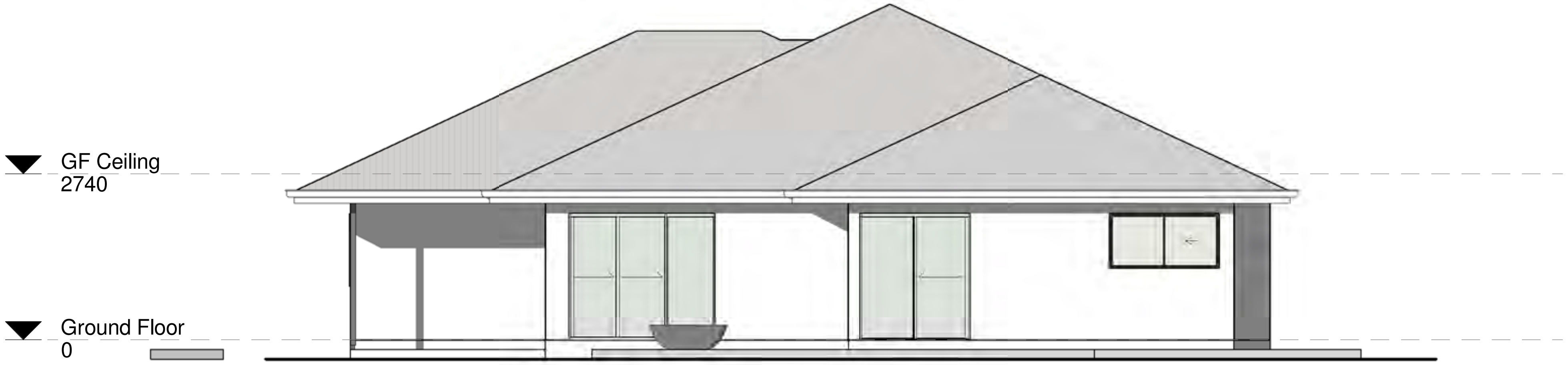
CLIENTS SIGNATURE:________________________ CLIENTS SIGNATURE:________________________

FINLAY

FINLAY HOMES

JOB ADDRESS:	DESIGN:	JOB NO:		PROPERTY DETAILS	STAGED PLAN:
LOT 7036 NORTH SHORE BURDELL QLD	PROPOSED RESIDENCE	16 00295		S.P.: 000	CONCEPT
		SCALE: 1 : 100	ISSUE: G	PARISH: AAA	
CLIENT: FINLAY HOMES	DATE: 20.06.17	DRAWN: ADM	CHECKED: NV	DWG NO: 202	COUNTY: AAA
				LAND AREA: 000	

USE FIGURED DIMENSIONS AT ALL TIMES. REFER ANY ENQUIRES TO **BUILDING CONTRACTOR**. ALL DIMENSIONS TO BE VERIFIED ON SITE PRIOR TO CONSTRUCTION. ALL WORK TO COMPLY WITH LOCAL AUTHORITY REGULATIONS AND BCA.



1 FRONT ELEVATION
1 : 100

2 REAR ELEVATION
1 : 100

Elevations

FINLAY

FINLAY HOMES

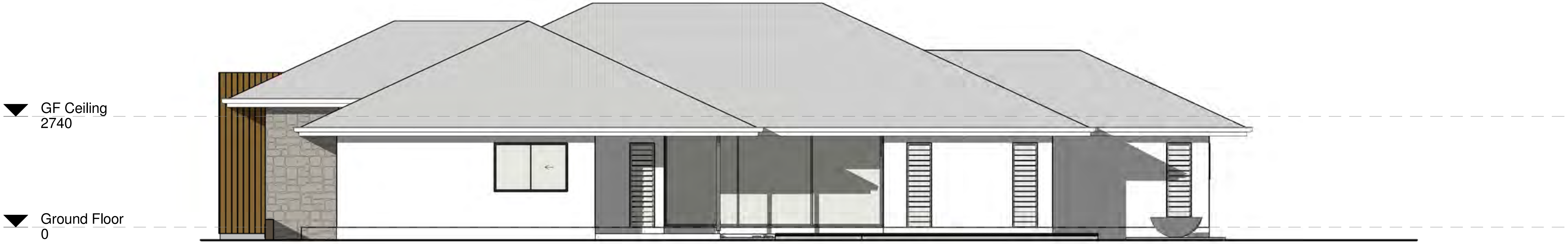
CLIENTS SIGNATURE:______________________ CLIENTS SIGNATURE:______________________

JOB ADDRESS: **LOT 7036 NORTH SHORE BURDELL QLD**	DESIGN: **PROPOSED RESIDENCE**			JOB NO: **16 00295**	
				SCALE: 1 : 100	ISSUE: **G**
CLIENT: **FINLAY HOMES**	DATE: 20.06.17	DRAWN: ADM	CHECKED: NV	DWG NO: 300	

PROPERTY DETAILS
S.P: 000
PARISH: AAA
COUNTY: AAA
LAND AREA: 000

STAGED PLAN:
CONCEPT

USE FIGURED DIMENSIONS AT ALL TIMES. REFER ANY ENQUIRES TO **BUILDING CONTRACTOR**. ALL DIMENSIONS TO BE VERIFIED ON SITE PRIOR TO CONSTRUCTION. ALL WORK TO COMPLY WITH LOCAL AUTHORITY REGULATIONS AND BCA.



1 LEFT ELEVATION
1 : 100

2 RIGHT ELEVATION
1 : 100

Elevations

FINLAY

FINLAY HOMES

CLIENTS SIGNATURE:______________________________ CLIENTS SIGNATURE:__________________________________

JOB ADDRESS: LOT 7036 NORTH SHORE BURDELL QLD	DESIGN: PROPOSED RESIDENCE			JOB NO: 16 00295	
				SCALE: 1 : 100	ISSUE: G
CLIENT: FINLAY HOMES	DATE: 20.06.17	DRAWN: ADM	CHECKED: NV	DWG NO: 301	

PROPERTY DETAILS	
S.P: 000	STAGED PLAN: CONCEPT
PARISH: AAA	USE FIGURED DIMENSIONS AT ALL TIMES. REFER ANY ENQUIRES TO **BUILDING CONTRACTOR**. ALL DIMENSIONS TO BE VERIFIED ON SITE PRIOR TO CONSTRUCTION. ALL WORK TO COMPLY WITH LOCAL AUTHORITY REGULATIONS AND BCA.
COUNTY: AAA	
LAND AREA: 000	

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– EST 1978 –

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SCHEDULE OF DRAWINGS:

SHEET	CONTENTS
1	COVER SHEET
2	SITE PLAN
3	FLOOR PLAN
5	ELEVATIONS 1-2
6	ELEVATIONS 3-4
7	SECTIONS
8	SLAB SETOUT PLAN
9	WET AREA DET.
10	SEDIMENT ANALYSIS PLN
11	STORMWATER PLAN

AMENDMENTS

ISS	DESCRIPTION	BY	DATE
A	APPLICATION PLANS		
B	APPLICATION PLANS	GB	20.06.18
C	REVISED APPLICATION PLANS	GB	02.07.18

APPLICATION PLANS

SIGNATURE:

NOTES:
PLEASE NOTE: DETAILS SHOWN ON THESE PLANS ARE INTENDED TO BE ACCURATE - HOWEVER INFORMATION WRITTEN INTO INDIVIDUAL CONTRACTS WILL TAKE PRECEDENCE OVER PLANS
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* ALL DIMENSIONS ARE TO STRUCTURAL FRAMES ONLY EXCLUDING FINISHED SURFACES

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1 HOMEBUSH BAY DRIVE, BLDG. F
LEVEL 2, SUITE 1
RHODES NSW 2138
TELEPHONE 02 8765 5500
FAX 02 8765 8099
Builder's licence No. 33493C

CLIENT:
RAWSON HOMES

SITE ADDRESS:
BLOCK I/AD
PROPOSED STREET
GINNINDERRY

HOUSE TYPE
MODEL: GRACE 25
FACADE: ELITE
TYPE: DOUBLE GARAGE
SPECIFICATION: LUX

DRAWING TITLE:
COVER SHEET

DRAWN BY:	DATE DRAWN:	CHECKED BY:	APPROVED FOR CONSTRUCTION:
Author	06/26/07	Checker	

COUNCIL AREA:

SCALE:

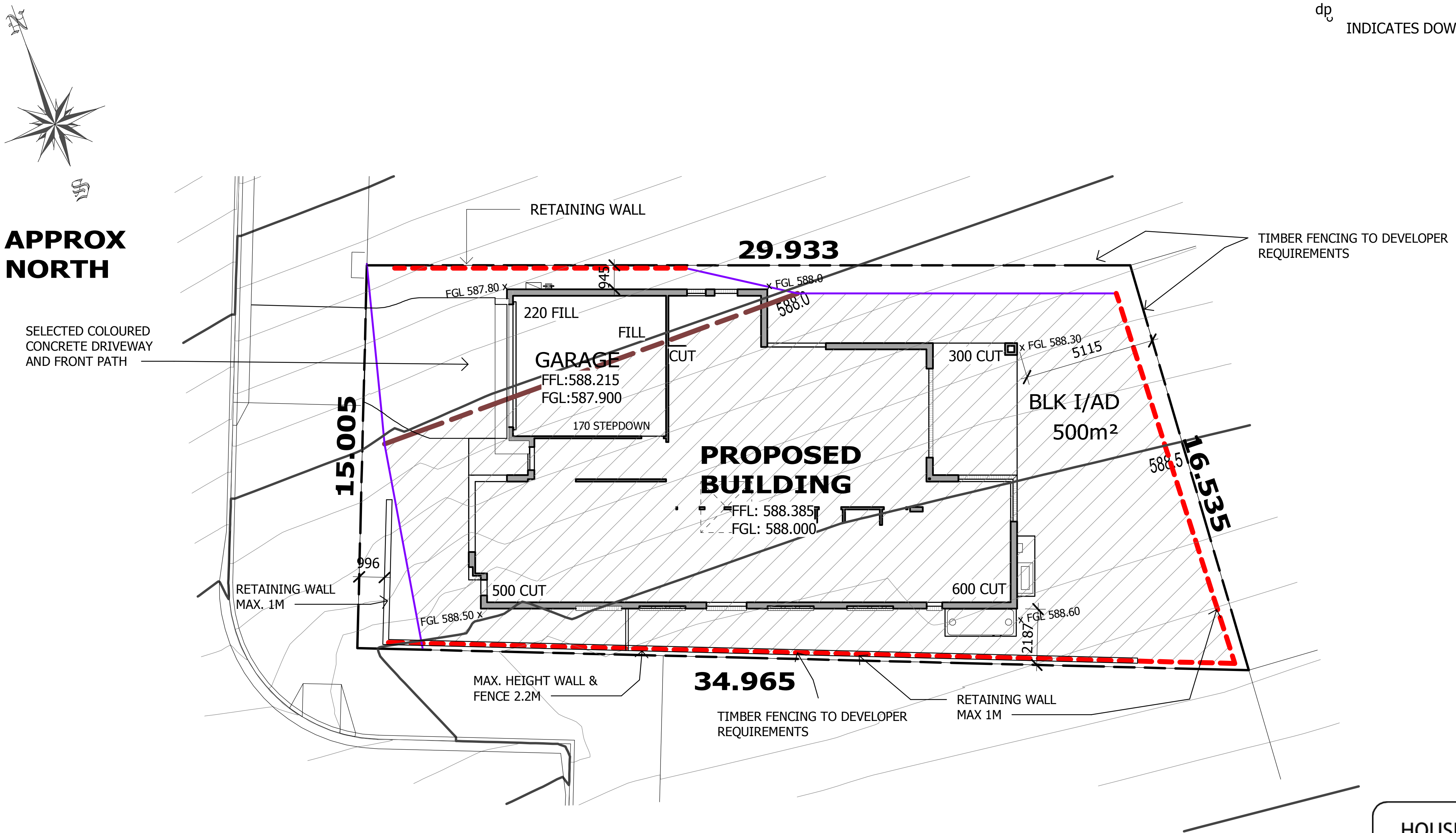
JOB No:	DRWG No:	ISSUE:
7471-STD	1	A

S:\17. DRAFTING\RAWSON HOMES\CONTRACTS AND JOB FILES\A007471 Lot IAD Ginninderry Display (Grace 25 Elite)\A007471 Blk I-AD - Submission Plan (Grace 25 Elite) (Standard).rvt

SITE NOTES:

BEFORE STARTING WORK ON SITE CHECK FOLLOWING:
1. SERVICE LOCATIONS
2. SEWER CONNECTION POSITION
3. DRIVEWAY ALIGNMENT & LEVELS

dp INDICATES DOWNPIPE LOCATION



HOUSE ENERGY RATING
143.6 MJ/m² / ANNUM 6.4 STARS
07-07-2018
SULAIMAN AKBARI
ASSESSOR

DIAL BEFORE YOU DIG www.1100.com.au The Essential First Step

SITE PLAN

NOTES:
PLEASE NOTE: DETAILS SHOWN ON THESE PLANS ARE INTENDED TO BE ACCURATE - HOWEVER INFORMATION WRITTEN INTO INDIVIDUAL CONTRACTS WILL TAKE PRECEDENCE OVER PLANS
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RAWSON HOMES
1 HOMEBUSH BAY DRIVE, BLDG. F
LEVEL 2, SUITE 1
RHODES NSW 2138
TELEPHONE 02 8765 5500
FAX 02 8765 8099
Builder's licence No. 33493C

CLIENT: RAWSON HOMES
SITE ADDRESS: BLOCK I/AD PROPOSED STREET GINNINDERRY

HOUSE TYPE
MODEL: GRACE 25
FACADE: ELITE
TYPE: DOUBLE GARAGE
SPECIFICATION: LUX
DRAWING TITLE: SITE PLAN

DRAWN BY:	DATE DRAWN:	CHECKED BY:	APPROVED FOR CONSTRUCTION:
Author	06/26/07	Checker	
COUNCIL AREA:		SCALE: 1 : 200	
JOB No: 7471-STD		DRWG No: 2	ISSUE: A

S:\17. DRAFTING\RAWSON HOMES\CONTRACTS AND JOB FILES\A007471 Lot IAD Ginninderry Display (Grace 25 Elite)\A007471 Blk I-AD - Submission Plan (Grace 25 Elite) (Standard).rvt

NOTES:

- ALL EXTERNAL DOORS TO BE FITTED WITH DRAFT EXCLUSION DEVICE
- WC DOORS TO BE FITTED WITH LIFT-OFF HINGES
- WINDOW OPENING SIZES TO BE CHECKED BEFORE FRAMES ARE CONSTRUCTED
- FRAMES & TRUSSES TO SATISFY AS 1684 SAA TIMBER FRAMING CODE

HOUSE ENERGY RATING

143.6 MJ/m² / ANNUM 6.4 STARS

07-07-2018

SULAIMAN AKBARI

ASSESSOR

GROUND FLOOR

FLOOR AREAS

LIVING AREA	182.65 m²
GARAGE	36.03 m²
ALFRESCO	17.09 m²
PORCH	3.35 m²
TOTAL	239.12 m²

NOTES:
PLEASE NOTE: DETAILS SHOWN ON THESE PLANS ARE INTENDED TO BE ACCURATE - HOWEVER INFORMATION WRITTEN INTO INDIVIDUAL CONTRACTS WILL TAKE PRECEDENCE OVER PLANS

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LEVEL 2, SUITE 1
RHODES NSW 2138
TELEPHONE 02 8765 5500
FAX 02 8765 8099
Builder's licence No. 33493C

CLIENT: RAWSON HOMES

SITE ADDRESS: BLOCK I/AD PROPOSED STREET GINNINDERRY

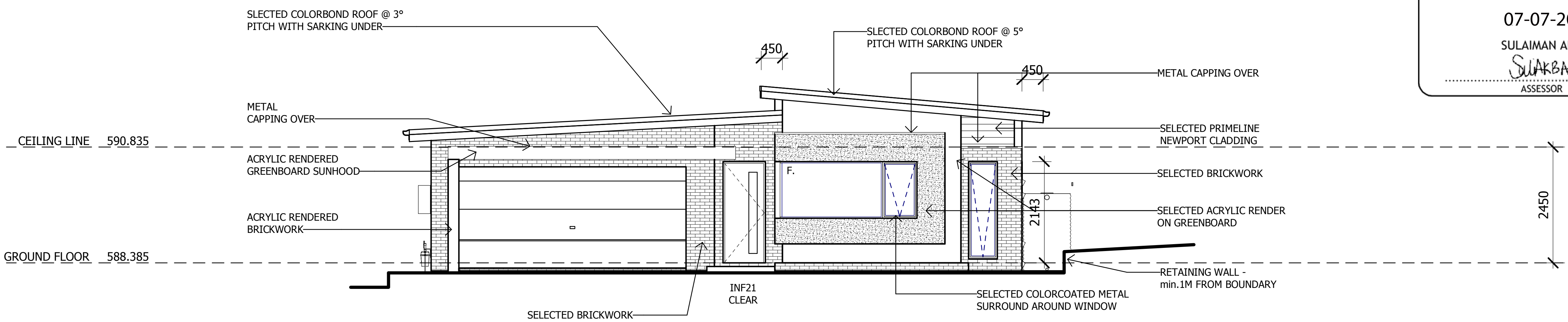
HOUSE TYPE
MODEL: GRACE 25
FACADE: ELITE
TYPE: DOUBLE GARAGE
SPECIFICATION: LUX

DRAWING TITLE: FLOOR PLAN

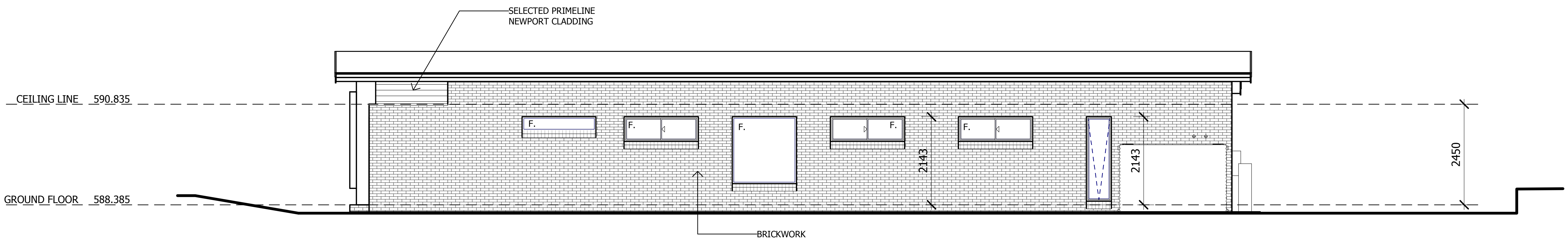
DRAWN BY:	DATE DRAWN:	CHECKED BY:	APPROVED FOR CONSTRUCTION:
Author	06/26/07	Checker	
COUNCIL AREA:		SCALE: 1 : 100	
JOB No: 7471-STD		DRWG No: 3	ISSUE: A

S:\17. DRAFTING\RAWSON HOMES\CONTRACTS AND JOB FILES\A007471 Lot IAD Ginninderry Display (Grace 25 Elite)\A007471 Blk I-AD - Submission Plan (Grace 25 Elite) (Standard).rvt

HOUSE ENERGY RATING
143.6 MJ/m² /ANNUM 6.4 STARS
07-07-2018
SULAIMAN AKBARI
ASSESSOR



ELEVATION 1



ELEVATION 2

S:\17. DRAFTING\RAWSON HOMES\CONTRACTS AND JOB FILES\A007471 Lot IAD Ginninderry Display (Grace 25 Elite)\A007471 Blk I-AD - Submission Plan (Grace 25 Elite) (Standard).rvt

NOTES:
PLEASE NOTE: DETAILS SHOWN ON THESE PLANS ARE INTENDED TO BE ACCURATE - HOWEVER INFORMATION WRITTEN INTO INDIVIDUAL CONTRACTS WILL TAKE PRECEDENCE OVER PLANS
* ALL DIMENSIONS ARE IN MILLIMETRES
* DO NOT SCALE - USE WRITTEN DIMENSIONS
* ALL DIMENSIONS ARE TO STRUCTURAL FRAMES ONLY EXCLUDING FINISHED SURFACES

RAWSON HOMES
1 HOMEBUSH BAY DRIVE, BLDG. F
LEVEL 2, SUITE 1
RHODES NSW 2138
TELEPHONE 02 8765 5500
FAX 02 8765 8099
Builder's licence No. 33493C

CLIENT:
RAWSON HOMES

SITE ADDRESS:
BLOCK I/AD
PROPOSED STREET
GINNINDERRY

HOUSE TYPE
MODEL: GRACE 25
FACADE: ELITE
TYPE: DOUBLE GARAGE
SPECIFICATION: LUX

DRAWING TITLE:
ELEVATIONS 1-2

DRAWN BY:	DATE DRAWN:	CHECKED BY:	APPROVED FOR CONSTRUCTION:
WA	06/26/07	Checker	

COUNCIL AREA:

SCALE: 1 : 100

JOB No:	DRWG No:	ISSUE:
7471-STD	5	A

HOUSE ENERGY RATING

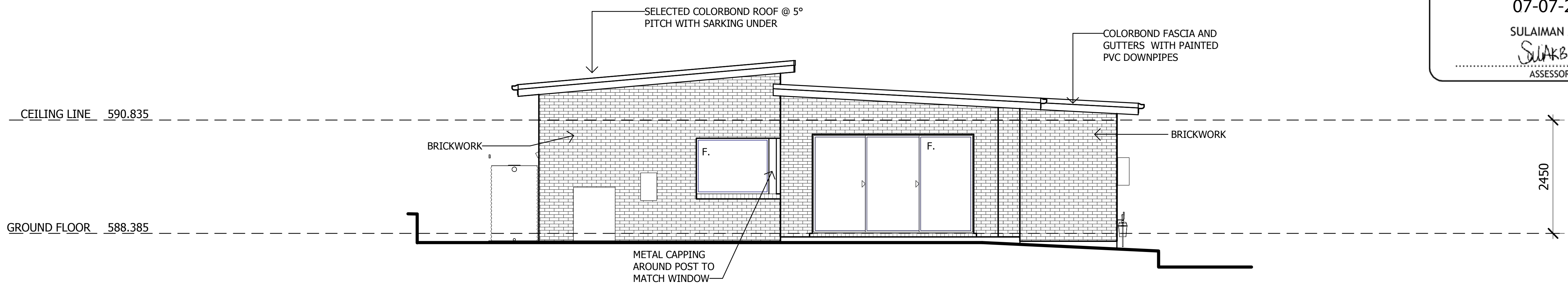
143.6 MJ/m² /ANNUM 6.4 STARS

07-07-2018

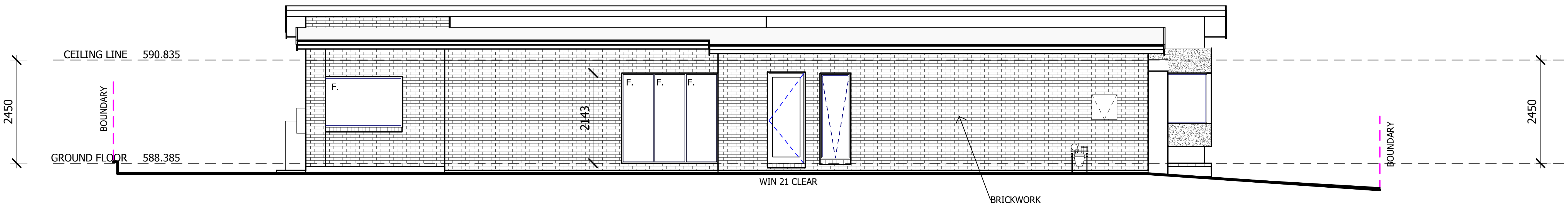
SULAIMAN AKBARI

SUAKBARI

ASSESSOR



ELEVATION 3



ELEVATION 4

NOTES:
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LEVEL 2, SUITE 1
RHODES NSW 2138
TELEPHONE 02 8765 5500
FAX 02 8765 8099
Builder's licence No. 33493C

CLIENT:
RAWSON HOMES

SITE ADDRESS:
BLOCK I/AD
PROPOSED STREET
GINNINDERRY

HOUSE TYPE
MODEL: GRACE 25
FACADE: ELITE
TYPE: DOUBLE GARAGE
SPECIFICATION: LUX

DRAWING TITLE:
ELEVATIONS 3-4

DRAWN BY:	DATE DRAWN:	CHECKED BY:	APPROVED FOR CONSTRUCTION:
Author	06/01/10	Checker	
COUNCIL AREA:		SCALE: 1 : 100	
JOB No: 7471-STD		DRWG No: 6	ISSUE: A

S:\17. DRAFTING\RAWSON HOMES\CONTRACTS AND JOB FILES\A007471 Lot IAD Ginninderry Display (Grace 25 Elite)\A007471 Blk I-AD - Submission Plan (Grace 25 Elite) (Standard).rvt

HOUSE ENERGY RATING

143.6 MJ/m² /ANNUM 6.4 STARS

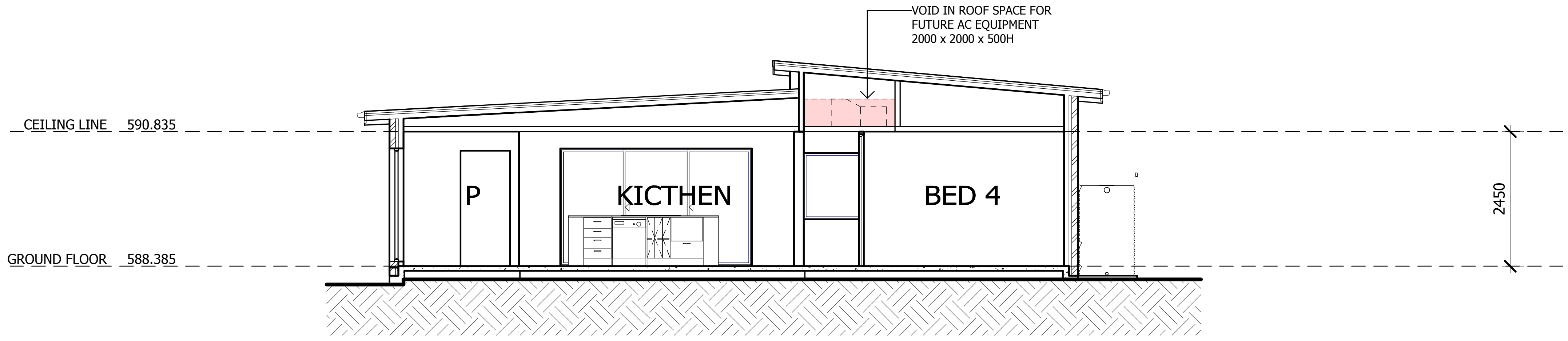
07-07-2018

SULAIMAN AKBARI

ASSESSOR

INSULATION NOTE:

- R3.5 BULK INSULATION BATTS TO LIVING AREA CEILINGS
- R2.0 INSULATION TO EXTERNAL WALLS



SECTION A-A

S:\17. DRAFTING\RAWSON HOMES\CONTRACTS AND JOB FILES\A007471 Lot IAD Ginninderry Display (Grace 25 Elite)\A007471 Blk I-AD - Submission Plan (Grace 25 Elite) (Standard).rvt

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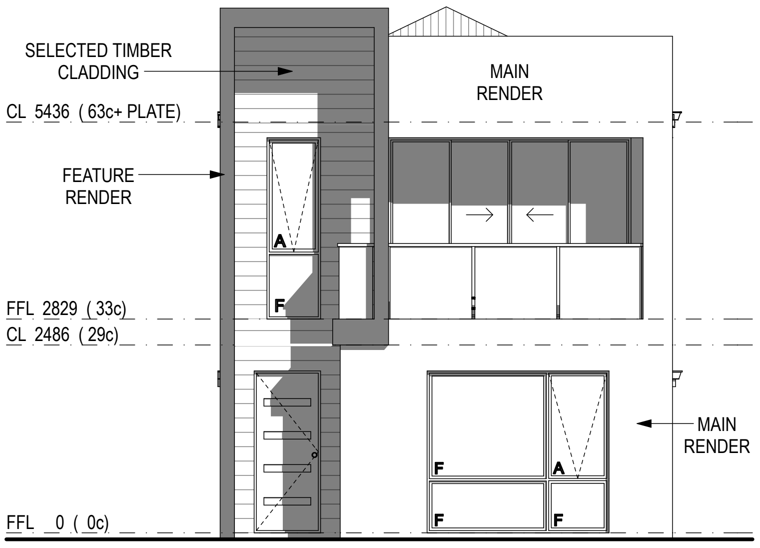
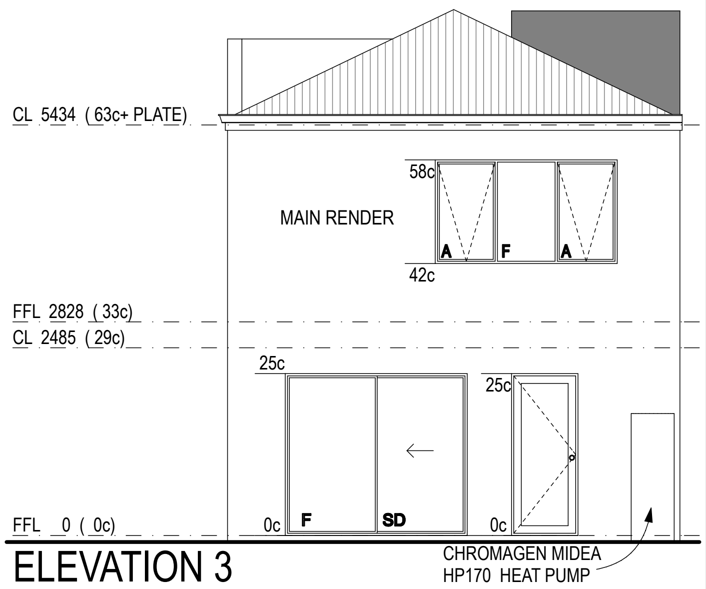
RAWSON HOMES
1 HOMEBUSH BAY DRIVE, BLDG. F
LEVEL 2, SUITE 1
RHODES NSW 2138
TELEPHONE 02 8765 5500
FAX 02 8765 8099
Builder's licence No. 33493C

CLIENT: RAWSON HOMES	HOUSE TYPE	DRAWN BY: Author	DATE DRAWN: 06/26/07
SITE ADDRESS: BLOCK I/AD PROPOSED STREET GINNINDERRY	MODEL: GRACE 25	CHECKED BY: Checker	APPROVED FOR CONSTRUCTION:
	FACADE: ELITE	COUNCIL AREA:	SCALE: 1 : 100
	TYPE: DOUBLE GARAGE		
	SPECIFICATION: LUX		
	DRAWING TITLE: SECTIONS	JOB No: 7471-STD	DRWG No: 7 / ISSUE: A



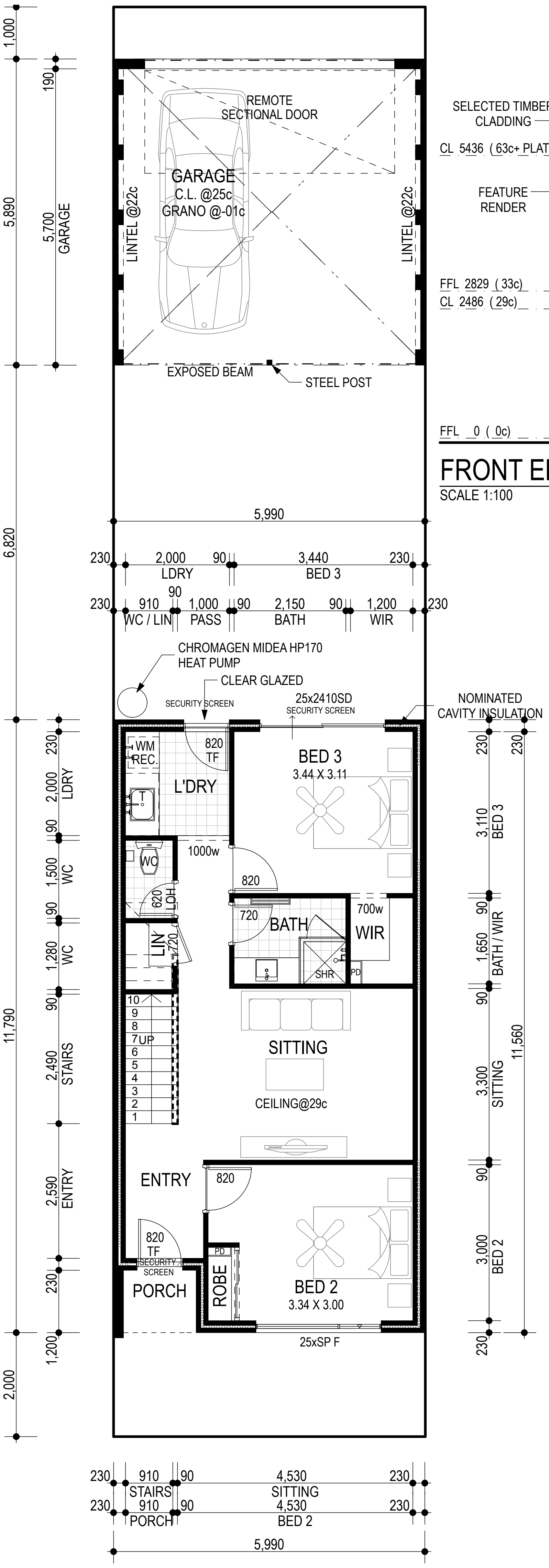
FRONT ELEVATION

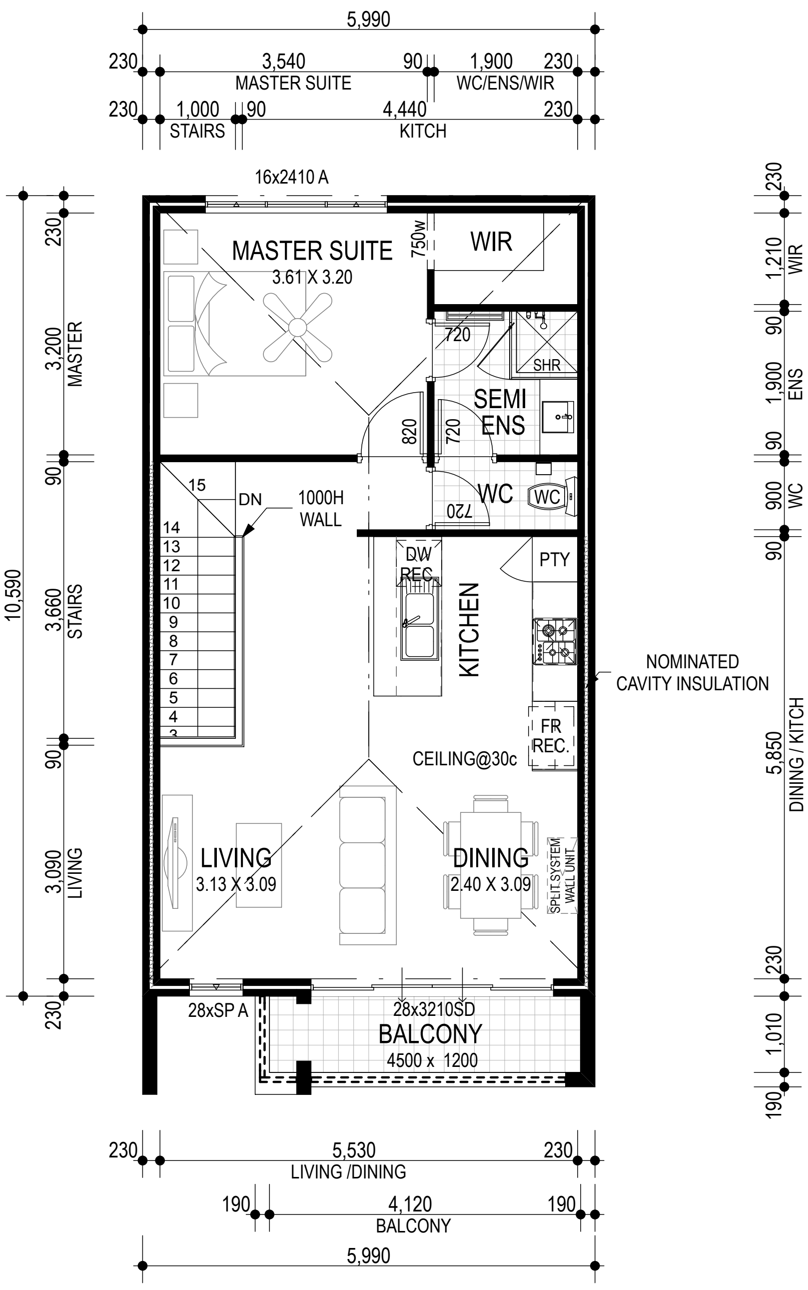
SCALE 1:100

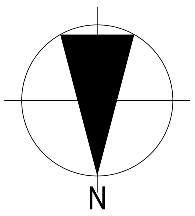


ELEVATION 3

SCALE 1:100







ROOF AREAS		
AREA [m2 ON THE FLAT]		95.00
AREAS:		
	PERIM. (m)	AREA (m2)
GROUND FLOOR	35.56	68.71
FIRST FLOOR	33.16	63.43
GARAGE	0.00	35.34
BALCONY	---	5.47
PORCH	5.78	2.07
		175.02 m²

BUILDER: ________________/__/__/__/

CLIENT(S):________________/__/__/__/

WITNESS: ________________/__/__/__/

ADDRESS:
LOT 711 , ARIES VISTA
BENNETT SPRINGS

VARIATIONS:
AMEND'S 06/08/18 FG

SHEET 1 OF 1

LAST OPENED: 24/08/2018
TIME: 4:58 pm
MODEL NAME: THE WINDSOR

DATE: XX/XX/XX
DRN: XX
CHD: XX
SCALE: 1:100

JOB No: XXXXX

TERRACE

FILE PATH: /Volumes/shares/pcp-design/01 Sales Sketches/Jess Reid/WINDSOR 6 STAR NEW/WINDSOR NEW 7.pln