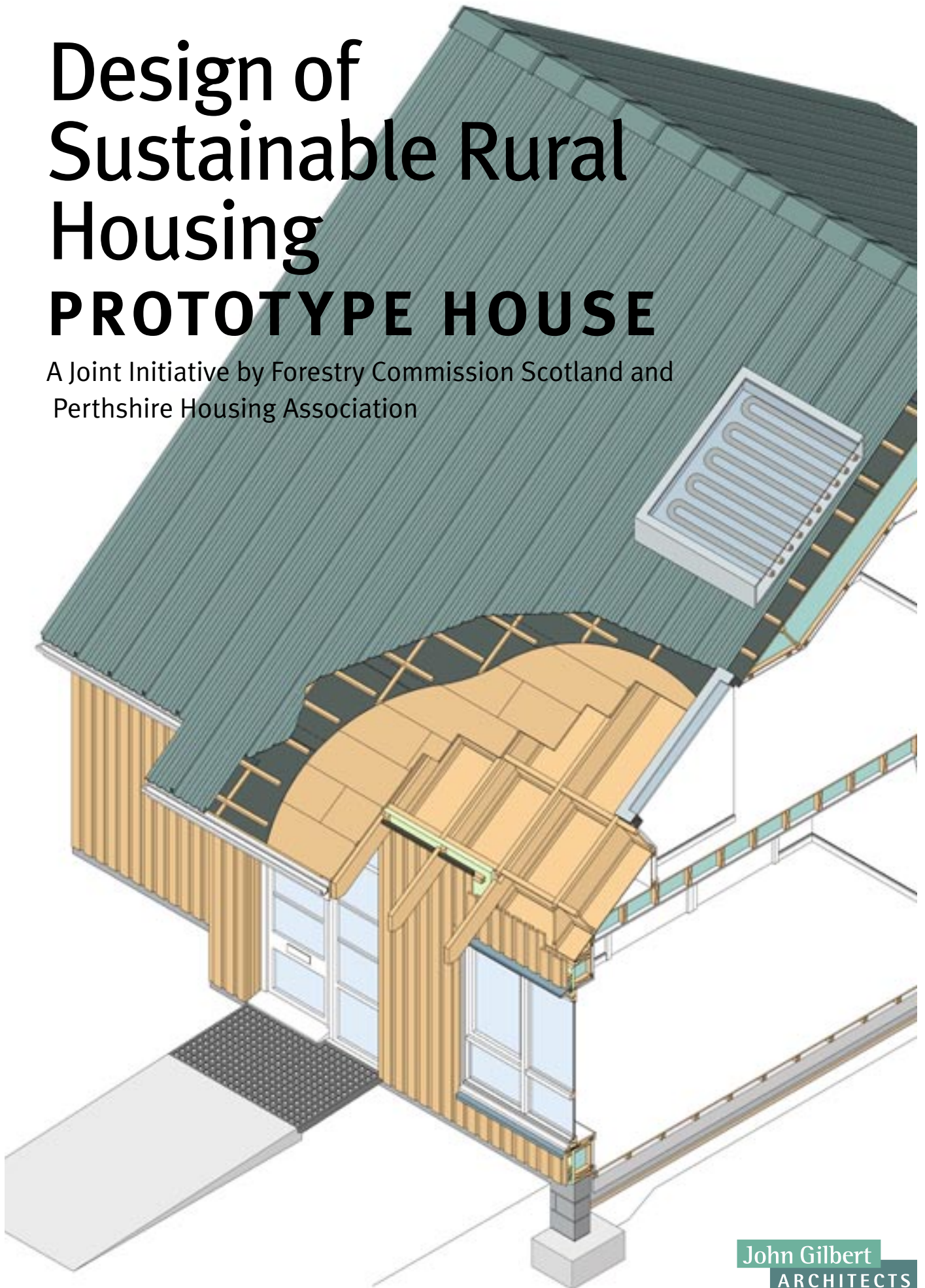
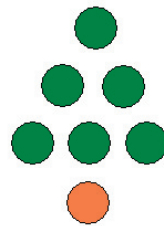


# Design of Sustainable Rural Housing **PROTOTYPE HOUSE**

A Joint Initiative by Forestry Commission Scotland and  
Perthshire Housing Association



This project has been funded by:



SCOTTISH FOREST INDUSTRIES CLUSTER

Published June 2006

## Synopsis

This report by John Gilbert Architects was commissioned by Perthshire Housing Association and Forestry Commission Scotland, with support from Scottish Forest Industries Cluster, with the aim of reaching a wider audience that would include all those involved in providing social and private housing for rural locations.

The provision of locally sourced and produced construction materials is a key part of the sustainable design agenda. Rural Scotland is on the periphery of most transport networks and has vast timber resources; the potential to reduce transportation and increase local employment is huge. This report examines current sustainable housing and uses the lessons learnt to develop a new prototype, maximising the use of Scottish timber in rural, affordable, low energy housing provision. In addition it examines the practical implementation issues, such as costs, procurement issues and potential hurdles that need to be addressed.

The report is split into two sections, Section one outlines the development of a prototype, initial costs and the issues that would be important in construction. Drawings and supplementary information are within the appendices at the back.

Section two analyses four case studies of complete social housing projects, in terms of their construction, timber usage and environmental credentials. It also considers the main reasons why Scottish timber is currently not commonly used in timber frame buildings.

In preparing these documents, John Gilbert Architects acknowledge the assistance and guidance given by a number of individuals, particularly Ivor Davis and Geoff Pitts together with information and assistance from J. Jones. Their input is much appreciated, though the final report is the responsibility of the authors. Information contained in this report does not infer compliance with the Building Standards, where a building warrant is required, appropriate advice can be obtained from the relevant local authority Building Control office.

## Contents

### Section 1 – The Prototype House

<b>1.</b>	<b>Prototype House Development</b>	<b>4</b>
1.1	Introduction and Brief .....	4
<b>2.</b>	<b>Prototype Development</b>	<b>5</b>
2.1	Approach .....	5
2.2	Prototype 1 .....	5
2.3	Prototype 2 .....	6
2.4	Prototype 3 .....	7
2.5	Prototype 4 .....	8
2.6	Preferred Option .....	9
<b>3.</b>	<b>Growing Greener Specification</b>	<b>12</b>
3.1	Issues .....	12
3.2	Basic Building Regulation Standard.....	13
3.3	Enhanced Kit Construction .....	13
3.4	Enhanced (High Thermal Mass) .....	13
3.5	Timber High Insulation .....	13
3.6	Zero Emissions .....	14
3.7	Green to Greener Calculations .....	14
3.8	Green to Greener Specification .....	15
<b>4.</b>	<b>Cost Report</b>	<b>18</b>
4.1	Introduction.....	18
4.2	House Areas .....	19
4.3	Building Elements .....	20
4.4	Contract Preliminaries .....	20
4.5	Phase 1 & 2 .....	20
4.6	Other Costs.....	20
4.7	Further Savings.....	20
<b>5.</b>	<b>Construction Issues</b>	<b>21</b>
5.1	Wall Construction .....	21
5.2	Underbuilding.....	22
5.3	Roof.....	22
5.4	Floor .....	22
5.5	Doors and Windows .....	23
5.6	Sunspaces.....	23
5.7	Air Tightness and Ventilation .....	23
5.8	Insulation .....	24
<b>6.</b>	<b>Heating</b>	<b>27</b>
6.1	Introduction.....	27
6.2	Wood fuel .....	27
6.3	Solar .....	27
6.4	Wind .....	28
6.5	Electric.....	29
6.6	Communal Heating Options .....	29
6.7	Reducing Electrical Loads .....	29
<b>7.</b>	<b>Material Selection</b>	<b>31</b>
7.1	Introduction.....	31
7.2	Health .....	33
<b>8.</b>	<b>Meeting Ecohomes Standards</b>	<b>34</b>
<b>9.</b>	<b>Site related matters</b>	<b>36</b>
<b>10.</b>	<b>Prototype Summary</b>	<b>37</b>

**11. Appendix 1** **38**  
11.1 Cost Breakdowns..... 38

**12. Appendix 2** **39**  
12.1 Prototype Plans and details..... 39

# 1. Prototype House Development

## 1.1 Introduction and Brief

- 1.1.1 The first section of this report outlines the Rural House Prototype developed by John Gilbert Architects. Perthshire Housing Association commissioned the development of this house, with the aim of investigating the best approach for affordable rural housing that would only require back up heating and would maximise the use of Scottish timber and timber products.
- 1.1.2 The Association were keen to see what the additional costs might be for more energy efficient forms of construction as well as various heating and ventilation options that would make the building less dependant on fossil fuels. The nature of the project demanded a design that could be used on a variety of sites and locations within rural Scotland. It was agreed to develop a 'prototype house' designed in the form of a semi-detached house, with the assumption that a typical development would consist of about six houses. It is appreciated at the outset that a site-less design needs to be robust enough to accommodate changes in site, levels, orientation, surroundings and ground conditions.
- 1.1.3 The housing was to provide a minimum of two bedrooms at the outset, but be capable of extending into the roof space in order to create more space for a growing family. This would thus avoid the need for young families to relocate as their housing requirements changed over time.
- 1.1.4 The prototypes show a progression of the design and are not necessarily comparable. Types one and two have two bedrooms at ground level, with the additional upper floor bedrooms added in a later phase. This is likely to be the most flexible way of providing attic space that can be extended into as stairs do not need to be built nor do additional services get plumbed in upstairs. The Association wanted to have a prototype that would present a narrower overall width in plan, as a result, prototypes 3 and 4 were developed, both of which only have one bedroom downstairs. These options then require both a stair and wall and floor finishes to be built in at the outset. Although the third bedroom and additional bathroom can be left to be finished at a later stage, it would be more economical to build all the rooms at the same time.
- 1.1.5 In parallel with the development of the building design, a range of specification options were to be developed. These narrowed down the vast array of specification options to five sets. This we have called our 'green to greener' specification, starting off with a base model typical of that provided under the Building Regulations, and ending up with a zero emissions option. Each option illustrates building fabric specification, heating and hot water systems and potential energy generation measures. These options are then used to calculate annual energy usage and an indicative cost for the prototype.
- 1.1.6 In addition there is a commentary on the main elements of the design with reasoning behind the choices made and a full cost analysis.
- 1.1.7 It should be noted that this report is written in the Scottish context, with all references to Standards and Regulations being the appropriate Scottish documents. In particular, space standards refer to those accepted as benchmarks by Communities Scotland.

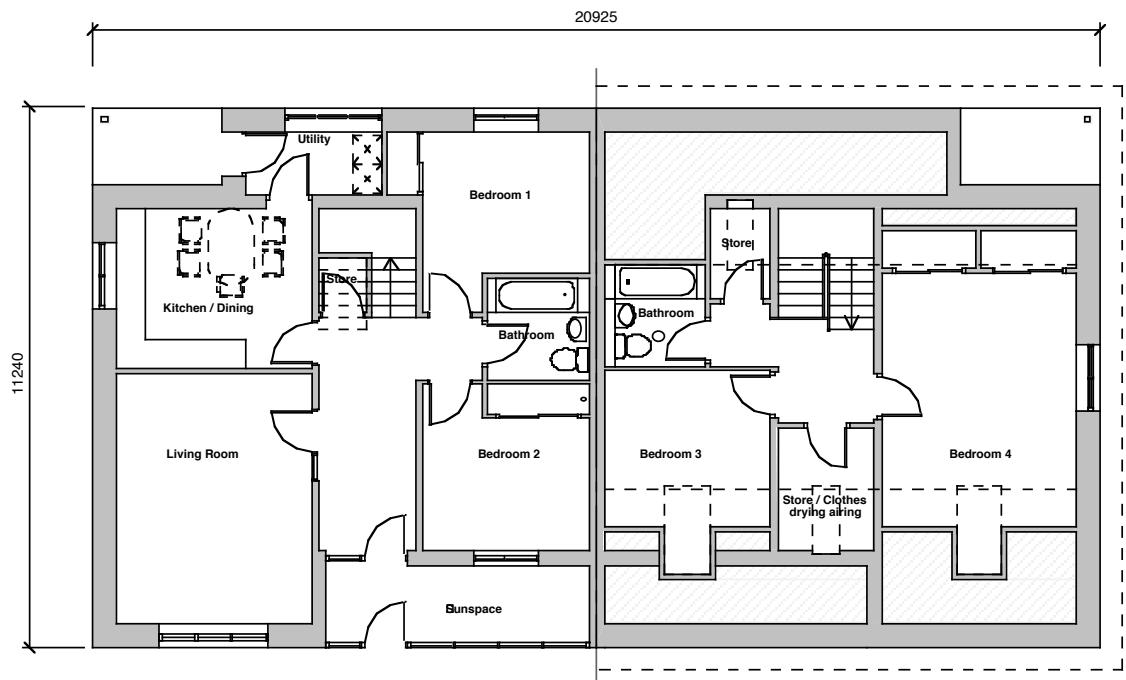
## 2. Prototype Development

### 2.1 Approach

- 2.1.1 Four house prototypes were developed for initial discussion with the client group. The types developed from two different approaches. One approach was to create a two bedroomed semi-detached bungalow, with all facilities at ground level, but where the upper attic floor could be converted to provide two additional bedrooms at a later stage. This approach assumed that the staircase would be installed at a later date. The other main approach was to install the staircase under the first stage, providing a ground floor bedroom and an upper floor bedroom. An additional bedroom and bathroom could then be added at a later stage.

### 2.2 Prototype 1

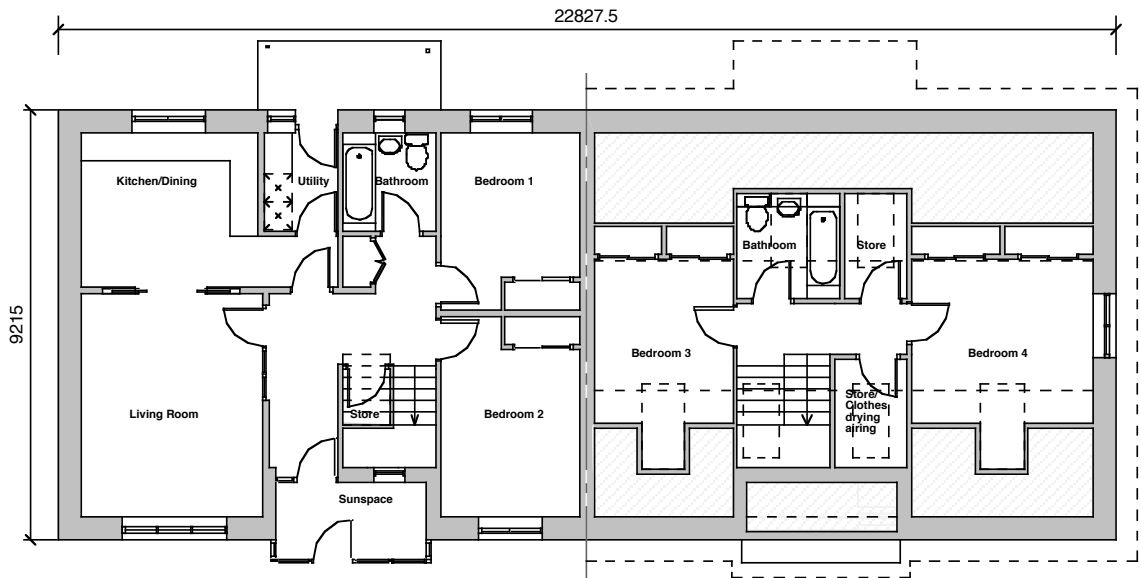
- 2.2.1 This is a simple rectangular plan providing separate kitchen and living facilities and two double bedrooms on the ground floor. There is an integrated sunspace which provides a buffer space at the front entrance and a rear utility room, also providing an unheated buffer space. The bathroom is internal although this could be altered to a gable location if the plan was flipped. The space where the stairs would be located in the second stage is given over as a clothes drying room. In the second stage, two additional bedrooms can be installed in the attic space plus an additional bathroom and the drying room is relocated. This plan eventually provides a four bedroomed 8 person house.



**PROTOTYPE 1 - GROUND & UPPER FLOOR PLANS**

## 2.3 Prototype 2

2.3.1 This plan takes a similar approach to prototype 1 but has a wider footprint (though a smaller overall area). It also has a buffer space front and back with interlinking kitchen/dining and living spaces. The bathroom faces the rear. There is a clothes drying store adjacent to the sunspace which provides space for the installation of the stair in the second stage. Two additional bedrooms and a bathroom can be installed in the roofspace.

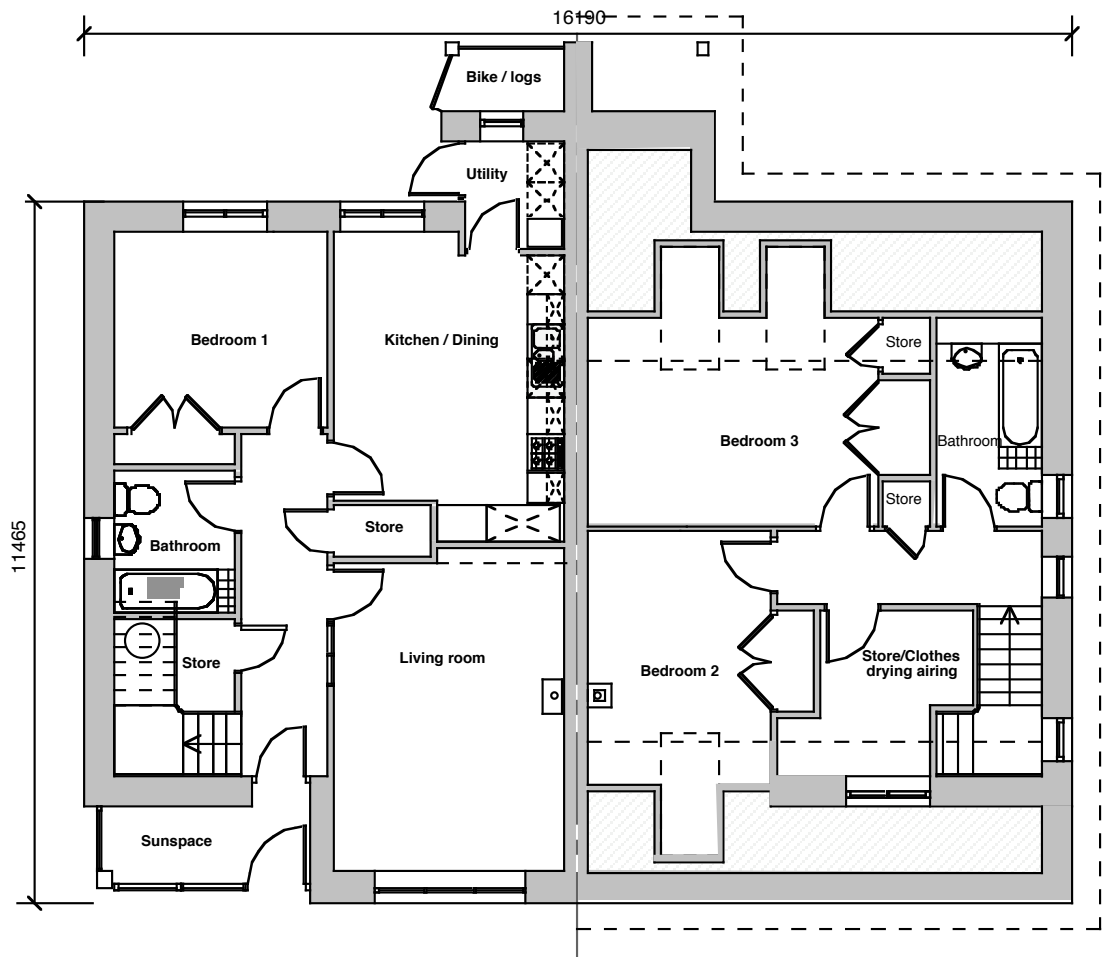


**PROTOTYPE 2 - GROUND & UPPER FLOOR PLANS**

## 2.4 Prototype 3

2.4.1 This plan provides one bedroom at ground level and an upper floor bedroom, requiring the staircase to be built in. The bathroom on the ground floor is on the gable with the front and back doors each having a buffer space (sunspace and utility space respectively). Kitchen/ dining space and living room are generous, but take into account the requirements of a larger household. Upstairs a single bedroom would be formed initially (bedroom 2). The upstairs bathroom could be installed at a later date, or completed in phases, initially as a toilet and wash hand basin. Under the second stage it is a relatively simple task to form an additional bedroom and there is also space for a clothes drying room or study. A space for bike storage and logs is also provided.

2.4.2 Whilst the overall width of this plan is much narrower than prototypes 1 and 2, it has the disadvantage that the stairs and much fitting out needs to be completed upstairs. Whilst it would be simple to add the extra bedroom and bathroom at a later stage, it would be more cost effective to complete all the work at the initial building stage. This comment also applies to prototype 4.

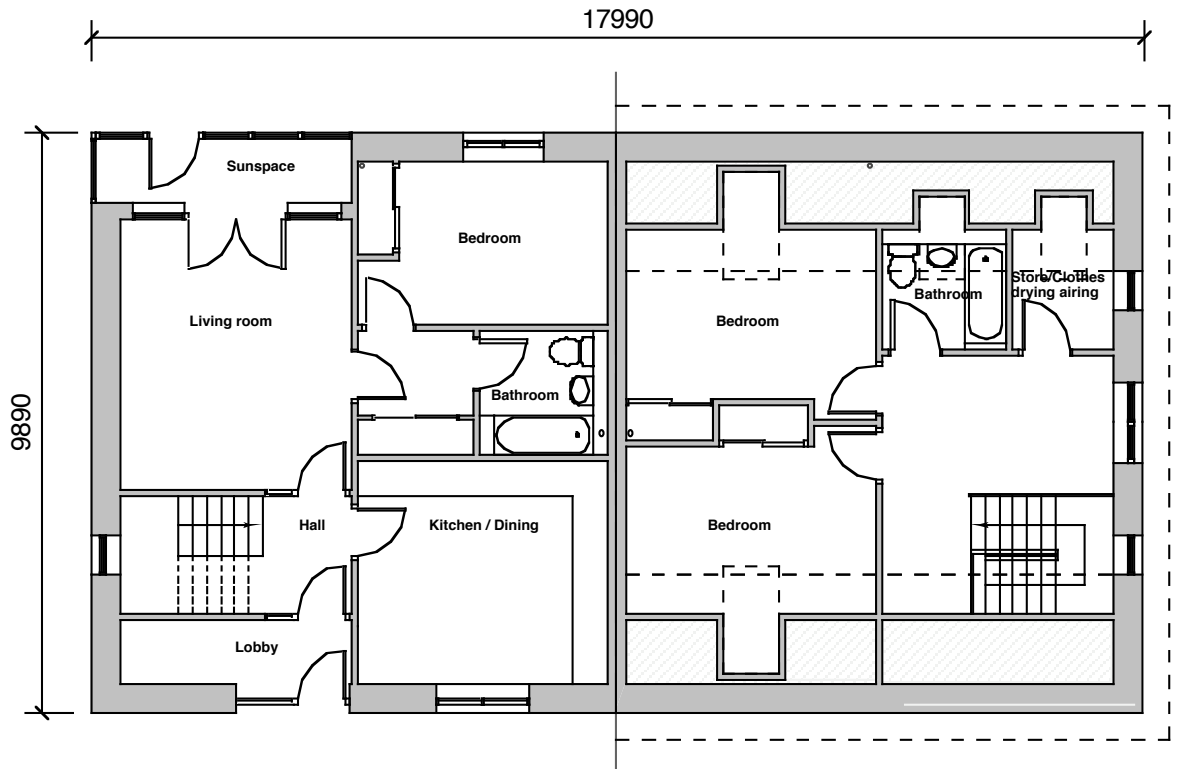


**PROTOTYPE 3 - GROUND & UPPER FLOOR PLANS**

## 2.5 Prototype 4

2.5.1 This plan provides similar accommodation to prototype 3 but re-orientates the living room and kitchen to take into account a different orientation. The rear, south facing living room opens out into a sunspace and a buffer space is provided at the north facing front entrance. The ground floor bedroom and bathroom are accessed off a small lobby off the living area. The upstairs bedroom is accessed from an open hallway space and an upstairs bathroom and drying room are also included.

2.5.2 Because the kitchen is to the front in this option, a utility space is not included, but a draught lobby is.



**PROTOTYPE 4 - GROUND & UPPER FLOOR PLANS**

## 2.6 Preferred Option

2.6.1 The diagram overleaf shows the constructional elements of the prototype. Full details of the proposed plan, elevations and details are contained in Appendix 2. It should be noted that the prototype would always need adjustment to fit the specific site context, the slope of the land, orientation, open or forested location together with any requirements of the local planning department etc.

2.6.2 The preferred option developed prototype 3, adjusting the floor area to meet the Scottish Housing Handbook, Bulletin 1 Metric Space Standards and incorporation of a sunspace. There is one ground floor double bedroom, a full wheelchair accessible bathroom, a kitchen and dining space and an 18.4m<sup>2</sup> living room. Under the first phase there is one double bedroom upstairs together with a store for drying clothes and airing. Under the second phase an additional bedroom can be added, as well as an upstairs bathroom that could have a shower rather than a bath. The clothes drying room is relocated providing a large walk in store.

2.6.3 This gives the following floor areas:

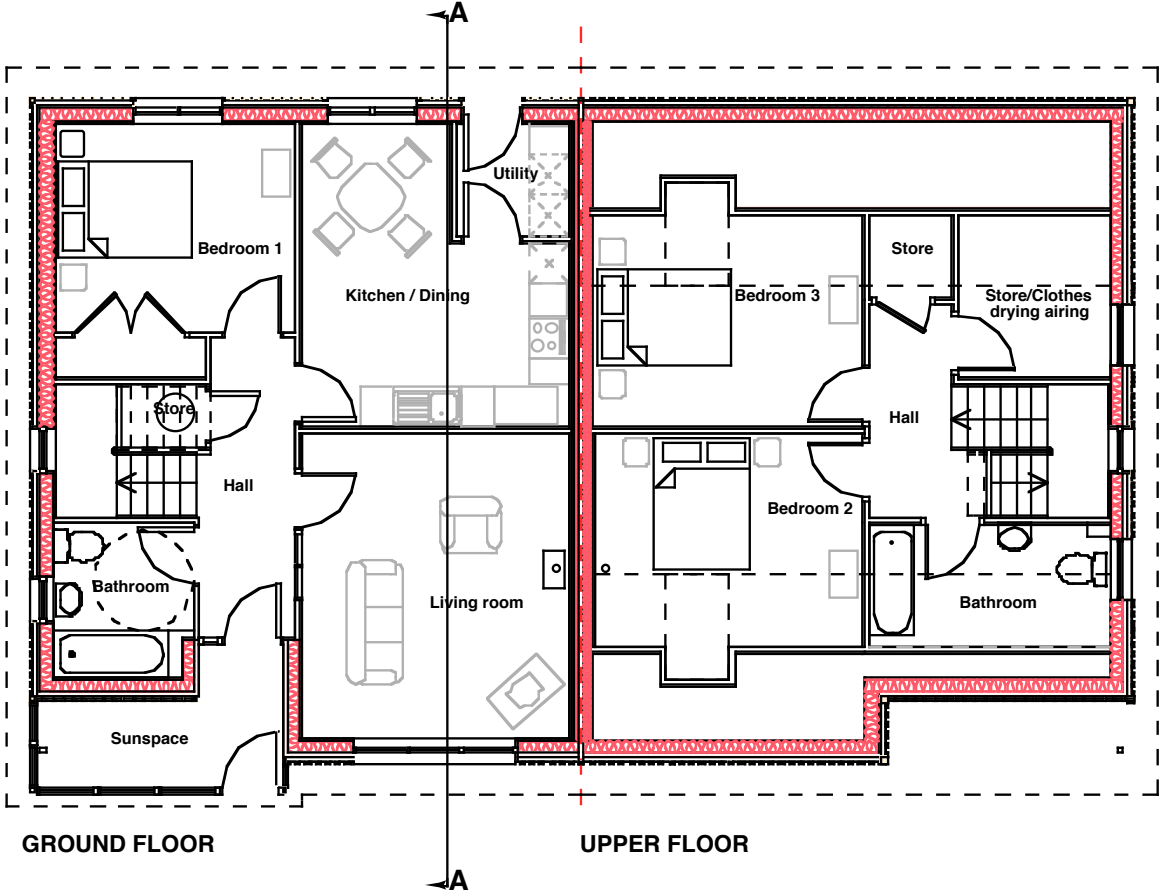
Phase	Size	Scottish Housing Handbook, Metric Space Standards	Prototype Size
Phase 1 only	4 Person	84 m <sup>2</sup>	87.9 m <sup>2</sup>
Phase 1 + 2 Together	6 Person	107 m <sup>2</sup>	106.9 m <sup>2</sup>

Table 1

2.6.4 As previously stated, there is less advantage in phasing this work to build two bedrooms initially, then add an extra bedroom and bathroom.

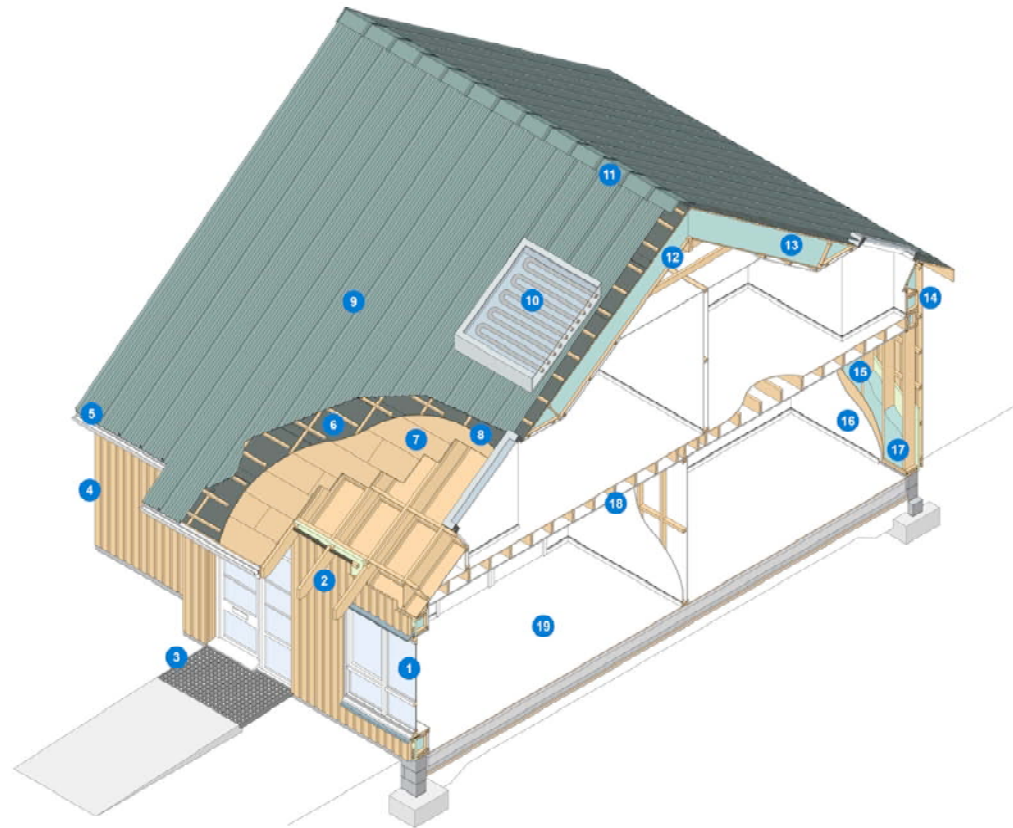
2.6.5 Full plans and elevations are in appendix 2.

2.6.6 Each of the other prototypes have their merits, depending on the particular site constraints.



**PREFERRED OPTION - GROUND & UPPER FLOOR PLANS**

## 2.7 Cut-away Diagram of Prototype House based on Enhanced (High Thermal Mass) Specification.



1. 4:16:6, I Plus, Low E, Argon filled, timber framed windows
2. Rafter extensions to provide roof overhang and protect cladding
3. Perforated deck to allow moisture dispersal and provide wheelchair access
4. Heartwood Larch cladding with ventilated space behind
5. Galvanised metal gutter
6. Timber battens and counter battens to allow ventilation of underside of roof finish
7. Wood fibre board sarking
8. Vapour permeable underlay
9. Roof finish to suit local style and planning policies
10. Solar water panel on south slope (optional)
11. Ridge capping
12. Engineered timber ridge beam
13. Timber web beam 300mm deep filled with cellulose insulation
14. Wall make up of 195mm x 44mm C16 home grown timber studs
15. Orientated Strand Board (OSB) or similar sheathing with service zone
16. Plasterboard
17. Cellulose fill insulation
18. Timber joists or web beams depending on span
19. PFA levelling screed on concrete slab on 100mm EPS insulation

### 3. Growing Greener Specification

#### 3.1 Issues

- 3.1.1 One of the original aims of the study was to try and achieve affordable rural housing that would be so well insulated that it would require minimal heating. Ideally central heating could then be omitted resulting in savings (and gas supplies were unlikely).
- 3.1.2 A wood fired stove could then provide back up heating in cold snaps. However location of any site would need to take into account proximity to a supply of wood, as this is not always easily available.
- 3.1.3 To achieve a house that would require no heating, but simply rely on body heat, an overall U-value in the region of  $0.1 \text{ Wm}^2\text{K}$  would be required. This target is unlikely and it was also felt that some form of heating would still be a requirement in any socially rented house to cater for varying requirements of comfort.
- 3.1.4 In order to assess the viability of different levels of insulation we have provided costs and U-values for a range of constructions. Clearly there are a tremendous number of variables in wall construction types, so we have tried to focus in on constructions that were a) hygroscopic, breathing wall construction which did not require an additional plastic vapour barrier and b) constructions that would favour use of solid C16 timbers, rather than I beams, enabling timber to be used that could be sourced from homegrown sources. There is a source of I beams manufactured in Scotland from Scottish produced OSB.
- 3.1.5 If homegrown timber is to be encouraged, then kit suppliers who source their timber within Scotland should be allowed to tender for the kit manufacture.
- 3.1.6 The U-value's, CO<sub>2</sub> emissions, SAP and energy use are calculated using Elmhurst SAP Software, and based on the standard calculations given in section 6 of the Domestic Section of the Scottish Building Regulations. The Scottish Building Regulations state that where available, it is acceptable to use certified manufacturers thermal resistance and U-values. We have done this with a number of products throughout this study, giving a more accurate assessment of the U-value and energy use.
- 3.1.7 Timber frame constructions need to be designed to prevent interstitial condensation taking place within the frame, otherwise rot outbreaks could occur. Vapour control is required in all constructions with the general requirement that the vapour resistance inside is 5 times that of the outside face. This can be provided by a polythene vapour check (and other membranes), however vapour checks can be damaged in the course of a building's history. As a result, we have opted to design walls that do allow vapour transmission, but still maintain some form of internal vapour control layer on the internal face. This can usually be achieved with a board material.
- 3.1.8 Air tightness or the lack of air tightness is a key source of energy loss in well insulated buildings. There has been a great deal of recent work on this issue, with the Revised English Building Regulations now having a clause specifying the maximum leakage allowable. This is set at  $10 \text{ m}^3/\text{hr}/\text{m}^2$  at 50 pascals. The Scottish Building Regulations do not have a comparable clause. Air tightness is primarily achieved by good detailing at the design stage to minimise routes for draughts, and on site by good supervision, ensuring air pathways are sealed.

3.1.9 Three tables, summarising five different specifications are given in section 4.8. For each specification we have taken the prototype and calculated the various U values, SAP ratings, energy requirements, CO<sub>2</sub> emissions and running costs per annum. Different ecohomes levels would apply, but these are indicative, as they require site-specific information.

3.1.10 The different specifications may be summarised as follows:

### **3.2 Basic Building Regulation Standard.**

3.2.1 This assumes a typical timber kit construction using 89 x 38mm studs and glass wool insulation to achieve a wall U value of 0.38 W/m<sup>2</sup>K. Wall and roof construction, windows and doors, are all designed to meet the present Scottish Building Regulation Standards. It is assumed that the dwelling will meet the Air Tightness test required under the revised English Building Regulations, of 10 m<sup>3</sup>/hr/m<sup>2</sup> at 50 pascals. Even at this basic standard, the heating costs per annum are relatively modest, however the CO<sub>2</sub> emissions are twice as high as the enhanced kit.

### **3.3 Enhanced Kit Construction**

3.3.1 Enhanced 145 x 47mm C16 studs are used in the wall framing with cellulose insulation used throughout walls and roof. The roof is formed using I Joists providing 300mm of insulation. Floor insulation is enhanced (see table 4.8) and windows are low E glazed, argon filled in attic windows. Passive stack ventilation is provided and air tightness is increased to what is considered to be normal practice of 9 m<sup>3</sup>/hr/m<sup>2</sup> at 50 pascals. This specification is similar to that in Leitch Street which was the subject of a case study.

### **3.4 Enhanced (High Thermal Mass)**

3.4.1 This is similar to the enhanced kit construction but incorporates a solid screeded ground floor to provide additional thermal mass. Lightweight structures are able to make best use of passive solar and incidental energy if it can be stored in the fabric over periods where there is no heat gain. In this case the floor insulation is further increased. It would be ideally suited to an underfloor heating system. The wall construction still uses the 145 x 47mm studs, but sheep's wool insulation is used instead of cellulose to facilitate the construction process. The external fibreboard sarking also reduces cold bridging of the solid stud timbers.

3.4.2 In this case, whilst there is still passive stack ventilation, there is also the inclusion of solar roof ventilation providing a positive input of pre-heated air to the hallway space. Solar roof ventilation is only possible where the roof is not overshadowed. Heat gain from the sun's rays on the tiles heats up the air in the space under the tiles and this is then pumped into the house. Incoming air is thus pre-heated by up to 10°C. All glazing is enhanced with argon with a wider space between panes, and the door U value is also increased

### **3.5 Timber High Insulation**

3.5.1 This option aims to provide a high level of insulation using 195 x 38mm C16 studs. Wool insulation is used again and the external sarking is increased to a 60mm fibreboard, leading to reduced air leakage of 5 m<sup>3</sup>/hr/m<sup>2</sup> @ 50 pascals and a reduction in cold bridging. The wall U-value here at 0.15W/m<sup>2</sup>K is approaching the zero emission standards. Roof construction remains at 300mm using I Joists, but the ground floor is made using timber with a solum space. This floor would be well insulated but ramping would be required front and back to raise to the finished

level of the timber floor. The option has been included to maximise the use of C16 timber although site and ground conditions may suggest a solid floor construction which may also facilitate a barrier free design. The sunspace (an optional extra) would be lined with a wood fibre board and clay plaster to provide a form of thermal mass.

- 3.5.2 A mechanical heat recovery ventilation system is incorporated rather than passive stack ventilation. Solar water panels are also included in the proposal.

### **3.6 Zero Emissions**

- 3.6.1 In fact this 'best' proposal does produce 0.25 tonnes of CO<sub>2</sub> per annum, but this is a fraction of the 3.5 tonnes per annum that the basic building regulation standard achieves. This construction adopts 300 deep timber I Joists filled with cellulose for the wall construction. This achieves a U value of 0.13W/m<sup>2</sup>K. The floor reverts to a concrete screed but the insulation levels are increased. Particular care is taken in achieving the best practice air tightness rate of 3 m<sup>3</sup>/hr/m<sup>2</sup> @ 50 pascals. As before, a mechanical heat recovery system is used but in this case we have also incorporated the sunwarm air solar collector that provides heat to the hot water system as well as preheating the air supply.

### **3.7 Green to Greener Calculations**

- 3.7.1 The following table summarises the above construction options. The calculations are based on the U-value and SAP calculation methods in the Scottish Building Regulations. Using this data and taking an average site, with average occupancy, a total energy requirement per annum for space and water heating is calculated, along with a CO<sub>2</sub> output and indicative cost for space and water heating. The methods in the Scottish Building Regulations make no allowance for specific site conditions.
- 3.7.2 The SAP and U-value calculations have all been performed in-house by John Gilbert Architects on Elmhurst Energy software and corroborated independently by MVM.
- 3.7.3 Where applicable, specific products have been researched, named and their specific thermal resistance used to assist accurate calculations. Window and Door U-values have been verified by confirming that two companies can supply a window or door to at least the specified U-value.
- 3.7.4 Air tightness in timber framed buildings has been discussed with the BRE and Elmhurst Energy Software, we have also reviewed publications by the Air Tightness Testing Methods Association. This has led us to the range of air tightness values from 10 m<sup>3</sup>/hr/m<sup>2</sup> at 50 pascals (the current standard under the English Building Regulations and the only UK standard) and 3 m<sup>3</sup>/hr/m<sup>2</sup> at 50 pascals which is considered to be best practice by all parties consulted.
- 3.7.5 The costs illustrated are abstracted by standardised occupancy and the generic nature of the calculation software. As such they are useful for comparison with each other, but should be used with caution for comparison with other, external figures.
- 3.7.6 The timber sizes are all available as a standard product, readily sourced from UK homegrown timber mills. These sizes have been corroborated with Scottish saw mills. Note that the Basic Building Regulations specification assumes the current standard frame size of 89x38mm for comparison, this timber is usually imported.

### **3.8 Green to Greener Specification**

Is contained in the following table.

## PERTSHIRE RURAL HOUSING PROTOTYPE: GROWING GREENER

	Basic B-Reg ecohomes level SAP 65 Target U value 0.37	Enhanced X - Pass SAP 79 Average U value 0.26	Enhanced (High Thermal Mass) XX - Good SAP 80 Average U value 0.21	Timber High Insulation XXX - Very Good SAP 104 Average U Value 0.20	Zero Emissions xxxx - Excellent SAP 120 Average U value 0.18
Wall construction	89 x 38 Timber kit	145 x 44 Timber Kit	145 x 44 Timber Kit	195 x 44 stud	300 web stud
Wall Insulation	Glass wool, OSB sheathing and vapour barrier and plasterboard internally	Panelvent external, 145mm Warmcell, panel line internal, with service zone and plasterboard	35mm isolair board external, 150mm Wool, Paneline plus service zone and plasterboard	60mm pavatherm board external, 200mm Wool with Paneline and service zone with plasterboard	Panelvent external, 300mm Warmcell, OSB internal, service zone and plasterboard
Wall Uvalue	0.38	0.24	0.22	0.15	0.13
Case Study Equivalent		Leitch Street - JGA		Inverurie - MAST	Ruchazie - VMA
Roof construction	Internal Plasterboard, 175 deep rafter with warmcell, externally finished in 35mm isolair and clay tiles	Internal Plasterboard, 300 deep web beam with warmcell, externally finished in 35mm isolair and clay tiles	Internal Plasterboard, 300 deep web beam with warmcell, externally finished in 35mm isolair and clay tiles	Internal Plasterboard, 300 deep web beam with warmcell, externally finished in 35mm isolair and clay tiles	Internal Plasterboard, 300 deep web beam with warmcell, externally finished in 35mm isolair and clay tiles
Roof Uvalue	0.18	0.12	0.12	0.12	0.12
Floor construction	particleboard on EPS 75mm on concrete slab	softwood floor on battens on conc screed on 75mm EPS on site concrete	PFA levelling screed on conc slab on 100mm EPS insulation	250 x 45 floor joists, infilled with 200mm wool, softwood flooring or OSB flooring	PFA levelling screed on concrete on 200mm EPS on site concrete
Floor Uvalue	0.22	0.17	0.19	0.17	0.11
Windows	Timber double glazed 4:12:4	Timber double glazed 4:16:4 low E (As Nordan)	Timber double glazed 4:16:4 low E (As Nordan)	Timber double glazed Iplus Low E glass internal, 4:16:6 argon filled	Timber double glazed Iplus Low E glass internal, 4:16:6 argon filled
Window U value	2	1.6	1.6	1.1	1.1
Roof Window	Timber double glazed 4:12:4	Timber double glazed 4:10:4 low E with argon (As Velux)	Timber double glazed 4:16:4 low E with Argon (As Velux)	Timber double glazed 4:16:4 low E with Argon (As Velux)	Timber double glazed 4:16:4 low E with Argon (As Velux)
Roof Window Uvalue	2	1.7	1.2	1.2	1.2
External doors	Timber with draughtseal	Timber with draughtseal with buffer space and secondary door front and back	Insulated Timber with draughtseal with buffer space and secondary door front and back	Insulated Timber with draughtseal with buffer space and secondary door front and back	Insulated Timber with draughtseal with buffer space and secondary door front and back
Door Uvalue	2	1.8	1.6	1.6	1.6
Air Tightness	10 m <sup>3</sup> /(h.m <sup>2</sup> ) @ 50Pa	9 m <sup>3</sup> /(h.m <sup>2</sup> ) @ 50Pa	5 m <sup>3</sup> /(h.m <sup>2</sup> ) @ 50Pa	5 m <sup>3</sup> /(h.m <sup>2</sup> ) @ 50Pa	3 m <sup>3</sup> /(h.m <sup>2</sup> ) @ 50Pa

Passive solar	south facing	South facing, buffer space	South facing	South facing solar sunspace with solid timber and pavatherm and clay plaster for thermal capacity	South facing solar sunspace with clay brick for increased thermal capacity
ventilation	mechanical extract fans	passive stack ventilation	passive stack ventilation with solar roof ventilation	mechanical heat recovery ventilation system	mechanical ventilation with heat recovery, using solar panel, as sunwarm system
Electrical Heating system (assumes no gas and all individual systems)	Electric storage radiators on eco 2000 tarriff	Manual feed log Stove (Clearview Pioneer 500)	Manual feed log Stove (Clearview Pioneer 500)	Log stove with direct feed to HWC and Hallway radiator (with TRV) (Clearview Vision 500 with boiler)	Pellet stove (90% eff.) providing back up, with direct feed to HWC and Hallway radiator (with TRV) (3G Energi Preziosa Ceramic)
Secondary heating System		Electric storage radiators on eco 2000 tarriff, green supplier	Electric storage radiators on eco 2000 tarriff, green supplier	Electric storage radiators on eco 2000 tarriff, green supplier	0.75 KW electric panel heaters as secondary system
Hot water supply	Electric immerser boost with offpeak load	Electric immerser boost with offpeak load, green supplier	Electric immerser boost with offpeak load, green supplier	Solartwin panels linked to HWC, linked to wood stove	Sunwarm solar panels heating 200 litre tank (80mm insul) with off peak and boost electrical immerser
CO2 (Tonnes per year)	3.50	1.40	1.30	0.30	0.25
Energy Required (kWh per Year)	8,555	9,583	8,861	7,611	4,361
Cost Per Year	£ 311.00	£ 240.00	£ 227.00	£ 147.00	£ 86.00
Additional Electrical Input method			Redland PV-80 Roof tile system, 15.3m <sup>2</sup>	600W Wind generator (assumes av. Wind speed = 12mph)	6kW Communal Wind Generator (Assumes av. Wind speed of 12mph and 6 houses per development)
Additional Electrical Input (kWh Per Year)			1,469	1,333	2,000
Total Energy Required (kWh per Year)			7,392	6,278	2,361

Updated: 23/05/06

## 4. Cost Report

### 4.1 Introduction

- 4.1.1 Gordon Hyslop of Towler and Hyslop, Chartered Quantity Surveyors has prepared the cost estimates contained in appendix 1. Towler and Hyslop have had considerable experience of houses similar to the proposed prototypes. In compiling the enclosed estimate Towler & Hyslop have used current rates where applicable. John Gilbert Architects provided rates for some of the more specialised items. The Notes and Assumptions should be read carefully before looking at our estimates in detail.
- 4.1.2 The costs are based on the range of specifications identified in the Green to Greener Specification. Refer to section 3.
- 4.1.3 Although the initial areas and associated costs were high, from these costings it was apparent that the preferred prototype would be cheaper in the long run, on the assumption that the house would eventually be adapted. If this was a marginal risk, then prototype 2 would be slightly cheaper, although at a greater cost over the first stage because of the greater substructure costs.
- 4.1.4 It was agreed that prototype 3 would be developed as the preferred option, and to re-adjust the design to try and reduce the overall floor area and the costs to within Communities Scotland benchmarks. The ground floor area was reduced to 68.0m<sup>2</sup> the upper floor, fully built out, totalled 38.9m<sup>2</sup> with 1.5m or more headroom, resulting in a total area of 106.9m<sup>2</sup>. In this prototype there is an option to install an additional 5.4m<sup>2</sup> sunspace at the front of the house. This choice would depend on location, orientation and any overshadowing.
- 4.1.5 It should be noted that the sizes for phase 1 will always appear to be larger than necessary for a 4 person house, as the living room, kitchen and bathrooms are actually sized to fit the ultimate household size of 6.
- 4.1.6 Following revision of Prototype 3, phase 1 only allowed for the installation of one upstairs bedroom and drying space (68.0m<sup>2</sup> downstairs and 19.9m<sup>2</sup> upstairs or 87.9m<sup>2</sup> overall)
- 4.1.7 The costs for prototype 3 are:

**Table 2: Phase 1 Build Cost**

Prototype 3 Phase 1	Bed/Person	Total unit area	Cost per m <sup>2</sup>	Cost per unit
Basic Building Regs	2 Bed 4 Person	87.9m <sup>2</sup>	£1,010	£83,390
Enhanced	2 Bed 4 Person	87.9m <sup>2</sup>	£1,074	£88,468
Enhanced (High Thermal Mass)	2 Bed 4 Person	87.9m <sup>2</sup>	£1,102	£90,431
Timber High Insulation	2 Bed 4 Person	87.9m <sup>2</sup>	£1,313	£109,143
Zero Emissions	2 Bed 4 Person	87.9m <sup>2</sup>	£1,432	£118,535

**Table 3: Phase 2 Additional Retrospective Costs**

Preferred Prototype	Bed/Person	Additional area	Cost for Additional Area
Basic Building Regs	3 Bed 6 Person	+19m <sup>2</sup>	£7,489
Enhanced	3 Bed 6 Person	+19m <sup>2</sup>	£7,787
Enhanced (High Thermal Mass)	3 Bed 6 Person	+19m <sup>2</sup>	£7,787
Timber High Insulation	3 Bed 6 Person	+19m <sup>2</sup>	£7,809
Zero Emissions	3 Bed 6 Person	+19m <sup>2</sup>	£9,070

**Table 4: Phase 1 + 2 in One Operation**

Preferred Prototype	Bed/Person	Total unit area	Cost per m <sup>2</sup>	Cost per unit
Basic Building Regs	3 Bed 6 Person	106.9m <sup>2</sup>	£973	£90,879
Enhanced	3 Bed 6 Person	106.9m <sup>2</sup>	£1,036	£96,255
Enhanced (High Thermal Mass)	3 Bed 6 Person	106.9m <sup>2</sup>	£1,065	£98,218
Timber High Insulation	3 Bed 6 Person	106.9m <sup>2</sup>	£1,244	£116,952
Zero Emissions	3 Bed 6 Person	106.9m <sup>2</sup>	£1,366	£127,605

4.1.8 A full breakdown of the costs is given in appendix 1.

4.1.9 In all of these tables the actual build cost is the most pertinent figure. It can be seen that constructing the first phase alone or both phases together, there is a relatively modest increase in cost from the Basic Building Regulations construction option to accommodate the Enhanced and Enhanced (High Thermal Mass) constructions. Both the Timber High Insulation and Zero Emissions option represent a significant increase in initial build costs over the basic building regulations.

4.1.10 Constructing phase one initially, then later, undertaking Phase 2 is more expensive overall as these prices do not reflect an additional premium for undertaking work whilst a house is occupied.

## 4.2 House Areas

4.2.1 The preferred prototype, constructed as phase 1 and 2 together, compares favourably with the Scottish Housing Handbook Bulletin 1 Metric Space Standards. This is based on a 6 person, 2-storey house. These space standards are used by Communities Scotland for assessing schemes for HAG funding together with allowances for Housing for Varying Needs Part 1. They are also the basis for the New Indicative Cost Limits (Ref CSGN 2003/10). Within these space standards, the house not only accommodates barrier free design but also gives substantial storage space and live/work options.

4.2.2 The sunspace is treated as an option, and is omitted from these calculations. If it is included, it takes the floor area very slightly over the above space standards.

4.2.3 It should be noted that Phase 1 is approximately 4m<sup>2</sup> above the Scottish Housing Handbook Bulletin 1 Metric Space Standards for a 4 person dwelling, this is mainly due to the initial construction of a clothes drying room (that is later converted into an upstairs bathroom) and additional space required in the kitchen and living room for future expansion.

### **4.3 Building Elements**

- 4.3.1 The Substructure, Superstructure, Internal Finishes and Services Elements of Prototype 3 have all been costed. Towler & Hyslop have not estimated the External Works or Site Development and Servicing Elements as these elements would be site specific and no details were available. Therefore direct comparison of the enclosed estimated costs and the New Indicative Costs.

### **4.4 Contract Preliminaries**

- 4.4.1 As we believe that an Affordable Housing provider would seek cost efficiency in providing a number of houses on one site, built in one contract. For the purposes of this report we have assumed this contract would be for 3 pairs of semi-detached houses (total of 6 dwellings) for the calculation of the Contract Preliminaries. We estimate that it would take 39 weeks to build 6 houses and we enclose a breakdown of estimate for the Preliminaries. Our elemental estimates are for a block of 2 semi-detached houses therefore we have proportioned the allowance for Contract preliminaries accordingly. Increasing the number of units in a scheme would reduce the cost per unit.

### **4.5 Phase 1 & 2**

- 4.5.1 We have costed both Phase 1 and Phase 2 in total although it would be the intention to carry out Phase 1 and then carry out Phase 2. The extra cost between Phase 1 and Phase 2 is included in the overall summary. However these costs would actually be higher due to inflation depending on when Phase 2 was carried out. Other factors affecting the extra cost for Phase 2 would be working within occupied properties, number of houses altered at one time etc.

### **4.6 Other Costs**

- 4.6.1 The cost estimates are works only costs and exclude Vat, Professional Fees and Planning and Building Warrant charges. It also excludes site acquisition and site investigation costs etc.

### **4.7 Further Savings**

- 4.7.1 Once a Prototype is finalised and acceptable to all parties then further savings might be achieved through volume procurement or repetition.

## 5. Construction Issues

### 5.1 Wall Construction

- 5.1.1 The prototype designs assume an average wall thickness, rather than a specific wall make up. Constructional choice will depend on the site, scale, timescales and contractor selected. Small developments are more likely to be 'stick built' on site rather than 'kit built', but kits have the advantage of early site erection and the ability to provide a weathertight enclosure at an early stage.
- 5.1.2 In walls which utilize cellulose, the material is most likely to be 'turbofilled' on site. The internal sheathing can be a compressed fibreboard or OSB, the OSB has the advantage of local sourcing and also provides racking strength. However the installation of cellulose requires specialist installers, if the site is remote, work could be delayed.
- 5.1.3 Cellulose that is spray applied has the advantage that the internal lining sheet can be plasterboard, whereas when it is turbofilled, the enclosing sheet material will tend to bow, requiring the inclusion of a service zone to compensate for the irregularities. This is not a problem as OSB is often used for racking strength as well, although it can be designed out by using other forms of bracing, either steel straps or timber bracing. Thus a preformed insulation (known as a batt) like wool could be designed to omit an additional board layer.
- 5.1.4 Wool (and other hygroscopic materials such as cellulose and flax) is supplied in batts and can thus be installed by the contractor. It is cheaper than cellulose and flax in batt form although it is quite difficult to cut.
- 5.1.5 Wool insulation has a low embodied energy and can be recycled. It has been used in other social housing projects where the wall make up is suited for its use. Clearly other products, including glass fibre and vapour membranes could also be specified to provide similar U values, but in this case, wool has been specified because it is hygroscopic, comes in batt form and has a lower embodied energy than glass wool.
- 5.1.6 A breathable wood fibre board has been used as a sheathing. This has the benefit of insulating the wall studs, thus reducing cold bridging, it is specified as tongued and grooved board to further increase air tightness.
- 5.1.7 It is assumed that all internal walls are dry lined in plasterboard. However additional thermal capacity, improved insulation and better internal air quality could be achieved by lining the walls with a fibreboard or clayboard and applying a clay plaster. Costs are likely to be outwith affordable practices but it would be useful to see how well such a system would work in any pilot development. It could also be used adjacent to any sunspaces in order to provide added thermal capacity.
- 5.1.8 It is assumed that the insulated walls would then be battened and clad with timber cladding. (Ivor Davies personal comment) The choice of cladding will depend on the site location and availability of good quality heartwood larch. Whilst most heartwood larch can be classified as class 3-4 (moderately or slightly durable), variability occurs and quality can reduce to class 5 (not durable). Selection of the larch is thus important as quality can vary. UK larch should therefore be preservative treated when used as an external cladding unless grading and selection can guarantee a class 3 product. Juvenile heartwood occupying the first 15 rings should be discarded as should the non durable sapwood. Good detailing and design also remain important factors in the use of any timber cladding.

- 5.1.9 Some recent work (Ivor Davies personal comment) is also assessing the suitability of home grown Spruce as external cladding product, drawing on experience of Norway, where preservative treatment and additional coatings are applied.

## **5.2 Underbuilding**

- 5.2.1 Where underbuilding or blockwork foundations are required it is possible to specify concrete blocks which have a recycled content. Thermalite make lightweight concrete blocks which use pulverised fuel ash in manufacture and Masterblock make use of recycled aggregates. Some sites may also be close to a brick maker (for example Errol bricks in Fife) where frostproof clay bricks may be selected.

## **5.3 Roof**

- 5.3.1 As the roof is designed to be fully insulated, rather than have the insulation at the attic floor level, the first choice is to use a trussless roof construction using I Joists at least 300 deep and filling the void space with cellulose or wool. This is the option we have selected for the prototype house which gives a U value of  $0.12\text{Wm}^2\text{degC}$ . If the web beam is deepened to 400mm, then the U value can drop down to  $0.1\text{Wm}^2\text{K}$ . Other construction options are available including formation of an attic truss. Such trusses can facilitate speed of construction as they also incorporate flooring joists for the attic. However they can be more problematic to insulate because of the trusswork.
- 5.3.2 The roof covering would normally use concrete tiles on a battened and counter-battened roof. Some planning departments may require a particular roof finish. An alternative option is to use corrugated lightweight roofing. Aluminium and metal roof finishes which can be profiled to appear tile like or in simple corrugations. Stainless steel sheet roofing has the advantage that it can be taken from recycled steel. Aluminium, which is capable of being recycled, requires, like steel, a high amount of energy to produce it. Steel coated in plastic protective finishes is less attractive ecologically, although it can be recycled. The various coatings increase the cost of recycling.

## **5.4 Floor**

- 5.4.1 The requirement for level floor access has tended to result in a much greater use of concrete raft floors than suspended timber floors. This can be used to provide additional thermal mass to a lightweight structure. Insulation below the slab and at perimeters is essential and floor finishes are best formed to benefit the thermal mass. Tiled finishes on a levelling screed, should be considered here.
- 5.4.2 Many Housing Associations prefer to finish a concrete base with a battened timber floor, carrying any services in the void space below, and adding additional insulation at perimeters. This approach will reduce the effectiveness of the thermal mass of the concrete slab, but barrier free access is maintained.
- 5.4.3 A suspended all timber floor will allow the best underfloor insulation and will work well on a sloping site where underbuilding structure can be avoided. However a raised timber floor needs ventilation under it and this can result in additional substructure and ramping costs.
- 5.4.4 The use of solid 32mm pine flooring, on a suspended timber floor, would provide some additional thermal mass to this lightweight construction and could act as a finished floor surface, provided the timber quality was good.

- 5.4.5 Most softwoods produced in Scotland tend to be too soft for use in flooring, so the majority of softwood flooring is imported. It is possible to obtain good quality homegrown pine, larch and douglas fir flooring from some suppliers, but it is not readily available. Scottish hardwood flooring is available but considered to be outwith the price bracket for social housing. More commonly, particleboard and OSB flooring is used, with tenants providing a carpet, vinyl or laminated floor finish.

## 5.5 Doors and Windows

- 5.5.1 Window sizing should be designed to suit the orientation of the house. We would expect that any site specific design would address the site to achieve maximum passive solar gain. However views and internal daylighting are also very important. The specification of glazing has improved considerably so that U values of  $1.1\text{W/m}^2\text{K}$  are readily achievable provided argon filling is specified (double glazing with 16mm argon filled cavity and a silver coating on inner pane). However windows still present an area of heat loss so care must be taken in avoiding the excesses of glazing.
- 5.5.2 The u-value of doors and windows in the Green to Greener Specification have been corroborated by requesting u-values from two separate manufacturers. All manufacturers who have provided information have confirmed that the u-values calculations conform to BS EN 10077 pt1 & 2.
- 5.5.3 Doors are less well insulated, even those that are purpose designed systems only reach U values of  $1.5\text{W/m}^2\text{K}$ . Also, we are conscious that as peoples lifestyles vary, a single access door can be responsible for large heat losses. The prototype therefore always shows a two door buffer space between inside and outside. Where possible, this unheated area provides useful space for either coats, boots and prams or as a utility room.

## 5.6 Sunspaces

- 5.6.1 These are welcome additions to any house, but their inclusion will add to the total area and thus increase costs. There would be more advantage in building a sunspace to a 3 or 4 bedroom house than a two bed roomed starter home. The preferred prototype has a sunspace as an option in place of the buffer space.
- 5.6.2 It should be noted that the sunspace should be omitted in a forest context where there would be minimal heat gain.

## 5.7 Air Tightness and Ventilation

- 5.7.1 Good envelope design is an essential part of sustainable housing. Higher standards of insulation are achievable in new buildings, although air leakage can still present a problem if care is not taken in construction, detailing and specification.
- 5.7.2 The British Units for air leakage are  $\text{m}^3/(\text{h.m}^2)$ . Currently, there are no standards for maximum permissible air leakage in the Scottish Building Regulations. In the English Regulations buildings fail if a post completion pressure test achieves  $10\text{ m}^3/(\text{h.m}^2)$  or greater.
- 5.7.3 We have discussed airtightness in the context of timber frame houses, with Mike Jaggs at BRE, Elmhurst Energy and reviewed publications by the Air Tightness Testing Association. Current experience shows that timber frames can achieve ratings between  $18\text{ m}^3/(\text{h.m}^2)$  and, in exceptional cases,  $1\text{ m}^3/(\text{h.m}^2)$ . Normal practice is  $9\text{ m}^3/(\text{h.m}^2)$  and good practice is generally  $3\text{ m}^3/(\text{h.m}^2)$ .

- 5.7.4 Infiltration can account for between 30 and 50 percent of heat loss (and gain) in buildings of poor performance. As well as door and window openings, there are numerous services that penetrate through the fabric, such as water pipes, electricity and telephone cables, flues, vents, waste pipes etc. Such items are often installed by subcontractors who have no interest in energy conservation or even filling the hole that they create.
- 5.7.5 In a small semi-detached cottage, the areas that will require attention in addition to sealing holes will be sealing the base plate to the foundation, junctions between wall and window and door frames, and panel junctions of any prefabricated kit. Corded wool or jute can be used as a filling material for small gaps.
- 5.7.6 The more airtight we make our buildings, the more we need to ensure that adequate ventilation is maintained to ensure removal of moisture and pollutants that are released from a range of materials in every house, as well as the activities of occupants. Poor air quality is produced by higher levels of formaldehyde concentrations and VOCs being released. Higher humidity levels and warm environments lead to an increase in dust mites. The resulting internal environment can exacerbate the onset of asthma and other respiratory infections. Mechanical heat recovery systems are therefore more important in air tight buildings. We have shown a number of different ventilation options which would be appropriate in the Green to Greener specification:
- Natural passive stack ventilation. Works through the stack effect and will draw stale air from the rooms to exhaust at roof level. They can be controlled by humidistat controlled window vents.
  - As above but with the incoming air being fed into the common hallway, by taking fresh air, pre-warmed with the solar gain from under the roof finish.
  - A mechanical heat recovery ventilation system
  - An integrated air solar/ heat recovery ventilation system supplying both fresh air and a contribution to heating the hot water.

## 5.8 Insulation

- 5.8.1 This is the key to achieving low energy housing in Scotland. We have illustrated three different insulation materials in the Green to Greener specification, glass wool ( $\lambda$  0.040), cellulose ( $\lambda$  0.035), and sheep's wool ( $\lambda$  0.039). These are used in a variety of thicknesses, to achieve very high insulation values.
- 5.8.2 As previously noted, we have selected insulation materials with very low embodied energy that are hygroscopic in nature. This allows moisture vapour to migrate through the structure without condensing out, provided the internal wall face has 5 times the vapour resistance of the external face. We recognise that other forms of insulation exist, such as glass wool, mineral wool and reflective foil sandwich membranes, all of which can achieve very high levels of insulation with the advantage that wall thickness can be kept small. However they need to be used in association with impermeable vapour membranes which we are trying to avoid because of the possibility of poor site control and damage to the membrane over the buildings life.
- 5.8.3 The progressive increase in insulation levels is shown in the diagrams below:

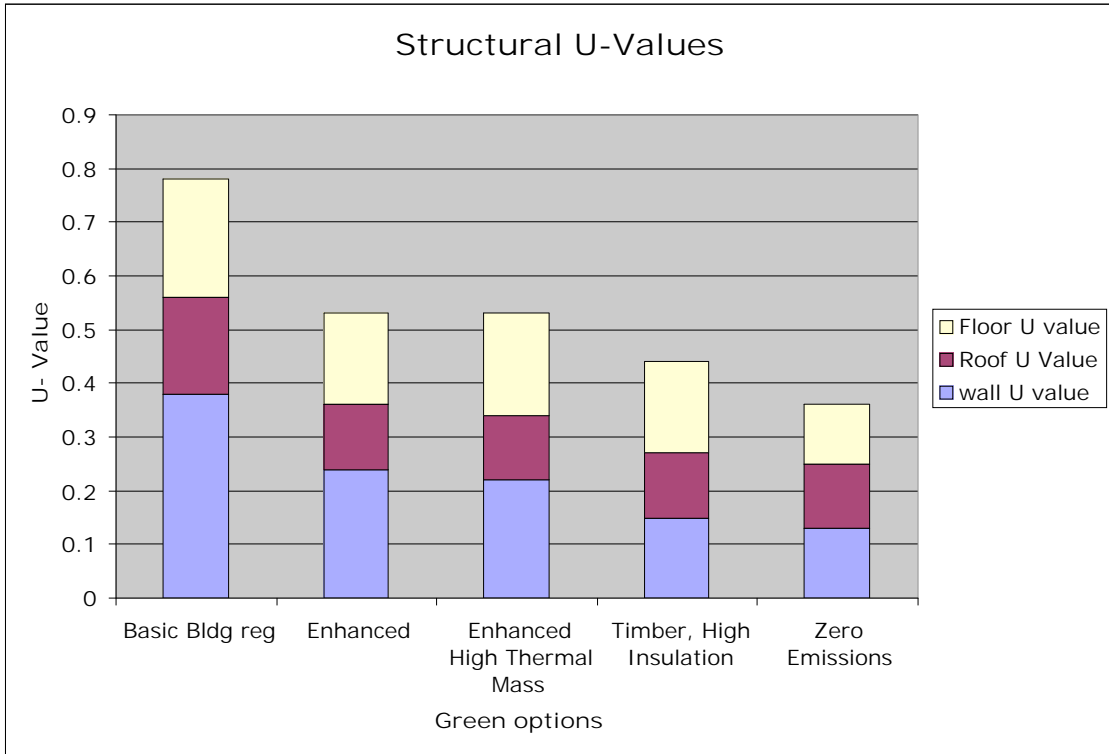


Fig 1: Summary of the changes in structural U values with the different options

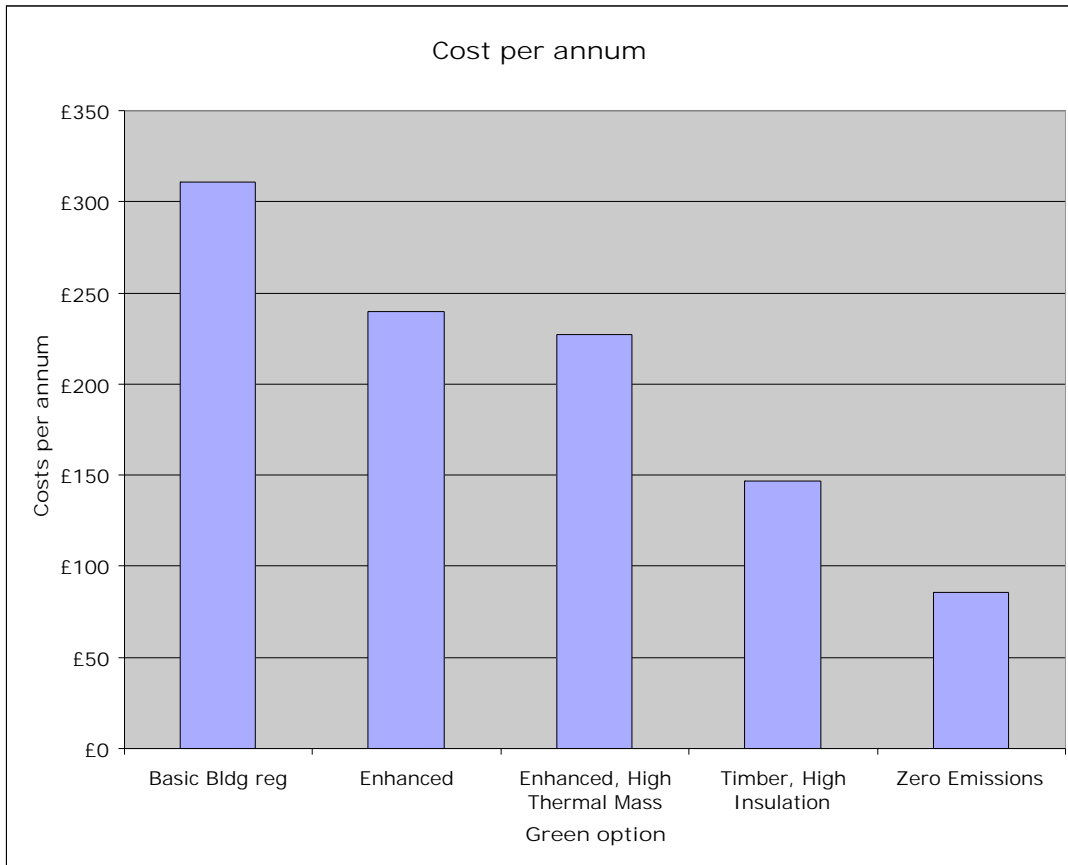
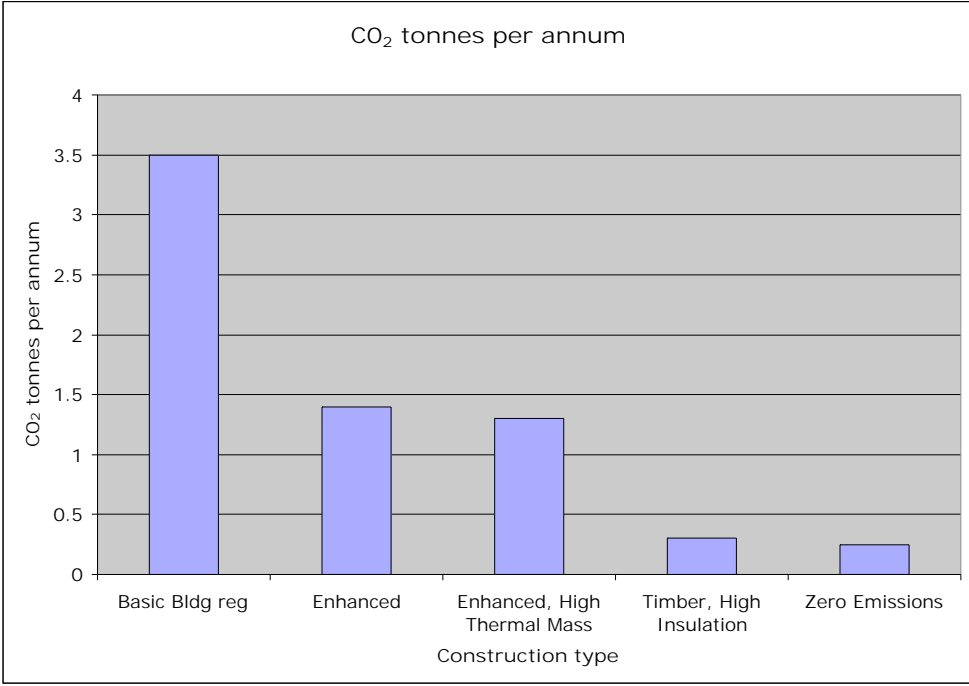


Fig 2: estimate of all energy costs over a year for the different specifications



*Fig 3: chart showing the reduction of CO<sub>2</sub> emissions with improvements to specification levels. The Housing Energy Best Practice Programme estimate that a 4 person house built in 1995 will produce 4,2 tonnes of CO<sub>2</sub> per annum.*

## 6. Heating

### 6.1 Introduction

- 6.1.1 Heating spaces and water accounts for the majority of the energy used in Scottish homes. We have assumed that the site is located away from the gas mains grid and have therefore examined a number of options based on electrical energy, renewable energy and wood fuels.

### 6.2 Wood fuel

- 6.2.1 Wood as a fuel, in Scotland is generally available in three forms throughout the country, either as logs or as chips or imported pellets. The advantage of pellet fed stoves is that it requires significantly less attention than the equivalent log fuelled stoves and they are more efficient. Hoppers on the pellet stoves can provide heating for up to 3 days without the need for refilling. The disadvantage is that there is an additional cost for this automation.
- 6.2.2 At present, the supply of pellets in Scotland is limited. The pellets that are sold are currently imported, and have different efficiencies and costs. It is possible to purchase small individual bags of pellets from some local stores, but this will be more expensive than bulk buying. For example 900 kilograms (nearly a ton) of Austrian pellets in the form of 60 No 15kg bags taking up a space of 1220 x 1520 on a pallet.
- 6.2.3 An average centrally heated house could use between 1 and 3 metric tons of wood pellets per year, a highly insulated house would require less. However, until the pellets can be made from home-grown timber, it will make more sense to rely on using a log burner, sourcing the timber as locally as possible.
- 6.2.4 Log stoves typically last a couple of hours before re-stoking is required, most modern designs incorporate thermal mass to enable the stove to continue emitting heat after the fire has gone out. Compared to gas systems, standard log fuelled models may have a low efficiency and seem to require more energy, but this is balanced out by the low cost and low CO<sub>2</sub> emissions of wood. Logs for burning need to be stored and dried for about two seasons before being used.
- 6.2.5 A simple log burning stove such as the Clearview pioneer 400 has a firebrick backing to store and release heat, the fire producing 5kW. If it is to be connected to a hot water system or any kind of simple heating system, then the Vision 500 with boiler should be used. However it should be recognised that if using the boiler option, the fire should be kept going to ensure the benefits of the system. This can be more problematic with log burners than with pellet stoves. Our view is that it is probably simpler to rely on the log stove for simple back up heating and nothing more, leaving the hot water and electrical loads to be supplied electrically or by solar water and pv.
- 6.2.6 For comparison, we have included the pellet stove system in the Zero Emissions option. Whilst more expensive, than the log stove initially, it provides space heating and hot water heating, but still has the problem of pellet supply. This means that electrical panels are for use as a back-up system and that the CO<sub>2</sub> and annual cost is a small percentage of the basic building regulations house.

### 6.3 Solar

- 6.3.1 Wherever possible, housing orientation and design should make best use of solar gain. This may range from having large south facing windows and small north facing windows, to providing sunspaces and thermal mass in order to make best

use of solar gain. Sunspaces can also be used as useful buffer spaces to reduce heat losses when entering the house, and as a useful space to dry clothes in.

- 6.3.2 There are two main options using solar energy to heat water or provide electricity, through solar water heating panels for hot water and through photovoltaic (PV) panels for electricity.
- 6.3.3 A 5m<sup>2</sup> solar water panel on a south-facing roof, connected through to the hot water cylinder can considerably reduce the demand for water heating. Even in Scotland this can reduce the load on hot water systems considerably. Obviously the effect on the hot water heating system depends on what system is used. Whilst the energy is only available intermittently, with a well-insulated hot water tank, hot water can be stored for a number of hours until required. Fitting a solar hot water heating panel at construction stage is relatively cheap and provides reasonable heating energy reductions, whatever heating system is eventually chosen. We have assumed 5m<sup>2</sup> of solar hot water panels in the Timber High Insulation model and the Zero Emissions model. A number of different models are available but we have chosen the freeze tolerant 'solartwin' model because of its simplicity in not requiring drain back of water or anti-freeze. It also incorporates a pv panel which powers a pump which circulates the warmed water.
- 6.3.4 Photovoltaic roof panels are becoming more widespread. This converts solar energy directly into electrical energy. Many products are available to fit a variety of roof types, although care would be required to ensure the roof direction and pitch optimised a panel's performance. Photovoltaic panels have a number of disadvantages, in that they are still comparatively expensive to fit a system large enough to make a significant impact on a dwellings energy use, and that the electricity they generate is intermittent, storage being a costly addition. A very large roof area of PV panels (say the whole roof) could produce enough energy to lower electricity costs by 70%, but the initial capital costs would be high. It does have certain advantages, even in cloudy weather, some electricity can be generated. Every square metre of PV panel can displace two tonnes of CO<sub>2</sub> over its lifetime.
- 6.3.5 If choosing a system, it will be necessary to decide if battery storage is to be incorporated. This will add to the cost and also takes up space. It can be simpler to make use of the electricity during daylight hours only and not rely on battery back up. The system we have shown as optional such as the Redland 24 tile pv tile kit. This gives a coverage of 15.3m<sup>2</sup>, a peak output of 2 kilowatts and costs around £18,000. It would be grid connected and we estimate that it would contribute some 1,469 kWh per annum to the house. A smaller 10 tile kit would cost around £8,000 contributing about 600 kWh per annum.
- 6.3.6 Some simple measures to reduce the electrical load in the house should be considered although the selection of white goods is often left in the tenants hands.

#### **6.4 Wind**

- 6.4.1 Wind is available to some degree on all sites in Scotland, however the feasibility of a wind turbine is very site specific, dependant of ground form, surrounding buildings and site exposure. In the analysis of prototype we have made a number of assumptions, basing our data on a site suitable for a variety of turbine sizes and average wind speed.
- 6.4.2 There are a variety of sizes of wind turbine, from individual domestic scale to large commercial generators. Recently, an economical domestic scale wind turbine has been developed, this system does not store energy or return it to the grid, its sole purpose is to supply electricity to cover the base load (i.e. the things that are

always on). It is a relatively simple system to install and for a single building provides a reasonable output for a modest initial outlay.

- 6.4.3 There are significant advantages in a communal system serving a number of houses. Whilst initially more expensive, a single larger turbine would be more efficient than several smaller turbines, the need for storage is reduced as there would be a larger base load on the system, and annual maintenance costs would be lower. It would be possible to size a system so that the output of a communal system matches the combined output of individual system.
- 6.4.4 In principle, a communal wind generator, serving 6 dwellings, on an average site could provide 2,000 kWh per annum or approximately 50% of the energy requirements for the Zero Emissions house type or 20% of the energy requirements for the Basic Building Regulations house type over the year. For this energy to be converted into heat and hot water, the house must operate on an all-electric system.

## **6.5 Electric**

- 6.5.1 Standard electrical storage heaters are shown as a secondary heating system supplementing the wood boiler in 4 options. Their efficiency, low initial cost and ability to be free from a distribution system makes them a reasonable choice provided the house is well insulated. They should not be treated as the main heating system and tenants would need to understand that their use should be limited and follow the use of the wood fuel stove.
- 6.5.2 However storage radiators are dependant on off peak electricity, so they are not very responsive to changing conditions. In the zero emissions house we have opted for simple electric panel heaters to provide back up heating in very cold snaps.

## **6.6 Communal Heating Options**

- 6.6.1 There are a number of communal heating options, depending on the number of houses within a single development. However there can be more management requirements for a communal system. A single wood chip boiler could supply the necessary energy though it would have a high cost initially without capital grant aid. Geothermal heating could also be organised communally, extracting low grade heat from a borehole or a ground loop, (or a lake or river) and converting the energy with a heat pump using off-peak electricity, then storing the warm water in a thermal storage tank before circulating to the houses.
- 6.6.2 If gas was available a simple gas fired communal boiler could be used.
- 6.6.3 Each option would need to be assessed in relation to the number of units required for each site and site specific constraints in terms of ground conditions, fuel available locally etc. Because there are so many site and development specific matters in choosing a communal system, we have omitted this from all our calculations.

## **6.7 Reducing Electrical Loads**

- 6.7.1 With significantly greater emphasis being placed on structural insulation standards, the heating demand will fall. However there is an increasing demand for appliances, so the choice and use of electrical products should take into account their energy use.
- 6.7.2 The use of low energy lighting and fluorescent fittings will save energy, as will good daylighting standards.

- 6.7.3 Fridges can be low energy-rated and should not be sited near heat producing appliances like cookers. Air should be allowed to circulate freely around the fridge.
- 6.7.4 Washing machines should use a hot water supply fed from the solar connected cylinder. They should also have a half load facility to reduce energy loads. Spin driers are more efficient than tumble driers and if possible, an internal drying area should be provided to reduce dependence and use of the spin drier. Where possible EU energy rated white goods should be used. The ecohomes standard (ENE 4) requires A rated appliances for all appliances except for dryers and washer driers which can be B rated and above.

## 7. Material Selection

### 7.1 Introduction

7.1.1 Within the tight cost constraints of affordable housing projects, there is limited scope in specifying materials which cost more than the cheapest product on the market. Life expectancy, recyclability and environmental side effects are not often taken into account when comparing costs.

7.1.2 The prototype house is aiming to use C16 timbers for wall construction which can be sourced from homegrown suppliers. Use of homegrown timber should be incorporated into the design and specification at the outset and reviewed continually throughout the construction process. The wall frames of timber kit housing can be designed to only require C16 grade timber. Kit manufacturers may however choose to use imported C24 timbers because of their supply chain and manufacturing processes. It is thus advantageous to try and source kit manufacturers who source their timber from homegrown forests at an early stage. Other timber products and insulation materials have been discussed elsewhere in this report, but a few alternatives to certain products should be incorporated in the prototype house:

	Material	Option with lower embodied energy or less toxic.
FOUNDATIONS	Hardcore	recycled hardcore Pulverised Fuel Ash, as an additive to concrete as it reduces the cement content.
STRUCTURE	Concrete blockwork	Durox lightweight blocks Recycled aggregate blocks
EXTERNAL SKIN	Brick	recycled brick, specify local brick manufacturer if possible.
	Concrete block and roughcast	Calcium silicate board and render system
	cement mortar	lime mortar
TIMBER PRODUCTS	Softwood	From sustainable sources only conforming to FSC certified. Chain of custody paperwork should be provided. Specify C16 for structural use as it can be sourced in Scotland. Composite joists use smaller sections of timber.
	Hardwood	Should be FSC certified or locally sourced Otherwise avoid where possible.
	Imported plywood	non tropical with low formaldehyde glues eg using birch and spruce or pine veneers.
	Particle board etc	Ideally we should adopt materials with zero formaldehyde content, if particle board is used it can be provided formaldehyde free. OSB flooring grade is

		also an option.
	timber preservatives	Avoid where possible through good detailing. However Insurance companies may require preservative treated timbers to be used on external walls to satisfy their warranties.
ROOFWORK	Roof finishes	concrete roof tiles – (not necessarily slates) may be sourced in Scotland. Clay tiles. Stainless steel, copper and aluminium profiled sheet materials which can be recycled.
LININGS, SUNDRY ETC	roof insulation	cellulose insulation (recycled paper) Wool
	solvent woodstains	water based woodstains wax finishes
	solvent based paints	water based paints
	kitchen units	low formaldehyde chipboard or solid wood
	tungsten light bulbs	2D low energy bulbs
PLUMBING	Cisterns	Dual flush cisterns 4/6 litres
	Wash basins	Flow regulators, autosave off systems, aerating taps, showers with flow rate equal or less than 4.5 litres a minute
	PVC drains	HDPE pipe/ clay drains
	PVC gutters and downpipes	Galvanised steel or aluminium gutters and downpipes (Nordal or Lindab)
EXTERNAL LANDSCAPE	Peat mulch	Bark and straw mulch
	Surface drainage	SUDS Systems. Gravel instead of brick and block driveways. Grasscrete.
INSULATION	polyurethane insulation and other oil based insulants, sometimes used in composite lining boards in timber frame kits.	Mineral fibre/rockwool Fibreglass batts made locally. Cellulose and wool insulation

Table 4: alternative materials

## 7.2 Health

- 7.2.1 Whilst health and safety legislation covering the work place is among the reasons for minimising solvents in paints and varnishes, market place competition is also driving change. The contribution that natural paint manufacturers are making to the growth of the sustainable development agenda is significant. In the area of specification for a healthy interior air quality their expertise is indispensable. Cost, therefore, has to be weighed against this consideration when health concerns, such as asthma are especially prevalent in Scotland. In special needs houses provided for people with respiratory or allergy problems, natural paints and varnishes, where Volatile Organic Compounds (VOC's) are absent, are essential regardless of cost.
- 7.2.2 Currently non-VOC paints can be up to as much as five times more expensive than conventional paints. In a specification for affordable housing this is an obvious dilemma.
- 7.2.3 It should however be noted that most of the large paint manufacturers are taking notice of the need to reduce VOCs. Water based matt emulsions are available instead of solvent based emulsions and most major manufacturers make a low solvent (40% less solvent) gloss paint as an alternative to high VOC gloss paint.

## 8. Meeting Ecohomes Standards

8.1.1 EcoHomes is an environmental assessment method created by The Building Research Establishment, BRE, to provide a credible, transparent label for new and refurbished homes.

8.1.2 It is not limited to energy matters but considers the broad environmental concerns of climate change, use of resources and impacts on wildlife. It also considers the requirements for a healthy internal environment.

8.1.3 The issues assessed are grouped into seven categories:

- Energy
- Water
- Pollution
- Materials
- Transport
- Ecology and land use
- Health and wellbeing.

8.1.4 An EcoHomes assessment is undertaken by licensed assessors (Paul Barham in our practice is a licensed assessor) for a fee and is carried out at the design stage in a similar way to a SAP rating. Every house type on a site is considered, but the award is given for the whole development. The environmental performance is expressed on a scale of pass to excellent and depicted by sunflowers, one for a pass, two for 'good', three for 'very good' and four for 'excellent'. The various criteria may be described as follows:

- **Pass:** Most developments should achieve this with only minor changes to the specification and at minimal additional cost.
- **Good:** The developer has been able to demonstrate good practice in most areas.
- **Very Good:** Developments which push forward the boundaries of environmental performance.
- **Excellent:** Developments which demonstrate exemplary environmental performance across the full range of issues.

8.1.5 The only case study project which has undergone an eco-homes assessment was at Leitch Street where a 'very good' rating was achieved.

8.1.6 In order to achieve an 'excellent' rating care has to be taken to meet the full range of ecohomes criteria. We have found that the following points could make a difference between achieving an 'excellent' rating and a 'very good' rating:

- Cycle storage should be provided.
- Any timber should have a full chain of custody for certification. (this can be very difficult to achieve because of the use of packers and lippings, thresholds etc that are so commonly used).
- Hard landscaped areas should use gravel (permeable blockwork appears not to be acceptable, although we would question the validity of this criteria)

- There should be water reducing features (much more of an issue in England than in Scotland)
- Downpipes should have water butts, but it only counts as part of an integrated water attenuation design. (SUDS design not included in ecohomes)
- A planting regime which incorporates ecological enhancement. This means only specifying native species, difficult since many of our common plants may have been imported in the past.

8.1.7 There are limitations to ecohomes:

- It is geared to pressures affecting housing developments and environment in the South of England. In this respect it does not account for rural housing where access to local transport networks is more difficult.
- The building footprint favours higher densities – not an issue in rural areas.

## 9. Site related matters

- 9.1.1 A fundamental element of building design, both aesthetically and functionally, is that buildings respond to their context. In this respect a prototype always needs some level of adaptation to fit its context.
- 9.1.2 Individual site specific designs would need to be adopted for different orientations, open or forested locations, site and access conditions.
- 9.1.3 Site conditions and planning constraints may dictate that cladding materials and roof finishes are changed. In particular, if groups of houses are built adjacent to one another, gable ends will require to be clad in a fireproof material (such surfaces need to provide class 0 surface spread of flame and the overall wall needs to provide 60 minutes fire resistance). Whilst brick, and the ubiquitous block and render can be used, it is possible to clad the building in a lightweight calcium silicate board, or provide a render finish on the board or a mesh backing.
- 9.1.4 Site orientation and aspect will influence which windows will receive most solar gain and whether the installation of a sunspace will provide added value as well as energy savings.
- 9.1.5 The slope of any site will have an influence on the type of foundations and underbuilding that may be required. On heavily sloping sites the post and beam frame system reduces the need for underbuilding, however there may be other considerations such as level access to consider. In this respect it is not appropriate to say which floor build up is best without knowing the constraints of a site.
- 9.1.6 Other points to be considered include:
- Shelter from wind
  - On site sewage treatment
  - Surface drainage
  - Existing trees and biodiversity
  - Soil conditions
  - Access and parking requirements
  - Proximity to services
- 9.1.7 In summary, the prototype will always need some level of adjustment for any site, to adequately respond to its context.

## 10. Prototype Summary

- 10.1.1 This report illustrates that it is entirely feasible to construct a warm, energy efficient and low carbon emitting affordable house. The prototype design meets Communities Scotland space benchmarks and maximises the use of C16 timber to allow homegrown timber to be used. A range of options in the Green to Greener specification allows for varying levels of specification and cost.
- 10.1.2 The preferred option provides a flexible house that can initially be built with two bedrooms and then be extended to three. However the installation of the stair at the first phase does have a cost penalty and the house sizes are largely dictated by the need to provide sufficient ground floor space for a three bedroomed house with six people.

Phase	Size	Scottish Housing Handbook, Metric Space Standards	Prototype Size
Phase 1 only	4 Person	84 m <sup>2</sup>	87.9 m <sup>2</sup>
Phase 1 + 2 Together	6 Person	107 m <sup>2</sup>	106.9 m <sup>2</sup>

- 10.1.3 The costs for phase 1 range from £83,390 for the basic building regulations type to £118,535 for the zero emissions type. If both phases are done at the outset, providing a 3 bedroomed house, the costs range from £90,879 for the basic building regulations type to £127,605 for the zero emissions type. In both configurations the basic building regulations standard house costs about 70% of the cost of the zero emissions house.
- 10.1.4 It would be more cost effective to build the three bedroomed house at the outset.
- 10.1.5 The report illustrates that it is possible to build this prototype using C16 homegrown timber within the structure.
- 10.1.6 The Green to Greener specification illustrates the range of options available for insulating, heating and servicing a dwelling in rural Scotland. It illustrates the concept that incremental increase in insulation thickness can be matched with varying types of heating system to provide warm, energy efficient housing that emit low levels of carbon dioxide.
- 10.1.7 In addition to specifying highly insulated components and efficient heating systems, the report outlines a number of other approaches to energy generation and a range of construction materials that have low toxicity in their use or production. We have examined how the prototypes could potentially measure up against the Ecohomes criteria, a national benchmark of Environmental quality.
- 10.1.8 A pilot house which demonstrates the principles of this prototype, would be of great benefit to those wishing to specify greater use of homegrown timber in social housing. Whilst we recognise that there are pilot demonstrations such as the Timberframe 2000 project which built a 6 storey block of flats largely from C16 Scottish timber, we do not think that this makes the necessary link to providing simple rural housing, nor is it accessible for clients and organisations wishing to view the pilot and learn from it.

## **11. Appendix 1**

### **11.1 Cost Breakdowns**

PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - OPTION A

ARCHITECT : JOHN GILBERT ARCHITECTS

DATE : REVISED 18TH APR 2006

CLIENT: PERTSHIRE HOUSING ASSOCIATION

PRELIMINARY ESTIMATE OF COSTS

NOTES AND ASSUMPTIONS

- 1 Estimate based on Architects drawing number Prototype 3 Phase 1 and 2 Option A dated 10/08/04.  
Estimate is based on two semi detached properties.
- 2 Estimate based on specification details in Architects report for each standard.
  - Basic B-reg
  - Enhanced
  - Enhanced (High Thermal Mass)
  - Timber High Insulation
  - Zero emissions
- 3 No roof flashings and timbers allowed.
- 4 No step allowed between semis. Plot area assumed flat.
- 5 Raft foundation 200mm thick with perimeter downstand of 350mm assumed for substructure.  
Raft foundation increases in area with wider external wall widths.
- 6 No ground decontamination removal costs allowed.
- 7 One penetration for soil pipe allowed in roof.
- 8 Marley Plain Tile assumed for roof tile.
- 9 Estimate assumes weatherboarding is not painted with opaque microporous water repellent coating.
- 10 No gas installation allowed.
- 11 Contract Preliminaries are based on a 39 week construction period for three blocks of two semi detached houses, that is six houses per contract.  
If the project was more than six dwellings the preliminaries would reduce as a percentage of works cost.  
Alternatively if the project was less than six dwellings the preliminaries would increase as a percentage of works cost.
- 12 Base date for estimate is now April 2006.
- 13 It is assumed that where the structural frame increases in thickness the gross internal area will stay the same therefore the external dimensions of the substructure and superstructure increases.
- 14 We have shown the net cost difference between building the Phase 1 house and building a Phase 2 house.  
This net cost will be greater if Phase 1 is built with the Phase 2 works added at a later date as there would be increased management and overhead costs eg working in occupied house etc.
- 15 As an Optional extra the Redland 24 tile pv kit from Sundog Energy would cost £18,371 per house.  
The smaller 10 tile kit would cost £8,930 per house.
- 16 All costs are exclusive of Professional Fees and vat and excludes Planning and Building Warrant charges.
- 17 Costs exclude External Works and Site Development and Servicing costs as these costs would be site specific and would be constant irrespective of house specification.

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE : REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**OVERALL SUMMARY (WORKS COSTS ONLY EXCLUDING FEES, VAT AND DEVELOPMENT CONTROL CHARGES)**

	<b>WORKS COST</b>	<b>COST PER M2</b>	<b>COST PER HOUSE</b>
<b>PHASE 1</b>			
<b>BASIC B-REG</b>	£ 166,780	£ 1,010	£ 83,390
<b>ENHANCED</b>	£ 176,936	£ 1,074	£ 88,468
<b>ENHANCED (HIGH THERMAL MASS)</b>	£ 180,861	£ 1,102	£ 90,431
<b>TIMBER HIGH THERMAL MASS</b>	£ 218,286	£ 1,313	£ 109,143
<b>ZERO EMISSIONS</b>	£ 237,069	£ 1,432	£ 118,535
	<b>WORKS COST</b>	<b>COST PER M2</b>	<b>COST PER HOUSE</b>
<b>PHASE 2</b>			
<b>BASIC B-REG</b>	£ 181,758	£ 973	£ 90,879
<b>ENHANCED</b>	£ 192,509	£ 1,036	£ 96,255
<b>ENHANCED (HIGH THERMAL MASS)</b>	£ 196,435	£ 1,065	£ 98,218
<b>TIMBER HIGH THERMAL MASS</b>	£ 233,903	£ 1,244	£ 116,952
<b>ZERO EMISSIONS</b>	£ 255,210	£ 1,366	£ 127,605
	<b>WORKS COST</b>	<b>COST PER HOUSE</b>	
<b>EXTRA COST FOR PHASE 2</b>			
<b>BASIC B-REG</b>	£ 14,978	£ 7,489	
<b>ENHANCED</b>	£ 15,573	£ 7,787	
<b>ENHANCED (HIGH THERMAL MASS)</b>	£ 15,574	£ 7,787	
<b>TIMBER HIGH THERMAL MASS</b>	£ 15,617	£ 7,809	
<b>ZERO EMISSIONS</b>	£ 18,141	£ 9,070	

**PROPOSED SCHEME :NEW BUILD HOUSING - PROTOTYPE 3 - OPTION A**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

<b>PRELIMINARIES FOR EACH SPECIFICATION STANDARD (ASSUMING 39 WEEKS FOR 6 SEMI DETACHED HOUSES)</b>	<b>AN EXISTING CONTRACT</b>		<b>ASSUME 39 WEEK CONSTRUCTION PERIOD</b>
MANAGEMENT AND STAFF	£ 34,840.00		£ 34,840.00
INSURANCE	£ 1,000.00		£ 1,000.00
SITE ACCOMMODATION	£ 9,360.00		£ 9,360.00
SERVICES AND FACILITIES	£ 1,224.00		£ 1,224.00
POWER	£ 752.00		£ 752.00
FUELS	£ 716.00		£ 716.00
WATER	£ 700.00		£ 700.00
SAFETY, HEALTH AND WELFARE	£ 2,200.00		£ 2,200.00
SECURITY	ASSUME RURAL £ 10,760.00	REDUCE	£ 3,000.00
MAINTAIN PUBLIC ROADS	£ 1,040.00		£ 1,040.00
SMALL PLANT AND TOOLS	£ 7,856.00		£ 7,856.00
MECHANICAL PLANT	£ 576.00		£ 576.00
CRANES	£ 3,096.00		£ 3,096.00
HOISTS	£ 1,266.00		£ 1,266.00
PERSONNEL TRANSPORT	ASSUME RURAL £ 578.00	INCREASE	£ 1,950.00
ACCESS SCAFFOLDING	£ 14,760.00		£ 14,760.00
HOARDINGS, FANS ETC	ASSUME RURAL £ 2,684.00	REDUCE	£ 1,500.00
HARDSTANDINGS	£ 1,488.00		£ 1,488.00
TRAFIC REGULATIONS	£ 2,518.73		£ 2,518.73
SITE SIGNBOARD	£ 1,000.00		£ 500.00
ESTIMATED PRELIMS	£ 98,414.73		£ 90,342.73
THEREFORE TOTAL PRELIMS FOR BLOCK OF TWO SEMIS			£ 30,114.24

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 1 - OPTION A - BASIC B-REG SPECIFICATION**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**40 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**182 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	NR OF UNITS	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
1.0 SUBSTRUCTURE	£ 20,766.08	£ 146.24	2	£ 26,148.54	£ 184.14	£ 13,074.27
2.0 SUPERSTRUCTURE						
2.1 EXTERNAL WALLS	£ 1,173.60	£ 6.45	2	£ 1,477.79	£ 8.12	£ 738.90
VERTICAL WEATHERBOARDING	£ 3,753.00	£ 20.62	2	£ 4,725.76	£ 25.96	£ 2,362.88
PAINING WEATHERBOARDING	£ -	£ -	2	£ -	£ -	£ -
2.2 INTERNAL WALLS	£ 176.70	£ 0.97	2	£ 222.50	£ 1.22	£ 111.25
2.3 UPPER FLOORS	£ 960.00	£ 5.27	2	£ 1,208.83	£ 6.64	£ 604.42
2.4 ROOF	£ 12,907.81	£ 70.92	2	£ 16,253.45	£ 89.30	£ 8,126.73
2.5 STAIRS	£ 800.00	£ 4.40	2	£ 1,007.36	£ 5.54	£ 503.68
2.6 SKIRTINGS	£ 888.16	£ 4.88	2	£ 1,118.37	£ 6.14	£ 559.19
2.7 WINDOW AND EXT DOORS	£ 6,420.75	£ 35.28	2	£ 8,084.98	£ 44.42	£ 4,042.49
2.8 INTERNAL DOORS	£ 5,773.40	£ 31.72	2	£ 7,269.84	£ 39.94	£ 3,634.92
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 13.19	2	£ 3,022.07	£ 16.61	£ 1,511.04
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 5.09	2	£ 1,166.52	£ 6.41	£ 583.26
2.11 STRUCTURAL KIT	£ 19,143.02	£ 134.81	2	£ 24,104.79	£ 169.75	£ 12,052.40
TOTAL	£ 55,322.84	£ 333.60	2	£ 69,662.26	£ 420.05	£ 34,831.16
3.0 INTERNAL FINISHES						
3.1 WALL FINISHES	£ 6,759.48	£ 37.14	2	£ 8,511.50	£ 46.77	£ 4,255.75
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	2	£ 2,537.25	£ 17.87	£ 1,268.63
3.3 CEILING FINISHES	£ 2,298.66	£ 12.63	2	£ 2,894.46	£ 15.90	£ 1,447.23
3.4 PAINTING AND DECOR	£ 3,891.16	£ 21.38	2	£ 4,899.73	£ 26.92	£ 2,449.87
TOTAL	£ 14,964.28	£ 85.34	2	£ 18,842.94	£ 107.46	£ 9,421.48
4.0 SERVICES						
4.1 SANITARY APPLIANCES	£ 2,180.00	£ 11.98	2	£ 2,745.04	£ 15.09	£ 1,372.52
4.2 SOIL AND WASTE INSTALL	£ 968.24	£ 5.32	2	£ 1,219.20	£ 6.70	£ 609.60
4.3 WATER INSTALL	£ 1,941.94	£ 10.67	2	£ 2,445.28	£ 13.44	£ 1,222.64
4.4 HEATING INSTALL	£ 6,812.00	£ 37.43	2	£ 8,577.64	£ 47.13	£ 4,288.82
WOOD STOVE HEATER	£ -	£ -	2	£ -	£ -	£ -
4.5 VENTILATION INSTALL	£ 872.60	£ 4.79	2	£ 1,098.77	£ 6.03	£ 549.39
4.6 ELECTRICAL INSTALL	£ 10,082.80	£ 55.40	2	£ 12,696.21	£ 69.76	£ 6,348.11
4.7 GAS INSTALL	£ -	£ -	2	£ -	£ -	£ -
4.8 RAINWATER INSTALL	£ 2,273.00	£ 12.49	2	£ 2,862.15	£ 15.73	£ 1,431.08
TOTAL	£ 25,130.58	£ 138.08	2	£ 31,644.29	£ 173.88	£ 15,822.16
SUB TOTAL	£ 116,183.78	£ 703.26	2	£ 146,298.03	£ 885.53	£ 73,149.07
UPDATE FROM MARCH 2004 TO APRIL 2006.	ADD 14%	£ 16,265.73	2	£ 20,481.72	£ 123.97	£ 10,240.87
PRELIMINARY ESTIMATE	£ 132,449.51	£ 801.72	2	£ 166,779.75	£ 1,009.50	£ 83,389.94

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - BASIC B-REG SPECIFICATION**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**78 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**220 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
<b>1.0 SUBSTRUCTURE</b>	£ 20,766.08	£ 146.24	£ 25,601.69	£ 180.29	£ 12,800.85
<b>2.0 SUPERSTRUCTURE</b>					
2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,446.89	£ 6.57	£ 723.45
VERTICAL WEATHERBOARDING	£ 3,726.00	£ 16.94	£ 4,593.64	£ 20.88	£ 2,296.82
PAINING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 263.52	£ 1.20	£ 131.76
2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,307.92	£ 10.49	£ 1,153.96
2.4 ROOF	£ 14,047.50	£ 63.85	£ 17,318.61	£ 78.72	£ 8,659.31
2.5 STAIRS	£ 800.00	£ 3.64	£ 986.29	£ 4.49	£ 493.15
2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,323.60	£ 6.02	£ 661.80
2.7 WINDOW AND EXT DOORS	£ 7,109.56	£ 32.32	£ 8,765.10	£ 39.85	£ 4,382.55
2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 8,154.27	£ 37.06	£ 4,077.14
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 2,958.87	£ 13.45	£ 1,479.44
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,142.12	£ 5.19	£ 571.06
2.11 STRUCTURAL KIT	£ 19,143.02	£ 134.81	£ 23,600.68	£ 166.20	£ 11,800.34
<b>TOTAL</b>	£ 59,099.53	£ 316.43	£ 72,861.51	£ 390.12	£ 36,430.78
<b>3.0 INTERNAL FINISHES</b>					
3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 10,073.46	£ 45.79	£ 5,036.73
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,484.19	£ 17.49	£ 1,242.10
3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 3,425.63	£ 15.57	£ 1,712.82
3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 5,798.88	£ 26.36	£ 2,899.44
<b>TOTAL</b>	£ 17,667.98	£ 85.34	£ 21,782.16	£ 105.21	£ 10,891.09
<b>4.0 SERVICES</b>					
4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 6,376.36	£ 28.98	£ 3,188.18
4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,442.94	£ 6.56	£ 721.47
4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 2,894.02	£ 13.15	£ 1,447.01
4.4 HEATING INSTALL	£ 7,442.00	£ 33.83	£ 9,174.95	£ 41.71	£ 4,587.48
WOOD STOVE HEATER	£ -	£ -	£ -	£ -	£ -
4.5 VENTILATION INSTALL	£ 1,196.60	£ 5.44	£ 1,475.24	£ 6.71	£ 737.62
4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 15,026.11	£ 68.30	£ 7,513.06
4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
4.8 RAINWATER INSTALL	£ 2,273.00	£ 10.33	£ 2,802.29	£ 12.74	£ 1,401.15
<b>TOTAL</b>	£ 31,789.40	£ 144.50	£ 39,191.91	£ 178.15	£ 19,595.97
<b>SUB TOTAL</b>	£ 129,322.99	£ 692.51	£ 159,437.27	£ 853.77	£ 79,718.69
<b>UPDATE FROM MARCH 2004 TO APRIL 2006.</b>					
<b>ADD</b>	14% £ 18,105.22	£ 96.95	£ 22,321.22	£ 119.53	£ 11,160.62
<b>PRELIMINARY ESTIMATE</b>	£ 147,428.21	£ 789.46	£ 181,758.49	£ 973.30	£ 90,879.31

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 1 - OPTION A - ENHANCED SPECIFICATION**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**40 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**182 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
<b>1.0 SUBSTRUCTURE</b>	£ 22,981.28	£ 161.84	£ 28,513.79	£ 200.80	£ 14,256.90
<b>2.0 SUPERSTRUCTURE</b>					
2.1 EXTERNAL WALLS	£ 1,173.60	£ 6.45	£ 1,456.13	£ 8.00	£ 728.07
VERTICAL WEATHERBOARDING	£ 4,005.45	£ 22.01	£ 4,969.72	£ 27.31	£ 2,484.86
PAINING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
2.2 INTERNAL WALLS	£ 176.70	£ 0.97	£ 219.24	£ 1.20	£ 109.62
2.3 UPPER FLOORS	£ 960.00	£ 5.27	£ 1,191.11	£ 6.54	£ 595.56
2.4 ROOF	£ 13,703.19	£ 75.29	£ 17,002.10	£ 93.42	£ 8,501.05
2.5 STAIRS	£ 800.00	£ 4.40	£ 992.59	£ 5.46	£ 496.30
2.6 SKIRTINGS	£ 888.16	£ 4.88	£ 1,101.98	£ 6.05	£ 550.99
2.7 WINDOW AND EXT DOORS	£ 6,602.75	£ 36.28	£ 8,192.30	£ 45.01	£ 4,096.15
2.8 INTERNAL DOORS	£ 5,773.40	£ 31.72	£ 7,163.29	£ 39.36	£ 3,581.65
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 13.19	£ 2,977.78	£ 16.37	£ 1,488.89
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 5.09	£ 1,149.42	£ 6.32	£ 574.71
2.11 STRUCTURAL KIT	£ 21,363.90	£ 150.45	£ 26,507.05	£ 186.67	£ 13,253.53
<b>TOTAL</b>	£ 58,773.55	£ 356.00	£ 72,922.71	£ 441.71	£ 36,461.38
<b>3.0 INTERNAL FINISHES</b>					
3.1 WALL FINISHES	£ 6,759.48	£ 37.14	£ 8,386.76	£ 46.08	£ 4,193.38
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,500.07	£ 17.61	£ 1,250.04
3.3 CEILING FINISHES	£ 2,298.66	£ 12.63	£ 2,852.04	£ 15.67	£ 1,426.02
3.4 PAINTING AND DECOR	£ 3,891.16	£ 21.38	£ 4,827.92	£ 26.53	£ 2,413.96
<b>TOTAL</b>	£ 14,964.28	£ 85.34	£ 18,566.79	£ 105.89	£ 9,283.40
<b>4.0 SERVICES</b>					
4.1 SANITARY APPLIANCES	£ 2,180.00	£ 11.98	£ 2,704.81	£ 14.86	£ 1,352.41
4.2 SOIL AND WASTE INSTALL	£ 968.24	£ 5.32	£ 1,201.33	£ 6.60	£ 600.67
4.3 WATER INSTALL	£ 1,941.94	£ 10.67	£ 2,409.44	£ 13.24	£ 1,204.72
4.4 HEATING INSTALL	£ 6,422.00	£ 35.29	£ 7,968.03	£ 43.79	£ 3,984.02
WOOD STOVE HEATER	£ 3,228.00	£ 17.74	£ 4,005.11	£ 22.01	£ 2,002.56
4.5 VENTILATION INSTALL	£ 1,236.60	£ 6.79	£ 1,534.30	£ 8.42	£ 767.15
4.6 ELECTRICAL INSTALL	£ 10,082.80	£ 55.40	£ 12,510.13	£ 68.74	£ 6,255.07
4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
4.8 RAINWATER INSTALL	£ 2,313.26	£ 12.71	£ 2,870.15	£ 15.77	£ 1,435.08
<b>TOTAL</b>	£ 28,372.84	£ 155.90	£ 35,203.30	£ 193.43	£ 17,601.68
<b>SUB TOTAL</b>	£ 125,091.95	£ 759.08	£ 155,206.59	£ 941.83	£ 77,603.36
UPDATE FROM MARCH 2004 TO APRIL 2006. ADD 14%	£ 17,512.87	£ 106.27	£ 21,728.92	£ 131.86	£ 10,864.47
<b>PRELIMINARY ESTIMATE</b>	£ 142,604.82	£ 865.35	£ 176,935.51	£ 1,073.69	£ 88,467.83

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - ENHANCED SPECIFICATION**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**78 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**220 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT	
<b>1.0 SUBSTRUCTURE</b>	£ 22,981.28	£ 161.84	£ 27,969.00	£ 196.96	£ 13,984.50	
<b>2.0 SUPERSTRUCTURE</b>						
2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,428.31	£ 6.49	£ 714.16	
VERTICAL WEATHERBOARDING	£ 4,005.45	£ 18.21	£ 4,874.77	£ 22.16	£ 2,437.39	
PAINING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -	
2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 260.14	£ 1.18	£ 130.07	
2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,278.29	£ 10.36	£ 1,139.15	
2.4 ROOF	£ 14,834.15	£ 67.43	£ 18,053.67	£ 82.06	£ 9,026.84	
2.5 STAIRS	£ 800.00	£ 3.64	£ 973.63	£ 4.43	£ 486.82	
2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,306.61	£ 5.94	£ 653.31	
2.7 WINDOW AND EXT DOORS	£ 7,329.56	£ 33.32	£ 8,920.33	£ 40.55	£ 4,460.17	
2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 8,049.59	£ 36.58	£ 4,024.80	
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 2,920.88	£ 13.28	£ 1,460.44	
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,127.46	£ 5.12	£ 563.73	
2.11 STRUCTURAL KIT	£ 21,363.90	£ 150.45	£ 26,000.60	£ 183.10	£ 13,000.30	
<b>TOTAL</b>	£ 62,606.51	£ 337.92	£ 76,194.28	£ 411.25	£ 38,097.18	
<b>3.0 INTERNAL FINISHES</b>						
3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 9,944.14	£ 45.20	£ 4,972.07	
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,452.30	£ 17.27	£ 1,226.15	
3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 3,381.65	£ 15.37	£ 1,690.83	
3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 5,724.44	£ 26.02	£ 2,862.22	
<b>TOTAL</b>	£ 17,667.98	£ 85.34	£ 21,502.53	£ 103.86	£ 10,751.27	
<b>4.0 SERVICES</b>						
4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 6,294.50	£ 28.61	£ 3,147.25	
4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,424.42	£ 6.47	£ 712.21	
4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 2,856.87	£ 12.99	£ 1,428.44	
4.4 HEATING INSTALL	£ 7,442.00	£ 33.83	£ 9,057.17	£ 41.17	£ 4,528.59	
WOOD STOVE HEATER	£ 3,228.00	£ 14.67	£ 3,928.59	£ 17.85	£ 1,964.30	
4.5 VENTILATION INSTALL	£ 1,636.60	£ 7.44	£ 1,991.80	£ 9.05	£ 995.90	
4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 14,833.21	£ 67.42	£ 7,416.61	
4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -	
4.8 RAINWATER INSTALL	£ 2,313.26	£ 10.51	£ 2,815.32	£ 12.79	£ 1,407.66	
<b>TOTAL</b>	£ 35,497.66	£ 161.35	£ 43,201.88	£ 196.35	£ 21,600.96	
<b>SUB TOTAL</b>	£ 138,753.43	£ 746.45	£ 168,867.69	£ 908.42	£ 84,433.91	
UPDATE FROM MARCH 2004 TO APRIL 2006.	ADD 14%	£ 19,425.48	£ 104.50	£ 23,641.48	£ 127.18	£ 11,820.75
<b>PRELIMINARY ESTIMATE</b>	£ 158,178.91	£ 850.95	£ 192,509.17	£ 1,035.60	£ 96,254.66	

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 1 - OPTION A - ENHANCED (HIGH THERMAL MASS)**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**40 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**182 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT	
<b>1.0 SUBSTRUCTURE</b>	£ 23,631.64	£ 166.42	£ 29,168.20	£ 205.41	£ 14,584.10	
<b>2.0 SUPERSTRUCTURE</b>						
2.1 EXTERNAL WALLS	£ 1,173.60	£ 6.45	£ 1,448.56	£ 7.96	£ 724.28	
VERTICAL WEATHERBOARDING	£ 4,034.48	£ 22.17	£ 4,979.70	£ 27.36	£ 2,489.85	
PAINING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -	
2.2 INTERNAL WALLS	£ 176.70	£ 0.97	£ 218.10	£ 1.20	£ 109.05	
2.3 UPPER FLOORS	£ 960.00	£ 5.27	£ 1,184.91	£ 6.50	£ 592.46	
2.4 ROOF	£ 13,703.19	£ 75.29	£ 16,913.66	£ 92.93	£ 8,456.83	
2.5 STAIRS	£ 800.00	£ 4.40	£ 987.43	£ 5.43	£ 493.72	
2.6 SKIRTINGS	£ 888.16	£ 4.88	£ 1,096.24	£ 6.02	£ 548.12	
2.7 WINDOW AND EXT DOORS	£ 6,602.75	£ 36.28	£ 8,149.68	£ 44.78	£ 4,074.84	
2.8 INTERNAL DOORS	£ 5,773.40	£ 31.72	£ 7,126.03	£ 39.15	£ 3,563.02	
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 13.19	£ 2,962.29	£ 16.28	£ 1,481.15	
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 5.09	£ 1,143.44	£ 6.28	£ 571.72	
2.11 STRUCTURAL KIT	£ 24,128.64	£ 169.92	£ 29,781.64	£ 209.73	£ 14,890.82	
<b>TOTAL</b>	£ 61,567.32	£ 375.63	£ 75,991.68	£ 463.62	£ 37,995.86	
<b>3.0 INTERNAL FINISHES</b>						
3.1 WALL FINISHES	£ 6,759.48	£ 37.14	£ 8,343.13	£ 45.84	£ 4,171.57	
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,487.06	£ 17.51	£ 1,243.53	
3.3 CEILING FINISHES	£ 2,298.66	£ 12.63	£ 2,837.20	£ 15.59	£ 1,418.60	
3.4 PAINTING AND DECOR	£ 3,891.16	£ 21.38	£ 4,802.80	£ 26.39	£ 2,401.40	
<b>TOTAL</b>	£ 14,964.28	£ 85.34	£ 18,470.19	£ 105.33	£ 9,235.10	
<b>4.0 SERVICES</b>						
4.1 SANITARY APPLIANCES	£ 2,180.00	£ 11.98	£ 2,690.74	£ 14.79	£ 1,345.37	
4.2 SOIL AND WASTE INSTALL	£ 968.24	£ 5.32	£ 1,195.09	£ 6.57	£ 597.55	
4.3 WATER INSTALL	£ 1,941.94	£ 10.67	£ 2,396.91	£ 13.17	£ 1,198.46	
4.4 HEATING INSTALL	£ 6,422.00	£ 35.29	£ 7,926.58	£ 43.56	£ 3,963.29	
WOOD STOVE HEATER	£ 3,228.00	£ 17.74	£ 3,984.28	£ 21.90	£ 1,992.14	
4.5 VENTILATION INSTALL	£ 1,236.60	£ 6.79	£ 1,526.32	£ 8.38	£ 763.16	
4.6 ELECTRICAL INSTALL	£ 10,082.80	£ 55.40	£ 12,445.06	£ 68.38	£ 6,222.53	
4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -	
4.8 RAINWATER INSTALL	£ 2,313.26	£ 12.71	£ 2,855.22	£ 15.69	£ 1,427.61	
<b>TOTAL</b>	£ 28,372.84	£ 155.90	£ 35,020.20	£ 192.44	£ 17,510.11	
<b>SUB TOTAL</b>	£ 128,536.08	£ 783.29	£ 158,650.27	£ 966.80	£ 79,325.17	
UPDATE FROM MARCH 2004 TO APRIL 2006.	ADD 14%	£ 17,995.05	£ 109.66	£ 22,211.04	£ 135.35	£ 11,105.52
<b>PRELIMINARY ESTIMATE</b>	£ 146,531.13	£ 892.95	£ 180,861.31	£ 1,102.15	£ 90,430.69	

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - ENHANCED (HIGH THERMAL MASS)**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**78 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**220 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
<b>1.0 SUBSTRUCTURE</b>	£ 23,631.64	£ 166.42	£ 28,636.29	£ 201.66	£ 14,318.15
<b>2.0 SUPERSTRUCTURE</b>					
2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,422.14	£ 6.46	£ 711.07
VERTICAL WEATHERBOARDING	£ 4,034.48	£ 18.34	£ 4,888.89	£ 22.22	£ 2,444.45
PAINING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 259.02	£ 1.18	£ 129.51
2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,268.45	£ 10.31	£ 1,134.23
2.4 ROOF	£ 14,834.15	£ 67.43	£ 17,975.69	£ 81.71	£ 8,987.85
2.5 STAIRS	£ 800.00	£ 3.64	£ 969.42	£ 4.41	£ 484.71
2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,300.96	£ 5.91	£ 650.48
2.7 WINDOW AND EXT DOORS	£ 7,329.56	£ 33.32	£ 8,881.80	£ 40.38	£ 4,440.90
2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 8,014.82	£ 36.43	£ 4,007.41
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 2,908.27	£ 13.22	£ 1,454.14
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,122.59	£ 5.10	£ 561.30
2.11 STRUCTURAL KIT	£ 24,128.64	£ 169.92	£ 29,238.54	£ 205.91	£ 14,619.27
<b>TOTAL</b>	£ 65,400.28	£ 357.52	£ 79,250.59	£ 433.24	£ 39,625.32
<b>3.0 INTERNAL FINISHES</b>					
3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 9,901.19	£ 45.01	£ 4,950.60
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,441.71	£ 17.20	£ 1,220.86
3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 3,367.04	£ 15.30	£ 1,683.52
3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 5,699.72	£ 25.91	£ 2,849.86
<b>TOTAL</b>	£ 17,667.98	£ 85.34	£ 21,409.66	£ 103.42	£ 10,704.84
<b>4.0 SERVICES</b>					
4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 6,267.31	£ 28.49	£ 3,133.66
4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,418.26	£ 6.45	£ 709.13
4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 2,844.53	£ 12.93	£ 1,422.27
4.4 HEATING INSTALL	£ 7,442.00	£ 33.83	£ 9,018.05	£ 40.99	£ 4,509.03
WOOD STOVE HEATER	£ 3,228.00	£ 14.67	£ 3,911.62	£ 17.78	£ 1,955.81
4.5 VENTILATION INSTALL	£ 1,636.60	£ 7.44	£ 1,983.20	£ 9.02	£ 991.60
4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 14,769.14	£ 67.13	£ 7,384.57
4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
4.8 RAINWATER INSTALL	£ 2,313.26	£ 10.51	£ 2,803.16	£ 12.74	£ 1,401.58
<b>TOTAL</b>	£ 35,497.66	£ 161.35	£ 43,015.27	£ 195.53	£ 21,507.65
<b>SUB TOTAL</b>	£ 142,197.56	£ 770.63	£ 172,311.81	£ 933.85	£ 86,155.96
<b>UPDATE FROM MARCH 2004 TO APRIL 2006.</b>					
<b>ADD</b>	14% £ 19,907.66	£ 107.89	£ 24,123.65	£ 130.74	£ 12,061.83
<b>PRELIMINARY ESTIMATE</b>	£ 162,105.22	£ 878.52	£ 196,435.46	£ 1,064.59	£ 98,217.79

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 1 - OPTION A - TIMBER HIGH INSULATION**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**40 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**182 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	NR OF UNITS	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
1.0 SUBSTRUCTURE	£ 27,191.58	£ 191.49	2	£ 32,266.13	£ 227.23	£ 16,133.07
2.0 SUPERSTRUCTURE						
2.1 EXTERNAL WALLS	£ 1,173.60	£ 6.45	2	£ 1,392.62	£ 7.65	£ 696.31
VERTICAL WEATHERBOARDING	£ 4,278.42	£ 23.51	2	£ 5,076.87	£ 27.90	£ 2,538.44
PAINTING WEATHERBOARDING	£ -	£ -	2	£ -	£ -	£ -
2.2 INTERNAL WALLS	£ 176.70	£ 0.97	2	£ 209.68	£ 1.15	£ 104.84
2.3 UPPER FLOORS	£ 960.00	£ 5.27	2	£ 1,139.16	£ 6.25	£ 569.58
2.4 ROOF	£ 14,392.53	£ 79.08	2	£ 17,078.49	£ 93.84	£ 8,539.25
2.5 STAIRS	£ 800.00	£ 4.40	2	£ 949.30	£ 5.22	£ 474.65
2.6 SKIRTINGS	£ 888.16	£ 4.88	2	£ 1,053.91	£ 5.79	£ 526.96
2.7 WINDOW AND EXT DOORS	£ 6,602.75	£ 36.28	2	£ 7,834.97	£ 43.05	£ 3,917.49
SOLAR SUNSPACE	£ 16,675.55	£ 91.62	2	£ 19,787.57	£ 108.72	£ 9,893.79
2.8 INTERNAL DOORS	£ 5,773.40	£ 31.72	2	£ 6,850.84	£ 37.64	£ 3,425.42
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 13.19	2	£ 2,847.89	£ 15.65	£ 1,423.95
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 5.09	2	£ 1,099.29	£ 6.04	£ 549.65
2.11 STRUCTURAL KIT	£ 25,072.94	£ 176.57	2	£ 29,752.10	£ 209.52	£ 14,876.05
TOTAL	£ 80,120.45	£ 479.03	2	£ 95,072.69	£ 568.42	£ 47,536.38
3.0 INTERNAL FINISHES						
3.1 WALL FINISHES	£ 6,759.48	£ 37.14	2	£ 8,020.95	£ 44.07	£ 4,010.48
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	2	£ 2,391.02	£ 16.84	£ 1,195.51
3.3 CEILING FINISHES	£ 2,298.66	£ 12.63	2	£ 2,727.64	£ 14.99	£ 1,363.82
3.4 PAINTING AND DECOR	£ 3,891.16	£ 21.38	2	£ 4,617.34	£ 25.37	£ 2,308.67
TOTAL	£ 14,964.28	£ 85.34	2	£ 17,756.95	£ 101.27	£ 8,878.48
4.0 SERVICES						
4.1 SANITARY APPLIANCES	£ 2,180.00	£ 11.98	2	£ 2,586.84	£ 14.22	£ 1,293.42
4.2 SOIL AND WASTE INSTALL	£ 968.24	£ 5.32	2	£ 1,148.93	£ 6.31	£ 574.47
4.3 WATER INSTALL	£ 1,941.94	£ 10.67	2	£ 2,304.35	£ 12.66	£ 1,152.18
4.4 HEATING INSTALL	£ 6,422.00	£ 35.29	2	£ 7,620.49	£ 41.88	£ 3,810.25
WOOD STOVE HEATER	£ 4,044.00	£ 22.22	2	£ 4,798.70	£ 26.37	£ 2,399.35
WIND GENERATOR	£ 3,100.00	£ 17.03	2	£ 3,678.53	£ 20.21	£ 1,839.27
SOLARTWIN PANELS	£ 6,400.00	£ 35.16	2	£ 7,594.38	£ 41.72	£ 3,797.19
4.5 VENTILATION INSTALL	£ 1,600.60	£ 8.79	2	£ 1,899.31	£ 10.43	£ 949.66
4.6 ELECTRICAL INSTALL	£ 10,082.80	£ 55.40	2	£ 11,964.47	£ 65.74	£ 5,982.24
4.7 GAS INSTALL	£ -	£ -	2	£ -	£ -	£ -
4.8 RAINWATER INSTALL	£ 2,349.16	£ 12.91	2	£ 2,787.56	£ 15.32	£ 1,393.78
TOTAL	£ 39,088.74	£ 214.77	2	£ 46,383.56	£ 254.86	£ 23,191.81
SUB TOTAL	£ 161,365.05	£ 970.63	2	£ 191,479.33	£ 1,151.78	£ 95,739.74
UPDATE FROM MARCH 2004 TO APRIL 2006.	ADD 14%	£ 22,591.11	£ 135.89	£ 26,807.11	£ 161.25	£ 13,403.56
PRELIMINARY ESTIMATE	£ 183,956.16	£ 1,106.52	2	£ 218,286.44	£ 1,313.03	£ 109,143.30

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - TIMBER HIGH INSULATION**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**78 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**220 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
<b>1.0 SUBSTRUCTURE</b>	£ 27,191.58	£ 191.49	£ 31,869.03	£ 224.43	£ 15,934.52
<b>2.0 SUPERSTRUCTURE</b>					
2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,375.48	£ 6.25	£ 687.74
VERTICAL WEATHERBOARDING	£ 4,247.64	£ 19.31	£ 4,978.31	£ 22.63	£ 2,489.16
PAINTING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 250.52	£ 1.14	£ 125.26
2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,194.02	£ 9.97	£ 1,097.01
2.4 ROOF	£ 15,515.92	£ 70.53	£ 18,184.94	£ 82.66	£ 9,092.47
2.5 STAIRS	£ 800.00	£ 3.64	£ 937.61	£ 4.27	£ 468.81
2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,258.28	£ 5.72	£ 629.14
2.7 WINDOW AND EXT DOORS	£ 7,329.56	£ 33.32	£ 8,590.38	£ 39.05	£ 4,295.19
SOLAR SUNSPACE	£ 16,675.55	£ 75.80	£ 19,544.05	£ 88.84	£ 9,772.03
2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 7,751.85	£ 35.23	£ 3,875.93
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 2,812.84	£ 12.79	£ 1,406.42
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,085.76	£ 4.93	£ 542.88
2.11 STRUCTURAL KIT	£ 25,072.94	£ 176.57	£ 29,385.94	£ 206.94	£ 14,692.97
<b>TOTAL</b>	£ 83,915.06	£ 444.04	£ 98,349.98	£ 520.42	£ 49,175.01
<b>3.0 INTERNAL FINISHES</b>					
3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 9,576.33	£ 43.53	£ 4,788.17
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,361.59	£ 16.63	£ 1,180.80
3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 3,256.57	£ 14.80	£ 1,628.29
3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 5,512.71	£ 25.06	£ 2,756.36
<b>TOTAL</b>	£ 17,667.98	£ 85.34	£ 20,707.20	£ 100.02	£ 10,353.62
<b>4.0 SERVICES</b>					
4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 6,061.68	£ 27.55	£ 3,030.84
4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,371.73	£ 6.24	£ 685.87
4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 2,751.20	£ 12.51	£ 1,375.60
4.4 HEATING INSTALL	£ 7,442.00	£ 33.83	£ 8,722.16	£ 39.65	£ 4,361.08
WOOD STOVE HEATER	£ 4,044.00	£ 18.38	£ 4,739.64	£ 21.54	£ 2,369.82
WIND GENERATOR	£ 3,100.00	£ 14.09	£ 3,633.26	£ 16.51	£ 1,816.63
SOLARTWIN PANELS	£ 6,400.00	£ 29.09	£ 7,500.92	£ 34.09	£ 3,750.46
4.5 VENTILATION INSTALL	£ 2,076.60	£ 9.44	£ 2,433.81	£ 11.06	£ 1,216.91
4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 14,284.56	£ 64.93	£ 7,142.28
4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
4.8 RAINWATER INSTALL	£ 2,349.16	£ 10.68	£ 2,753.26	£ 12.52	£ 1,376.63
<b>TOTAL</b>	£ 46,289.56	£ 210.41	£ 54,252.22	£ 246.60	£ 27,126.12
<b>SUB TOTAL</b>	£ 175,064.18	£ 931.28	£ 205,178.43	£ 1,091.47	£ 102,589.27
<b>UPDATE FROM MARCH 2004 TO APRIL 2006.</b>					
<b>ADD</b>	14% £ 24,508.99	£ 130.38	£ 28,724.98	£ 152.81	£ 14,362.50
<b>PRELIMINARY ESTIMATE</b>	£ 199,573.17	£ 1,061.66	£ 233,903.41	£ 1,244.28	£ 116,951.77

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 1 - OPTION A - ZERO EMISSIONS**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**40 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**182 M2 GROSS**

**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
<b>1.0 SUBSTRUCTURE</b>	£ 34,453.46	£ 242.63	£ 40,287.46	£ 283.71	£ 20,143.73
<b>2.0 SUPERSTRUCTURE</b>					
2.1 EXTERNAL WALLS	£ 1,173.60	£ 6.45	£ 1,372.33	£ 7.54	£ 686.17
VERTICAL WEATHERBOARDING	£ 4,878.90	£ 26.81	£ 5,705.04	£ 31.35	£ 2,852.52
PAINTING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
2.2 INTERNAL WALLS	£ 176.70	£ 0.97	£ 206.62	£ 1.13	£ 103.31
2.3 UPPER FLOORS	£ 960.00	£ 5.27	£ 1,122.56	£ 6.16	£ 561.28
2.4 ROOF	£ 16,089.35	£ 88.40	£ 18,813.76	£ 103.37	£ 9,406.88
2.5 STAIRS	£ 800.00	£ 4.40	£ 935.46	£ 5.15	£ 467.73
2.6 SKIRTINGS	£ 888.16	£ 4.88	£ 1,038.55	£ 5.71	£ 519.28
2.7 WINDOW AND EXT DOORS	£ 6,602.75	£ 36.28	£ 7,720.79	£ 42.42	£ 3,860.40
SOLAR SUNSPACE	£ 17,013.08	£ 93.48	£ 19,893.90	£ 109.31	£ 9,946.95
2.8 INTERNAL DOORS	£ 5,773.40	£ 31.72	£ 6,751.01	£ 37.09	£ 3,375.51
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 13.19	£ 2,806.39	£ 15.42	£ 1,403.20
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 5.09	£ 1,083.27	£ 5.95	£ 541.64
2.11 STRUCTURAL KIT	£ 26,032.86	£ 183.33	£ 30,441.00	£ 214.37	£ 15,220.50
<b>TOTAL</b>	£ 83,715.20	£ 500.27	£ 97,890.68	£ 584.97	£ 48,945.37
<b>3.0 INTERNAL FINISHES</b>					
3.1 WALL FINISHES	£ 6,759.48	£ 37.14	£ 7,904.06	£ 43.43	£ 3,952.03
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,356.18	£ 16.59	£ 1,178.09
3.3 CEILING FINISHES	£ 2,298.66	£ 12.63	£ 2,687.89	£ 14.77	£ 1,343.95
3.4 PAINTING AND DECOR	£ 3,891.16	£ 21.38	£ 4,550.05	£ 25.00	£ 2,275.03
<b>TOTAL</b>	£ 14,964.28	£ 85.34	£ 17,498.18	£ 99.79	£ 8,749.10
<b>4.0 SERVICES</b>					
4.1 SANITARY APPLIANCES	£ 2,180.00	£ 11.98	£ 2,549.14	£ 14.01	£ 1,274.57
4.2 SOIL AND WASTE INSTALL	£ 968.24	£ 5.32	£ 1,132.19	£ 6.22	£ 566.10
4.3 WATER INSTALL	£ 1,941.94	£ 10.67	£ 2,270.77	£ 12.48	£ 1,135.39
4.4 HEATING INSTALL	£ 5,512.00	£ 30.29	£ 6,445.35	£ 35.42	£ 3,222.68
WOOD STOVE HEATER	£ 4,790.00	£ 26.32	£ 5,601.09	£ 30.78	£ 2,800.55
SUNWARM SYSTEM	£ 14,533.00	£ 79.85	£ 16,993.87	£ 93.37	£ 8,496.94
WIND GENERATOR	£ 3,100.00	£ 17.03	£ 3,624.92	£ 19.91	£ 1,812.46
4.5 VENTILATION INSTALL	£ 1,600.60	£ 8.79	£ 1,871.63	£ 10.28	£ 935.82
4.6 ELECTRICAL INSTALL	£ 10,082.80	£ 55.40	£ 11,790.12	£ 64.78	£ 5,895.06
4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
4.8 RAINWATER INSTALL	£ -	£ -	£ -	£ -	£ -
<b>TOTAL</b>	£ 44,708.58	£ 245.65	£ 52,279.08	£ 287.25	£ 26,139.57
<b>SUB TOTAL</b>	£ 177,841.52	£ 1,073.89	£ 207,955.40	£ 1,255.72	£ 103,977.77
<b>UPDATE FROM MARCH 2004 TO APRIL 2006.</b>					
<b>ADD</b>	14% £ 24,897.81	£ 150.34	£ 29,113.76	£ 175.80	£ 14,556.89
<b>PRELIMINARY ESTIMATE</b>	£ 202,739.33	£ 1,224.23	£ 237,069.16	£ 1,431.52	£ 118,534.66

**PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - ZERO EMISSIONS**

**ARCHITECT : JOHN GILBERT ARCHITECTS**

**DATE :**

**REVISED 18TH APR 2006**

**CLIENT : PERTSHIRE HOUSING ASSOCIATION**

**142 M2 GRD**

**78 M2 1ST**

**PRELIMINARY ESTIMATE**

**G.F.A.**

**220 M2 GROSS**

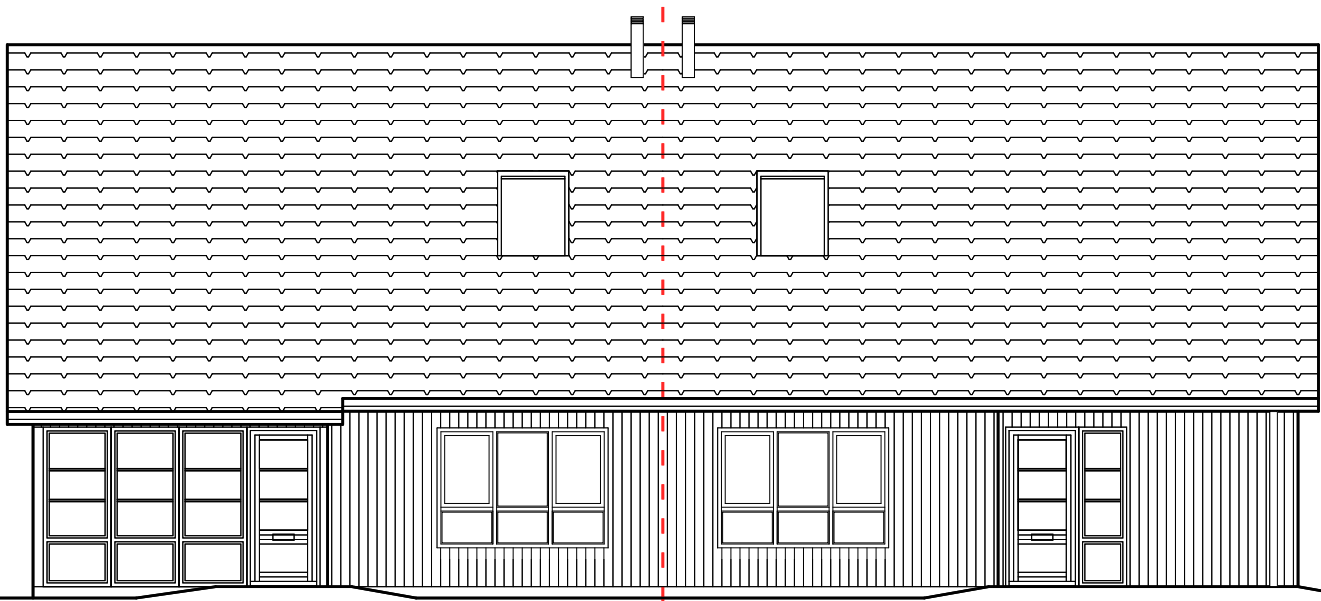
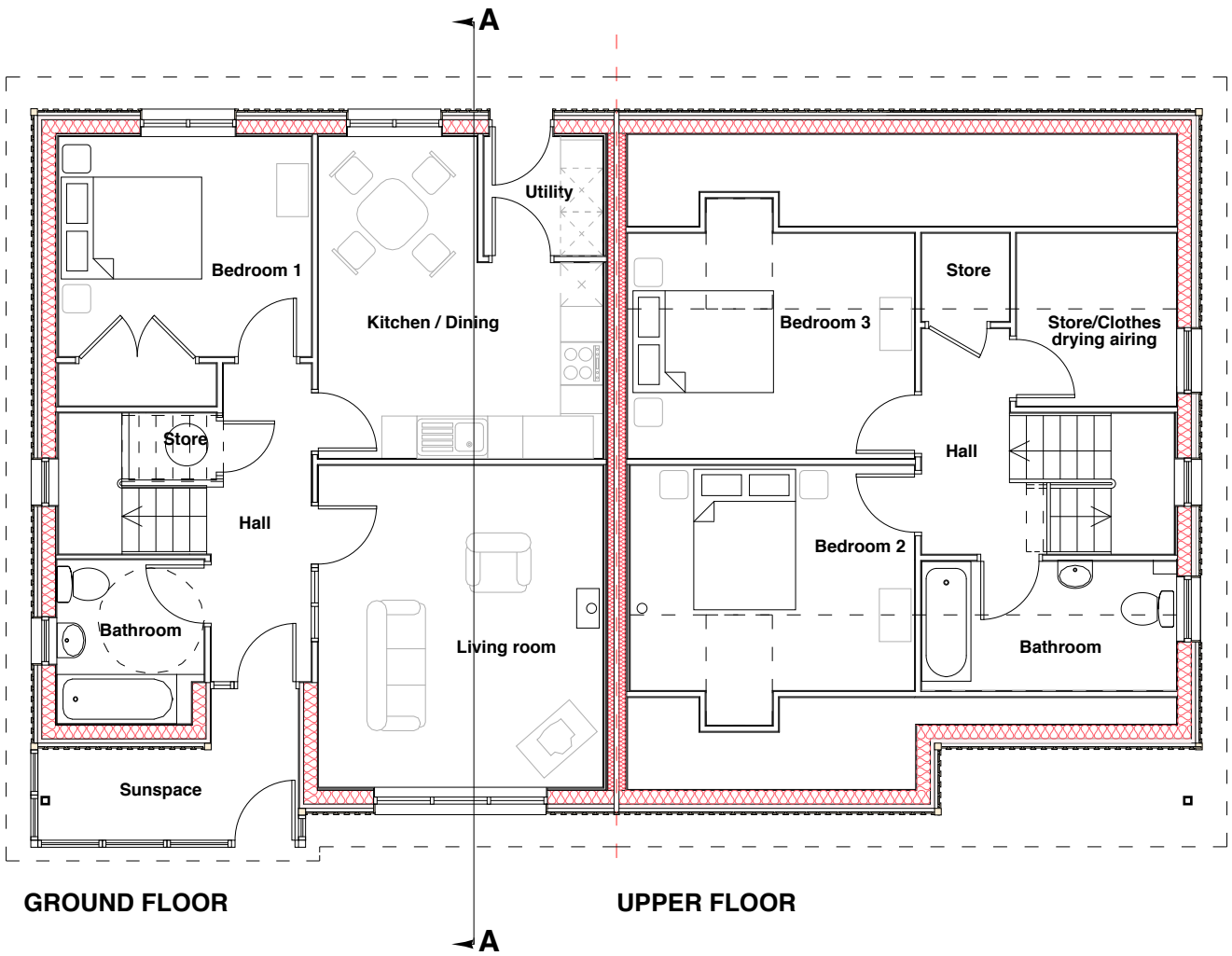
**NR OF UNITS**

**2 NR**

ELEMENT	WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
<b>1.0 SUBSTRUCTURE</b>	£ 34,453.46	£ 242.63	£ 39,808.56	£ 280.34	£ 19,904.28
<b>2.0 SUPERSTRUCTURE</b>					
2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,356.01	£ 6.16	£ 678.01
VERTICAL WEATHERBOARDING	£ 4,843.80	£ 22.02	£ 5,596.67	£ 25.44	£ 2,798.34
PAINTING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 246.97	£ 1.12	£ 123.49
2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,162.96	£ 9.83	£ 1,081.48
2.4 ROOF	£ 17,194.11	£ 78.16	£ 19,866.59	£ 90.31	£ 9,933.30
2.5 STAIRS	£ 800.00	£ 3.64	£ 924.34	£ 4.21	£ 462.17
2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,240.47	£ 5.64	£ 620.24
2.7 WINDOW AND EXT DOORS	£ 7,329.56	£ 33.32	£ 8,468.79	£ 38.50	£ 4,234.40
SOLAR SUNSPACE	£ 17,013.08	£ 77.33	£ 19,657.42	£ 89.35	£ 9,828.71
2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 7,642.13	£ 34.73	£ 3,821.07
2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 2,773.03	£ 12.61	£ 1,386.52
2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,070.39	£ 4.86	£ 535.20
2.11 STRUCTURAL KIT	£ 26,032.86	£ 183.33	£ 30,079.15	£ 211.82	£ 15,039.58
<b>TOTAL</b>	£ 87,486.86	£ 462.67	£ 101,084.92	£ 534.58	£ 50,542.51
<b>3.0 INTERNAL FINISHES</b>					
3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 9,440.79	£ 42.91	£ 4,720.40
3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,328.17	£ 16.40	£ 1,164.09
3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 3,210.48	£ 14.59	£ 1,605.24
3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 5,434.68	£ 24.70	£ 2,717.34
<b>TOTAL</b>	£ 17,667.98	£ 85.34	£ 20,414.12	£ 98.60	£ 10,207.07
<b>4.0 SERVICES</b>					
4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 5,975.88	£ 27.16	£ 2,987.94
4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,352.32	£ 6.15	£ 676.16
4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 2,712.26	£ 12.33	£ 1,356.13
4.4 HEATING INSTALL	£ 6,342.00	£ 28.83	£ 7,327.74	£ 33.31	£ 3,663.87
WOOD STOVE HEATER	£ 4,790.00	£ 21.77	£ 5,534.51	£ 25.15	£ 2,767.26
SUNWARM SYSTEM	£ 14,533.00	£ 66.06	£ 16,791.86	£ 76.33	£ 8,395.93
WIND GENERATOR	£ 3,100.00	£ 14.09	£ 3,581.83	£ 16.28	£ 1,790.92
4.5 VENTILATION INSTALL	£ 2,076.60	£ 9.44	£ 2,399.37	£ 10.91	£ 1,199.69
4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 14,082.38	£ 64.01	£ 7,041.19
4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
4.8 RAINWATER INSTALL	£ 2,425.32	£ 11.02	£ 2,802.29	£ 12.73	£ 1,401.15
<b>TOTAL</b>	£ 54,144.72	£ 246.11	£ 62,560.44	£ 284.36	£ 31,280.24
<b>SUB TOTAL</b>	£ 193,753.02	£ 1,036.75	£ 223,868.04	£ 1,197.88	£ 111,934.10
<b>UPDATE FROM MARCH 2004 TO APRIL 2006.</b>					
<b>ADD</b>	14% £ 27,125.42	£ 145.15	£ 31,341.53	£ 167.70	£ 15,670.77
<b>PRELIMINARY ESTIMATE</b>	£ 220,878.44	£ 1,181.90	£ 255,209.57	£ 1,365.58	£ 127,604.87

## **12. Appendix 2**

### **12.1 Prototype Plans and details**



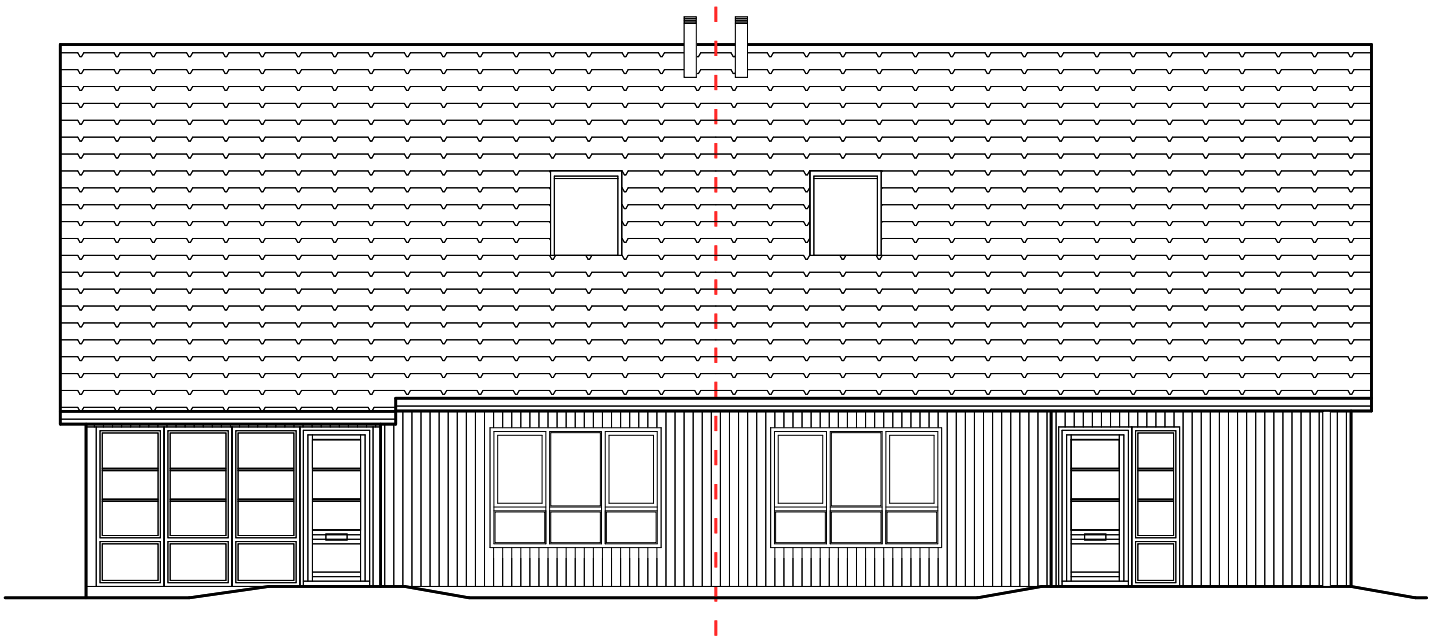
**FRONT ELEVATION**  
with sunspace

**FRONT ELEVATION**  
without sunspace

**John Gilbert**  
**ARCHITECTS**

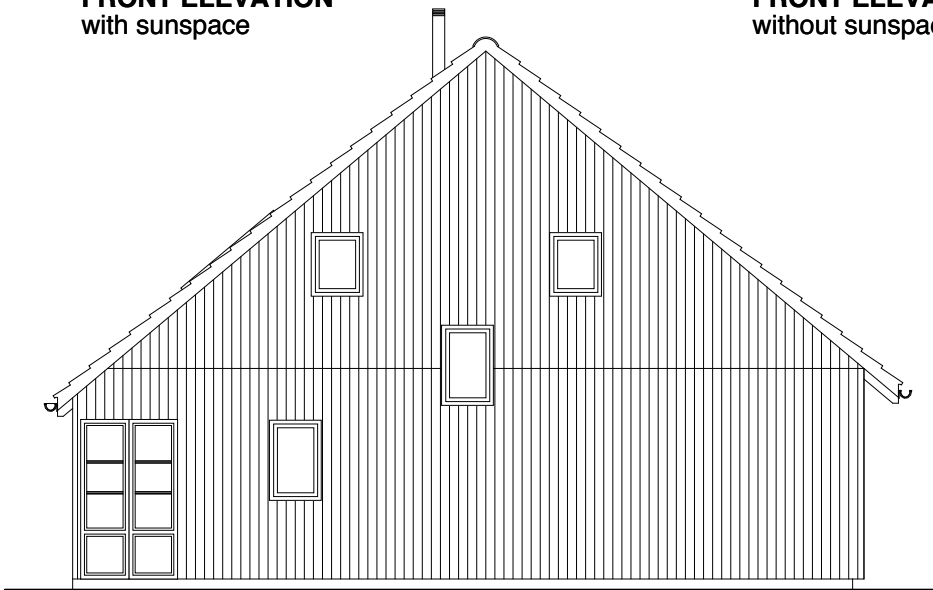
4C1 Templeton Business Centre  
Templeton Street, Glasgow G40 1DA  
Tel 0141-551 8383 Fax 0141-554 7884  
e-mail: info@johngilbert.co.uk  
www.johngilbert.co.uk

Title			Project		
<b>Prototype 3</b> <b>Two bedroom house</b> <b>PLANS AND FRONT ELEVATION</b> <b>Phase 2</b>			<b>Perthshire HA</b>		
			Job No	02770	Scale
Rev	Alteration	Date	Date	Drawn by	Size
			Dec 04	NM	A4
			Drg No	Rev	
			PT3.3		

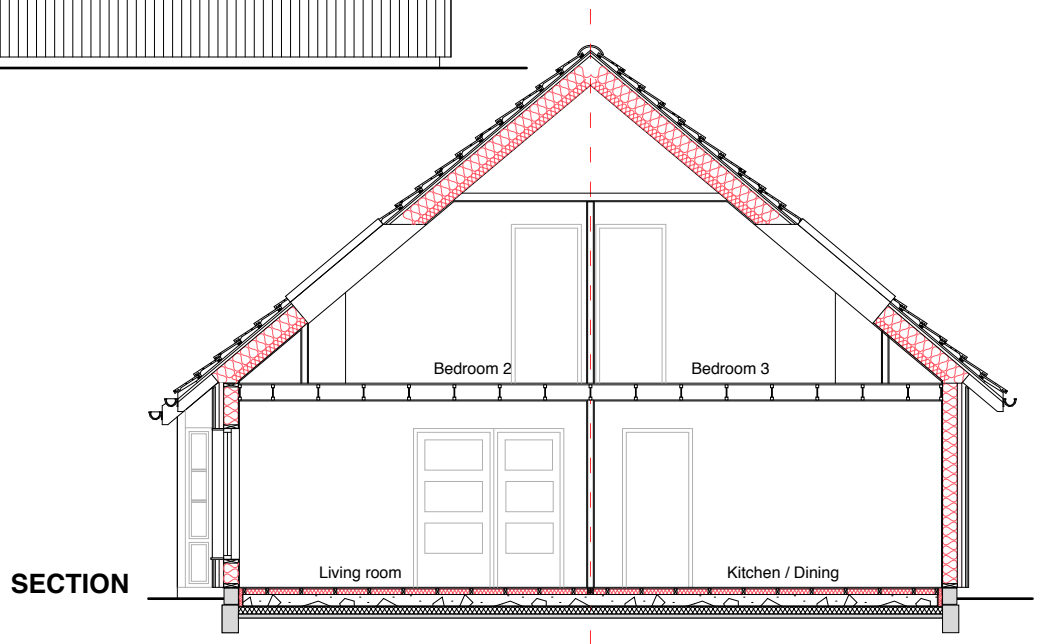


**FRONT ELEVATION**  
with sunspace

**FRONT ELEVATION**  
without sunspace



**SIDE ELEVATION**



**SECTION**

**John Gilbert**  
**ARCHITECTS**

4C1 Templeton Business Centre  
Templeton Street, Glasgow G40 1DA  
Tel 0141-551 8383 Fax 0141-554 7884  
e-mail: info@johngilbert.co.uk  
www.johngilbert.co.uk

Title

**Prototype 3**  
**Two bedroom house**  
**ELEVATIONS AND SECTION**  
**Phase 2**

Project

**Perthshire HA**

Rev

Alteration

Date

Job No

02770

Scale

1:100

Date

Dec 04

Drawn by

NM

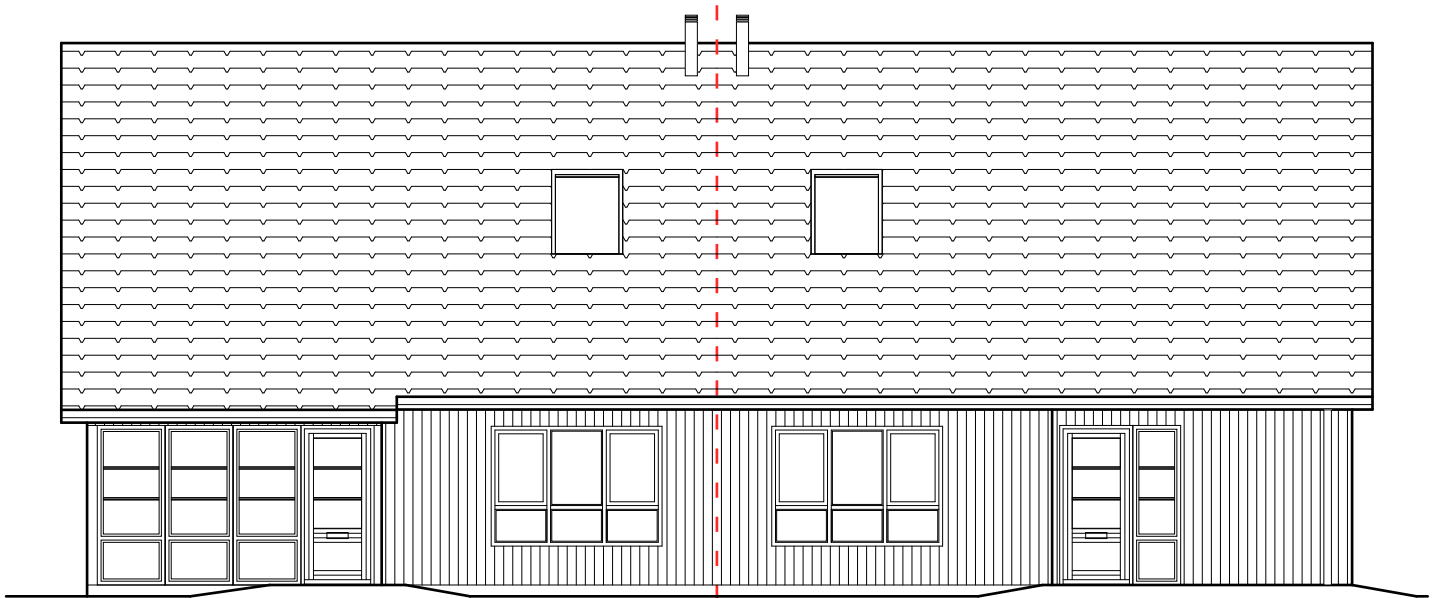
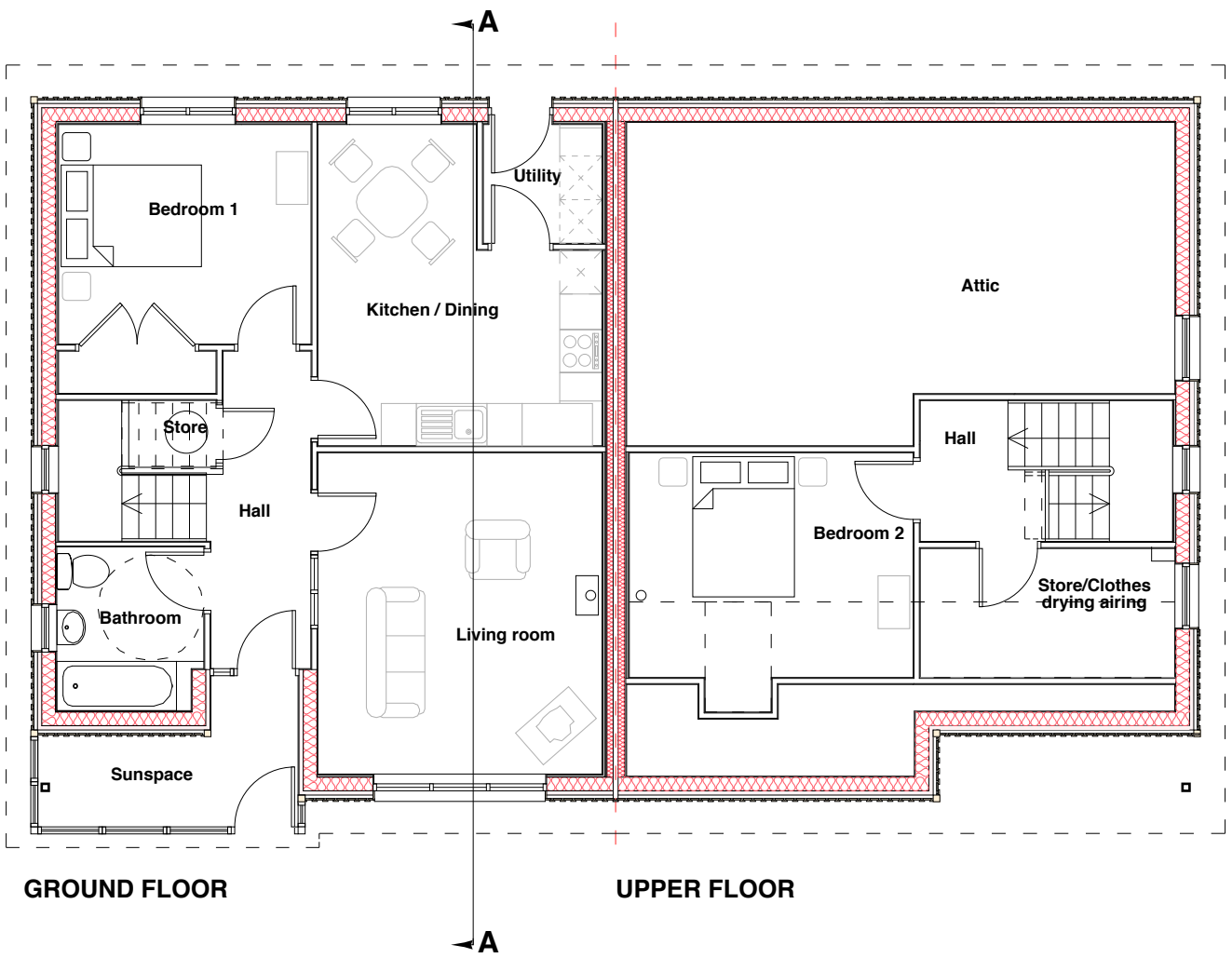
Size

A4

Drg No


PT3.4

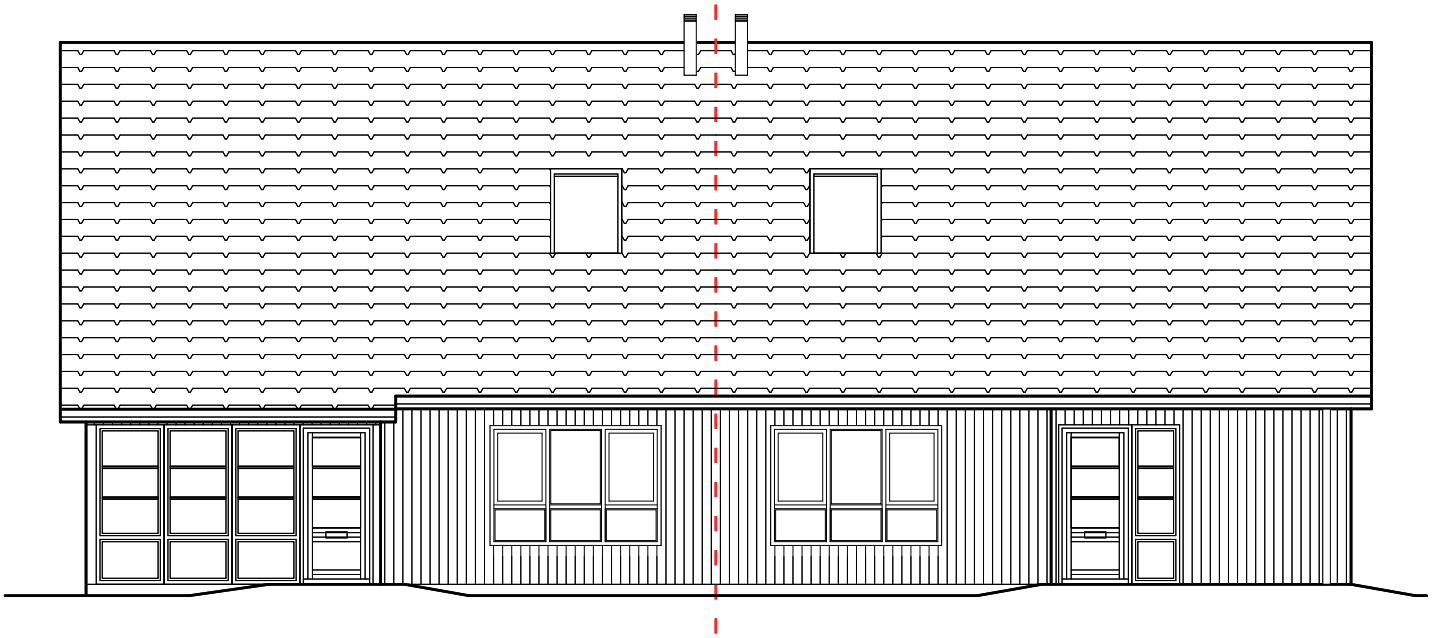
Rev



**FRONT ELEVATION**  
with sunspace

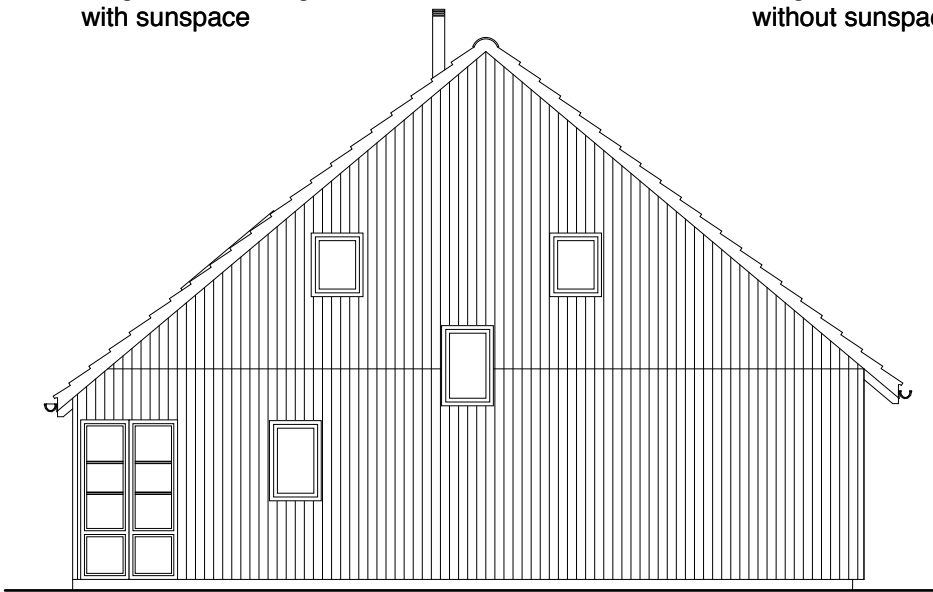
**FRONT ELEVATION**  
without sunspace

 4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk	Title <b>Prototype 3          Two bedroom house          PLANS AND FRONT ELEVATION          Phase 1</b>		Project <b>Perthshire HA</b>				
	Rev Alteration		Date		Job No 02770	Scale 1:100	
					Date Dec 04	Drawn by NM	Size A4
					Drg No PT3.1		Rev

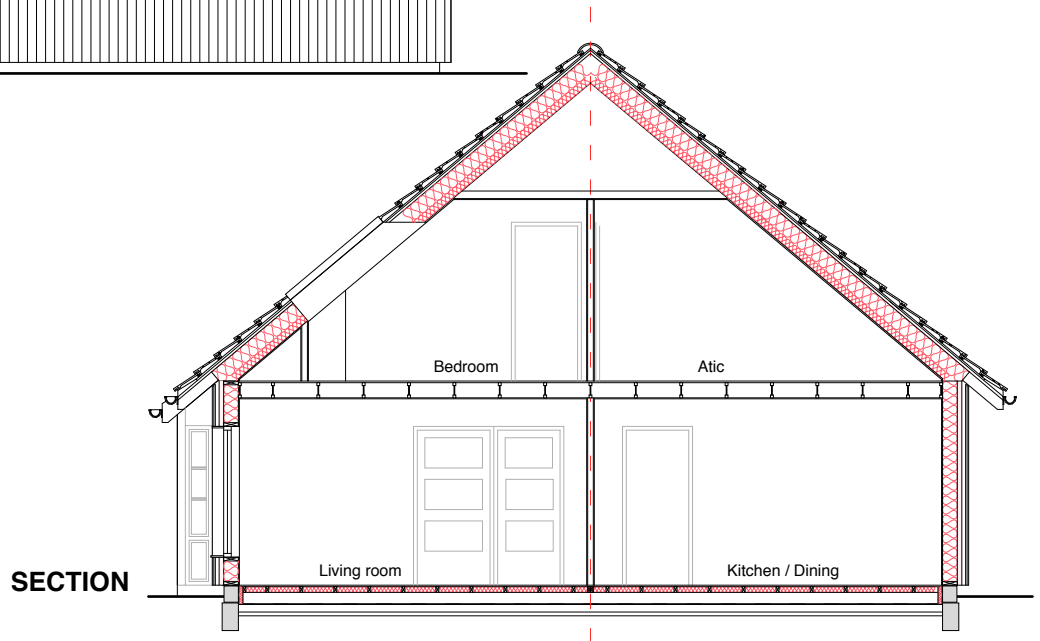


**FRONT ELEVATION**  
with sunspace

**FRONT ELEVATION**  
without sunspace



**SIDE ELEVATION**



**SECTION**

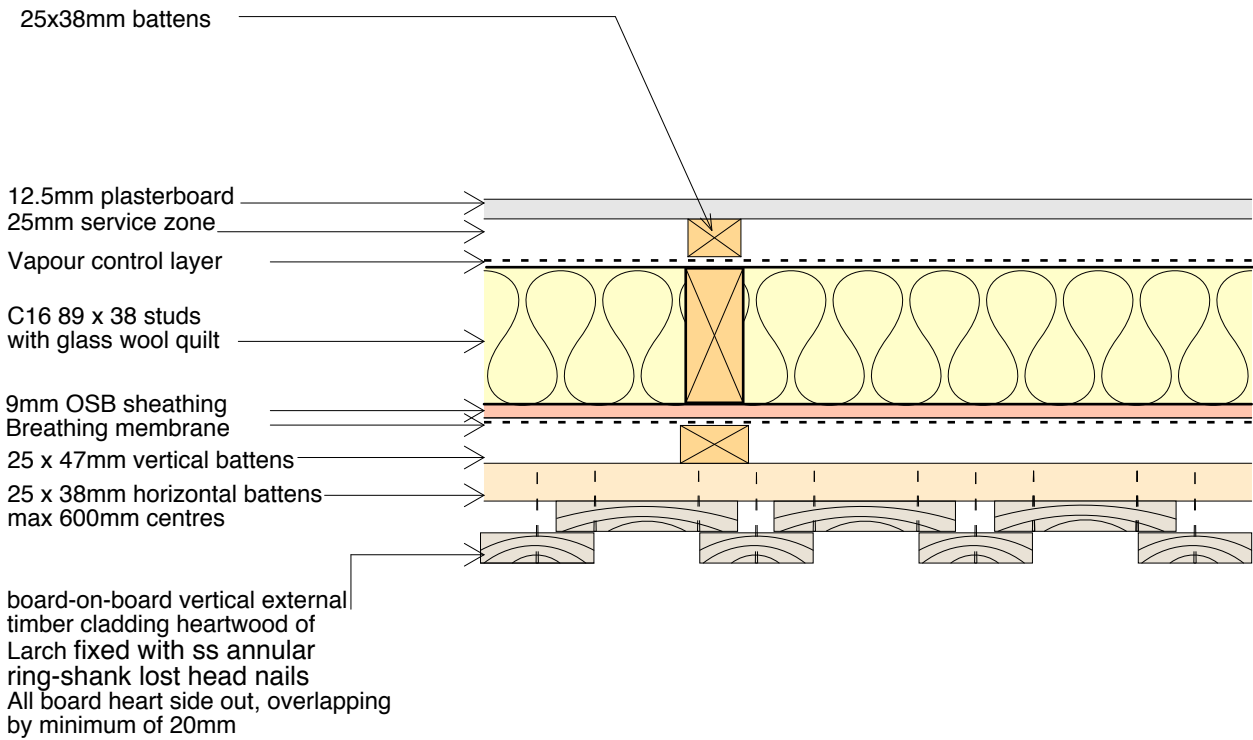
**John Gilbert**  
**ARCHITECTS**

4C1 Templeton Business Centre  
Templeton Street, Glasgow G40 1DA  
Tel 0141-551 8383 Fax 0141-554 7884  
e-mail: info@johngilbert.co.uk  
www.johngilbert.co.uk


Title  
**Prototype 3  
Two bedroom house  
ELEVATIONS AND SECTION  
Phase 1**

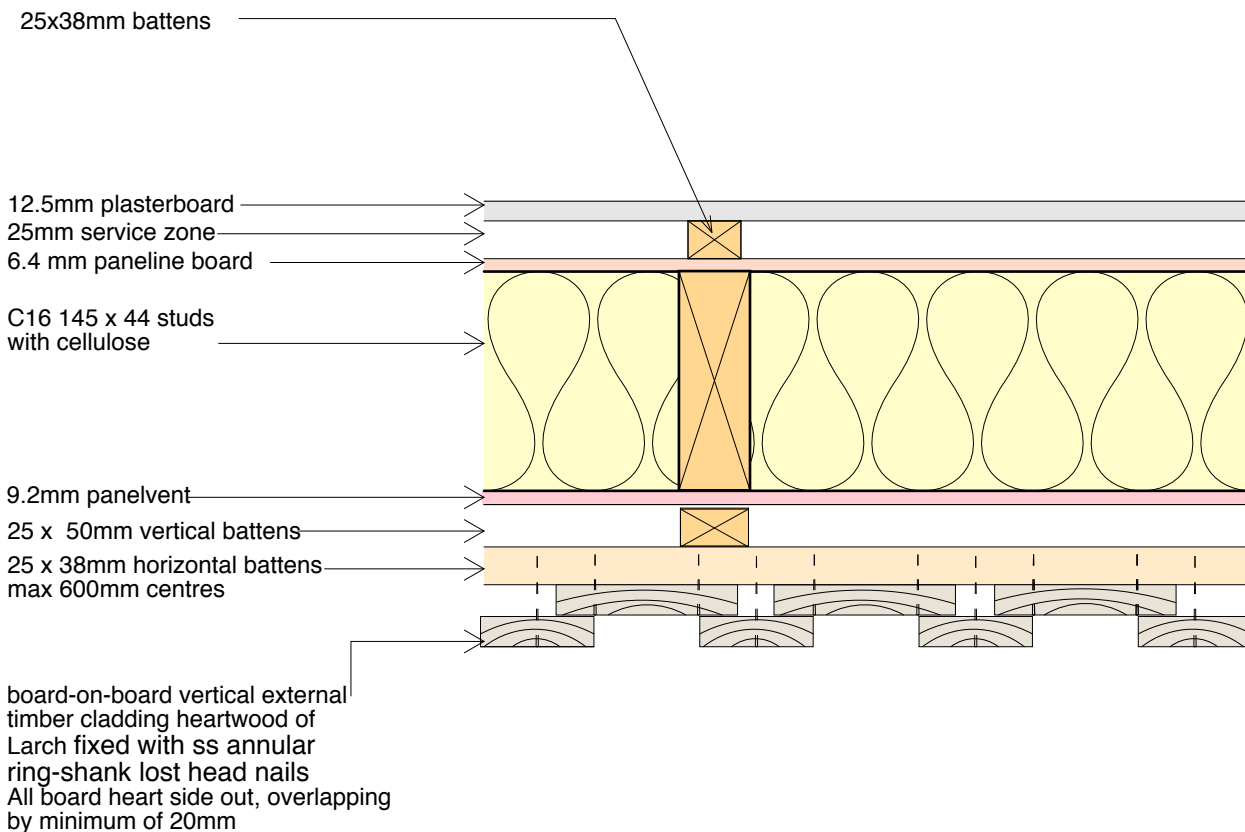
Rev	Alteration	Date

Project <b>Perthshire HA</b>		
Job No <b>02770</b>	Scale <b>1:100</b>	
Date <b>Dec 04</b>	Drawn by <b>NM</b>	Size <b>A4</b>
Drg No <b>PT3.2</b>		Rev




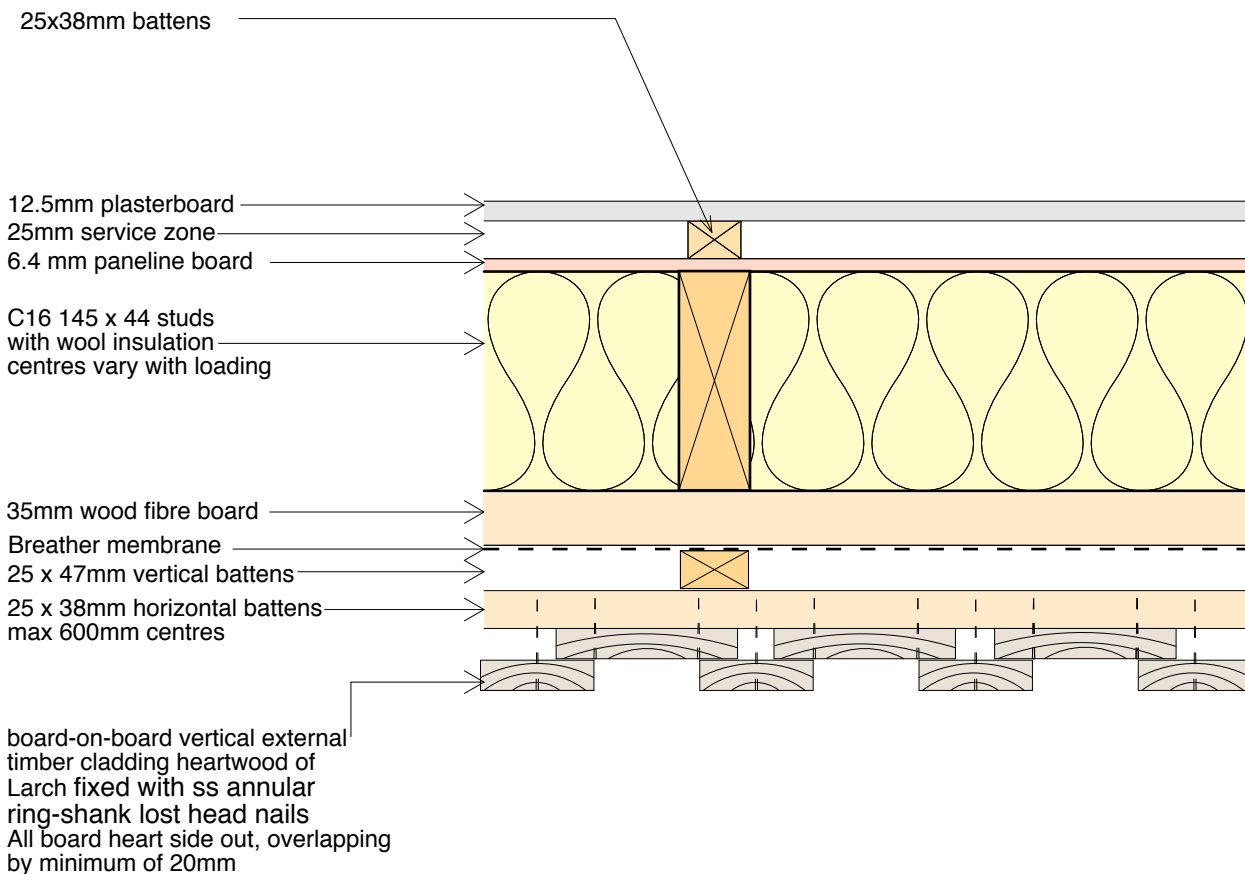
Recent TRADA guidance shows the underboard with heartside in, this appears to be based on Norwegian details published about 20 years ago. The Norwegians have since changed their advice - their current details specify that the most weather tight option is where both the inner and outer board face heart side out on the wall.

 <p>4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk</p>	Title		Project		
	<p><b>BASIC BUILDING REGULATION EXTERNAL WALL DETAIL PLAN</b></p>		<p><b>Perthshire HA</b></p>		
			Job No	Scale	
	Rev	Alteration	Date	Date	Drawn by
			Mar 06	JG	A4
			Drg No	Rev	
			[21]10		




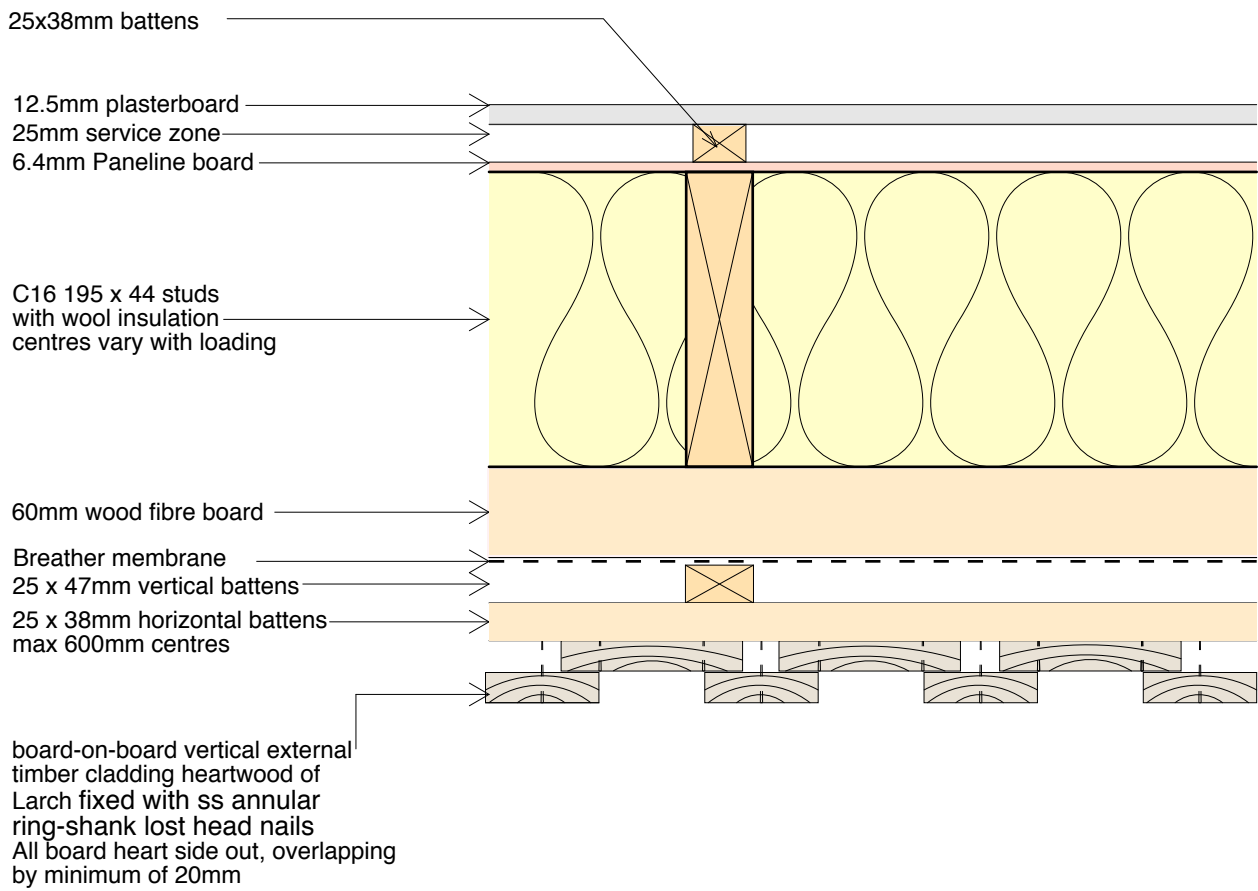
\*

 <p>4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk</p>	Title		Project			
	ENHANCED		Perthshire HA			
	EXTERNAL WALL DETAIL PLAN		Job No	02770	Scale	1:5
	Rev	Alteration	Date	Date	Mar 06	Drawn by JG
			Drg No	[21]11	Rev	A




**\*\***

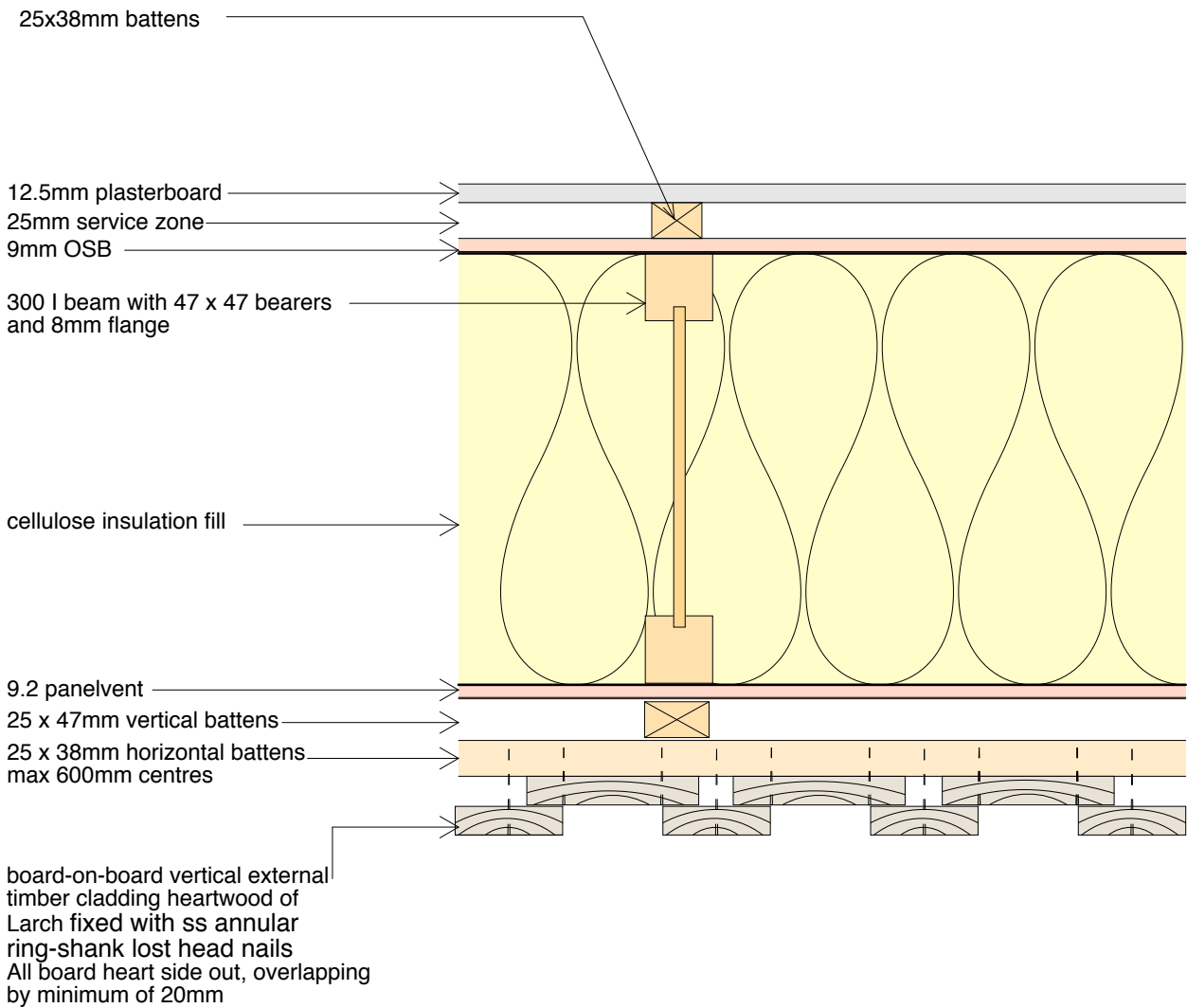
 <p>4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk</p>	Title		Project			
	ENHANCED (HIGH THERMAL MASS)		Perthshire HA			
	EXTERNAL WALL DETAIL PLAN		Job No	02770	Scale	1:5
	Rev	Alteration	Date	Date	Mar 06	Drawn by JG
			Drg No	[21]12		Rev




The wood fibreboard does not contain any glue or wood preservatives and is made to DIN 68755 Part 1. The board is made in two bonded densities, one at 160Kg/m<sup>3</sup> and the outer part at 250Kg/m<sup>3</sup>

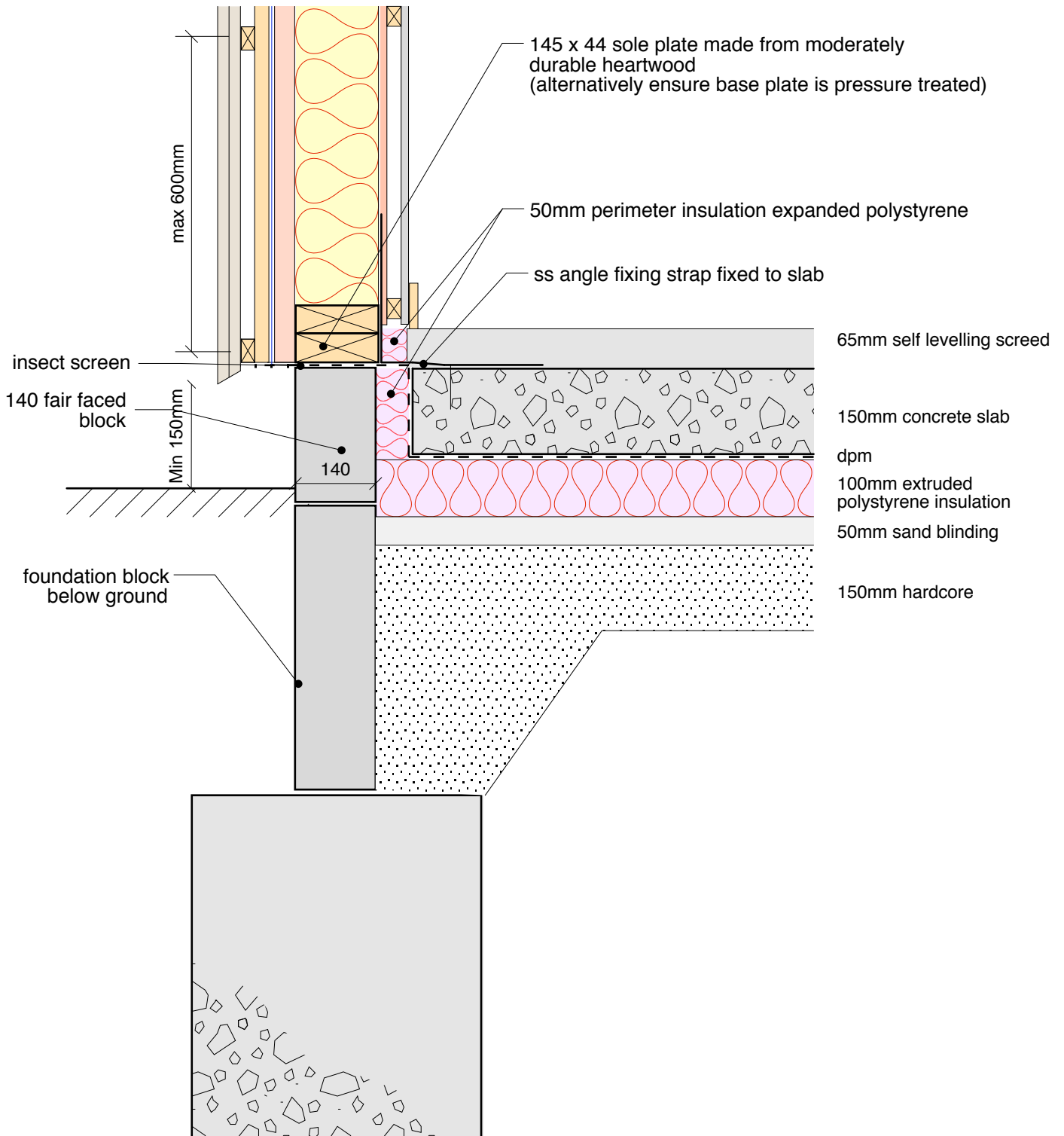
\*\*\*


 <p>4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk</p>	Title		Project			
	TIMBER HIGH INSULATION		Perthshire HA			
	EXTERNAL WALL DETAIL PLAN		Job No	02770	Scale	1:5
	Rev	Alteration	Date	Date	Mar 06	Drawn by JG
			Drg No	[21]13	Rev	

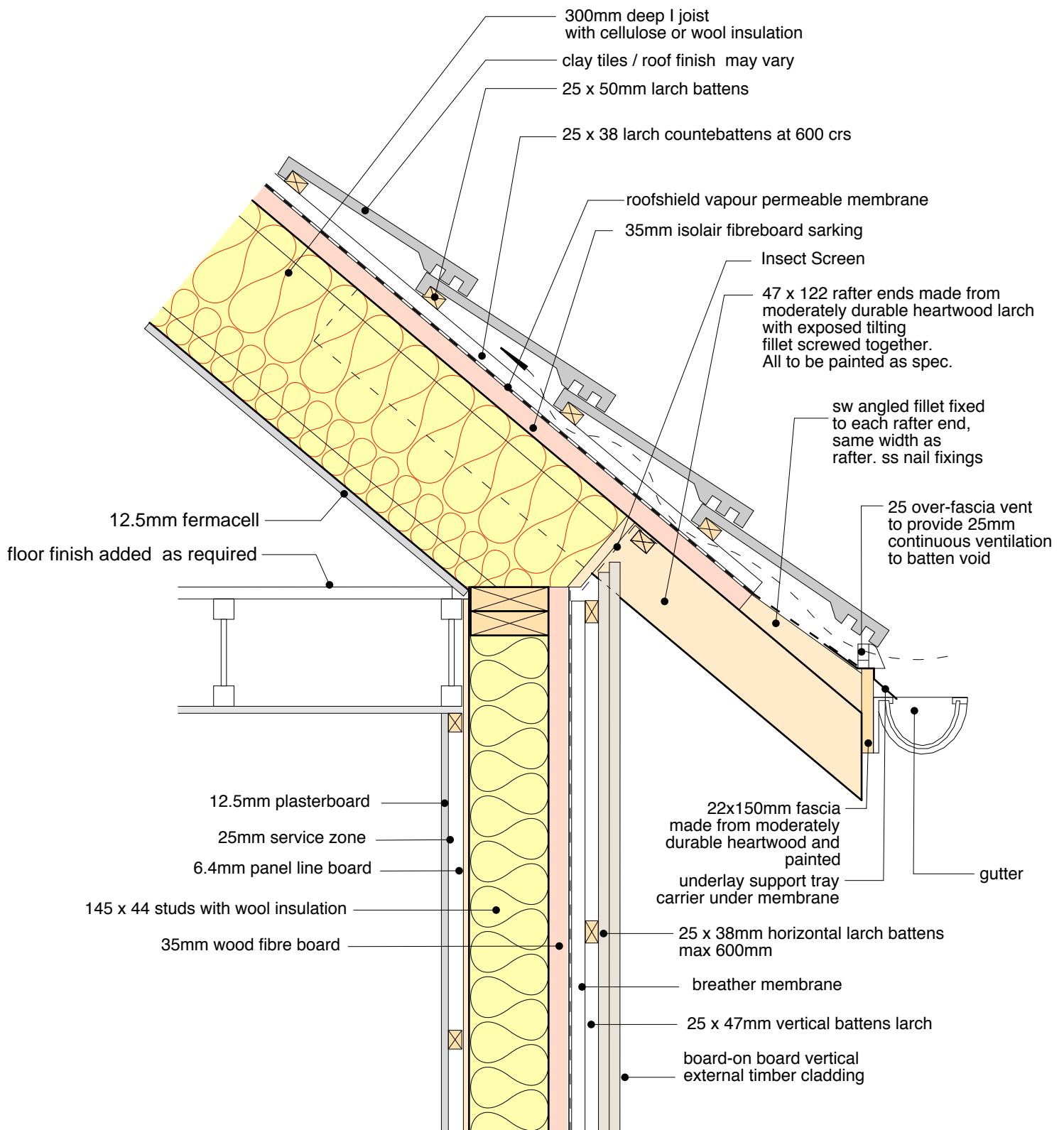



\*\*\*\*

 <p>4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk</p>	Title		Project	
	ZERO EMISSIONS		Perthshire HA	
	EXTERNAL WALL DETAIL PLAN		Job No	Scale
	Rev	Alteration	Date	Date
			02770	1:5
			Mar 06	Drawn by JG
				Size A4
			Drg No	Rev
			[21]14	



 <p>4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk</p>	Title		Project		
	GROUND SLAB WITH SOLID FLOOR ENHANCED HIGH THERMAL MASS		Perthshire HA		
	Rev	Alteration	Date	Job No	Scale
				02770	1:10
				Date	Drawn by
			May 06	NM	A4
			Drg No	[18]02	Rev



 <p>4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk</p>	Title		Project		
	EAVES DETAIL ENHANCED (HIGH THERMAL MASS)		Perthshire HA		
	Rev	Alteration	Date	Job No	Scale
	A	Varies amendments.	080605	02770	1:10
			Date	Drawn by	Size
			Dec 04	NM	A4
			Drg No	Rev	
			[37]01	A	