Design, Access and Planning Statement
for a
Self-Heating House Using Thermal Banks.

Adjacent to 1 Walpole Barns, Thwaite Common

THE SITE, PLANNING CONSIDERATIONS AND PLANNING HISTORY

The Site

The site is set within a loose finger of development off Thwaite Common where infill plots have been allowed in the past.

The proposed site is set back 70 metres from the Highway screened by 55.0m of woodland. It is sited within the natural settlement boundary (see aerial photographs).

Statutory areas:

- It is outside (north and adjacent) of the north-eastern edge of the Mannington and Wolterton Conservation Area.
- It is outside the nearby County Wildlife Site.
- It is not adjacent to a Scheduled Monument.
- It is not adjacent to a Listed Building. The nearest is Nutmeg Cottage, Grade II,
- 94.0m to the south-east of the site.
- The proposed house is not within the AONB.

1 Proposed site outlined already developed

2 Natural Settlement Boundary

Planning Considerations

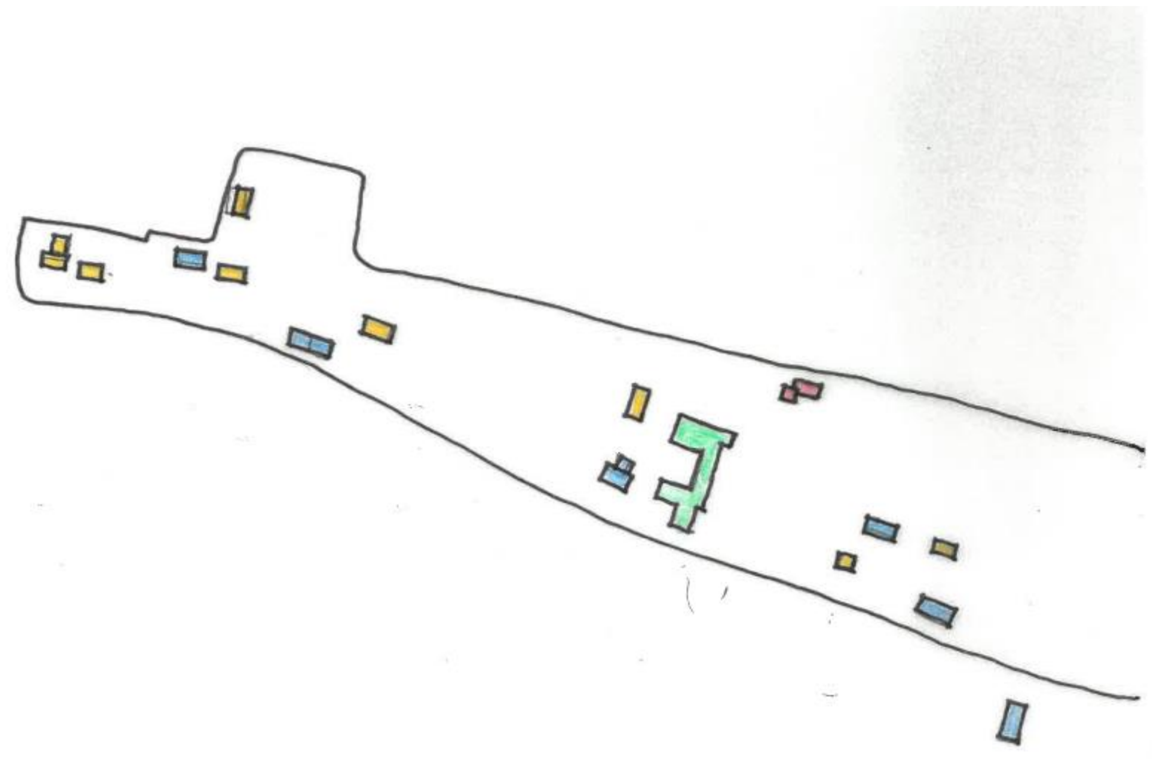
Although within the settlement boundary and part of the established finger of development that runs along the northern edge of the Common the site is, in policy terms, in the countryside, although not isolated. It is in an area where consent has been given for at least six new houses within the last 40 years.

Relevant Policies:

SS2 Development in the countryside
Policy H07 Making the most effective use of land
Policy EN2 Protection and enhancement of landscape and settlement character
Policy EN4 Design
Policy EN7 Renewable energy
Policy EC2 Re-use of buildings in the countryside

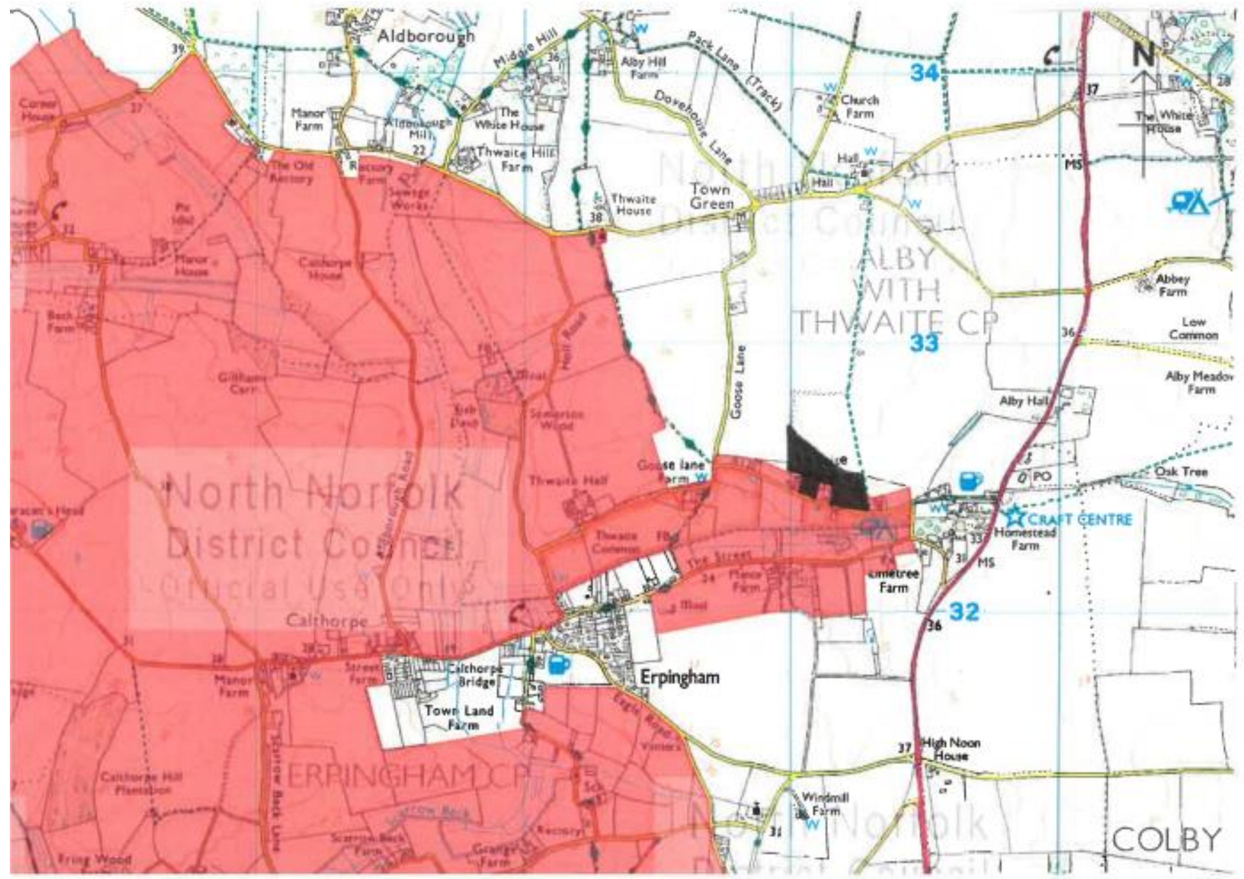
Planning History

Walpole Barns were converted to residential in 1990. Subsequent to this, consent was given to replace the stables, outbuildings and tennis court with an aircraft hangar in 2017. This was not built.



3 Development north of Thwaite Common

Key: Blue - Historic and pre-war   Yellow - New houses 1970s onwards   Green - Barn conversions 1990s   Red - Proposed house



4 The proposed site north of Conservation except for two areas of existing woodland

THE PROPOSAL

The proposal is now not to build the aircraft hangar and cease all use of the helicopter and replace this and the remaining stables, outbuildings concrete court etc with a self-heating house (no boiler) cut into the bank and surrounded on three sides by earth banks acting as thermal stores.

The proposal is linked to and part of a rewilding and refurbishment of 3450m² (3.45ha) of countryside associated with the house currently split into areas of farmland, grass and plantation woodland. Natural heating side by side with enhanced nature.

The proposed house will be cut into the existing bank in a similar manner to the approved aircraft hangar. It will be unseen from outside of the plot (see Landscape Statement from Chris Yardley).

Motivation:

The applicant is a civil engineer and has for a long time been looking for greener ways to use concrete and experiment with different ways of building utilising engineering skills and wants to create a symbiotic relationship between the house, land, flora and fauna. To that end he has commissioned Chris Yardley and Glaven Ecology to create a Norfolk landscape character within the 3.5 hectares of existing woodland and fields.

4 The site in relation to Conservation Area

5 Proposed house seamlessly assimilated into the landscape

6 Existing stabels, outbuildings, concrete apron and tennis court

Planning Relevance:

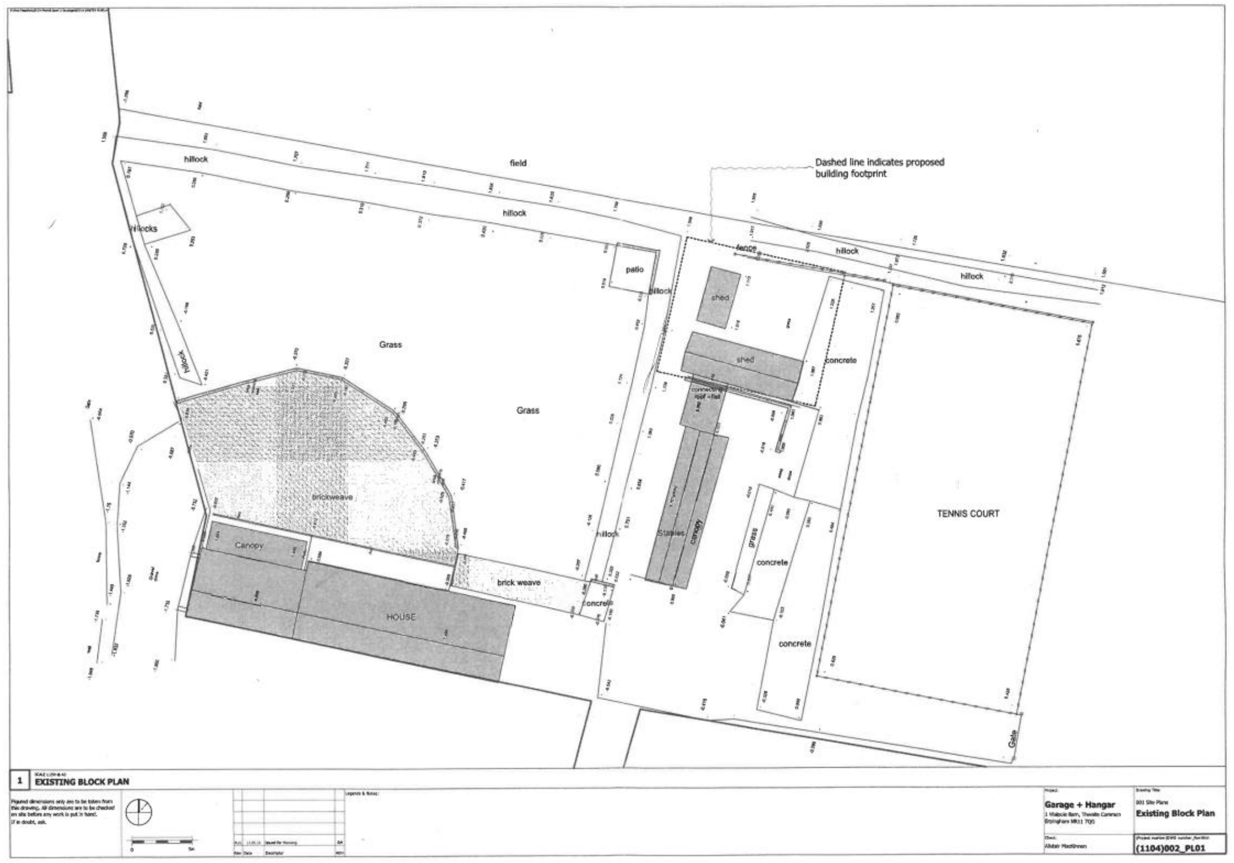
The proposal bases its case on six policy points and national precedent.

1. There was an approval on this site for an aircraft hangar of larger bulk and helicopter use. Helicopter use will cease, which will significantly enhance the amenity of neighbouring properties.
2. There are existing stables, outbuildings on extensive concreted areas of 1335.0m^2 that could be converted, so essentially a brownfield site. There are also examples of removing unsightly buildings and replacing them with sensitively sited houses elsewhere in the County and nationwide.
3. Section 80 is relevant in that the design looks to aim for the highest standard and to investigate new ways of using traditional, locally distinctive, materials.
4. In addition, the house aims to significantly enhance its immediate setting and be sensitive to the defining character of the area, both in form, flora and fauna.
5. It is a natural infill within an informal historical linear development (see schematic plan).
6. Ironically for a concrete based house, in the long-term it will be carbon neutral by using renewable energy to heat and power the highly insulated and airtight house. Also offset by the planting of hundreds of trees. Initial carbon use will be minimised by employing GGBS Cement substitute.

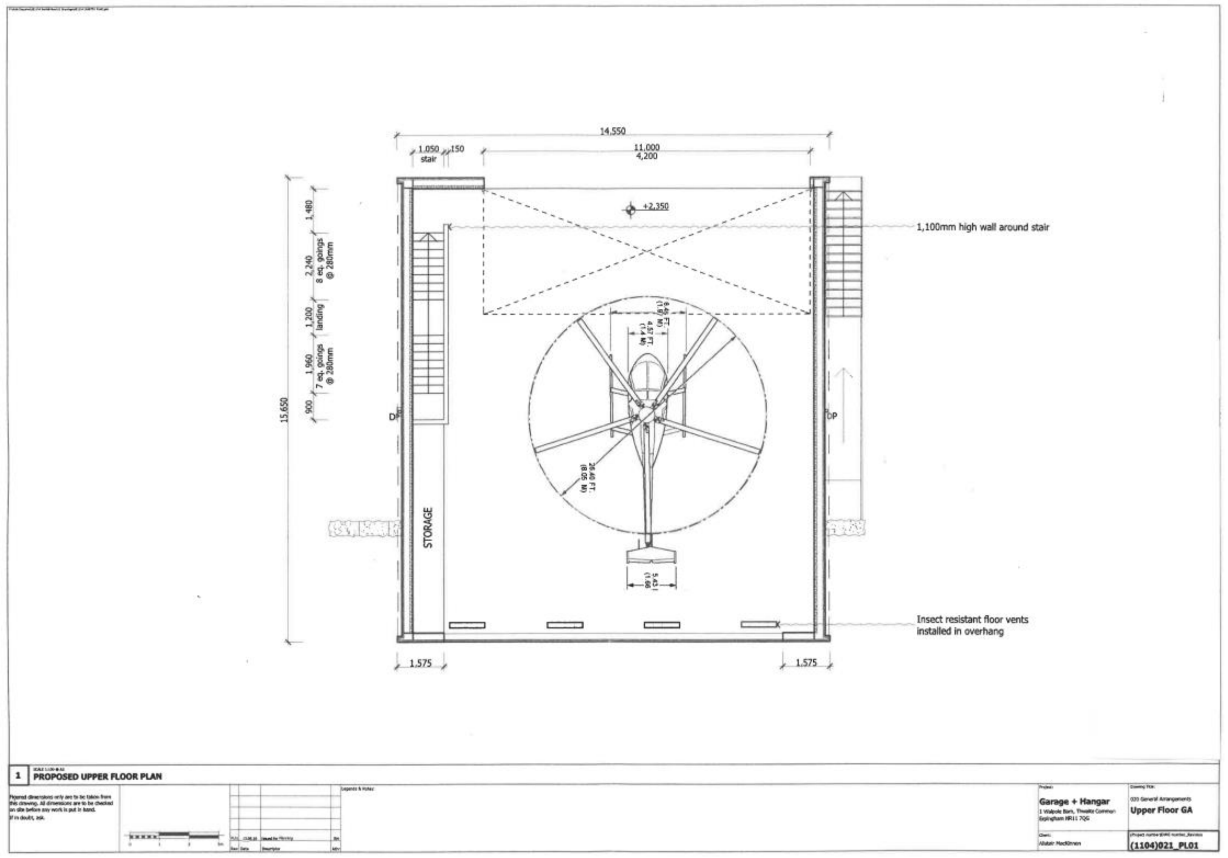
Notes:

It is proposed that the cumulative effect of the above considerations combine to make a viable case to acknowledge the principle infill plot and create a potentially innovative undertaking that will make the case that linking building to the landscape environment no matter how large or small the development is an essential act.

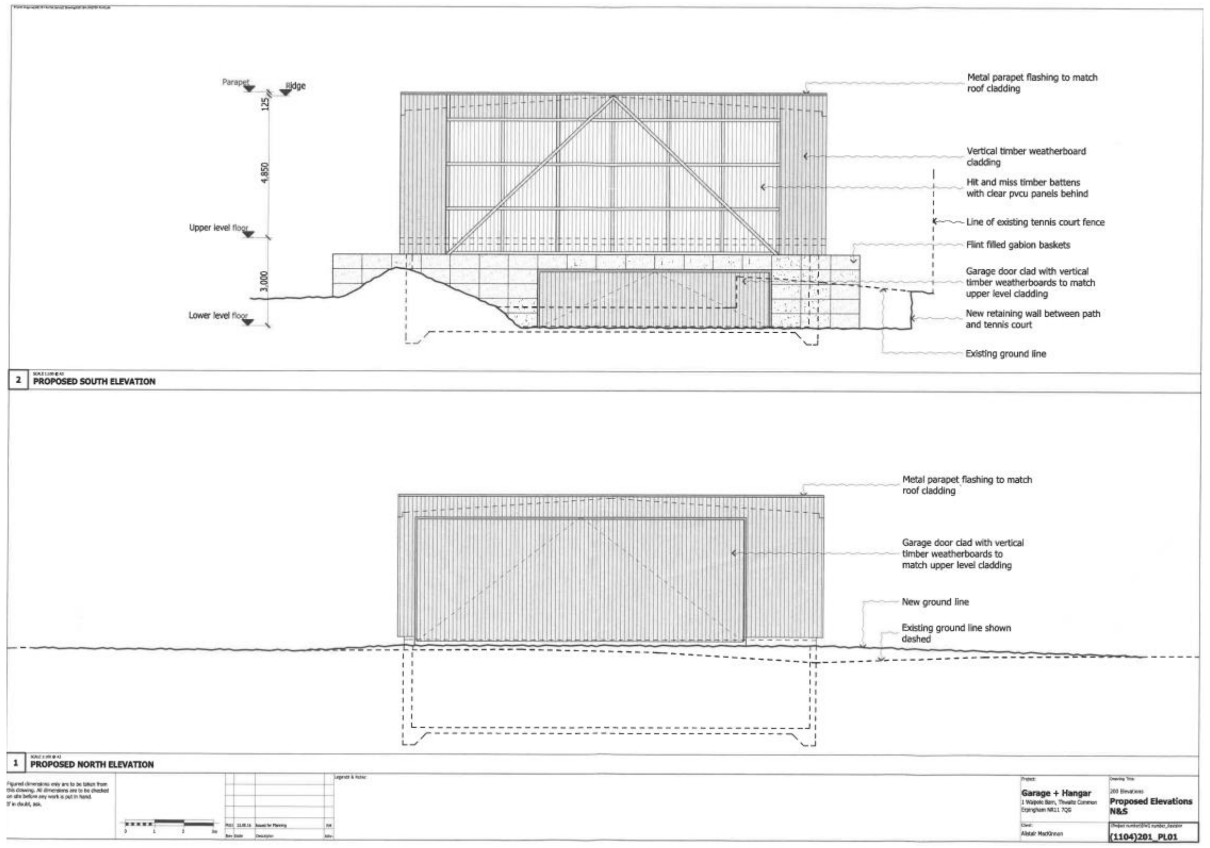
If each application enhanced the environment, even in a small way (ie tree planting), it would have a significant impact nationwide. It is believed that Government is currently considering such a link.



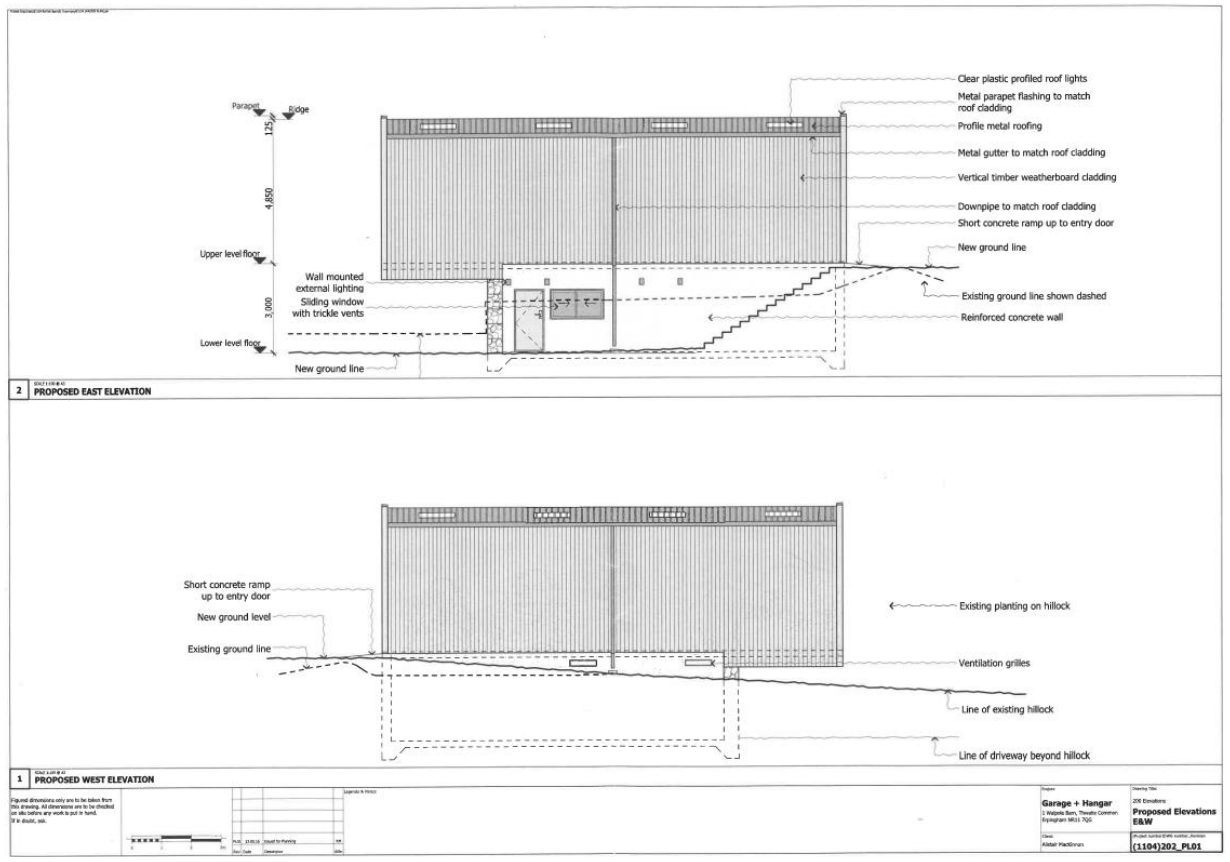
Approved Garage & Hangar: Existing Block Plan



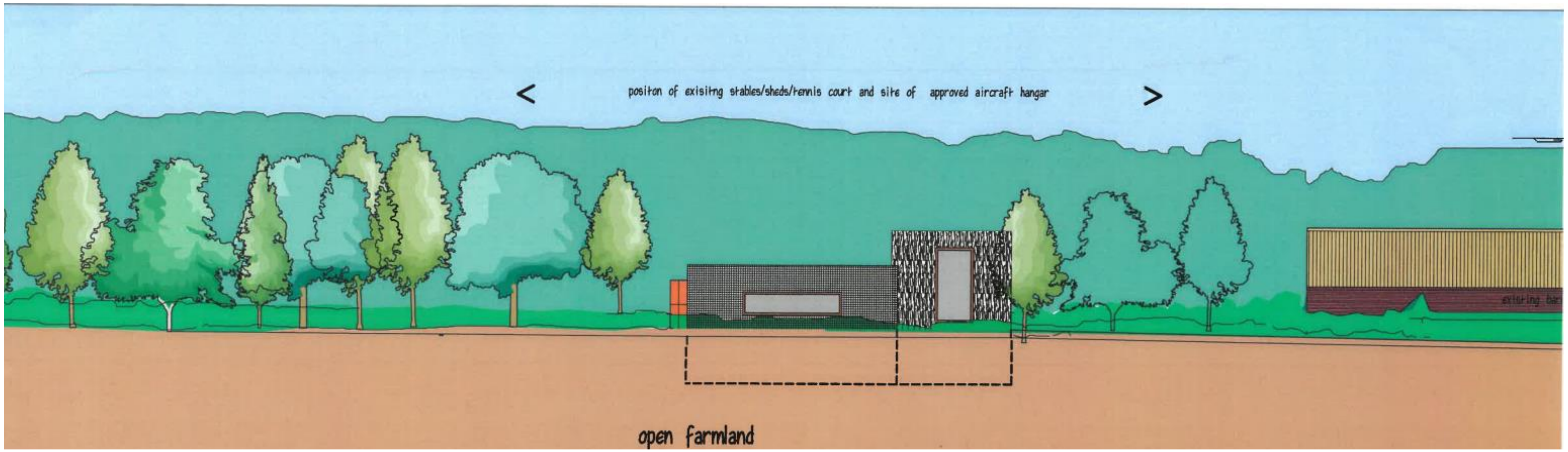
Approved Garage & Hangar: Upper Floor GA



Approved Garage & Hangar: Proposed elevations N&S



Approved Garage & Hangar: Proposed elevations E&W



Proposed North Elevation (from outside the site)

LAYOUT

The proposal is essentially an inward-looking courtyard house with two blocks that rise above the northern embankment to give blinkered views over the farmland to the north and two lower wings extending south and towards each other.

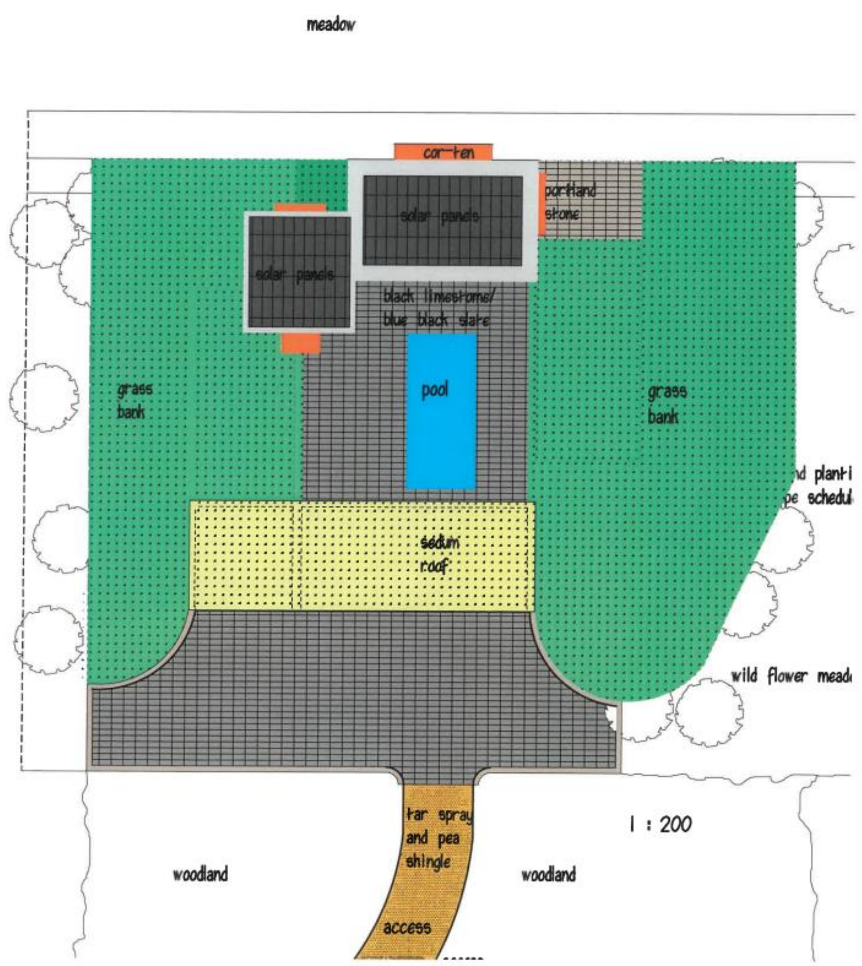
Entrance to the site comes by way of an existing gate and access drive off Thwaite Common. It is proposed that the drive curves away from Walpole Barns (to enhance the amenity) through the existing plantation woodland.

Once out of the woods, visitors will be confronted by two grassed banks that curve around to meet the bank to the north, either side of a covered entrance portal that also acts as a Porte Cochere.

Once through this, within the courtyard two single storey bedroom wings face each other east and west with a central pool.

The main section of the building rises to two storeys facing south and single storey facing north, and the living section is fully glazed facing south and with a low blinkered 'bird hide' window looking north.

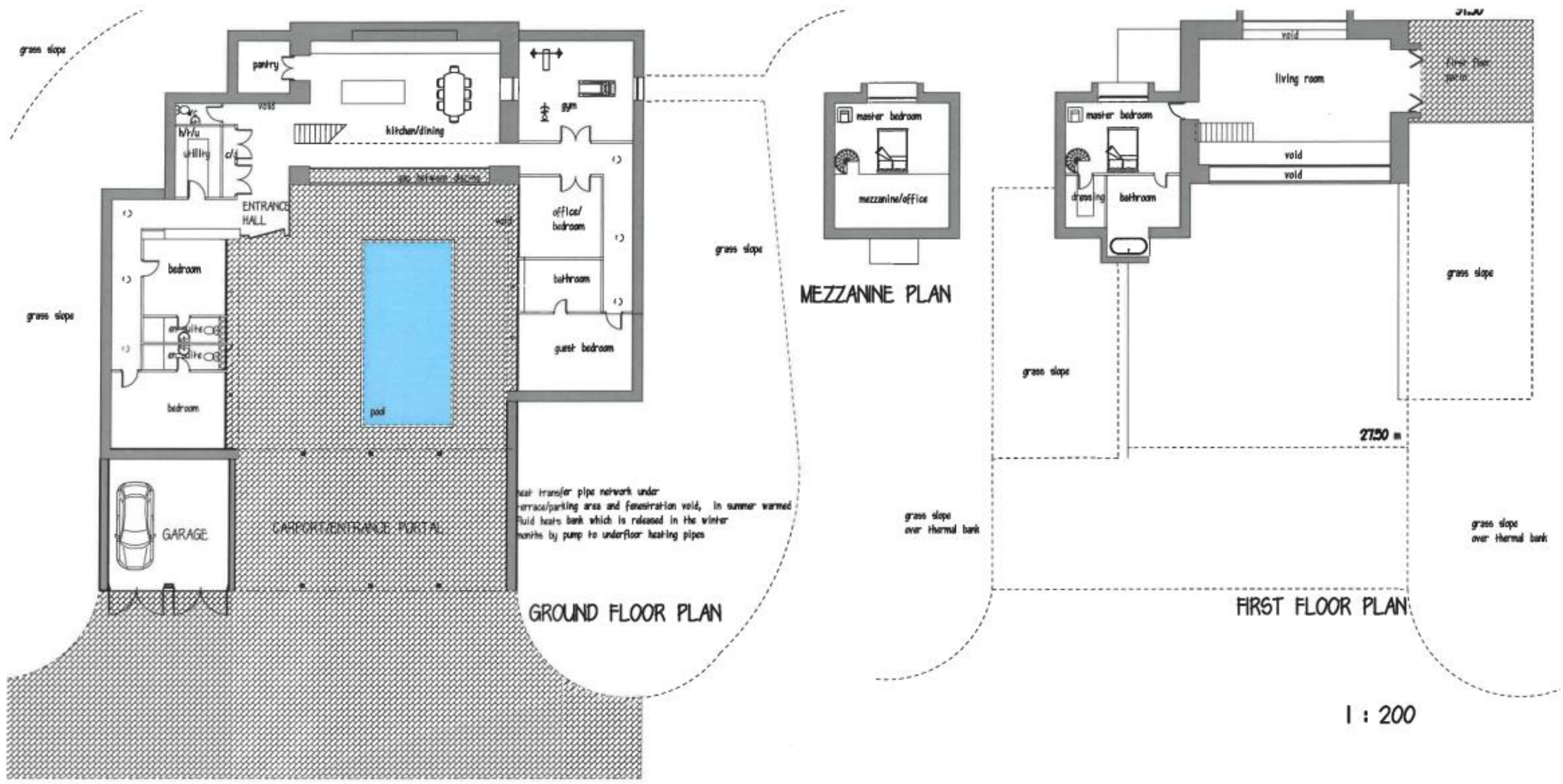
The master bedroom section has an east facing bay window and a slit window facing north.



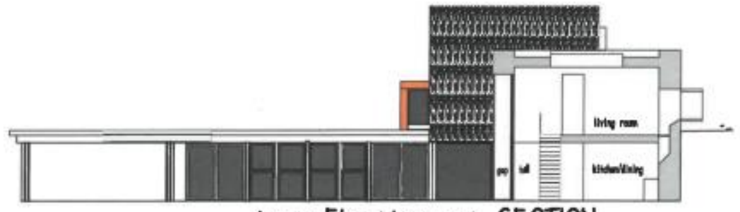
The two northern windows are boxed to frame views, reduce light pollution and add interest (see appearance).

The layout creates very different ways of experiencing the building. From within the courtyard it will be an intense, almost intimate, experience creating a calm introspective world of cloisters, water and enclosure. From outside it will be invisible from the road as the access curves through the trees.

It will appear as two planted banks from the east and west, more agricultural than domestic sitting on the edge of the farmland. Less impact than the approved aircraft hangar and less noise for the neighbours because of the absence of the helicopter.



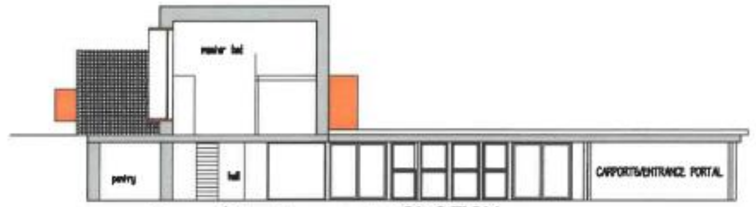
APPEARANCE AND MATERIALS



inner Elevation east SECTION

The use of materials is an integral part of the technical reach of the proposal, in creating thermal mass and from that a significant influence on the appearance of the house, ie it looks like what it is, a heat store.

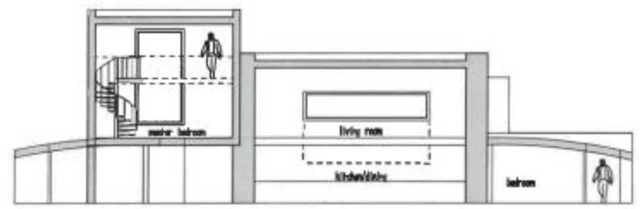
As stated earlier, the applicant is a civil engineer and is looking at innovative ways of using materials he is used to working with, to create an honest house that reflects his experience and enhances the landscape in which it is set in an environmentally friendly way. To that end the pallet influences are woodland, flint and meadow land.



inner Elevation west SECTION

The earth banks enable the proposed house to visually bed in, but they are also crucial to the heating of the house. They not only insulate the rooms underneath they also act as thermal banks that store heat in the summer months and release on demand in winter. It is, in effect, a rechargeable heat battery.

A pipe network just beneath the surface of a back limestone or blue-black slate courtyard and entrance area captures heat energy from the sun and stores it in a computer controlled thermal bank under the building. It is an essentially simple technology using the sun to heat the banks and mass to store energy.



SECTION east/west

The temperature of the substrate can average out around 10°c and can rise to around 25°c when fully charged. Insulated below ground, the heat is retained for up to three months and can be recharged on sunny days in winter.

To supplement this system there will be over 80.0m² of solar panels, to generate electricity, on the roof hidden behind the parapets. These will be a mix of wet and dry systems. The electrical panels will be connected to a solar battery. It will be possible to run the house without fossil fuels and with very little help from the electricity grid…although for practical reasons the house will be connected.

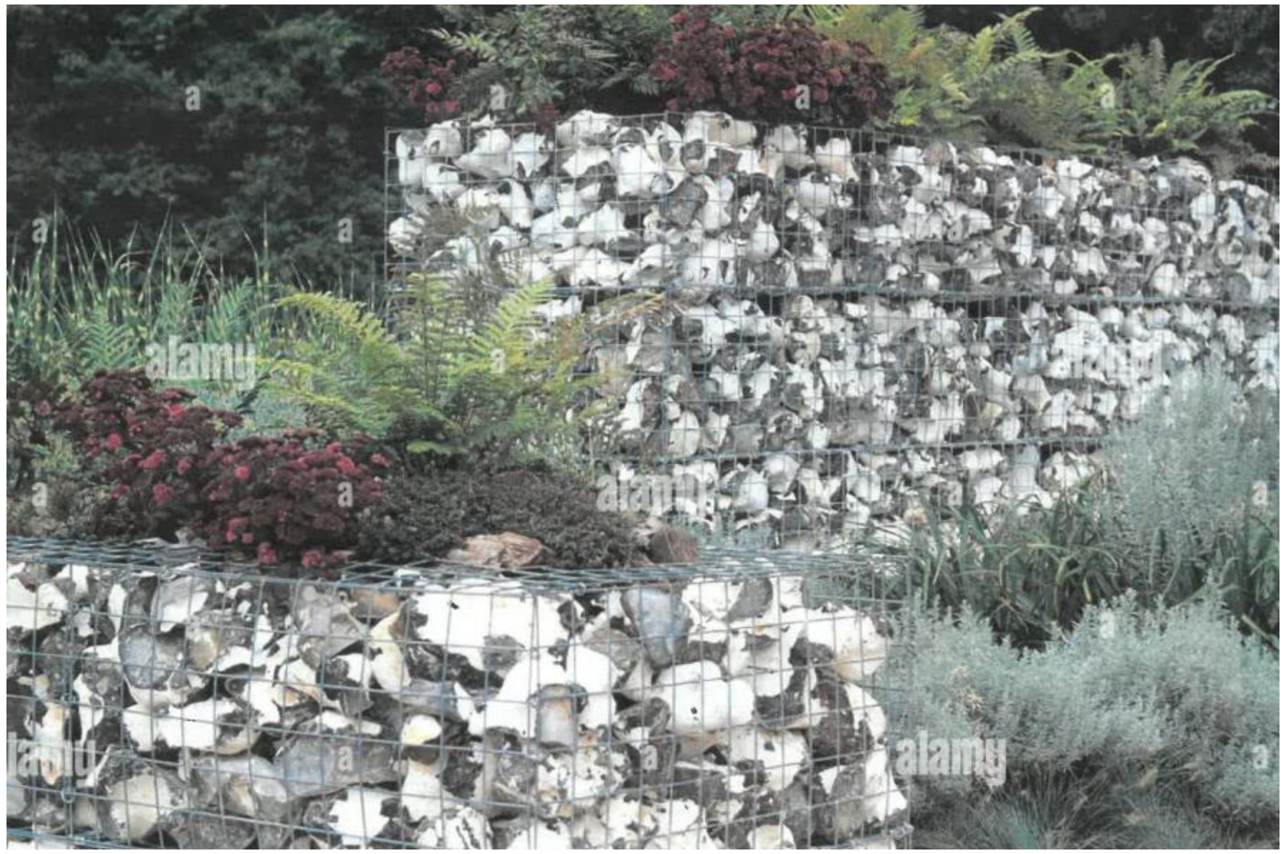
GLAZING

Apart from the 'blinkered' Corten windows there are three main areas of glazing. Two full glazed screens on the two bedroom wings, facing east and west. These will benefit from low sun in the morning and evenings, but because of their aspect will not overheat. The main two storey area of glazing faces south. Solar protection and prismatic glass will minimise overheating in the summer. The main protection will be the 900mm air gap between the outer glazing and the inner glazing. This heat will be used in winter and recycled in summer.

SOUTH ELEVATION including entrance canopy with planting over

Local Distinctiveness:

Concrete is not known for its cuddly qualities, however, in this case it can facilitate an idiosyncratic manifestation of the materials most associated with North Norfolk.

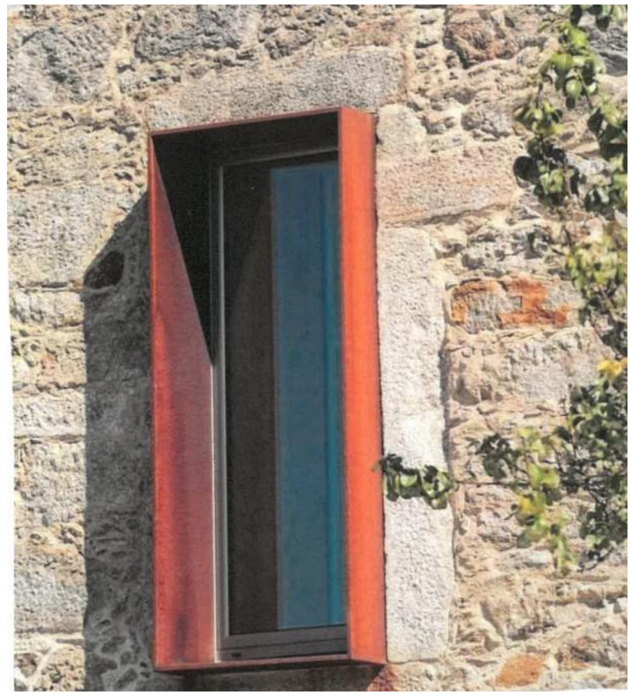


Pallet of Materials: *For walling, imagine gabions but without the wire cages*

The 900m thermal mass flint walling of the larger living section will essentially appear like gabions but without the wire cages. The loose flints retained by shuttering are bonded with insulated and reinforced mortar. Once cured the outside will be jetted to reveal the depth of the flints and give light and shade to the elevation.

Pallet of Materials: Example of vertical timber cladding in concrete

The bedroom sections will be of more conventional in-situ construction. To give variation vertical woodgrain textured formwork liners will be used to echo the woodland backdrop. Together the blocks of elemental materials will be comfortably assimilated into the wide farmland panorama.



Pallet of Materials: Corten window surrounds

To lighten the homogenous massing of the ‘elemental’ flint and wood grained finishes it is proposed to insert Corten extended surrounds around the visible openings. The rusty metal seems at home in the countryside, and they provide a practical solution for shielding light and framing views.

There are no roof materials. There will be waterproof layers under the solar panels and grass slopes.

LANDSCAPING

As explained above, Landscaping is a crucial part of this scheme and is explained in detail in Chris Yardley’s Landscaping Statement with Schedule and Landscape Management Plan. As can be seen from his drawings, reinforced by the Landscape Statement, in visual landscape terms the proposal will not have a detrimental effect. It is smaller than the approved aircraft hangar and will merge with the line of existing mature surrounding trees.

Work will be done to 'naturalise' the grid pattern of the existing plantation

ECOLOGICAL IMPACT

The aim is to naturalise the plantation grid and over time create a woodland that connects to provide a wildlife haven. Attached is an Ecological Impact Assessment from Glaven Ecology.

ENERGY

Also attached is a preliminary Energy Standard Review. Although an initial conventional assessment assumes that blinds or brise soleil may be necessary for the main glazed screen to the living area, it is contended that this will not be necessary because of the arrangement of the glazing screen.

The outer screen allows the gap to heat up but the inner screen, double or triple-glazed, contains it in the gap which can be used to contribute to warming the house in winter and preventing overheating in summer. In addition, the thermal mass of the walls will help both heating and cooling. Thermal mass absorbs heat from the sun and then radiates it out when the temperature drops. Therefore, there is a combination of elements that will combine to ensure carbon free comfort.

ACCESS

There is an existing vehicular access off Thwaite Common that is dedicated to the proposed site. Cars can access the courtyard area.

The open plan design and wide corridors will assist those with disability issues. There is also space for a personal lift if necessary.

CONCLUSION

In these uncertain times there needs to be a greater emphasis put on personal self-reliance in energy terms and a more immediate move away from fossil fuels. Sometimes it is the smaller experimental projects using a combination of methods that can be lamplighters for others who cannot afford to experiment or are not compelled to by inclination.

The thrust of this application is basically three-fold:

1. To explore systems that can work in combination to provide a functioning warm house that does not rely on fossil fuels and does not overheat in summer.
2. To more closely relate all building works with the environment to which they are indelibly connected as a matter of course.
3. To prove that these elements can be packaged in an attractive building.

The proposal involves considerable landscape work to the 3.5 ha of the application site, but this connection to the site could be done pro-rata everywhere to ensure that the land receives 'compensation' for its loss by planting or improvement elsewhere within the curtilage as standard. This of course already happens on some larger developments, but not smaller developments or extensions. This proposal aims, therefore, to not only sit politely within the landscape and its host settlement, but also to be of physical benefit to it as well as providing technical information on systems that can wean us off fossil fuels.

PJWR.JS.3003.PDB.01
22nd March 2022

APPENDIX

1. Previously approved hangar sits larger in the landscape. Drawings and Notice.
2. Thermal banks at a glance.
3. Using Thermal Mass.
4. Landscape Statement – Chris Yardley
5. Ecological Impact Assessment – Glaven Ecology.
6. Energy Assessment – preliminary.
7. Cement substitutes
8. Precedent in planning and technical terms.
9. Photographs

APPENDIX 1: Previously approved hangar sits larger in the landscape. Drawings and Notice

NORTH NORFOLK DISTRICT COUNCIL
HOLT ROAD CROMER NORFOLK NR27 9EN
Telephone 01263 513811
www.northnorfolk.org
e-mail planning@north-norfolk.gov.uk

NORTH NORFOLK DISTRICT COUNCIL

Mr Mackinnon
1 Walpole Barns
Thwaite Common
ERPINGHAM
Norfolk
NR11 7QG

Application Number
PF/16/1243

Date Registered
05 September 2016

Alby with Thwaite

DECISION NOTICE

Town and Country Planning Act 1990
The Town and Country Planning (Development Management Procedure) (England) Order 2015

Location: 1 Walpole Barns, Thwaite Common, Erpingham, Norwich, NR11 7QG

Proposal: Demolition of outbuildings/sheds and erection of two-storey garage and hanger

Applicant: Mr Mackinnon

NORTH NORFOLK DISTRICT COUNCIL, in pursuance of powers under the above mentioned Act hereby **PERMIT** the above mentioned development in accordance with the accompanying plans and subject to the conditions specified hereunder:

The building hereby permitted shall not be used until the flint filled gabion baskets have been installed in accordance with the details shown on the approved plans. The flint filled gabion baskets shall be retained thereafter.

Reason:
To ensure the satisfactory appearance of the development in the interests of the visual amenities of the area, in accordance with Policy EN 4 of the adopted North Norfolk Core Strategy.

1 The development to which this permission relates must be begun not later than the expiration of three years beginning with the date on which this permission is granted.

Reason:
The time limit condition is imposed in order to comply with the requirements of Section 91 of the Town and Country Planning Act 1990 as amended by Section 51 of the Planning and Compulsory Purchase Act 2004.

2 The development to which this permission relates shall be undertaken in strict accordance with the approved plans - drawing nos:

- 001_PL01;
- 002_PL01;
- 003_PL01;
- 020_PL01;
- 021_PL01;
- 022_PL01;
- 201_PL01;
- 202_PL01;
- Design & Access Statement

except as may be required by the conditions below.

Reason:
For the avoidance of doubt and to ensure the satisfactory development of the site, in accordance with Policy EN 4 of the adopted North Norfolk Core Strategy.

3 Prior to their first use on site details of the colour finishes to the vertical timber weatherboard, roof cladding and all other external surfaces of the building hereby permitted, shall be submitted to and approved in writing by the Local Planning Authority. Development shall be carried out in accordance with the approved details.

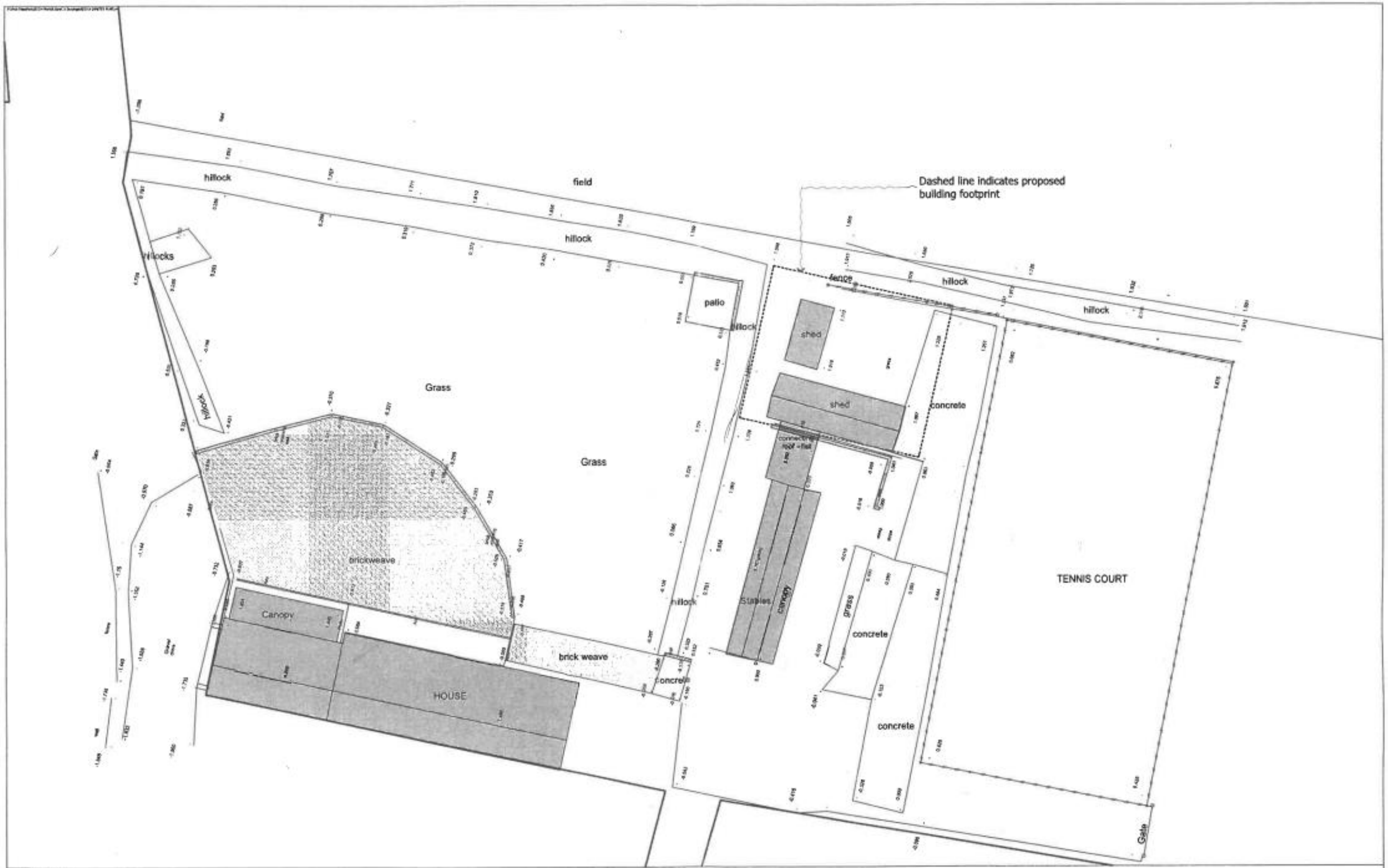
Reason
To ensure the acceptable appearance of the building in the interests of the visual amenities of the area, in accordance with Policy EN 4 of the adopted North Norfolk Core Strategy.

4 The development hereby permitted shall be carried out in accordance with the levels shown on the copy of drawing no. 202_PL01 annotated by the applicant and received by the Local Planning Authority on 4 February 2017

Reason:
To ensure the acceptable appearance of the building in the interests of the visual amenities of the area, in accordance with Policy EN 4 of the adopted North Norfolk Core Strategy.

5 The building hereby permitted shall not be used at any time other than for purposes ancillary to the residential use of the dwelling known as 1 Walpole Barns, Thwaite Common, Erpingham NR11 7QG and any aircraft, including helicopters, stored in the building shall be limited to only those for the private use of the occupier/s of that dwelling.

Reason:
To ensure no commercial use, including flying takes place, which could result in an unacceptable level of activity, in the interests of the amenities of the occupiers of nearby dwellings in accordance with Policies EN 4 and EN 13 of the adopted North Norfolk Core Strategy.



1 EXISTING BLOCK PLAN

Figured dimensions only are to be taken from this drawing. All dimensions are to be checked on site before any work is put in hand.
If in doubt, ask.

0 5m

Rev Date Descriptor

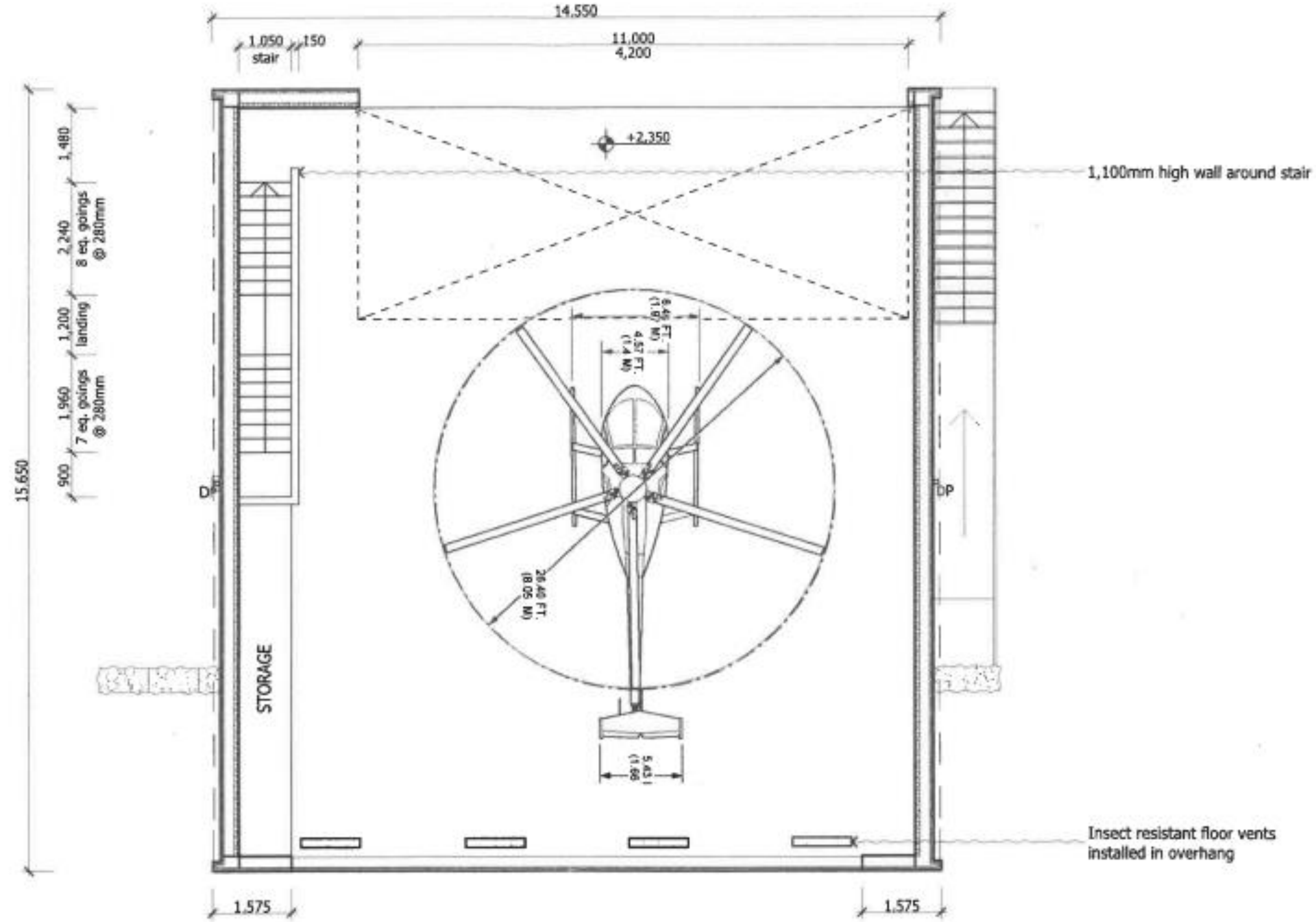
Legends & Notes:

Project:
Garage + Hangar
1 Walpole Barn, Thwaite Common
Erpingham NR11 7QG

Client:
Alistair MacKinnon

Drawing Title:
001 Site Plans
Existing Block Plan

Project number (DWG number_Revision)
(1104)002_PL01



1 **PROPOSED UPPER FLOOR PLAN**

Figured dimensions only are to be taken from this drawing. All dimensions are to be checked on site before any work is put in hand.
If in doubt, ask.

Rev | Date | Description | Attv

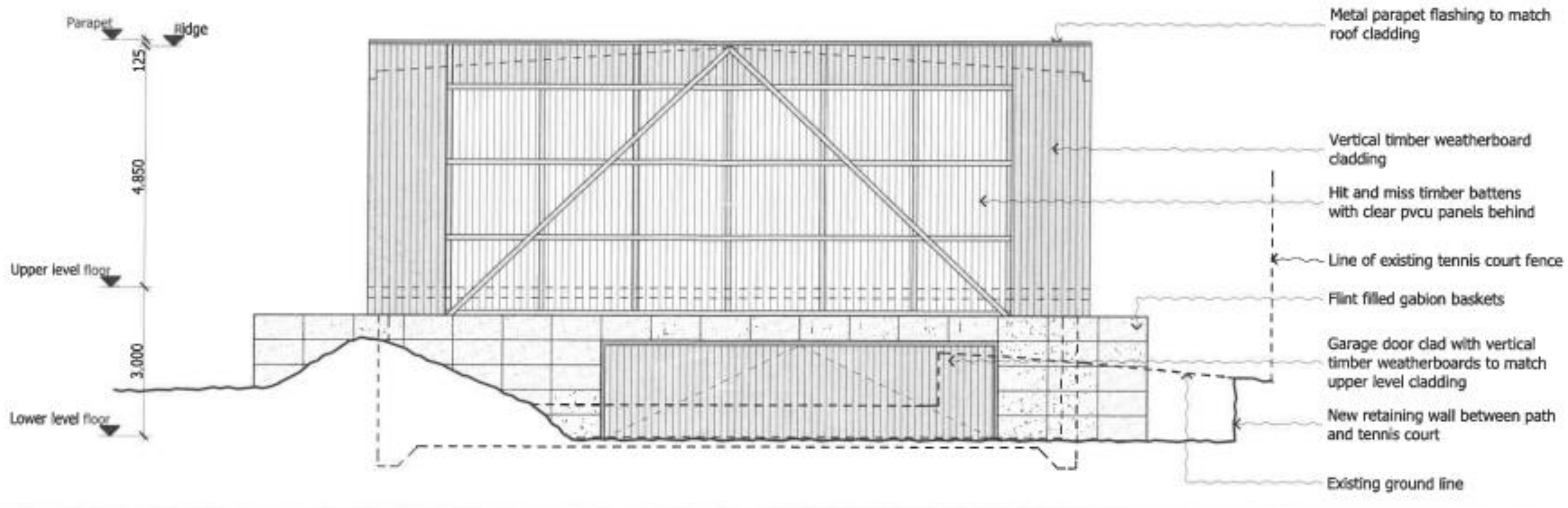
Legends & Notes:

Project:
Garage + Hangar
1 Walpole Barn, Thwaite Common
Erpingham NR11 7QG

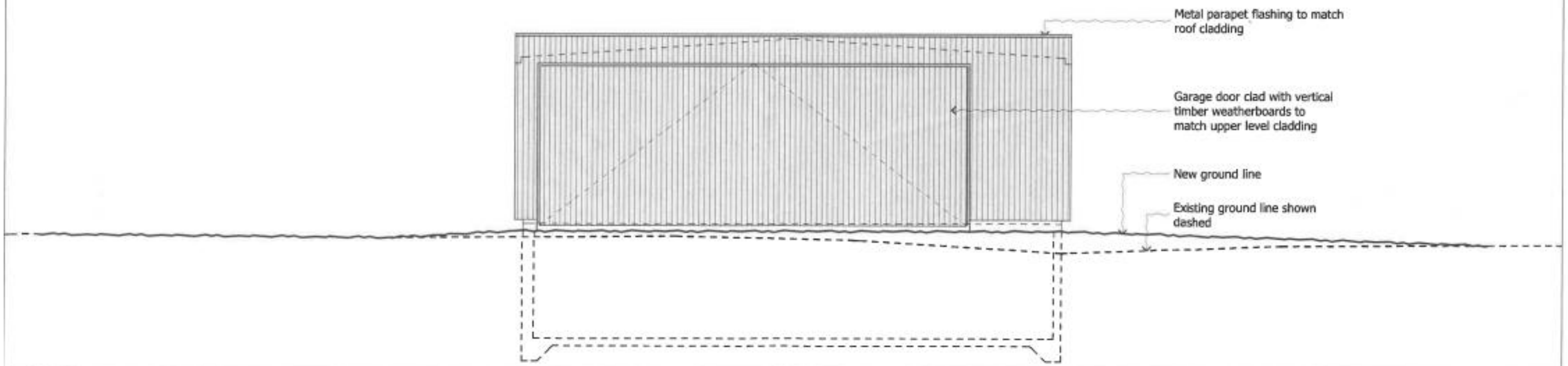
Client:
Alistair MacKinnon

Drawing Title:
020 General Arrangements
Upper Floor GA

(1104)021_PL01



2 PROPOSED SOUTH ELEVATION



1 PROPOSED NORTH ELEVATION

Figured dimensions only are to be taken from this drawing. All dimensions are to be checked on site before any work is put in hand.
If in doubt, ask.

Rev	Date	Description	Initials
PL01	22.08.16	Issued for Planning	AM

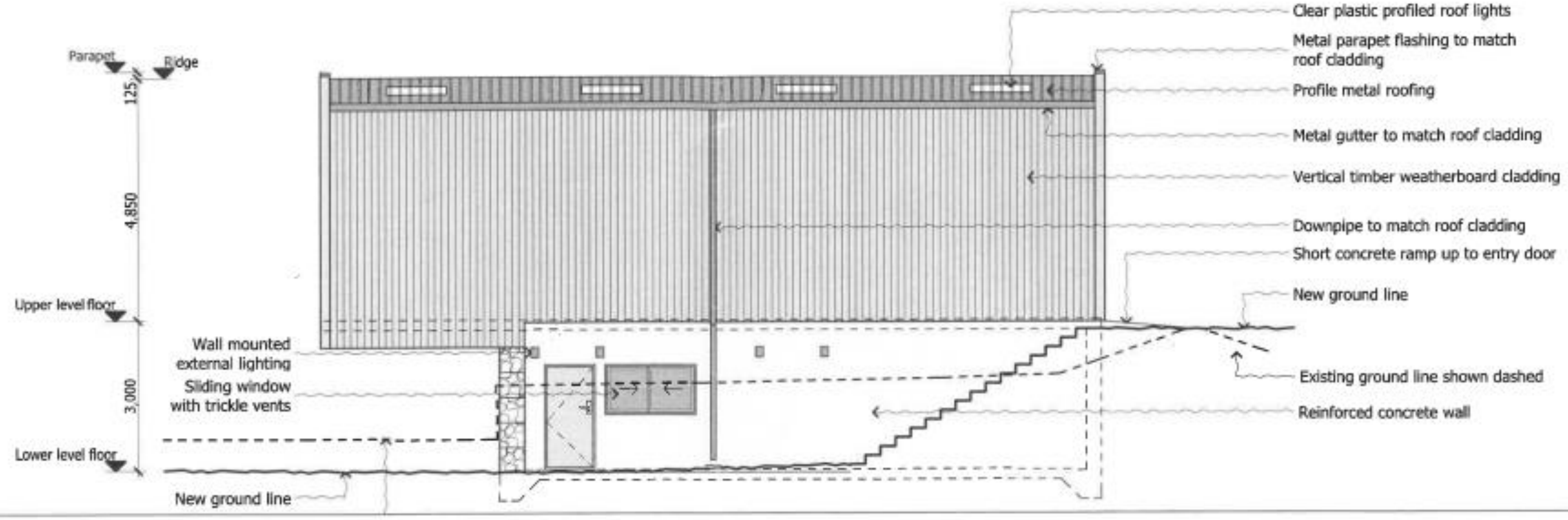
Legends & Notes:

Project:
Garage + Hangar
1 Walpole Barn, Thwaite Common
Erpingham NR11 7QG

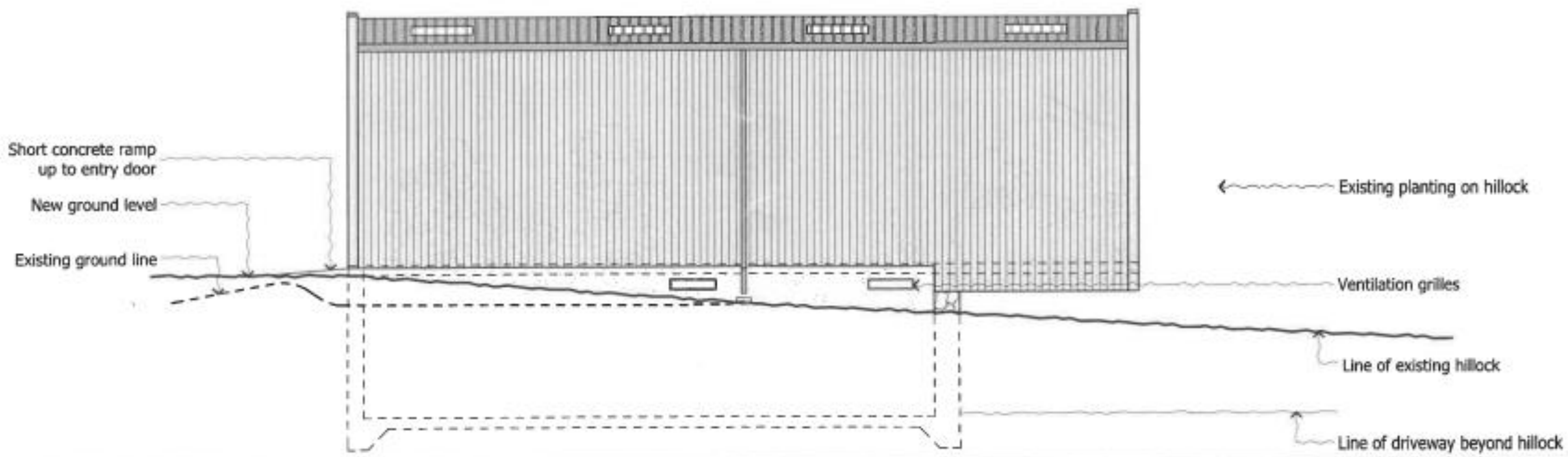
Client:
Alistair MacKinnon

Drawing Title:
200 Elevations
Proposed Elevations N&S

(1104)201_PL01



2 PROPOSED EAST ELEVATION



1 PROPOSED WEST ELEVATION

Figured dimensions only are to be taken from this drawing. All dimensions are to be checked on site before any work is put in hand. If in doubt, ask.

Rev	Date	Description	Ckd
PL01	11.03.10	Issued for Planning	

Legends & Notes

Project: **Garage + Hangar**
1 Walpole Barn, Thwaite Common
Erpingham NR11 7QG

Client: Alistair MacKinnon

Drawing Title: 200 Elevations
Proposed Elevations E&W

(1104)202_PL01

APPENDIX 2: Thermal Banks at a Glance

ThermalBanks™ store heat between seasons

and save carbon emissions by re-cycling Renewable Heat through Interseasonal Heat Stores

Seasonal Heat Storage

ThermalBanks store heat between seasons

A Thermal Bank is a bank of earth used to store heat energy collected in the summer for use in winter to heat buildings. A Thermal Bank is an integral part of an Interseasonal Heat Transfer system invented, developed and patented by ICAX to answer the need for on site renewable energy without burning fossil fuels.

Interseasonal Thermal Store – Rechargeable Heat Battery

A Thermal Bank is used to store warm temperatures over a very large volume of earth for a period of months, as distinct from a standard heat store which can hold a high temperature for a short time in an insulated tank. A Thermal Bank acts as a rechargeable heat battery.

Heat moves slowly in the ground – Thermal Inertia

It is a characteristic of earth that heat only moves very slowly through it – as slowly as one metre a month. ICAX exploits this thermal inertia to input surplus heat into the ground over the summer months and extract that heat over the winter months for use in the space heating of buildings.

Interseasonal Heat Transfer works by capturing heat energy from the sun via a collection pipe network just beneath the surface of black tarmac roads (or car parks or school playgrounds). It then stores the energy in computer-controlled Thermal Banks in the ground under the foundation of buildings, and releases it to heat the buildings in winter via heat pumps linked to underfloor heating.

Constant temperature only if undisturbed

The temperature of the ground at a depth of six metres in the UK will normally be very close to 10°C – the temperature will vary very little between summer and winter as heat only moves very slowly in the ground. ICAX uses this characteristic of the ground to store heat from summer to winter. Using fluid – in an array of pipes – as the transport mechanism solves the difficulty of getting the heat into the ground – and out again.

The way in which heat is absorbed and released by the ground is complex and required to be studied using complex iterative methods that have only become

practical with the use of computational fluid dynamics ("CFD"). The computer models developed by ICAX have since been tested in practical installations and refined to reflect empirical results. These have been used to refine the design parameters for successful ThermalBanks with an understanding of the Thermogeology involved.

Black surfaces absorb heat

Tarmac roads tend to absorb the heat of the sun up to the point when they radiate heat as quickly as they are absorbing it: the surface temperature of tarmac in full sunshine can often reach 15°C higher than the ambient air temperature.

ICAX collects heat using water circulating through an array of pipes embedded in the surface of the tarmac and deposits it in ThermalBanks constructed beneath the insulated foundation of buildings: solar recharge of the ground. The temperature across the ThermalBank can be increased from its natural temperature of 10°C to over 25°C in the course of the summer months.

ICAX uses a ground source heat pump to extract heat from the ThermalBank when it is needed to heat the building in winter using underfloor heating. Unlike a normal ground source heat pump which typically starts with an autumn ground temperature of 10°C the heat pump in an Interseasonal Heat Transfer system starts with a temperature of over 25°C from the ThermalBank.

IHT doubles the CoP by starting with warmth

This doubles the Coefficient of Performance of the heat pump and allows a 50% saving of carbon emissions compared to providing heat from a gas boiler.

Underground Thermal Energy Storage – UTES

A Thermalbank is also described as Underground Thermal Energy Storage - UTES, or as providing Seasonal Heat Storage because it can be used as a rechargeable heat battery.

Borehole Thermal Energy Storage – BTES

Where it is not practical to create a horizontal Thermalbank to store energy ICAX uses a borehole field to perform the same function. This is described as Borehole Thermal Energy Storage – BTES. Angled boreholes, also called an inclined boreholes, can be used if surface area is limited.

See also: Renewable Heat

See also: Renewable Heat Incentive clean energy cashback for most of your running costs for over 20 years.

See also: Banking on IHT

Ref: https://www.icax.co.uk/Thermal Banks.html (accessed 22/04/2021)

APPENDIX 3: Using Thermal Mass

SMARTER HOMES

SMART GUIDE
USING THERMAL MASS FOR HEATING AND COOLING

Some building materials are good at absorbing and storing the sun's heat.

This is related to:

Design

Thermal mass keeping your home comfortable

These materials are heavy and dense, and therefore high in what is technically called thermal mass. Common materials used for thermal mass include concrete or filled concrete block, stone or masonry usually used in floors or walls.

Used properly – the right amount in the right place, with proper external insulation – thermal mass can help maintain comfortable temperatures inside your home year-round. Thermal mass will absorb heat from the sun during the day and radiate it out as the temperature drops in the afternoon throughout the evening.

Thermal mass reduces the room temperature during midday and early afternoon and increases the room temperature late in the afternoon and early evening hours.

Building thermal mass into your new home or renovation doesn't have to increase costs. The money used for a carpet could for example instead be spent on polishing an exposed concrete floor.

Thermal mass materials

Probably the simplest form of thermal mass is a concrete slab floor. You can also use concrete blocks, tiles, brick, rammed earth and stone. Three factors determine how good a material is at absorbing and storing heat.

The ideal material is:

- dense and heavy, so it can absorb and store significant amounts of heat (lighter materials, such as wood, absorb less heat)
- a reasonably good heat conductor (heat has to be able to flow in and out)
- has a dark surface, a textured surface or both (helping it absorb and re-radiate heat).

Different thermal mass materials absorb varying amounts of heat, and take longer (or shorter) to absorb and re-radiate it. For example, a brick wall has higher thermal mass than a timber framed cavity wall, so it will absorb more heat than a timber framed wall of the same thickness.

When the sun is shining into a room and the air is warm, heat will be absorbed by the walls, floor and other surfaces in the room.

How much heat they can hold depends on what they're made of and how thick they are. Some materials can absorb a lot of heat without warming up very much. Others will become quite warm after absorbing small amounts of heat. Thermal mass materials belong to the former. That means that if, for example, a concrete slab floor is exposed to direct sunlight it will be able to absorb and store a lot of heat and release it slowly.

A different material, for example a timber floor, cannot absorb and store as much heat, so what heat it does absorb is released quickly. As a result, much of the energy in the sunlight will quickly end up in the surrounding air, increasing your room temperature during the warmest parts of the day.

You can compare thermal mass to a sponge. Much of the water hitting it will be absorbed. A material with little thermal mass properties will behave more like a plain surface. Any water hitting it will bounce back and end up in the air.

In winter, properly designed thermal mass will absorb the heat from the sunlight on it during the day. Then, as the air temperature drops, the heat will move from the warmer thermal mass to the cooler air and other surfaces in the room.

In summer, thermal mass inside a dwelling should be shaded from direct sunlight for the entire day and be exposed to cooling breezes to provide some cooling on hot days and nights.

The interaction of insulation, glazing and thermal mass is complex and varies with climate and seasons. Because of this it is important to ask an expert in solar design, such as a designer, architect or building scientist who specialises in passive solar design, to advise you on the best option for your situation.

TIP
THERMAL MASS

If you cover your thermal mass concrete slab floor with carpets or vinyl, you will reduce much of the sun's radiation being absorbed into the floor and less of the heat will be released later when it is colder.

To get the most out of your slab floor, leave it exposed or tile it with ceramic or stone tiles.

TIP
INSULATION

Remember that your first priority should always be your insulation, including the use of windows and frames with a high R values. If your home is poorly insulated, thermal mass can even make your house less comfortable and increase your energy use.

Where you should put thermal mass

Thermal mass should be placed where it will best be able to absorb heat in the colder months and be shaded in the warmer months. This means it is best to put it near windows or other glazed areas where it will be exposed to direct sunlight in winter. The north side of the house is generally best.

You can also put thermal mass near a woodburner, heater or another source of radiant heat.

TIP
THERMAL MASS FLOOR OR WALL

A thermal mass floor or wall exposed to direct sunlight is more effective than one only exposed to diffused sunlight, and hundreds of times more effective as one only exposed to warm air. Rather than a fully exposed concrete slab, you could consider just exposing a strip along the sunny side of a room.

Where you shouldn't put thermal mass

Thermal mass can be a liability if used incorrectly, so it should be kept away from:

- cold, draughty areas such as entryways or unheated hallways
- rooms that face south or don't get much winter sun
- areas with poor insulation.

Well-insulated, lightweight construction walls are suitable for cool, draughty areas and south-facing rooms.

Thermal mass in floors

In most climate conditions a concrete slab, insulated underneath and around the edge, where it is in direct contact with the ground, is the most effective way to increase thermal mass. This can form the whole floor, but just as effective is a strip of polished or tiled concrete along the sunny side of the room or a slab floor which is exposed around the edges with mats or carpet in the centre. Concrete slab floors should preferably be insulated both underneath and around the edges, or at the very least for a metre in from the perimeter.

Other floor options include brick, compressed earth or a suspended concrete slab in rooms with north-facing windows, with external insulation.

The surface can be polished or tiled where exposed to the sun. Surfaces exposed to direct sunlight shouldn't be covered with rugs or carpet, as this reduces the amount of heat the thermal mass can absorb.

Thermal mass in walls

Brick, concrete, concrete block (including insulated and aerated types) and rammed earth can be used for internal or external walls if they catch the sun or are close to a radiant heat source. Walls can either be solid or an internal veneer.

External thermal mass walls must be insulated on the external surface to prevent heat loss and exposed on the inside of the house (that is, without internal lining, but it can be plastered, stained, tiled, painted or wall-papered). Various methods and proprietary systems are now available to design and retrofit insulated concrete block, precast concrete panel, or poured concrete walls. These include:

- Insulating panels that can be fitted to the outside of new and existing concrete and concrete block walls
- Precast concrete 'sandwich' panels, which have a layer of insulation between two layers of concrete.

Polystyrene formwork (or shuttering) systems are available for concrete walls. In some cases the polystyrene on the internal surface can be removed, however its insulation benefits usually outweigh the thermal mass benefits.

Other options

Other options include:

- feature brick or stone walls
- Trombe walls. A trombe wall is a north-facing heavy wall made of concrete or some other thermal mass material, located behind a layer of glass. The wall's exterior is dark-coloured to attract the sun's heat. The heat takes several hours to travel through the wall before it is released into the home's living areas. Properly designed, it should start to release heat in the early evening as the temperature starts to fall. They can be used to maximise heat collection when views and glazing are oriented to the south or when site orientation is not ideal.

How much thermal mass do you need?

Area

The area of exposed thermal mass should be balanced against the area of glazing. You don't want to have so much glass that the room overheats in summer and loses heat too fast in winter.

As a rule of thumb, the exposed area of thermal mass should be about six times the area of glass that receives direct sunlight. For example, a north-facing room with a 1m2 window should have about 6m2 of exposed thermal mass, located where it will be exposed to direct winter sun. The exact glass-to-mass area ratio will of course vary with climate and design.

Your passive solar design expert can optimise the amount and placement of both glazing and thermal mass by using hour-by-hour simulations of the design.

Thickness

Concrete slab floors should be 100–200mm thick for the best performance, while thermal mass walls should be 100–150mm thick. Very thick thermal mass walls and floors may take too long to heat, while those that are too thin won't store enough heat. The exact amount should be calculated as part of the design process.

To prevent the potential for overheating thermal mass in summer, it's important to design appropriate eave widths.

Other things to consider

Insulation

Good insulation (including glazing) is essential to maximise the benefits of thermal mass. It's vital that thermal mass is insulated from outside temperature fluctuations. Without insulation, thermal mass can be a liability – radiating cold and exacerbating damp conditions in winter.

Thermal mass that doesn't receive sunlight

Consider insulating the inside of high thermal mass walls which don't receive direct sunlight or store heat from nearby radiant heat sources. This is particularly important if you only heat for part of the day – the thermal mass will absorb heat from the air until it is the same temperature.

Concrete drying

If you are using concrete as thermal mass in a floor or wall, you need to be aware that it will not perform at its best until it has dried out. Drying time will vary depending on humidity and thickness. A 100mm thick slab can take four months to dry out (longer in winter), and thicker slabs will take longer. During that time it is particularly important to ventilate the house regularly to avoid the build-up of internal moisture.

Adding thermal mass to an existing home

Some homes have thermal mass that isn't being used. Any concrete slab in a north-facing room can absorb and store heat, so long as it's uncovered and insulated. It may be worthwhile ripping up a carpet and putting ceramic tiles down to reduce some overheating in summer and capture some free solar gains in winter.

Thermal mass can be added to existing homes during renovations by:

- laying a concrete floor in a new extension
- adding a brick or stone feature wall. It will need to be exposed to direct sunlight or close to a radiant heat source, and be very well insulated if it's an external wall.

Ref: https://www.smarterhomes.org.nz/smart-guides/design/thermal-mass-for-heating-and-cooling/ (accessed 27/01/2021)

APPENDIX 4: Landscape Statement

Please see separate Report:

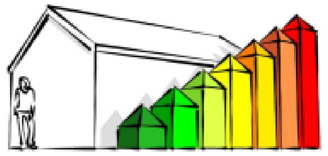
‘Landscaping Statement with Schedule and Landscape Management Plan
Site at Walpole Barn, Thwaite Common’
Prepared by CJ Yardley Landscape Survey and Design LLP
July 2021

APPENDIX 5: Ecological Impact Assessment

Please see separate Report:

‘Land at Thwaite Common Erpingham – Ecological Impact Assessment’
Reference: 2124-GE-PP
Prepared by Glaven Ecology
April 2021

APPENDIX 6: Energy Assessment – Preliminary



PRELIMINARY ENERGY STANDARD REVIEW

Proposed Residential Development, Thwaite Common

for Pike Partnership

Ref 497
June 2021

TER Building Energy Ltd
Telephone: 07759 900475
Email: tamsin@terbuildingenergy.co.uk
Website: www.terbuildingenergy.co.uk

The purpose of this review is to consider the Low Energy Standards for the proposed dwelling modelling with Preliminary PHPP Calculations and SAP Calculations.

The proposed dwelling is to be a thermally efficient home that is economic to run and comfortable to live in by using an enhanced fabric specification in tandem with a high build quality. The proposed design incorporates large areas of south facing glazing for optimal solar gain and earth banks used as thermal stores in conjunction with the thermal mass of the concrete building itself.

PHPP, the Passivhaus Planning Software, is critical to understanding the energy performance of a building design and has been proven as a very accurate predictor of energy usage. In cases where an energy consultant prepares the model in close collaboration with architect, the use of PHPP as a design tool rather than simply an energy predictor, can ensure energy performance is designed in from the outset.
Some of the principles of a 'PHI Low Energy Building' are intended for this project aiming for the Heating Demand Criteria of ≤ 30 kWh/m²/a and ensuring the frequency of overheating is ≤ 10%.

The Standard Assessment Procedure (SAP) is the UK government's recommended method system for measuring the energy rating of residential dwellings. It is proposed that the new dwelling achieve a minimum standard of 92 (A Rating) on the Energy Performance Certificate (EPC).

To comply with the above criteria consideration has been given to the possible build specification. The dwelling been modelled and calculated in PHPP and SAP and a summary of results can be found in Appendix A – PHPP Verification Pages and Appendix B – SAP Input & Predicted EPC.

The following u-values coupled with what would effectively be a Ground Source Heat Pump and thermal store to provide Heating & Hot Water along with PV Panels to provide a minimum 6 kWp are indicated to achieve compliance.

- Floor – 0.15 W/m²K
- Walls – 0.20 W/m²K
- Roof – 0.18 W/m²K
- Triple Glazed Windows & Doors – 0.9 W/m²K

Ventilation and air tightness are two sides of the same coin, and low air leakage should never be attempted without due consideration to appropriate ventilation. Buildings with MVHR and low air tightness offer the best energy efficiency and comfort levels and provide the lowest fuel bills.

The maximum air test result assumed is 3m³/hm² (building regs permeability, q50 against ventilation expressed as air changes per hour in PHPP, n50).

Building Regulations suggest that if an air test result below 3m³/hm² is likely to be achieved, then a whole house supply and extract ventilation system should be considered therefore Mechanical Ventilation with Heat Recovery is also proposed.

The PHPP calculations suggest that the overheating risk would be more than 10% so it is assumed that some additional shading will be required, i.e., Permanent External blinds to the Central South facing Glazed facades.

Tamsin Minty
Energy Assessor
22nd June 2021

Appendix A – PHPP Verification Page

PHI Low Energy Building Verification

Building:	Proposed Self-heating House		
Street:	Thwaite Common		
Postcode/City:			
Province/Country:		GB-United Kingdom/ Britain	
Building type:			
Climate data set:	GB0013a-Hemsby		
Climate zone:	3: Cool-temperate	Altitude of location:	28 m
Home owner / Client:	Alistair Mackinnon		
Street:			
Postcode/City:			
Province/Country:			
Architecture:	Pike Partnership	Mechanical engineer:	-
Street:	11 Hamilton Road	Street:	
Postcode/City:	NR27 9HL Cromer	Postcode/City:	
Province/Country:	Norfolk GB-United Kingdom/ Britain	Province/Country:	
Energy consultancy:	TER Building Energy Ltd	Certification:	-
Street:	48 London Road, Elveden	Street:	
Postcode/City:	IP24 3TG Thetford	Postcode/City:	
Province/Country:	Norfolk GB-United Kingdom/ Britain	Province/Country:	

Year of construction:	-	Interior temperature winter [°C]:	20.0	Interior temp. summer [°C]:	25.0
No. of dwelling units:	1	Internal heat gains (IHG) heating case [W/m²]:	2.2	IHG cooling case [W/m²]:	2.2
No. of occupants:	3.2	Specific capacity [Wh/K per m² TFA]:	204	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area — The PHPP has not been filled completely; it is not valid as verification

				Criteria	Alternative criteria	Fulfilled?[2]
	Treated floor area m²	341.3				
Space heating	Heating demand kWh/(m²a)	28	≤	30	-	yes
	Heating load W/m²	23	≤	-	-	
Space cooling	Cooling & dehum. demand kWh/(m²a)	-	≤	-	-	-
	Cooling load W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C) %	5	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	20		yes
Airtightness	Pressurization test result n_{50} 1/h	4.0	≤	1.0		no
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	3	≤	135		yes
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	1	≤	-	-	-
	Generation of renewable energy (in relation to projected building footprint area) kWh/(m²a)	0	≥	-	-	

[2] Empty field: Data missing; '-': No requirement

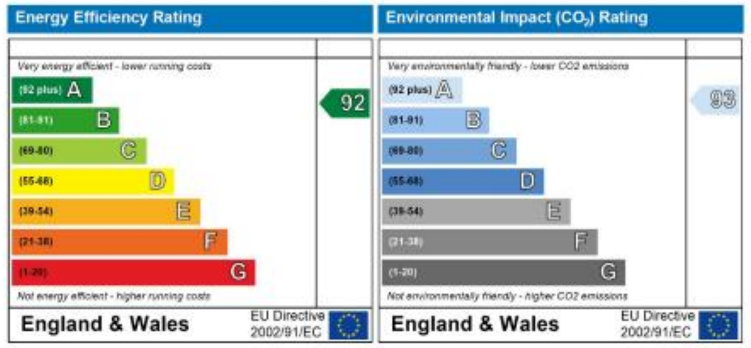
Appendix B – Predicted EPC & SAP Input

Predicted Energy Assessment

Proposed Low Energy Dwelling Thwaite Common	Dwelling type: Date of assessment: Produced by: Total floor area:	Detached House 21 June 2021 Tamsin Minty 362.47 m²

This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about the energy performance of the completed property.

Energy performance has been assessed using the SAP 2012 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO2) emissions.



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO2) emissions. The higher the rating the less impact it has on the environment.

SAP Input

Property Details: Proposed Dwelling

Address:	Proposed Low Energy Dwelling, Thwaite Common
Located in:	England
Region:	East Anglia
UPRN:	
Date of assessment:	21 June 2021
Date of certificate:	22 June 2021
Assessment type:	New dwelling design stage
Transaction type:	New dwelling
Tenure type:	Owner-occupied
Related party disclosure:	No related party
Thermal Mass Parameter:	Calculated 220.18
Water use <= 125 litres/person/day:	True
PCDF Version:	478

Property description:

Dwelling type:	House
Detachment:	Detached
Year Completed:	2021

Floor Location:	Floor area:	Storey height:
Floor 0	260.08 m²	2.34 m
Floor 1	85.29 m²	3.46 m
Floor 2	17.1 m²	2.45 m

Living area:	47.78 m² (fraction 0.132)
Front of dwelling faces:	South

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
W1	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W2	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W3	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W4	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W5	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W6	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W7	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W8	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W9	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W10	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W11	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W12	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W13	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W14	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W15	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W16	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break
W17	SAP 2012	Windows	low-E, En = 0.05, soft coat	No	Metal, thermal break

Name:	Gap:	Frame Factor:	g-value:	U-value:	Area:	No. of Openings:
W1	16mm or more	0.8	0.57	0.9	5.49	1
W2	16mm or more	0.8	0.57	0.9	7.71	1
W3	16mm or more	0.8	0.57	0.9	5.89	1
W4	16mm or more	0.8	0.57	0.9	5.64	1
W5	16mm or more	0.8	0.57	0.9	5.64	1
W6	16mm or more	0.8	0.57	0.9	5.89	1
W7	16mm or more	0.8	0.57	0.9	5.64	1
W8	16mm or more	0.8	0.57	0.9	1.54	1

SAP Input

W9	16mm or more	0.8	0.57	0.9	2.88	1
W10	16mm or more	0.8	0.57	0.9	8.16	1
W11	16mm or more	0.8	0.57	0.9	3.91	1
W12	16mm or more	0.8	0.57	0.9	2.67	1
W13	16mm or more	0.8	0.57	0.9	20.88	1
W14	16mm or more	0.8	0.57	0.9	22.62	1
W15	16mm or more	0.8	0.57	0.9	8.33	1
W16	16mm or more	0.8	0.57	0.9	6	1
W17	16mm or more	0.8	0.57	0.9	8.88	1

Name:	Type-Name:	Location:	Orient:	Width:	Height:
W1		Mass Wall	North	5	1.097
W2		Hybrid Wall	North	2	3.857
W3		Hybrid Wall	East	2.455	2.4
W4		Hybrid Wall	East	2.35	2.4
W5		Hybrid Wall	East	2.35	2.4
W6		Hybrid Wall	East	2.455	2.4
W7		Hybrid Wall	East	2.35	2.4
W8		Hybrid Wall	East	0.9	1.71
W9		Hybrid Wall - Ground	East	1.2	2.4
W10		Mass Wall	East	3.4	2.4
W11		Hybrid Wall	South	1.7	2.3
W12		Hybrid Wall	South	1.4	1.91
W13		Mass Wall	South	8.7	2.4
W14		Mass Wall	South	8.7	2.6
W15		Hybrid Wall	West	3.47	2.4
W16		Hybrid Wall	West	2.5	2.4
W17		Hybrid Wall	East	3.7	2.4

Overshading: Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
External Elements							
Hybrid Wall	206.75	67.74	139.01	0.2	0	False	17
Hybrid Wall - Ground	127.16	2.88	124.28	0.2	0	False	17
Mass Wall	125.16	57.15	68.01	0.2	0	False	17
Flat Roof	99.48	0	99.48	0.18	0		9
Roof below ground	162.81	0	162.81	0.18	0		9
Ground Floor	260.08			0.15			110
Exposed Floor	21.53			0.18			75
Internal Elements							
GF Walls	345.29						100
FF Walls	44.33						100
Internal Ceilings	97.44						9
Internal Floors	97.44						18
Party Elements							

Thermal bridges:

Thermal bridges: User-defined (individual PSI-values) Y-Value = 0.1183

Length	Psi-value		
54.63	1	E2	Other lintels (including other steel lintels)
7.3	0.08	E3	Sill
79.748	0.1	E4	Jamb
49.44	0.32	E5	Ground floor (normal)
53.8	0.32	E20	Exposed floor (normal)
61.34	0.07	E22	Basement floor

SAP Input

129.19	0.08	E14	Flat roof
43.55	0.18	E16	Corner (normal)
28.44	0	E17	Corner (inverted internal area greater than external area)

Ventilation:	
Pressure test:	Yes (As designed)
Ventilation:	Balanced with heat recovery Number of wet rooms: Kitchen + 5 Ductwork: Insulation, rigid Approved Installation Scheme: False
Number of chimneys:	0
Number of open flues:	0
Number of fans:	0
Number of passive stacks:	0
Number of sides sheltered:	2
Pressure test:	3
Main heating system:	
Main heating system:	Heat pumps with radiators or underfloor heating Electric heat pumps Fuel: Electricity Info Source: SAP Tables SAP Table: 211 Ground source heat pump with flow temperature <= 35°C Underfloor heating, pipes in concrete slab Boiler interlock: Yes MCS Installation Certificate
Main heating Control:	
Main heating Control:	Time and temperature zone control by suitable arrangement of plumbing and electrical services Control code: 2207
Secondary heating system:	
Secondary heating system:	None
Water heating:	
Water heating:	From main heating system Water code: 901 Fuel :Electricity Hot water cylinder Cylinder volume: 300 litres Cylinder insulation: Measured loss, 2.5kWh/day Primary pipework insulation: True Cylinderstat: True Cylinder in heated space: True Solar panel: False
Others:	
Electricity tariff:	Standard Tariff
In Smoke Control Area:	No
Conservatory:	No conservatory
Low energy lights:	100%
Terrain type:	Rural
EPC language:	English
Wind turbine:	No
Photovoltaics:	Photovoltaic 1 Installed Peak power: 6 Tilt of collector: Horizontal Overshading: None or very little

SAP Input

	Collector Orientation: South
Assess Zero Carbon Home:	No

APPENDIX 7: Cement Substitutes

greenspec®

Concrete: Cement Substitutes

GGBS

Producing cement uses a great deal of energy, so finding a waste product that can substitute for cement makes good environmental sense.

To varying degrees, cement substitutes work in two ways:

- First, they hydrate and cure like portland cement.
- Second they are "pozzolans," providing silica that reacts with hydrated lime, an unwanted by-product of concrete curing.

Pulverised Fuel Ash (PFA), aka 'Fly ash' as a cement substitute.

PFA is a by-product of coal-burning power stations. As part of the combustion process, coal is pulverised into a powder before being burned. About 18% of the fuel forms fine glass spheres, about 75% of which rise with the flue gases from the combustion. The 'ash' is recovered from the gases and used, amongst other functions, as a cement substitute.

PFA is always used in conjunction with Portland Cement. It is employed in ratios ranging from 80% Pc and 20% PFA – 60% Pc and 40% PFA according to the ultimate function of the cement. PFA can't be used completely as a substitute for cement, because it relies on the water and lime from the cement to hydrate as part of the overall chemical reaction.

In the future, as coal-burning power stations are phased out, PFA will gradually become unavailable.

Ground Granulated Blast-furnace Slag (GGBS) as a cement substitute

GGBS is a by-product of the iron and steel industry. In the blast furnace, slag floats to the top of the iron and removed. GGBS is produced through quenching the molten slag in water and then grinding it into a fine powder.

Chemically it is similar to, but less reactive than, Portland cement (Pc).

When mixed with water it will hydrate in a similar way to Portland cement. It is always used in combination with Portland cement, typically in the range 60% Pc and 40% GGBS - 30% Pc and 70% GGBS, according to the ultimate function of the cement. Very occasionally, it can be found up to a ratio of 90% GGBS and 10% Pc.

Concrete made with GGBS cement sets more slowly than concrete made with ordinary Portland cement, depending on the amount of GGBS in the cement mix, but also continues to gain strength over a longer period leading to improved overall durability and life expectancy.

Silica fume

Silica fume is a by-product from the manufacture of silicon. It is an extremely fine powder (as fine as smoke) and therefore it is used in concrete production in either a densified or slurry form. Due to economic considerations, the use of silica fume is generally limited to high strength concretes or concretes in aggressive environmental conditions. The most commonly used proportion of silica fume in UK - produced combinations is 10% by mass of total cementitious content.

Limestone fines

Limestone fines can be used as a constituent of cement to produce Portland limestone cement. BS 7979 [12] provides additional information on the specification of limestone fines for use with Portland cement. The most commonly used proportions of limestone fines in UK-produced combinations is 6-10% by mass of total cementitious content.

Alternative fuels

The use of alternative fuels not only diverts waste from landfill and saves on the need for fossil fuels, but can reduce the need for raw materials; for example, the use of waste tyres provides a fuel and minimises the need to add iron-oxide to cement due to wire content.

It is important to note that ECO2 of concrete should not be considered or specified in isolation of other sustainability factors such as strength gain.

Ref: https://www.greenspec.co.uk/building-desiogn/concrete-cement-substitutes/ (accessed 15/03/2021)

APPENDIX 8: Precedent in Planning and Technical Terms

'GRAND DESIGNS' - SELF HEATING HOUSE

The Grand Designs self-heating house is the first of its kind in the UK. It's set into a sloping site and covered by several hundred tons of earth. Built by Andrew and Margretta Smith, the house is a lesson in how to make a house unobtrusive in the landscape. But the blanket of soil isn't just about appearance, it is essential to the way the concrete building maintains a comfortable temperature all year round. It acts like a giant storage heater.

Andrew and Margretta moved to his parent's cottage in Buckinghamshire after they passed away. Although this was a decade ago, a self build project had long been the plan. It took the couple three years to get planning permission. Not because of the experimental nature or modern appearance of the house they wanted, but because it's located outside the village's designated building boundary.

The house is covered in turf from the excavated site. Photo: Jefferson Smith

Inter-seasonal heat storage

Andrew has a PhD in low-energy systems and was keen to use an innovative and experimental self heating system. The building is built into an earth bank which, during the summertime, soaks up enough heat to raise the internal temperature through the winter.

'With most homes the walls, roof and floor are insulated to stop warmth escaping. But I want heat to come through the house and also sink into the earth. This means the hundreds of tons of soil will gradually warm up. I think in about two years' time we won't need to heat the house at all,' says Andrew. 'Until then, there's a woodburner with a back boiler, plus a small air-source heat pump. We also have some solar thermal panels for the hot water.'

The timber cladding is western red cedar. Image: Jefferson Smith

The long game

Planners approved the project in May 2018, and the build got underway. Andrew took on the role of project manager. About 60 per cent of the house backs straight into the earth behind it. A courtyard layout brings light to this side of the building. The remaining glazed, rendered and cedar-clad right-angled façade faces the garden. Andrew and Margretta designed their home with help from an architect who refined their ideas and prepared the technical drawings.

The walls are stainless steel formwork, with timber formwork for the roof. These are filled with GGBS concrete made of 60 per cent ground granulated blast furnace slag. This is an industrial byproduct that is more sustainable than standard concrete. A structural engineer vetoed plans for prefabricated panels. He had concerns about weak spots where the panel joints would be under pressure from the weight of the earth.

A courtyard at the centre of the house brings light into the interior. Photo: Jefferson Smith

Sticking to the budget

Switching to an on-site poured concrete used up the contingency, so Andrew had to make sure everything else kept to budget. The couple funded the build using savings and by remortgaging the cottage. Shopping around proved key.

'It opened my eyes to how wildly prices can vary, even for big things like windows which you'd think would be uniform,' says Andrew. With Margretta's job on hold during the pandemic, she was able to get involved on site – rendering the exterior, taping up plasterboard and painting. Andrew estimates that, between them, their efforts saved around £200,000. The final build cost came to just £310,000, which is not bad at all for a house with four bedrooms.

Black floor tiles absorb the sun's warmth, passing it to pipes to the hot water tank. Photo: Jefferson Smith

Natural benefit

With rosy-toned western red cedar cladding and the site's biodiverse turf on top – carefully scalped and put to one side by Andrew – the Grand Designs self heating house feels like a part of nature, even with its mass of glazing.

'There was a muntjac deer on the roof the other day,' says Andrew. 'When Margretta and I were in the living room, we both said it was like being in a bird hide, there were so many birds flying backwards and forwards.'

A paved terrace surrounds the house on two sides. Photo: Jefferson Smith

Reference: https://www.granddesignsmagazine.com/grand-designs-houses/self-heating-house/ (Accessed 15/03/2022)

APPENDIX 9: Photographs

Site centre of the image. Walpole barn can just be seen

Site from Northwest

Corner of Tennis Court / Woodland

Regimented Woodland

Area for access. Walpole Barn to the right

Field to the North

Proposed site. Building runs from centre to right. Tennis court from centre to left

Existing tree line

Proposed site

Proposed wildlife meadow and wildlife bridge in front of Western Wood

Potential to enhance woodland

Existing Access to Site

Thwaite Common right / Proposal site left

Woodland maturing but needs thought to thrive

Potential to create glade with pond to enhance wildlife

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