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Flushing Out Poor Design Implementing a Sustainable Water Strategy for Wishanger House

AECB Conference – July 12th 2013

Nicola Thomas and Cath Hassell

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What is this seminar about?

- This workshop shows the step by step process to redesign a dwelling to really address sustainable water rather than just a tick box exercise.
- It includes designing for sustainable hot water, green roofs, irrigation and pool choice as well as which level of the CSH to meet and whether rainwater or greywater is required.

- Can the current decisions be improved upon to ensure a properly sustainable water strategy rather than merely ticking boxes?

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The Architect

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Site

frensham lane
wishanger lane
Site of Importance for
Nature Conservation
(SINC)
existing ponds
bacon lane
bridleway
smithfield lane
existing site entrance
existing site entrance
line of ownership boundary
churt road
spats lane
N

View of the ponds within the Wishanger Estate

View within the Wishanger Estate

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NATIONAL GUIDANCE

PPS7: SUSTAINABLE DEVELOPMENT IN RURAL AREAS

COUNTRY HOUSES: POLICY GUIDANCE

"Very occasionally the exceptional quality and innovative nature of the design of a proposed isolated house may provide this special justification for granting planning permission. Such a design should be truly outstanding and ground-breaking, for example in its use of materials, methods of construction or its contribution to protecting and enhancing the environment, so helping to raise standards of design more generally in rural areas."

Source: Paragraph 11, PPS7, August 2004.

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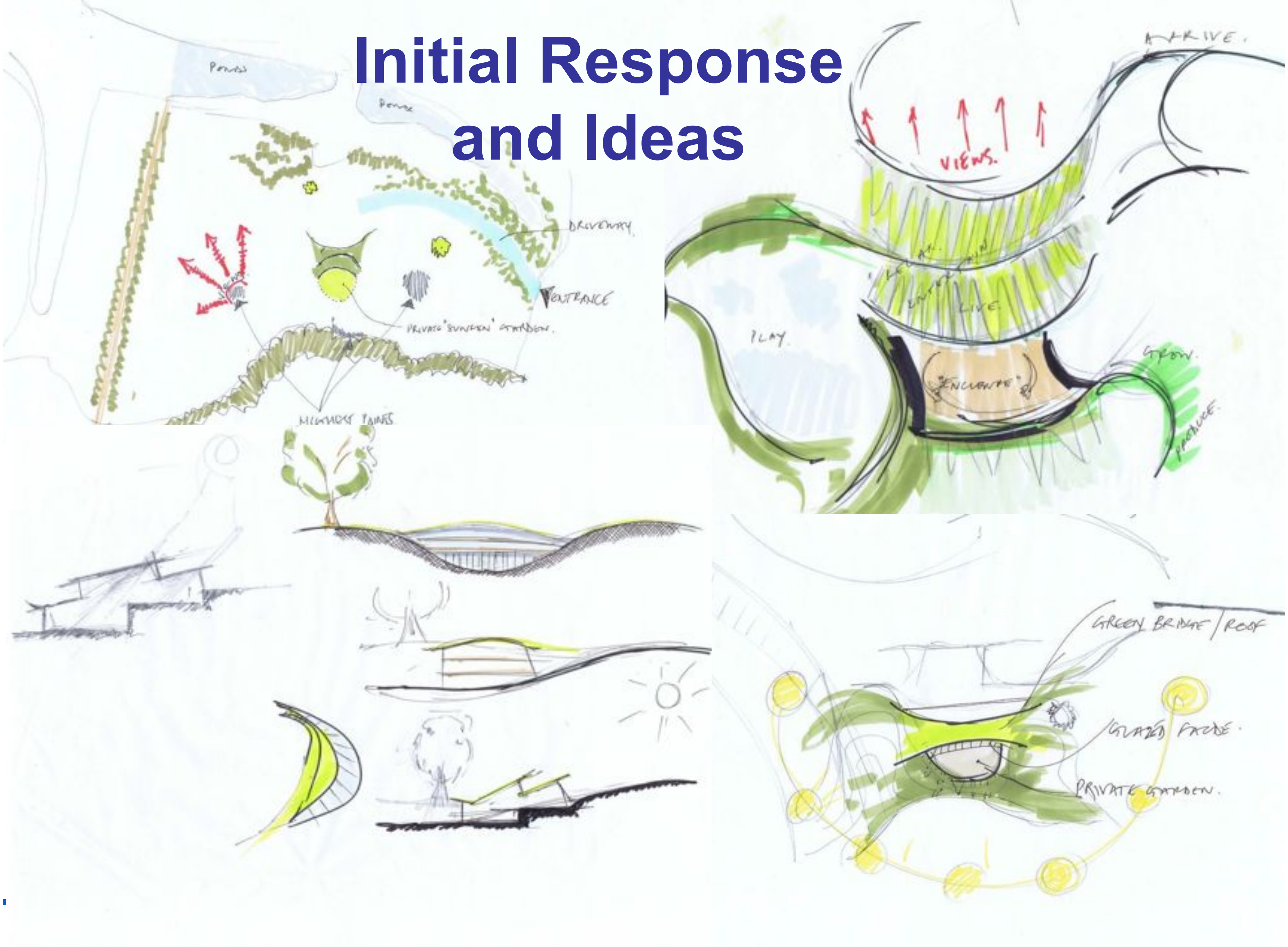
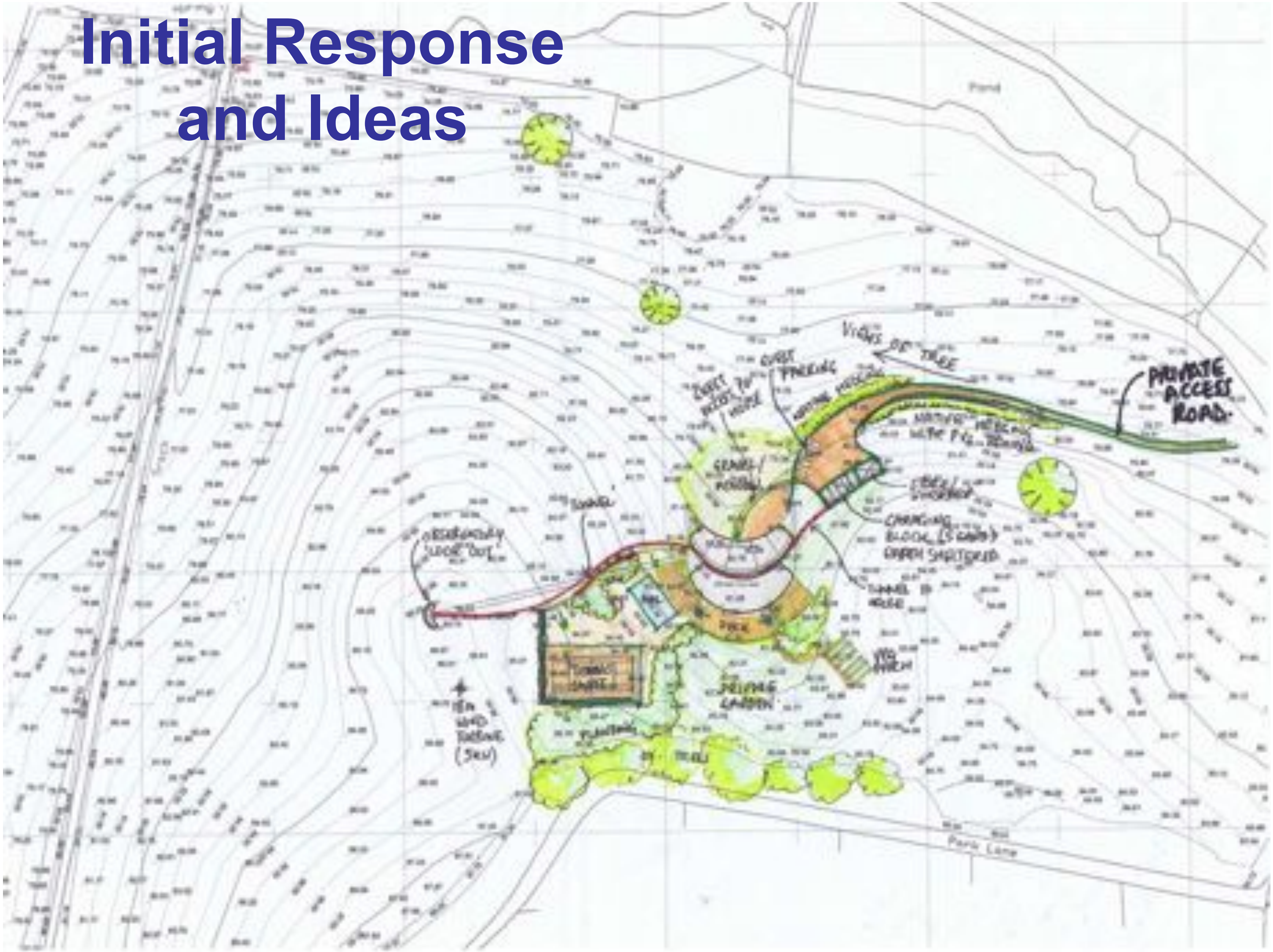
Initial Response and Ideas



Initial Response and Ideas



View from driveway approach

Front Elevation (Viewed from North East)

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Front Elevation (Viewed from North West)

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Aerial View (Viewed from North West)

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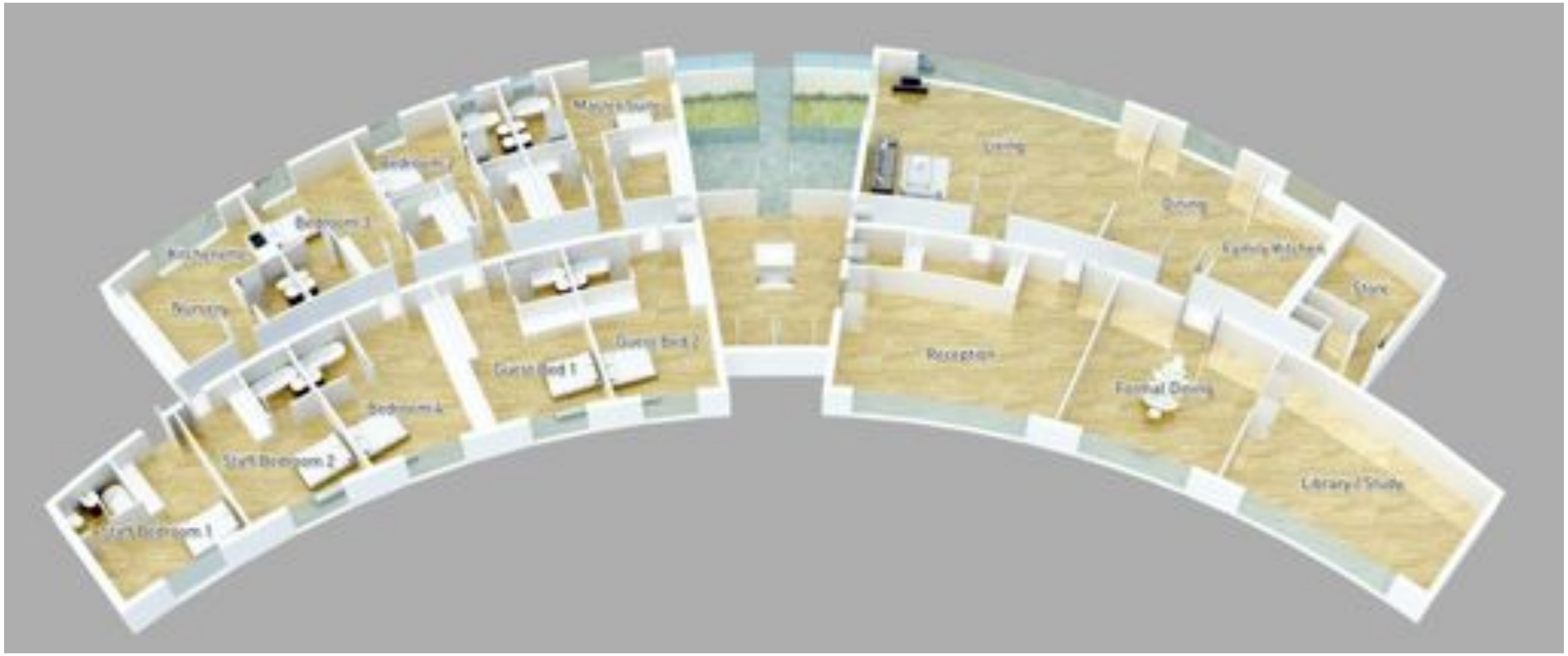
Rear Elevation
(Viewed from South West)

Ground Floor Plan



Lower Ground Floor Plan

Rear Elevation (Viewed from South West)

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Original Water Design

- Our aim was to reach Code for Sustainable Homes (CSH) level 6
- Therefore we asked Phlorum sustainability consultants to provide a CSH pre-assessment to ascertain whether Level 6 was possible.
- As far as water was concerned, their report stated that we should:

1. ‘reduce water consumption by using sensor spray taps and dual flush toilets’
2. ‘review options of rainwater harvesting systems, such as rainwater collection to flush the toilets and provide water to the washing machines’
3. ‘provide waste water treatment using reed beds, constructed wetlands and sustainable drainage systems’

To be honest we hadn’t thought much about water .

Response from the Architects Panel – Sept 2011

The criticism from the Panel was divided into elements of the proposed treatment of the wider site and of the design of the house.

The Wider Site

The Panel wanted to see benefits for the wider community as well as more information with regard to the curtilage, boundaries, access points etc.

Design of the house

We were asked to consider reducing the size of the house.

We were asked to be more selective in targeting energy saving technologies.

We wanted to provide a water use strategy.

We were asked to consider the design issues raised, e.g.. consider omitting the central corridor

We wanted to provide more detail of the structure and construction.

Is the proposal ‘outstanding’? Does it answer the challenge of living sustainably in a large country house?

Development of the scheme
Sept 11 – Dec 11 (i.e. BC – Before Cath!)

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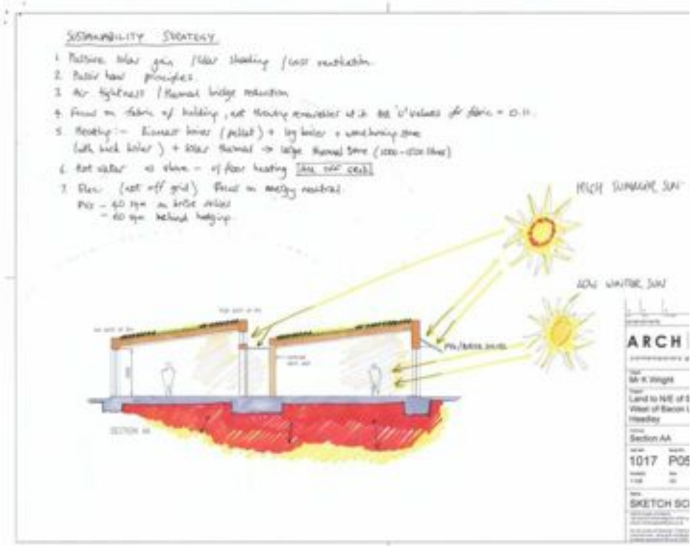

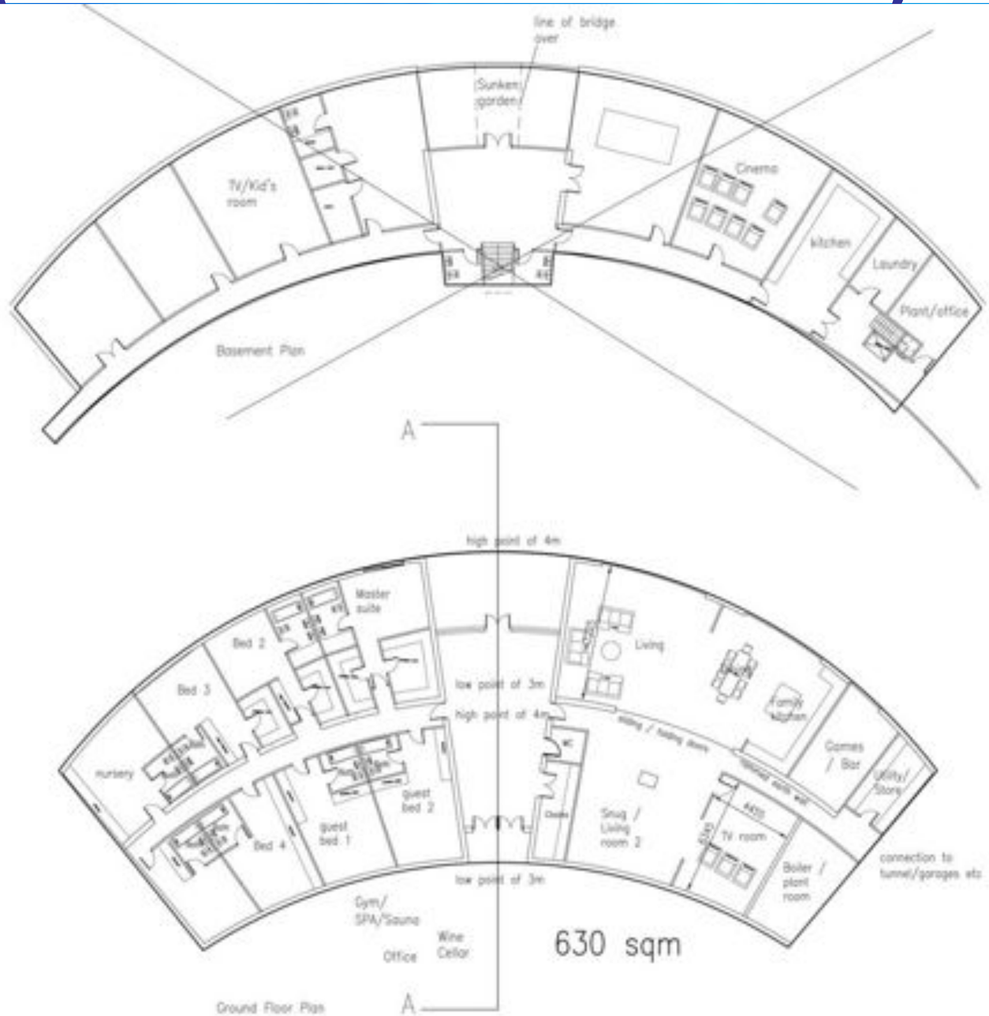

The sustainable water consultant

Overview of a sustainable water strategy

- A sustainable water strategy must address:
  - the supply and use of cold water and hot water
  - how hot water is heated
  - how waste and foul water is treated
  - whether to recycle greywater or harvest rainwater
  - how to dispose of rainwater falling on the building and its curtilage.

- Can the current decisions be improved upon to ensure a properly sustainable water strategy rather than merely ticking boxes?

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Carbon load of water

- A sustainable water strategy also considers the associated energy and carbon emissions associated with using water.
- On average in the UK 1.2 kWh of energy is required to provide 1m^3 of cold water to a building and to take the corresponding foul water away to clean it.
- The carbon footprint of 1m3 of cold water supplied and foul water treated is 1.0kgCO2e

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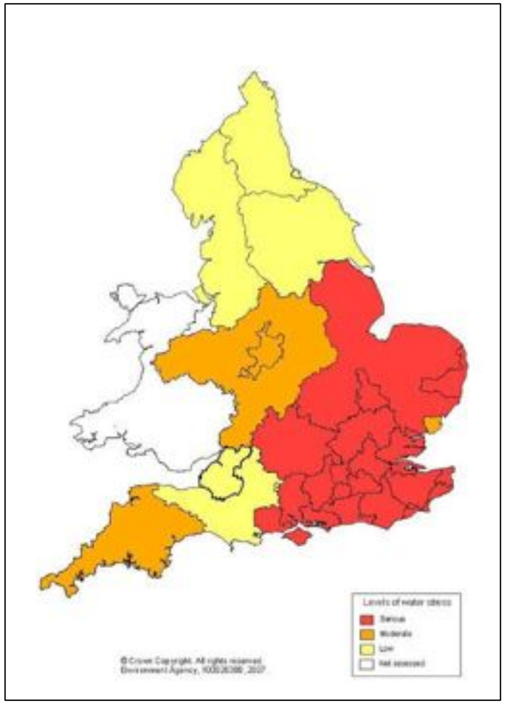
My first thoughts



- Green roof
- Swimming pool
- Large house so high flow rates etc, unlikely to want to meet the Code
- They'll probably want reed beds
- East Hampshire so water stressed area.

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A Tale of Two Plant Rooms

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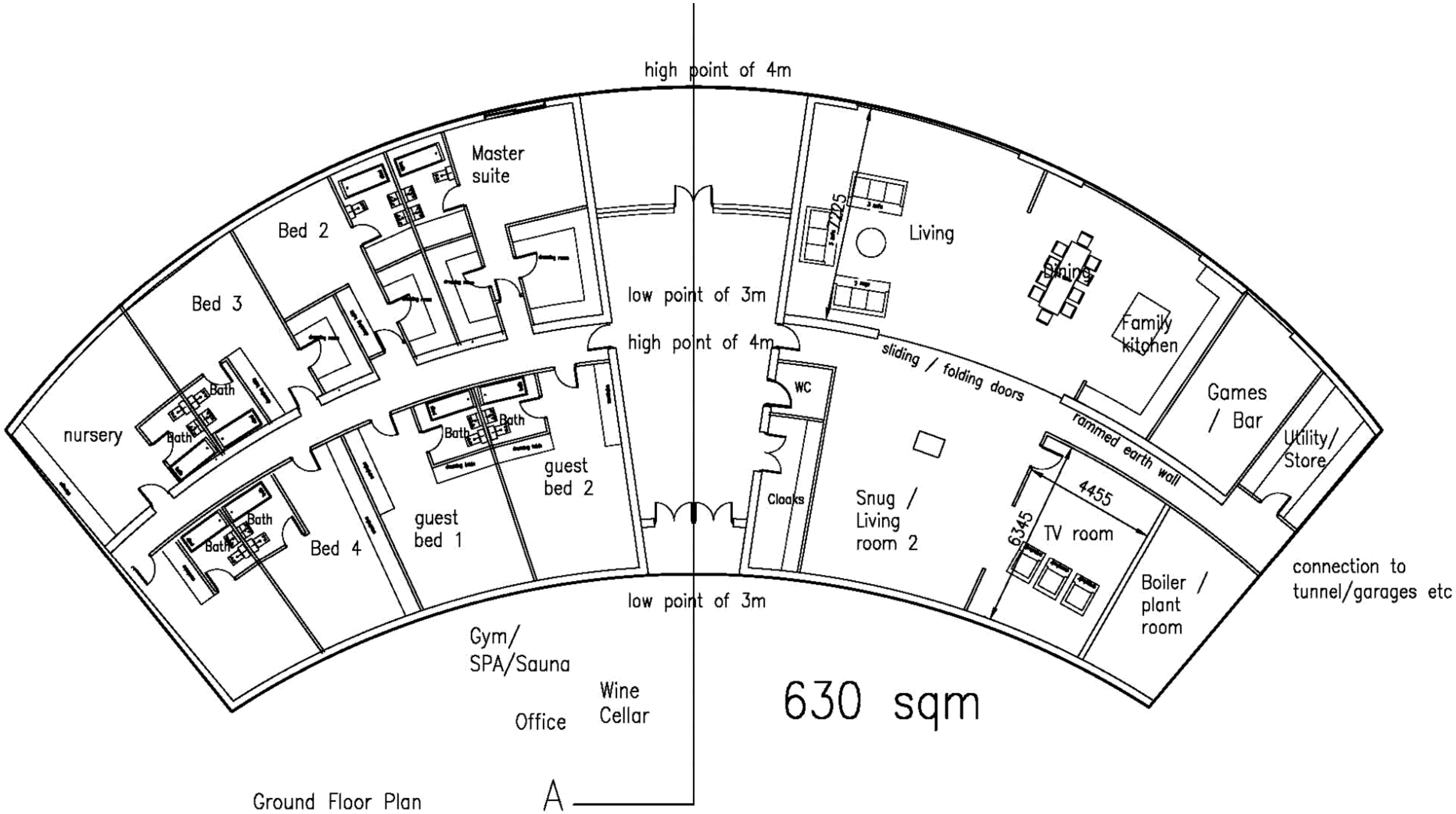
First layout as received by Cath



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A tale of two plant rooms 1

- I assumed there wasn't a rationale for where it was, BUT I was impressed there was a plant room!
- Sited for ease of access for pellet delivery and also access for logs at this point
- I requested plant room to be as near centre as possible to reduce length of secondary returns
- What did this request mean for the architects?

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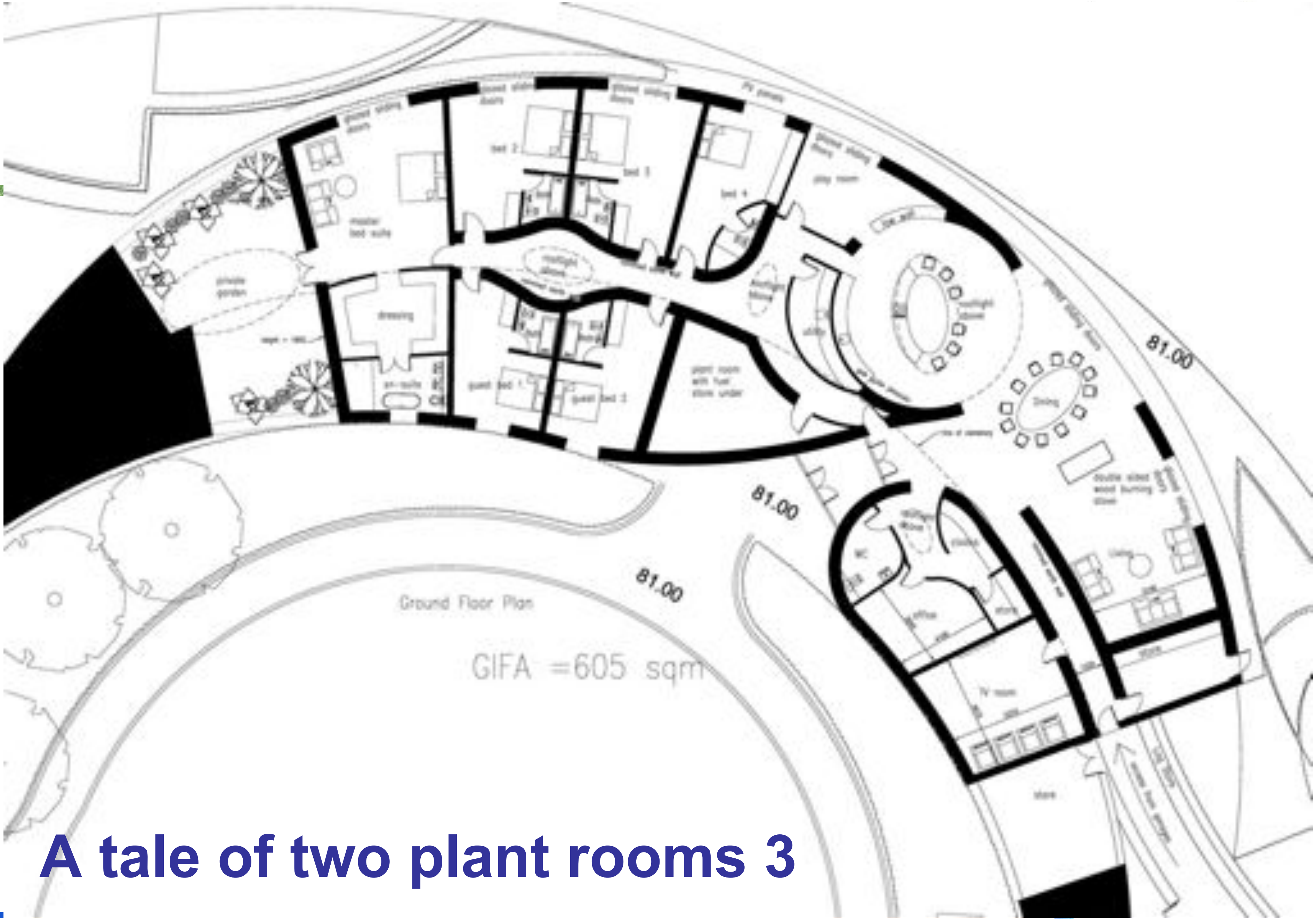
Redesigned layout

A tale of two plant rooms 3



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Secondary return - good design practice

- The Water Regulations require that hot water is available from any hot water outlet within 30 seconds.
- Pumping of the secondary return will be controlled by a timer, a flow switch or presence detector.
- Hot water supply and secondary return pipework will use PEX pre-lagged pipework to ensure as few heat losses (and to reduce heat gains during the summer months) as possible.
- The secondary return pump will be an A class pump (such as the Grundfos Alpha2) to optimise the efficiency of the secondary return and reduce the amount of energy required.

Hot Water

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Hot Water 1

- Function of space heating choice.
- Original plan was a water source heat pump from the ponds - innovative! Could have some solar thermal.
- Then changed to:
- Wishanger House will be heated by a wood pellet boiler with pellets supplied from a local supplier (Harvest Wood Fuels in Farnham)
- There will be a log burner with a back boiler as a focal point in the main living area, fuelled with wood from the estate.

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Hot Water 2

- Can affect footprint by installing solar thermal and reducing flow rates from taps and showers
- Followed AECB water standards
- Pellets will be sourced from within a 30 km boundary but still a resource, so specified solar thermal

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Solar thermal

- 400 litres of stored water in a dual coil unvented hot water cylinder and $8m^2$ of flat plate collector. To optimise solar gain and cover for higher then expected occupancy levels.
- The biomass boiler (as opposed to back boiler on log stove) will be used in the summer as back up heating for the hot water
- It is important to design against electricity being used to heat the water in the summer months; immersion heater will be side entry in top third of the cylinder

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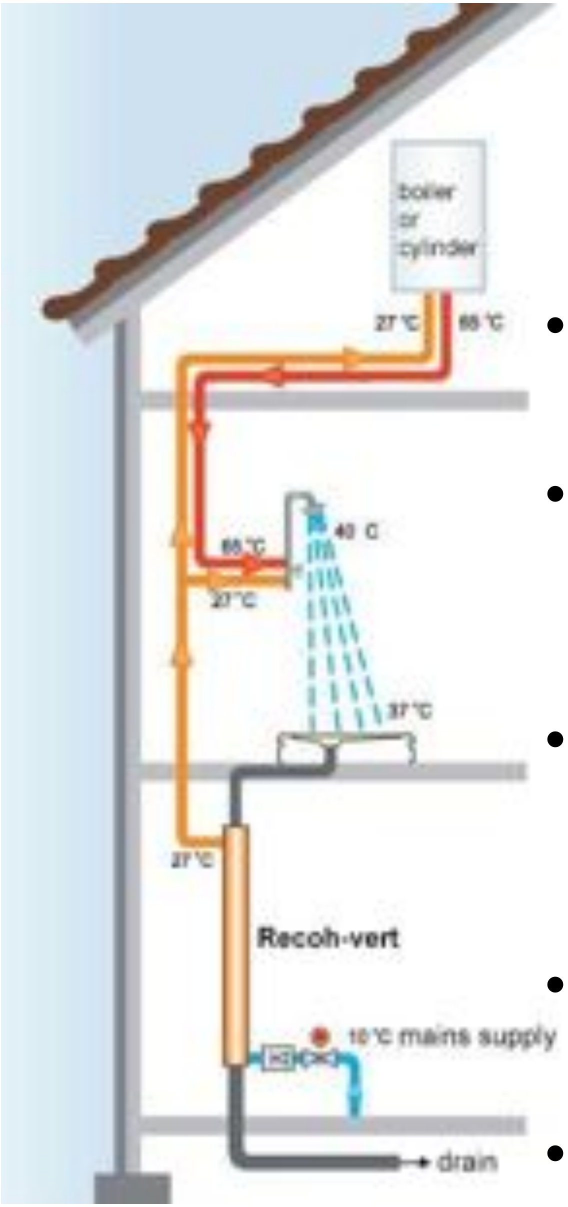
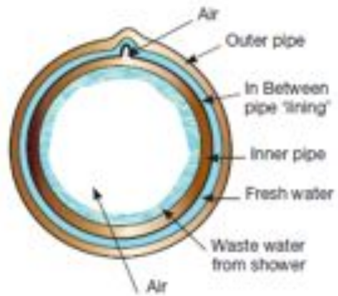


Heat recovery from greywater

- As hot water runs to drain it can be used to heat incoming cold water
- Requires a centralised collection point pre-heating a thermal store or used immediately to pre-heat shower water
- Tests on the Recoh-vert greywater recovery system have shown 62% of waste heat recovered with a flow rate of 7.5l/min
- Single storey layout and no basement precludes its use on this site
- Now available within shower tray



Appliances

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The Code or Part G?

- Original idea to meet Level 5 or 6 of the Code.
- Immediate impact on a sustainable water strategy. To meet it requires rainwater harvesting or greywater recycling and leads to higher specification at showers. Neither are suitable at Wishanger House

- Part G requires an average use per person per day of 125 litres. Compliance shown via the Water Calculator
- Properties with multiple bathrooms can specify excessively high flow rates at showers or extremely large baths. 2 x 300 litre baths across 6 bathrooms!

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AECB Good Practice Standard - Domestic

AECB Good Practice Standard	
Appliance	**Maximum flow rate or flush volume in litres**
WCs	6/4 litres dual flush or 4 .5 litres single flush
Showers	8-10 litres/min
Baths	180 litres max
Basin and bidet taps	4-6 litres/min
Sink taps	6-8 litres/min
Dead legs	< 1.5 litres
Dead legs off secondary circulation	< 0.5 litres
3.5 bar max pressure controlled by PRV. Leak detection shut off device	A water meter inside the building Outdoor taps to be sub metered
Appropriate number of water butts relative to garden size and layout	

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The Specification

Fittings Specification for Wishanger House		
Appliance	Maximum flow rate or flush volume in litres	WPL colour
WCs	4/2.6 litres dual flush	dark green
Showers	12 in master bedroom, 8 in all other showers	yellow and light green
Baths	185 in master bedroom, 170 for all other baths	yellow and light green
Basin and bidet taps	4	dark green
Sink taps	6	dark green
A water softener. Didn't think client would agree to 10 litres/minute shower		

Greywater recycling or rainwater harvesting?

Greywater recycling or rainwater harvesting?

Greywater recycling

- Few options for greywater recycling available on UK market
- Lack of basement would require complicated waste pipes layout

Rainwater harvesting

- Collecting rainwater from a green roof results in discoloured water
- A well designed green roof should limit run off considerably
- Large requirement for water outside so rainwater better utilised there

External Water Use

Natural Swimming Pool

- The one thing we were laid back about!

Natural Swimming Pools

- A swimming area and a planted area - the filtration zone. 15 - 25% of the surface area of the pool.
- No chemicals are required to clean the pool.
- Do not require draining down over the winter
- They use less energy as they are not heated; warmer water is pumped from the regeneration area into the swimming area, while the black material lining the swimming area heats up quickly and retains warmth.
- They provide a habitat for wildlife, within the pond, and birds.
- Reduced maintenance costs.

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Original size of pool at Wishanger House

- Original pool surface area $124m^2$ ($102m^2$ swimming area shallow planted zone $22m^2$).
- If average depth of 1.5m requires $153m^3$ for the swimming area and 4- $6m^3$ for the shallow planted zone.
- $153m^3$ of water is the equivalent of a daily use of 420 litres of water for a whole year.

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Filling the Pool

- Wanted to fill from the fish lakes and top up with rainwater.
- ClearWater natural pool system requires nutrient free first fill and top-up
- Nutrient levels from the ponds will be high (fish feed and fish poo) and the filter system unable to cope with such high levels of nutrients.
- RW top-up from a green roof also too nutrient rich.
- Biotop also requires nutrient free waters

Evaporation from the Pool

- Evaporation, even from an unheated pool, is significant and results in a large requirement for water to top up the pool. (As much as 56% from evaporation)
- The main factors that affect evaporation rates from domestic outdoor pools are: pool surface area, temperature difference between water and air, humidity and wind

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Water lost to evaporation

- Research in Australia has shown that the average daily evaporation rates from an unheated pool based on long term historical evaporation rates are 6.4 mm/day (6.4 litres/m^2/day) for the six hottest months in Melbourne. The same research shows that Perth, in the coldest months, loses 3000 litres a month over a surface area of $42m^2$
- Extrapolating that data to account for UK conditions, with a rate of 3.2mm evaporation a day, 397 litres a day is lost to evaporation. Over four months this would be 49,228 litres ($49m^3$), almost a third of the volume of the pool.

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New pool design

- $45m^2$ for the swimming area. Requires a planting zone of $12m^2$.
- $67.5m^3$ new pond capacity (down from $153m^3$), a reduction of 56%
- Surface area reduces to $57m^2$ from $124m^2$. Evaporation from the pond will now be cut by 54%. Though could still lose $20m^3$/year
- A cover over the swimming area will reduce evaporation losses and improve latent heat conservation. Unlikely to be used during the swimming season (even at night).

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Power requirement for the pump

- A pump is used to circulate the water through a filter to aid cleaning.
- The water is pumped continuously through the filter. The reduced pool design will have a volume of 75-100m^3 and will require a pump drawing 200-300 Watts.
- Assuming the larger volume and therefore greater pumping energy, the pump will require 2,628kWh of electricity a year.
- To provide that much electricity over a year, a 3.1kWp PV array would be required.

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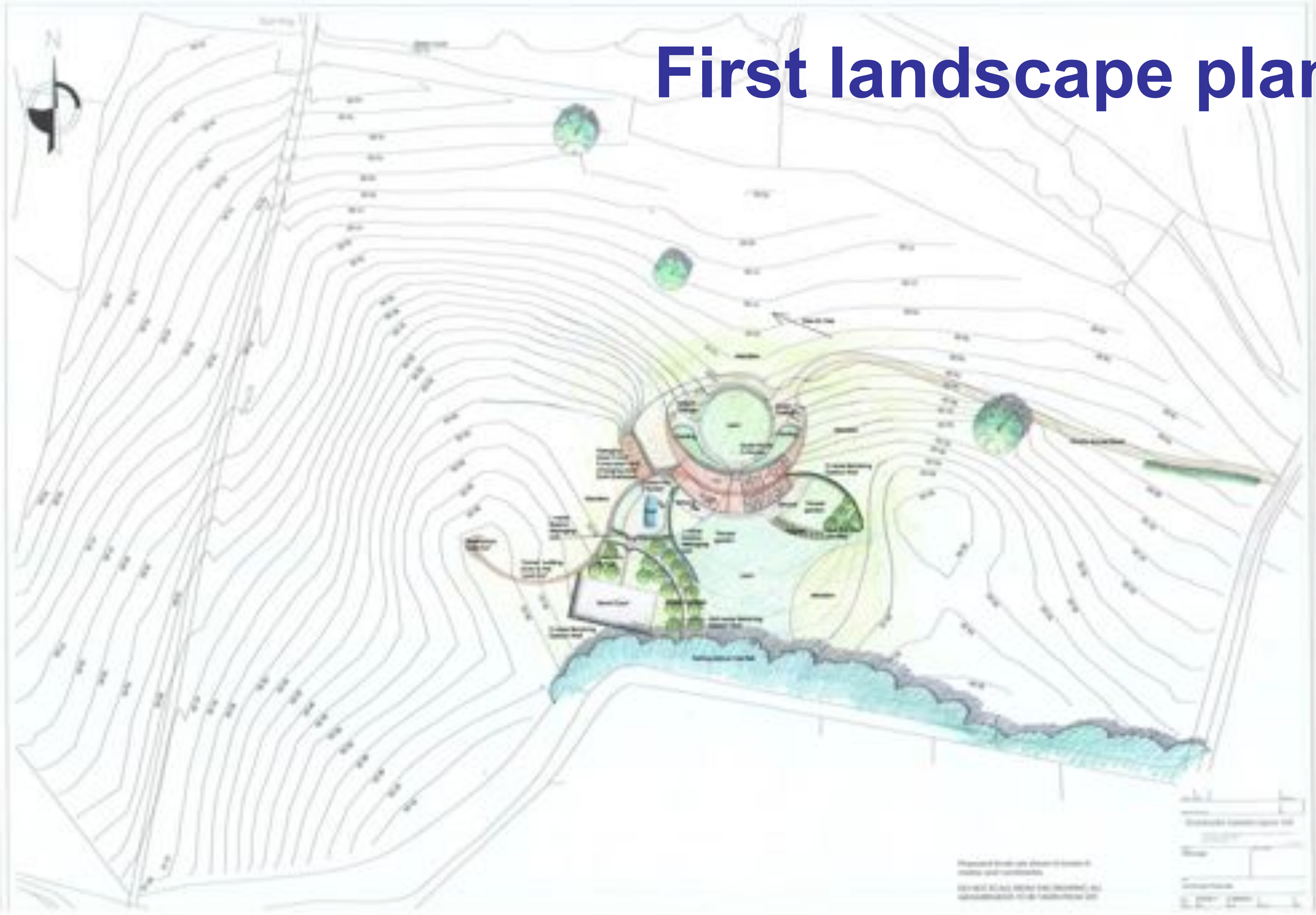
Landscaping

First landscape plan



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Planting at Wishanger House

- Irrigation minimised through planting choices and efficient irrigation.
- 26 acres of grassland allowed to revert to natural meadow.
- 7 acres of woodland will be sustainably managed
- Beds at the front of the house filled with a pictorial meadow mix which does not require watering.
- Formal lawn area at both the front (880m^2) and rear (1125m^2) of the house.
- 26m^2 of raised beds for use as a vegetable plot.
- Series of espalier fruit trees by the vegetable plot and other native trees planted around the house.

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Implementing a sustainable water strategy – ARCHangels and ech_2o

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Implementing a sustainable water strategy – ARCHangels and ech$_2$o

Alliaria petiolata – Garlic Mustard

Allium ursinum – Ramsons

Filipendula ulmaria – Meadowsweet

Betonica officinalis – Betony

Campanula trachelium – Nettle-leaved Bellflower

Digitalis purpurea - Foxglove

Galium album – Hedge Bedstraw

Prunella vulgaris - Selfheal

Primula vulgaris - Primrose

Hyacinthoides non- scripta - Bluebell

Teucrium scorodonia – Wood Sage

Stachys sylvatica – Hedge Woundwort

Silene flos-cuculi – Ragged Robin

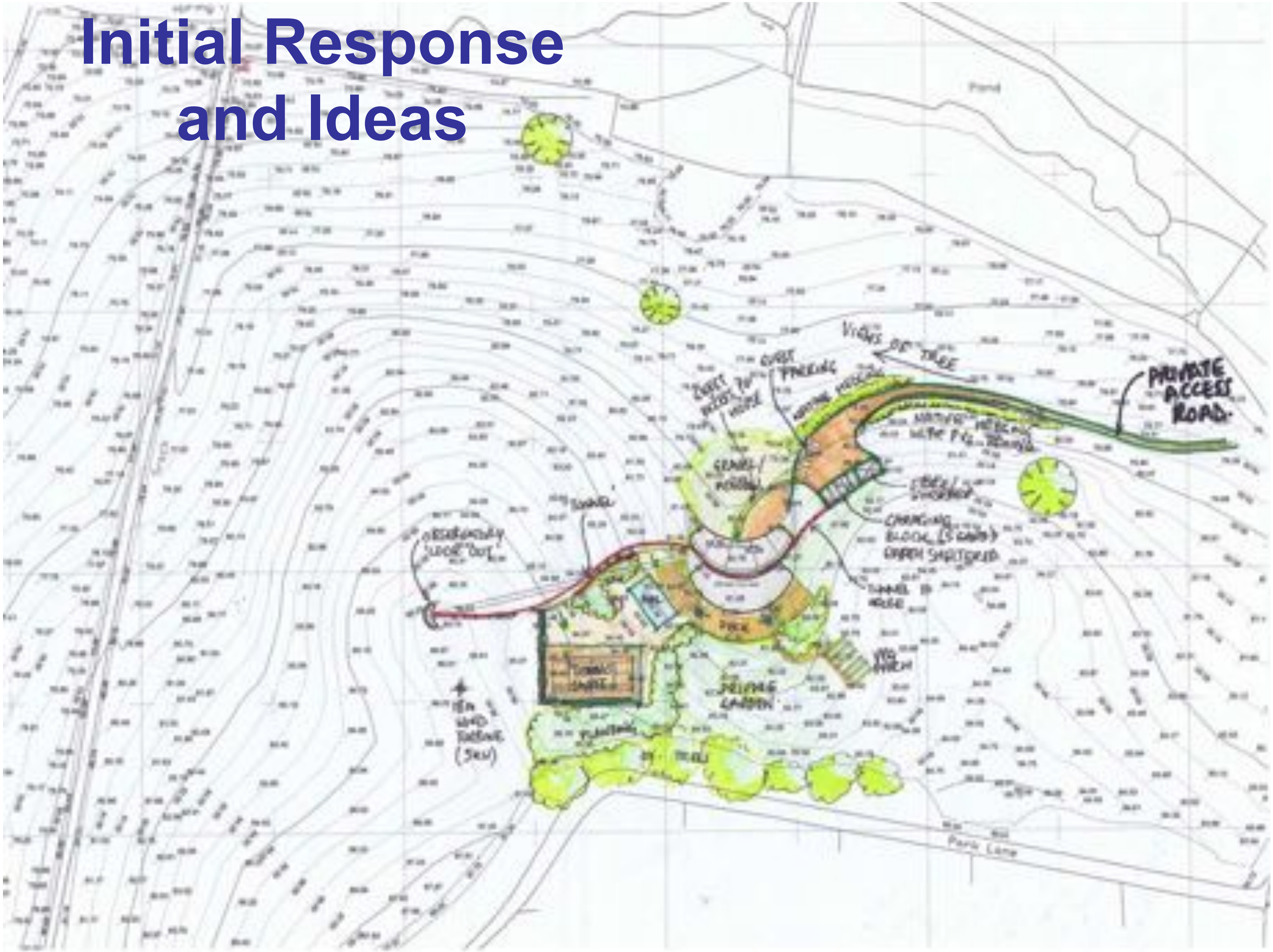
Silene dioica – Red Campion

Public Meadow

This meadow space would be open for public access. 'Land Artists' such as Chris Drury could be invited to the site to make site specific installations from natural materials available on site.

Final landscape plan

Initial Response and Ideas



Irrigation Requirements

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Lawn irrigation

- 2005m^2 of formal lawn area will require watering.
- Watering demand for the lawns will depend on turf type used.
- The irrigation system will be a permanent drip feed irrigation system with timed and soil moisture control - halves the demand for watering
- 45 litres of water per m^2 of lawn area will be required/year, a total of 90m^3.
- Many water companies now allow drip irrigation to continue even when a hose pipe ban is enforced.

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Vegetable plot irrigation

- Water requirement for vegetables varies due to the type of vegetable and when watering is required.
- On average it can be considered that with mixed and crop rotation of vegetables an average of 15 litres/m^2/week throughout the growing season will be required.
- Use drip irrigation system
- Wishanger House requires 390 litres/week, 7,800 litres a year. (8m^3)

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Tree irrigation

- Deciduous trees require soaking once a week for the first three to four years of their lives, while they are establishing. On average this is 25 litres per tree per week, 9,000 litres per year per tree. Assuming that 50% is from direct rainfall each tree will require 4,500 litres of water a year.
- The number of fruit and deciduous trees planted around the house to match available rainwater is 28 trees. ($126m^3$)
- Fish lakes can be used for irrigation for the trees if want to increase this number of trees

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Rainwater Harvesting for irrigation and natural pond

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RWH to meet irrigation requirements

- Rainwater will be collected off the complete roof (630m^2).
- With an average rainfall figure of 800mm a year, a drainage factor of 0.5 from the green roof and a filter efficiency of 90% the average yield per year will be 227m^3 of rainwater.
- There will be 10,000 litres (10m^3) of underground rainwater storage.
- Rainwater from the roof will provide 20,000 (20m^3) of water a year from the underground storage. (10,000 litres at the start of the growing season, with a further 10,000 litres collected during the growing season.)

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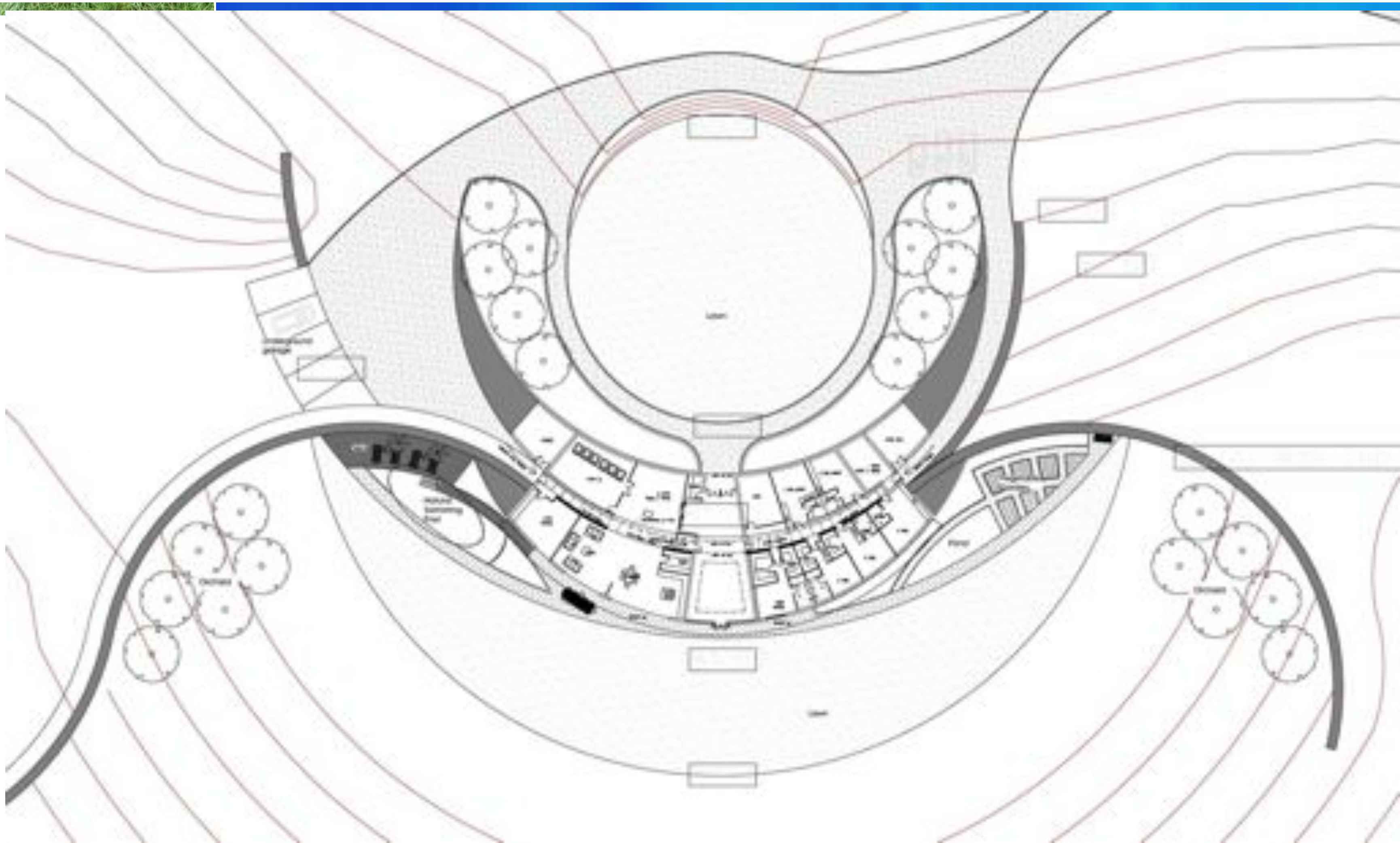
Natural pond

- Overflow from rainwater storage tank will run to a natural pond, sized to have sufficient capacity to meet irrigation requirements
- The level of the pond will rise and fall with the seasons/available rainfall, and any overflow from the pond will drain naturally into the ground via a series of swales.
- A natural pond will increase the biodiversity on the site as well as providing another focal point, and will use the runoff from the roof in the best possible way.
- Natural pond to be sited near the vegetable garden. (?)

Landscape plan with natural pond 1



Landscape plan with natural pond 2

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Dealing with sewage

Reed beds

- Architects categorically did not want reed beds – because?
- Great, go with septic tank and leach field - the best environmental option of treating sewage if ground conditions allow
- Requires suitable soil, a fall on the land and 50m from a well or borehole

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Septic tank and leachfield

- The soil characteristics on this site are sand and gravel (hoggin) over chalk.
- EA confirms the site is not in a Zone 1 ground water protection zone and they are satisfied there is no risk to any underground drinking water sources
- East Hants Council want to be sure that there is no possibility of effluent leaching into the ponds, and that any solution works to 2050 and beyond.
- There are no properties downwind of the property for over 500 metres and the boundary of the site is 150 metres from the proposed site of the septic tank
- Septic tank sized at 3,440 litres (occupancy of 8)

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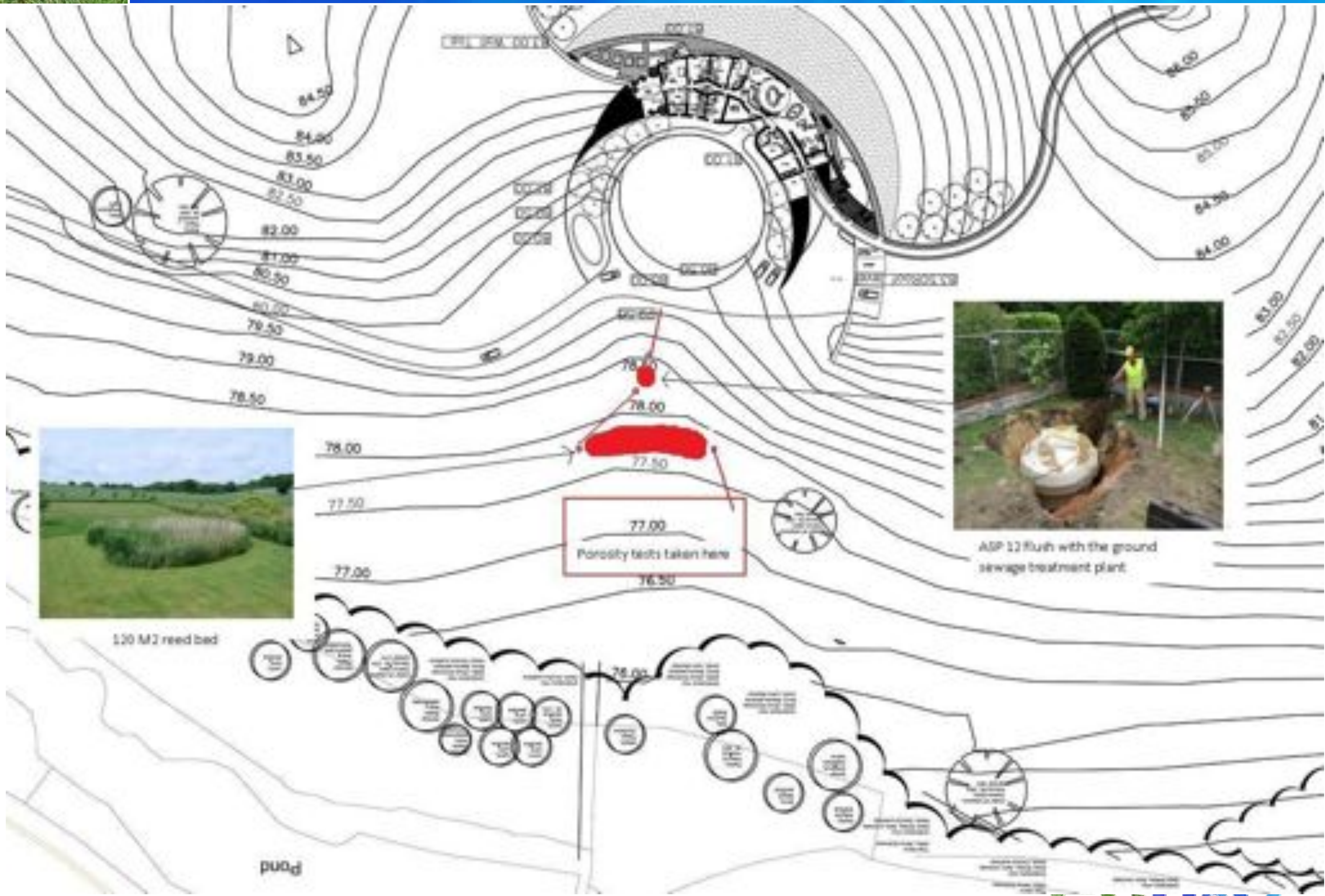
And the final design was???



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Solutions from ech$_2$o - water

- Identification of best water efficiency solutions and CSH solutions.
- Feasibility studies and design guidance for rainwater or greywater (new build or retrofit).
- Identification of most effective SUDS solutions for existing buildings including green roofs.
- Water audits of existing buildings – residential, commercial, educational and public.
- Work with stakeholders to change behaviour around water use.

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ech$_2$o consultants ltd work with a range of stakeholders to successfully incorporate sustainable water and low carbon solutions into the built environment.