MEP SERVICES
STAGE 2 REPORT

ASTON HALL BARNS

ON BEHALF OF

Giles Quarme Architects

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Prepared By	CH/AY
Checked By	KG

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EXECUTIVE SUMMARY

This Stage 2 design report provides an outline scope of works and design criteria proposals for the mechanical, electrical and public health works at Aston Hall and various outbuildings including utilities and sustainability. It establishes the design strategy and fundamentals for the MEP related installations and summarises the design work carried out to date. This report also identifies the fundamentals on which the design has been based and sets out the design work to be carried out in conjunction with the rest of the design team during the next stage of the design (Stage 3).

1.1 MECHANICAL

Severn Trent have been contacted and are in the process of providing a quotation for a new water supply to serve the proposed development including swimming pool. It is proposed that a single supply will be provided which will feed cold water storage tanks and booster sets in the new plantrooms (pool A/C and Barn D) where pressurised water supplies will be distributed to the various buildings that form part of the project.

In conjunction with the rest of the design team comprehensive strategies for the servicing of the heating, cooling, ventilation, domestic water and drainage requirements have been developed. Several options have been considered and assessed and the proposed systems included in this report aim to provide the optimum solutions for the development with regards to compliance, environmental performance, architectural design intent, suitability for the application, practicality and budget.

1.2 SUSTAINABILITY

During Stage 2 an Energy Feasibility study was produced and submitted as part of the Pre-App to address the local planning authority's key sustainability issues and to support the proposed planning application. Within this report, the optimal strategy to enhance sustainability and maximise carbon emissions savings was developed and included i) the use of ground source heat pumps to provide the space heating and domestic hot water requirements for the various buildings and ii) a PV array and battery installation to generate and store electricity.

This report can be found in Appendix B.

1.3 ELECTRICAL

Western Power have been contacted and an application has been made to upgrade the incoming supply at Aston Hall. This involves the removal of the existing three phase supply (Aston Hall), the upgrade of the existing pole mounted transformer and the provision of a new upgraded three phase supply. The new supply will be sized to serve the entire site and will terminate in the newly formed electrical room in Barn E . From here it will be distributed to the different buildings.

In conjunction with the rest of the team, an outline strategy for the electrical LV distribution, small power, lighting, data and fire alarms have been developed. The proposals will be developed further during the design stage in line with the architectural and interior design and the client's requirements.

2 INTRODUCTION

The site consists of Aston Hall and a number of ancillary accommodation and outbuildings:

- Aston Hall
- Barns
- Coach House
- New Pool Barn and Link Building

The proposed project involves the following:

- Construction of a new pool building in traditional barn form with an adjoining link to the existing barn buildings.
- Limited conversion of the existing Barns into ancillary areas (gym, changing rooms, WCs, showers, relaxation areas, offices etc.).
- Repair of existing Barns
- Upgrade to Aston Hall MEP services to accommodate the proposed scheme.
- Refurbishment of the existing Coach House

The report sets out the outline scope of works and design criteria proposals for the mechanical, electrical and public health works at Aston Hall.

The aim of the report is to develop and confirm the Client's brief, record the basis of the design, provide information to the Local Planning Authority and the other members of the design team and to form the basis of the design for the MEP services specification and drawings. It is also used to identify key assumptions, design development requirements, compliance with sustainability, planning and budget targets, design risks and client decisions for the project.

The document is divided into a description of the brief, design criteria, sustainability and environmental considerations, updated on utilities strategies and quotations, outline scope of works for the MEP services and appendices including supporting reports (Energy Feasibility study) and indicative layouts of the proposed systems and equipment.

Following the review and comment on this report and the supporting documentation by the rest of the design team, Client and Local Planning Authority we expect to arrive at a final approved Stage 2 design scheme which will form the basis of the Tender Stage 3 design.

3 DESIGN BRIEF & SCOPE

For Stages 0-2 Planning and Concept Design, the A Plus Consulting brief includes the following activities:

- Provide the necessary input on issues relating to Mechanical, Electrical & Public Health (MEP) services and energy issues to the formal submission of a planning application to Shropshire District Council.
- Develop the MEP services proposals to sufficient level for inclusion in the planning application.
- Produce single line drawings of the main plant areas and distribution routes to assist in the overall co-ordination and planning application submission
- Develop the MEP Services Strategy for the entire scheme and produce a Stage 2 Report document which will:
  1. Provide an outline scope for the mechanical and electrical element of the works
  2. Provide information for other members of the design team
  3. Form the basis for the MEP services detailed design
  4. Inform the cost consultant's budget estimates

3.1 DESIGN CRITERIA

The MEP services for the proposed scheme will be designed and installed to achieve the design criteria set out below and will be in accordance with the recommendations of the following:

1. Giles Quarme Architects RIBA Stage 2 report
2. CIBSE and SLL Guides
3. Statutory undertakings
4. Health and Safety Executive (HSE) Guidance and all relevant legislation
5. CDM regulations
6. Pressure system safety regulations
7. Relevant British Standards

3.1.1 EXTERNAL AMBIENT

Summer – 29°C dry bulb / 20°C wet bulb
Winter – -4°C saturated
External design conditions for thermal load calculations and plant sizing will be determined in accordance with CBSE Guide, Section A2, Weather and Solar Data.

External plant to be suitable for operation in external ambient conditions of 35°C dry bulb 50% RH. Humidity can be expected to be in the range of 30% to 70% except in the pool building where it will be maintained at 60-65% RH or in bathrooms and wet rooms where it will approach 100% at times.

3.1.2 INTERNAL CONDITIONS

Room	Winter	Summer
Bedrooms	21°C ±2°C	Uncontrolled Note 1
Bathrooms	23°C ±2°C	Uncontrolled Note 1
Corridors & Stairs	18°C ±2°C	Uncontrolled Note 1
Kitchen	19°C ±2°C	Uncontrolled Note 1
Dining Room	21°C ±2°C	Uncontrolled Note 1
Changing Rooms	21°C ±2°C	Uncontrolled Note 1
WCs and Showers	20°C ±2°C	Uncontrolled Note 1
Offices	22°C ±2°C	23°C ±2°C
Gym	16°C	16°C
Meeting Rooms	22°C ±2°C	23°C ±2°C
Storage/ Plantrooms	15°C ±2°C	Uncontrolled Note 1
Halls/Lobbies	19°C ±2°C	Uncontrolled Note 1
Swimming Pool	+1°C above pool water temp	+1°C above pool water temp

Notes

1. The upper temperatures in summer will not be controlled. However, an overheating assessment will be carried out and if a risk of overheating is a significant risk, mechanical cooling will be considered.

3.1.3 VENTILATION

The following typical extract ventilation rates are proposed in accordance with Building Regulations Approved Document F:

Room	Ventilation Rate
Bedrooms	Natural Ventilation
Bathrooms	Minimum 15 l/s intermittent extract
Corridors & Stairs	Natural Ventilation
Kitchen	Dedicated extract hood to suit new kitchen cooking requirements – subject to specialist input (minimum 60 l/s extract)
WCs and Showers	8 air changes per hour
Dining Rooms / Reception Rooms	Natural Ventilation (Where active fireplaces are present combustion makeup air will be required)

Gym	10 l/s/person
Changing Rooms	8 air changes per hour
Offices/meeting rooms	10 l/s/person
Store/Plantrooms	To suit equipment/ activities (minimum 30 l/s extract)
Swimming Pool	10 air changes per hour

3.1.4 LIGHTING

The design illuminance levels refer to the levels required as an average value and generally exclude a perimeter zone of 0.5m within each space.

The following table provides an overview of the lighting levels to be provided at finished floor level, unless indicated otherwise.

Area	Average Maintained Illuminance Levels (lux)
Office/Meeting Room	300
Dining Room	200
Kitchen	300 (General) 500 (Countertop)
Bedrooms	100-300 (General) 500 (Task)
Gym	300-500
Playroom	200-300
Swimming Pool	300-500
Changing Room	150
Corridors	100
Utility Room	200
Bathrooms	300 (General) 300-700 (Shave/Makeup)
Landing/Staircases	150
Plant Room	200
Store Rooms	100
Workshops	800

3.1.5 THERMAL PERFORMANCE OF BUILDING STRUCTURES

The values for the thermal performance of the various buildings' elements will be established and confirmed during the next stage of the design. These will be used for the detailed thermal calculations to determine the predicted heat losses and heat gains and appropriate sizing of all new equipment and plant.

4 PLANNING POLICIES & STANDARDS

All relevant legislation, regulations, standards, guidance and good practice should be adhered to. This includes the following:

- Current Building Regulations and Approved Documents
- South Shropshire District Council Policies
- HM Government – Domestic Building Services Compliance Guide, 2013 Edition
- B&ES (formally HVCA) Publications
- Chartered Institute of Building Services Engineers design (CIBSE) guides and commissioning codes
- BSRIA Best Practice Guidelines
- Health and Safety at Work Act
- CDM regulations
- Specific Requirements of the Local Building Control and Fire Officer
- The Institute of Plumbing and Heating Engineers – Plumbing Engineering Services Design Guide
- 2014 EU fluorinated greenhouse gas (F gas) regulation
- CIBSE TM13 Minimising the risk of Legionnaires Disease
- HSE ACoP L8 for the control of Legionella Bacteria
- Water Authority Bye-Laws
- The Water Supply (Water Fittings) Regulations 1999
- British Standard Codes of Practice for materials, equipment and workmanship
- Manufacturers requirements and recommendations for installation, testing and commissioning
- HSE - Safety in the installation and use of gas systems and appliances. Gas Safety (Installation and Use) Regulations 1998. Approved Code of Practice and guidance
- Pressure Systems Regulations
- HVAC Guide to good practice for site pressure testing of pipework.
- BS 7671:2018 - IEE Wiring Regulations (18th Edition) including latest amendments
- The Electrical Utility Company Guidelines
- Electricity Safety Quality and Continuity Regulations 2002
- NJUG guidelines on the positioning and colour coding of underground utilities' apparatus
- GSPHA – GSHVBS Vertical Borehole Standard

5 SUSTAINABILITY

A feasibility study was undertaken at the start of the project, identifying options for the MEP services which included renewable and low/zero carbon technologies and it was determined by the client that the preferred option was to provide space and water heating by ground source heat pumps, whilst a combination of PV array and batteries will provide on site generated electricity and storage.

An initial assessment was undertaken to predict the heat loss for the various buildings. We have estimated the energy demands of the existing building based on:

- Rules of thumb for space heating requirements of building of this age.
- Hot water calculated on the basis of the number of occupants in each building, and typical daily consumption figures.
- Electrical consumption based on data for average UK buildings.

The results were used to aid the design of the ground source heat pump and PV solutions. These estimates will be further refined as the project evolves and there will be an opportunity to produce detailed calculations based on thermal modelling and overall load assessments during the design stage.

5.1.1 OVERHEATING ASSESSMENT

A TM59 overheating assessment will be carried out to identifying any areas where a risk of overheating may occur so that an appropriate course of action may be implemented.

6 UTILITIES

The existing site is provided with an incoming water supply and an electricity supply. There is no mains gas connection to the site. The heating and hot water for the Main Hall is currently generated by oil fired boilers with below ground oil storage provided. It is proposed that the existing oil fired boilers will be removed in the future and be replaced with ground source heat pumps and therefore the oil storage and distribution will become redundant and removed from site.

As part of the proposed works, the incoming services will be upgraded and rationalised as outlined in the following sections.

6.1 SEVERN TRENT WATER

The Utilities Desktop Search has indicated a single mains supply at the boundary of the site. The route within the estate is unknown but is believed to follow the main drive. An application will be submitted for the upgrade of the existing water supply to the site, suitably sized for the proposed water demand including new swimming pool.

The upgraded water supply will be routed to the Main Hall, Coach House, swimming pool and GSHP plantrooms where it will serve the cold water storage tanks and boosters for the various uses.

6.2 WESTERN POWER

Western Power have been contacted and an application has been made to upgrade the existing supply and distribution. This involves the disconnection and removal of the existing three phase supply and the provision of an upgraded single three phase supply in an agreed location, to serve the entire site. The works will also involve the upgrade of the existing WPD owned pole mounted transformer feeding the site.

6.3 BT – DATA & COMMUNICATIONS

According to the Utility Desktop search, it appears that the site is currently served by BT overhead lines. No other service provided has been identified from the search. Subject to input/advice from the client, the existing service will be retained.

7 MECHANICAL SERVICES

7.1 HEATING AND COOLING

Heating and cooling in the different buildings on the site will be provided by ground source heat pumps (GSHP). It is currently estimated that a total of 30 bore holes would be required, with each one measuring approximately 150mm in diameter and spaced 10m apart to mitigate interference between the boreholes.

The initial feasibility study (included in Appendix B) explored various technologies and concluded that a GSHP solution with vertical borehole arrays would be the optimum system as there is a considerable area of land available on the site, which means that a borehole (vertical) option could be feasible. The indicative site layouts attached to this report and the Architectural proposals identify potential locations for the boreholes arrays.

A new plantroom area will be created over two levels in existing Barn D. Distribution pipework from the boreholes will run below ground to the new plant room, where dedicated heat pumps, hot water cylinders and buffer tanks will serve the various building. During the next design stages the option of a decentralised approach, consisting of each building having its own GSHP to provide both space heating and domestic hot water, will be further explored in an attempt to reduce distribution and associated losses.

7.1.1 ASTON HALL

Aston Hall is currently heated by oil fired boilers, located in the basement, generating low temperature hot water (LTHW) which serves wall mounted radiators.

It is proposed that the oil-fired boilers will be replaced with GSHPs, located within the existing plantroom, which will provide LTHW to serve the heating systems. A heat interface unit would be installed in the main house. This will allow the heat pump heating temperature to be varied according to the external conditions- offering an element of weather compensation. Supply of the LTHW at a lower temperature during milder weather would significantly increase heat pump efficiency.

The existing radiators and possibly the pipework distribution in the main Hall are likely to need to be upgraded in order to work with the lower water temperatures generated by the GSHP. The use of double panel compact radiators could help minimise the impact on space requirements within the room. A detailed survey of the existing LTHW installation shall be carried out in the next stage of the design to determine the extent of the upgrades required.

Cooling is to be provided as requested by the client. The GSHP selected will be reversible so that it can also provide chilled water which could serve fan coil units concealed within a joinery item or underfloor heating (UFH) installations. This is to be developed in the next stage of design as it will also help replenish the ground thermal output around the boreholes.

7.1.2 SWIMMING POOL BARN AND LINK

The space heating for the swimming pool building will be provided by an air handling unit (AHU), designed to keep the air temperature approximately 1 degree above the pool water temperature. The AHU will incorporate a heating/cooling coil which will be served by a GSHP and will provide the swimming pool area with treated air. As far as cooling and dehumidification is concerned the AHU will be fitted with a compressor able to cover the required loads. The AHU and compressor will be located in the new pool A/C plantroom.

Heating of the pool water will also be provided by the GSHP located within the new plantroom in Barn D, which will serve a dedicated heat exchanger in the pool A/C plantroom.

The addition of a wet UFH system will be provided within the perimeter floor surrounding the pool area. This will increase the comfort conditions of the occupants by elevating the floor temperature creating a feeling of temperature uniformity within the space (mean resultant temperature). This will also be served by the GSHP.

The Link building will be provided with an UFH system. Temperature control will be via local wall mounted thermostats.

7.1.3 BARNS

The existing Barn A, proposed to be converted, is not currently heated.

It is proposed that the newly formed areas within Barn A will be served by the GSHP, buffer vessel and domestic hot water cylinder located within the new plantroom in Barn D. The LTHW pipework will be distributed exposed at high level throughout the existing Barns. UFH systems (electric and wet) will be utilised throughout Barn A.

The Gym areas will also be served by a dedicated split air conditioning system to provide the reduced indoor temperatures anticipated. The condensing unit will be located in the Pool A/C plantroom and refrigerant pipework from the condenser will serve indoor cassette units.

Wall mounted digital thermostats will be provided in each area to control and maintain the temperatures.

7.1.4 COACH HOUSE

The Coach House is currently heated by a dedicated LPG boiler, located in the GF garage, generating low temperature hot water (LTHW) which serves a mixture of wall mounted radiators.

It is proposed that the LPG boiler will be replaced with GSHPs, located within the new plantroom in Barn D, which will provide LTHW to serve the heating system. The LTHW pipework will be distributed through Barn E, below ground and will be installed within a dedicated trench. A heat interface unit will be installed in the Coach House. This will allow the heat pump heating temperature to be varied according to the external conditions- offering an element of weather compensation. Supply of the LTHW at a lower temperature during milder weather would significantly increase heat pump efficiency.

The building will be served by UFH systems that will be split into multiple zones to provide individual temperature control of the zones via local wall mounted thermostats.

7.2 VENTILATION

7.2.1 ASTON HALL

Aston Hall is naturally ventilated by openable windows and natural infiltration (given the age and construction of the building) and it is proposed that this strategy will be retained. The openable windows will also be used for purge ventilation in line with Building Regulations. Purge ventilation is a manually controlled method of ventilating a space rapidly to dilute pollutants and water vapours.

In rooms with fireplaces, combustion make-up air should be supplied via air bricks in the external walls. These will be retained and where fireplaces are being reinstated, new make-up air paths will be provided.

No works, related to the GSHP, are envisaged in the existing bathrooms and kitchen. The existing ventilation systems shall be retained.

7.2.2 SWIMMING POOL BARN AND LINK

The new swimming pool building will be mechanically ventilated by a dedicated AHU which will maintain a set temperature and humidity within the pool building. The AHU will incorporate both fresh air, recirculated air and heat recovery to maximise energy efficiency..

Supply ductwork will be distributed within the pool building at high level with outlets strategically placed to ensure even distribution of air and prevent condensation from occurring on the glazing. Air will be extracted at one end of the pool building.

Due to the intermittent usage of the pool the selected HVAC system should be responsive and fast, without however compromising its energy performance. As such, the new swimming pool area will be heated and ventilated via an all air system.

A new dedicated AHU will be installed, providing heating, cooling, ventilation, heat recovery and dehumidification to maintain a set temperature and humidity within the pool building ensuring comfort to the pool occupants and the best efficiency.

The proposed AHU (Menerga) will be an all-in-one compact solution specifically designed for swimming pools, capable of covering the heating, cooling, ventilation and dehumidification requirements of the pool area ensuring comfortable conditions, and controlling humidity within the space in order to avoid condensation on internal surfaces (walls, glazing, roof). The AHU encompasses a built-in flat plate heat exchanger with a heat recovery efficiency in excess of 85%.

The AHU will be located in the pool AC plant room and will draw and discharge fresh air and exhaust air respectively, through louvered openings at the plant room's walls.

Supply air will be distributed via dedicated ductwork delivering treated air within the pool area via linear diffusers at low level, closer to the glazed side of the building.

The airstream of the diffusers will be directed towards the external glazing in order to ensure condensation does not occur on the glazed façade. Sound attenuators will be fitted at the supply and return ductwork to ensure noise is prevented from reaching the pool area.

Return air will be drawn back to the AHU from within the pool space at high level in order to ensure warm, moist air is captured and treated. The ductwork will run exposed along the swimming pool are and served by dedicated return air diffusers.

The heating, cooling and ventilation (HVAC) controls for the pool area will be local (thermostats), but in case it is required they could be connected to a sub-controller located in the main Hall and/or a smart phone app in order to allow the user to pre-condition the space before occupying it.

It is important that the envelope components (walls, roofs and glazing) selected have the best possible thermal properties in order to minimize operating expenditure and ensure the best possible operation of the HVAC installations, while also improving thermal comfort.

The regular and correct use of a pool cover will substantially reduce the heating requirements of the pool, while at the same time reduce the dehumidification needs (these account for about 80% of the losses in an indoor swimming pool environment) and in turn overall energy consumption. As such the installation of an automatic pool cover is strongly recommended.

Input and co-ordination will be required from the pool specialist in order for the ventilation design to be developed during the next stage.

Dedicated ventilation for the steam room and sauna pods will be provided as an integral part of the units and will be in line with supplier recommendations/guidelines.

7.2.3 BARNS

Each area of the converted Barn A will be provided with a localised ventilation system consisting of a mechanical ventilation heat recovery (MVHR) unit located within the roof space or within a cupboard.

Fresh air will be drawn from, and extracted to, louvres discretely integrated into the facade the building.

The extract air will be drawing from each kitchen area, WC, shower, changing room area, gym and offices be passed through a heat exchanger to temper the incoming fresh air prior to it being discharged to atmosphere.

The treated fresh air will be delivered directly to the habitable spaces, gym and offices.

Ventilation ductwork will be insulated and distributed within the roof void. Ceiling/wall mounted air valves will extract air from, and supply air to, the aforementioned spaces.

The MVHR units will operate continuously to ensure acceptable and consistent air quality is maintained at all times within each area. The MVHRs will be capable of operating at two different settings – normal and boost operation.

Openable windows will also be provided for purge ventilation in line with Building Regulations.

Each kitchen will be provided with a cooker hood that will be ducted to the roof space where they will discharge to atmosphere via a ridge vent or tile vent detail.

The full list of equipment shall be confirmed by the Client in the next stage of the design.

7.2.4 COACH HOUSE

Each area of the Coach House will be provided with a localised ventilation system consisting of an MVHR unit located within the roof space or within a cupboard.

Fresh air will be drawn from, and extracted to, louvres discretely integrated into the facade the building.

The extract air will be drawing from each kitchen area, WC, shower, bathroom and be passed through a heat exchanger to temper the incoming fresh air prior to it being discharged to atmosphere.

The treated fresh air will be delivered directly to the habitable spaces.

Ventilation ductwork will be insulated and distributed within the roof void. Ceiling/wall mounted air valves will extract air from, and supply air to, the aforementioned spaces.

The MVHR units will operate continuously to ensure acceptable and consistent air quality is maintained at all times within each area. The MVHRs will be capable of operating at two different settings – normal and boost operation.

Openable windows will also be provided for purge ventilation in line with Building Regulations.

Each kitchen will be provided with a cooker hood that will be ducted to the roof space where they will discharge to atmosphere via a ridge vent or tile vent detail.

The full list of equipment shall be confirmed by the Client in the next stage of the design.

8 PUBLIC HEALTH SERVICES

8.1 DOMESTIC COLD WATER SERVICES

A cold water storage tank will be provided and suitably sized to serve each of the new and converted buildings on the site. The tanks will be located in the new plantrooms (pool A/C and Barn D).

Each cold water tank will feed a packaged twin pump booster set in a duty / standby arrangement which will serve the multiple buildings by way of distribution pipework.

The incoming cold water supply to each property will be provided with a stop cock on entry into the building. From here pipework will be distributed within walls and ceiling voids to serve the connected appliances. A cold feed will also serve the domestic hot water generation equipment in each building.

8.2 DOMESTIC HOT WATER SERVICES

Domestic hot water (DHW) will be produced locally to each building and will be generated by GSHP. The borehole array will be located in the fields surrounding the site and distribution pipework to the individual GSHPs buried below ground.

8.2.1 ASTON HALL

DHW for Aston Hall is currently generated by two oil fired boilers serving a calorifier.

It is proposed that hot water will be generated by GSHPs serving calorifiers with all equipment located in the existing basement plantroom. Hot water will be distributed throughout the building using the existing pipework installations, no alteration to the connected appliances is currently proposed. The existing pipework will be re-used, subject to testing and validation

8.2.2 SWIMMING POOL BARN AND LINK

The pool water will be heated by way of a plate heat exchanger served by a the GSHP located in the new plantroom in Barn D and pool A/C plantroom. Input will be required from the pool specialist in order for the overall GSHP design to be finalised.

8.2.3 BARNS

It is proposed that the new GSHP will be provided with a dedicated hot water cylinder to generate the DHW requirements locally for the ancillary areas (WCs, showers, sauna/steam pods etc.). The GSHP will be located in the new plant area within Barn D and will be suitably sized to serve the demand.

New DHW distribution will be provided to suit the proposed layouts, based on an exposed and concealed installation within wall cavities and ceiling voids, to serve the connected appliances. Each connection to an appliance will be provided with an isolating valve.

8.2.4 COACH HOUSE

It is proposed that the new GSHP will be provided with a dedicated hot water cylinder to generate the DHW requirements locally for the Coach House . The GSHP will be located in the new plant area within Barn D and will be suitably sized to serve the demand.

New DHW distribution will be provided to suit the proposed layouts, based on an exposed and concealed installation within wall cavities and ceiling voids, to serve the connected appliances. Each connection to an appliance will be provided with an isolating valve.

8.3 FOUL DRAINAGE INSTALLATION

The existing above ground drainage connects into the below ground drainage system that is collected and routed to a septic tank, requiring periodic emptying.

The existing foul drainage connections will be utilised where possible, with any new connections required being provided.

The below ground drainage will be routed to a new sewage treatment plant as detailed in the Structural Engineer's Stage 2 report.

8.4 RAINWATER SYSTEM

The existing rainwater system will be retained and reused. New rainwater provisions will be provided in line with the architectural proposals and connect to the below ground drainage system as detailed in the Structural Engineer's Stage 2 report.

The potential for rainwater harvesting for irrigation purposes should be considered and reviewed during the next stage of the design.

8.5 CAT 5 WATER DISTRIBUTION

A new CAT5 break tank and booster set will be provided in an agreed location for irrigation, refuse wash down and car washing facilities.

9 ELECTRICAL SERVICES

9.1 LOW VOLTAGE DISTRIBUTION

According to the Western Power Distribution (WPD) record information, there is one supply currently serving the site. On the WPD drawings, the supply appears to be located within the main house area.

The existing 100A TPN supply will need to be upgraded to supply the extension and the new plant, solar PV, battery and other M&E equipment.

It is proposed that the incoming electrical supply will be upgraded by providing a new below ground LV cable to serve the site from the local pole mounted transformer. This would be routed into Barn E where the new service head and billing meter will be located. The new cable run should follow the route of existing cable into the site boundary. The cable can then rise up into the Coach House and terminate in Barn E, as indicated in the drawings. The route is subject to the WPD's review and agreement.

A new panel board with sub meters will be provided next to the service head and new sub main supplies will then be distributed to serve the other buildings on the site. All local distribution boards (DB), solar PV, battery system will be metered.

WPD have agreed and provided a budget quote to provide a new supply with import and export limited to 250A three phase cut out with maximum import capacity of 172kVA, maximum export capacity of 150kVA. Both capacities are sufficient for the site consumption and on site generation.

APC will request a revision of the quote previously produced, to reflect the latest scheme and route of the incoming supply.

9.2 SMALL POWER SYSTEMS

9.2.1 ASTON HALL

The condition of the existing electrical wiring of the main Hall is not clear. An Electrical Installation Condition Report (EICR) test shall be carried out to establish the condition and safety of the existing installation. Under the current scope, we assume that this is in good condition, and no additional works will be required. However, we will review the result in the EICR test and advise any additional works. A submain cable will be provided from the main proposed switch board in the open barn to replace the existing service head and meter.

9.2.2 BARN AREA

The Barns will be refurbished or repaired and therefore the small power wiring will be new, with the design and installation in accordance with the latest version of BS 7671. Each area will be fed from their respective RCD protected MCB consumer unit. Small power supplies will comprise of general 13A socket outlets, fused spurs and isolators to serve fixed equipment such as fans, sauna, gym equipment etc. The cabling will be based on either a concealed installation within the building fabric or within an exposed cable containment system.

9.2.3 SWIMMING POOL

The swimming pool building and ancillary areas will be newly constructed and therefore all small power wiring will be new, with the design and installation in accordance with the latest version of BS 7671.

The swimming pool plant room will be provided with metal clad, surface mount sockets and fused connections units. It is proposed that a DB for the swimming pool will be provided locally and served from the panel board in the Barn E.

9.2.4 COACH HOUSE

The Coach House will be refurbished and therefore the small power wiring will be new, with the design and installation in accordance with the latest version of BS 7671. A new consumer unit will be provided. Each area will be fed from their respective RCD protected MCB consumer unit. Small power supplies will comprise of general 13A socket outlets, fused spurs and isolators to serve fixed equipment. The cabling will be based on either a concealed installation within the building fabric or within an exposed cable containment system.

9.2.5 MECHANICAL PLANT

Dedicated DBs for mechanical plant will be provided in the respective plantrooms. Each DB will have their own meter to monitor the energy consumption. All mechanical plant will be provided with local isolators. The cabling to the plant will be either SWA or single cable protected within cable trunking or conduits in the plantroom.

Power supplies will be provided to the GSHP systems and the new waste treatment plant.

9.3 GENERAL LIGHTING SYSTEMS

9.3.1 MAIN HOUSE

Under the current scope, we assume that the existing lighting within the Mian House is in good condition, and no additional works will be required.

9.3.2 BARN AREA

New low energy LED lighting will be provided throughout the barn area, including areas with only repair work taking place. The lighting will be provided to suit the proposed architectural layouts and will generally consist of recessed downlights, wall lights and ceiling mounted pendant fittings. Simple lighting controls will be provided which can include two way switching and manual dimming should this be required.

9.3.3 SWIMMING POOL

New lighting will be provided in line with the architectural layouts and lighting design. Simple lighting controls will be provided which can include two way switching and manual dimming should this be required.

9.3.4 EXTERNAL LIGHTING

New external lighting will be provided in line with the architectural design to accommodate the new drive and landscaping. All cabling will be in SWA.

9.3.5 COACH HOUSE

New low energy LED lighting will be provided to suit the proposed architectural layouts and will generally consist of recessed downlights, wall lights and ceiling mounted pendant fittings. Simple lighting controls will be provided which can include two way switching and manual dimming should this be required.

9.4 FIRE DETECTION AND ALARM SYSTEMS

The fire alarm system for each building will be designed, installed and commissioned by an LPCB LPS 1014 Approved Fire Alarm Specialist throughout the different buildings in compliance with BS 5839 Part 1 and Part 6 to category L2, and LD 2, BS EN 54, BS 5588.

APC will seek advice from Building Control regarding the requirement of a central fire alarm panel. If a central fire alarm panel is required/preferred, the system can be setup to interlink detectors within all buildings to provide the occupants notification of a fire in another building. Each building will have a different zone. The system can be designed to activate all sounders in all buildings if fire has been detected in any building.

Combination detectors will be used in kitchens and other areas of potential dusts to minimise the chances of false alarm. Where other areas shall be provided with smoke detectors.

Alternatively, the client might wish to use “Smart Detectors” e.g. Nest system, and detectors will send notifications to a smart phone.

9.5 COMMUNICATION SYSTEMS

9.5.1 AV AND DATA

The condition of the current broadband connection in the property is not clear. The AV & Data provisions will be designed to suit the client’s requirements, this can include:

- Full Wi-Fi coverage throughout and hardwired data points in the required areas
- TV screens or projector with Sky TV and Sky Sports
- Monitors
- Speakers
- Multimedia controls

During the next stage of the design APC will consult with the client regarding any specific requirements for upgrades or reconfiguration of the existing data installations along with any proposals for the AV provisions.

9.5.2 TV ARRAY

A TV/FM distribution network will be provided to the pool area, Barn A and Coach House. The location of the TV/FM module outlets is to be confirmed by the client. The systems will comprise roof mounted digital/FM receivers serving amplification and distribution equipment with coaxial wiring to the individual TV/FM outlets. The location of the receivers to be agreed with the architect.

9.6 ACCESS CONTROL AND SECURITY SYSTEMS

The access control and security provisions will be designed to suit the client’s requirements. APC will consult with the client and any third-party security consultant regarding specific requirements and will incorporate power supplies and containment provisions in the next stage of the design. The client might wish to consider a new site wide security system including:

- CCTV cameras
- New video intercom for the main gate
- New intruder alarm to the various buildings
- Access control to the various outbuildings

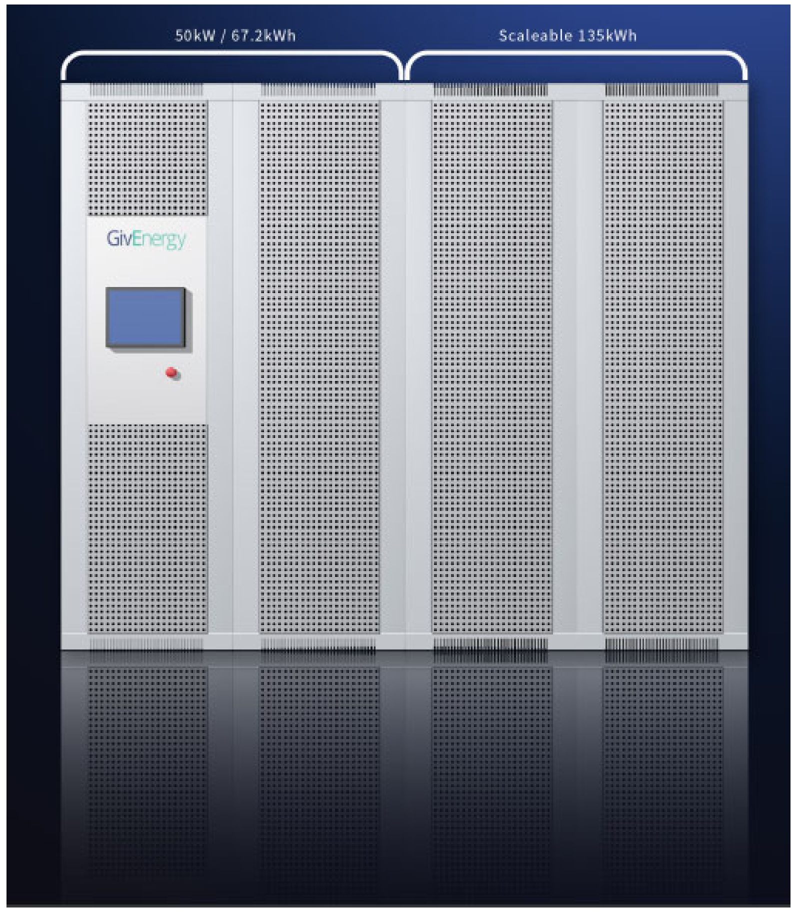
9.7 SOLAR PV AND BATTERY STORAGE SYSTEM

9.7.1 SOLAR PV SYSTEM

A 110kWp free-standing PV system is currently proposed to serve the site. The system will consist of 320 x 345W Monocrystalline solar panels. The panels will be ground-mounted, using ground anchored mounting frames inclined at 25^0 degrees and will be installed as indicated in the drawings.

The current design is based on a single inverter arrangement to convert the DC current generated by the PV panels to three phase AC current. The system will feed directly to the proposed main electrical panel board located within Barn E.

The system is anticipated to produce 101,237 kWh/annum of electricity, which is the equivalent of 52 Tonnes CO_2 saving. The generated electricity will prioritise the site consumption, and charge up the battery. Any surplus electricity will be exported into the grid.



9.7.2 BATTERY BACKUP

A battery storage system will be included to back up the entire site. The battery will be located in Barn E, as indicated in the drawings.

The system consists of 210kWh battery pack to provide a day of the average anticipated electrical demand. The system will utilise an inverter of 138kW. Even though the inverter size is slightly smaller than the size of the service head (172kVA), this should be sufficient to supply the site's demand.

The battery would provide full backup for the electrical systems within the properties in case of grid failure, however, it is primarily designed to store the renewable energy generated by the PV and hence minimise the electricity imported from the grid.

APPENDIX A – MEP DRAWINGS

DRAWINGS AND DOCUMENTS ISSUE SHEET

PROJECT TITLE:	**Aston Hall - Shropshire**	**Job No**	**AP220027**
		Sheet	1 of 1

MEP Services - Drawings	**Day**	09
	Month	09
	Year	21

Document Number	Title	Revision
AP220027-APC-AH-00-SK-M-001	PROPOSED BARN A & LINK BUILDING MECHANICAL SERVICES GROUND FLOOR	P1
AP220027-APC-AH-01-SK-M-002	PROPOSED BARN A & LINK BUILDING MECHANICAL SERVICES FIRST FLOOR	P1
AP220027-APC-AH-00-SK-M-003	PROPOSED BARN E, F, G MECHANICAL SERVICES GROUND FLOOR	P1
AP220027-APC-AH-01-SK-M-004	PROPOSED BARN E, F, G MECHANICAL SERVICES FIRST & SECOND FLOORS	P1
AP220027-APC-AH-00-SK-M-005	GENERAL ARRANGEMENT PROPOSALS - MECHANICAL SERVICES GROUND FLOOR	P1
AP220027-APC-AH-01-SK-M-006	GENERAL ARRANGEMENT PROPOSALS - MECHANICAL SERVICES FIRST FLOOR	P1
AP220027-APC-AH-00-SK-MEP-001	ASTON HALL SITE SERVICES DISTRIBUTION	P1

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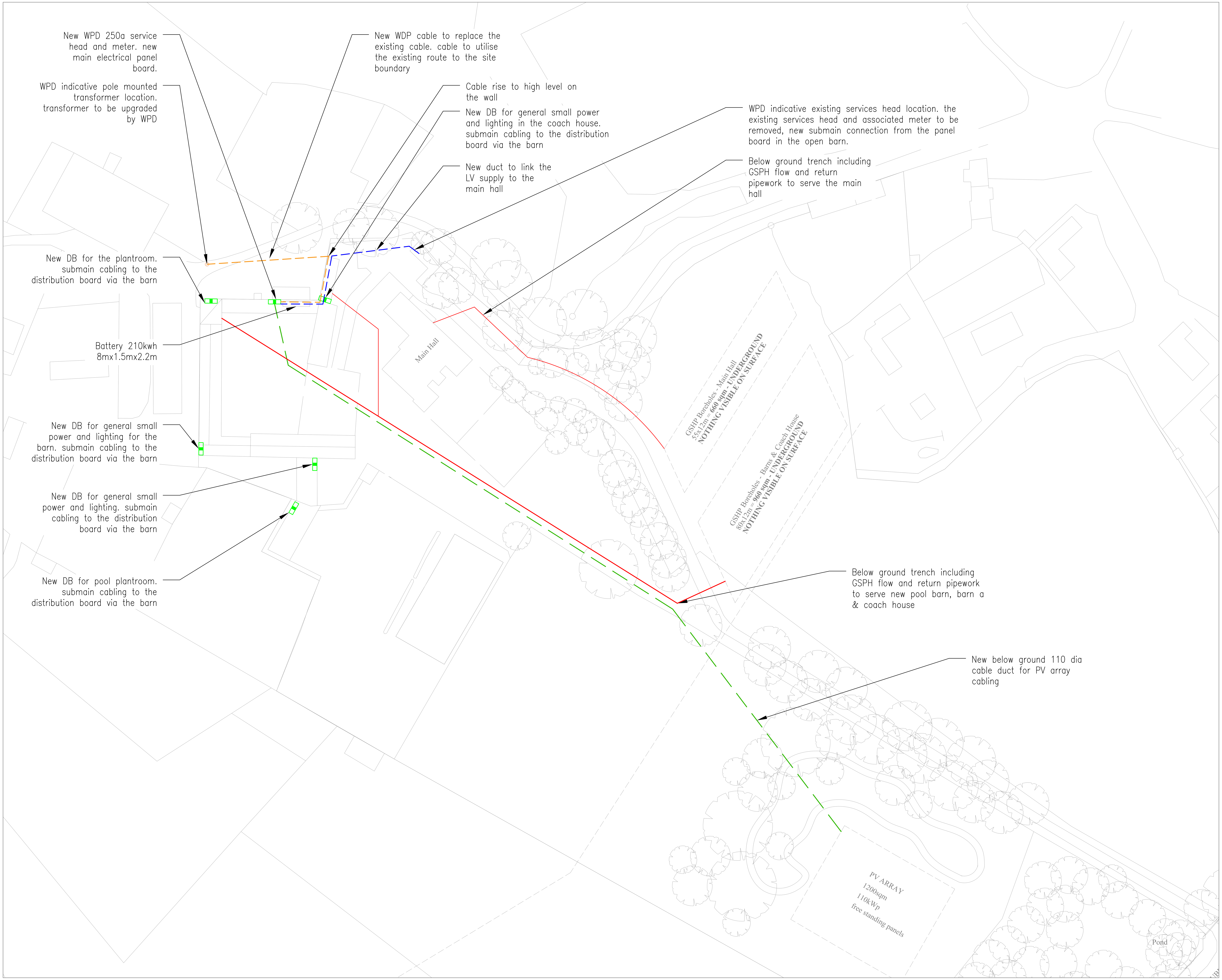

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REV	DATE	DESCRIPTION
P1	09.09.2021	STAGE 2 – PLANNING

PROJECT : ASTON HALL BARNS

CLIENT : GILES QUARME ARCHITECTS

REFERENCE : AP220027-APC-AH-00-SK-MEP-001

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ASTON HALL SITE SERVICES DISTRIBUTION

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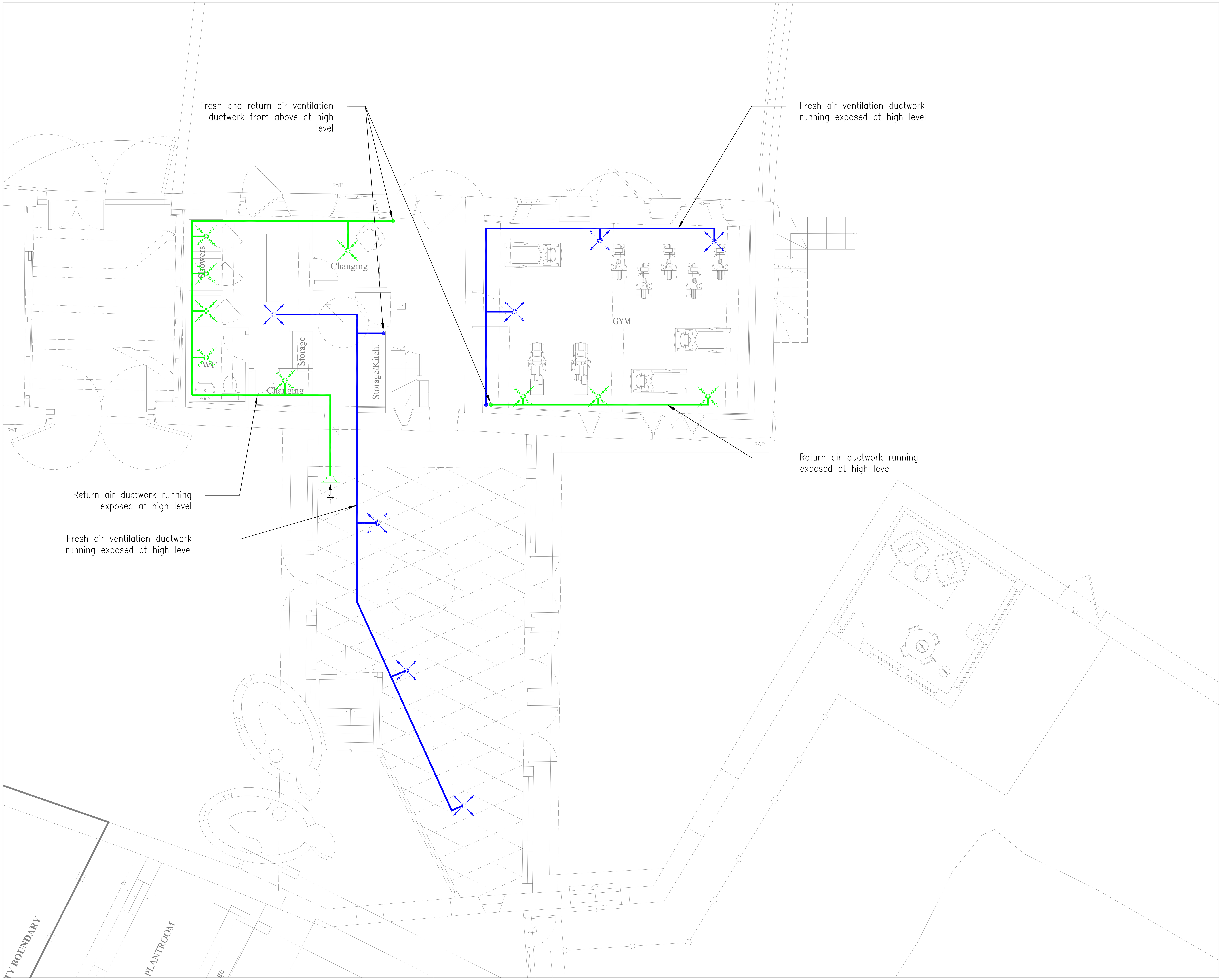

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PROJECT : ASTON HALL BARNS

CLIENT : GILES QUARME ARCHITECTS

REFERENCE : AP220027-APC-AH-00-SK-M-001

PROPOSED BARN A & LINK BUILDING MECHANICAL SERVICES GROUND FLOOR

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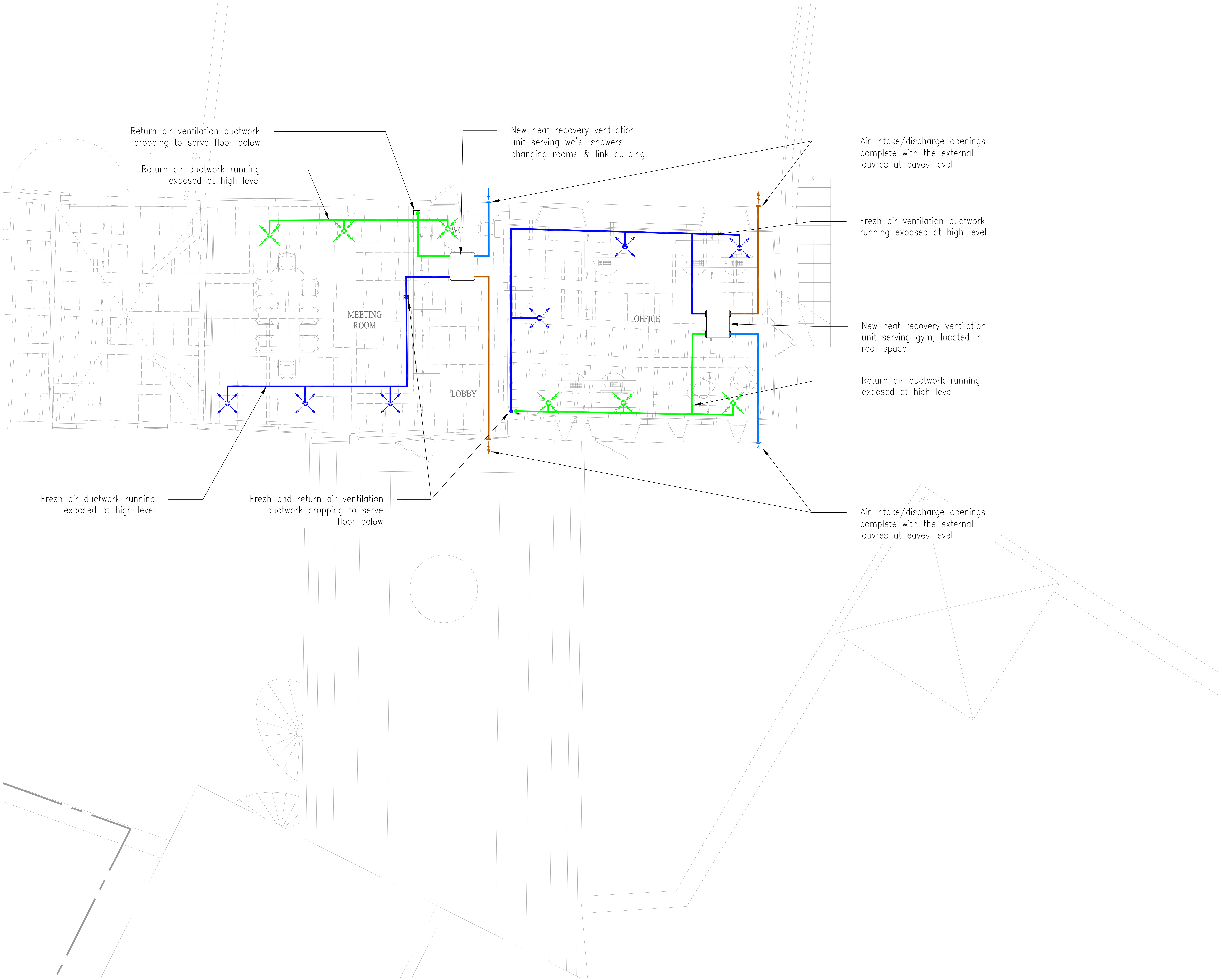

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PROJECT : ASTON HALL BARNS

CLIENT : GILLIES QUARME ARCHITECTS

REFERENCE : AP220027-APC-AH-01-SK-M-002

PROPOSED BARN A & LINK BUILDING MECHANICAL SERVICES FIRST FLOOR

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PROPOSED BARN E, F, G MECHANICAL SERVICES GROUND FLOOR

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REFERENCE : AP220027-APC-AH-01-SK-M-004

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PROPOSED BARN E, F, G MECHANICAL SERVICES FIRST & SECOND FLOORS

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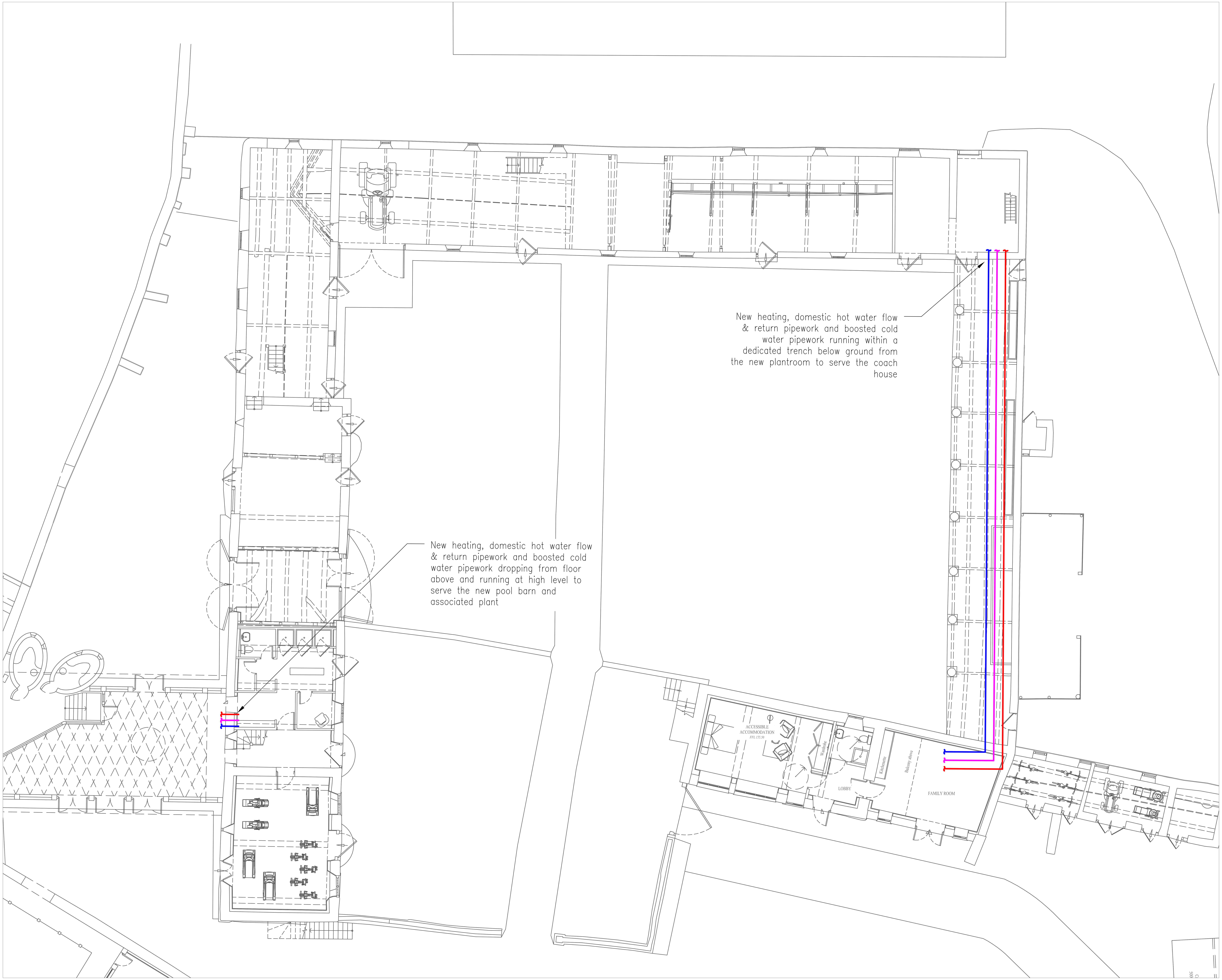

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GENERAL ARRANGEMENT PROPOSALS - MECHANICAL SERVICES GROUND FLOOR

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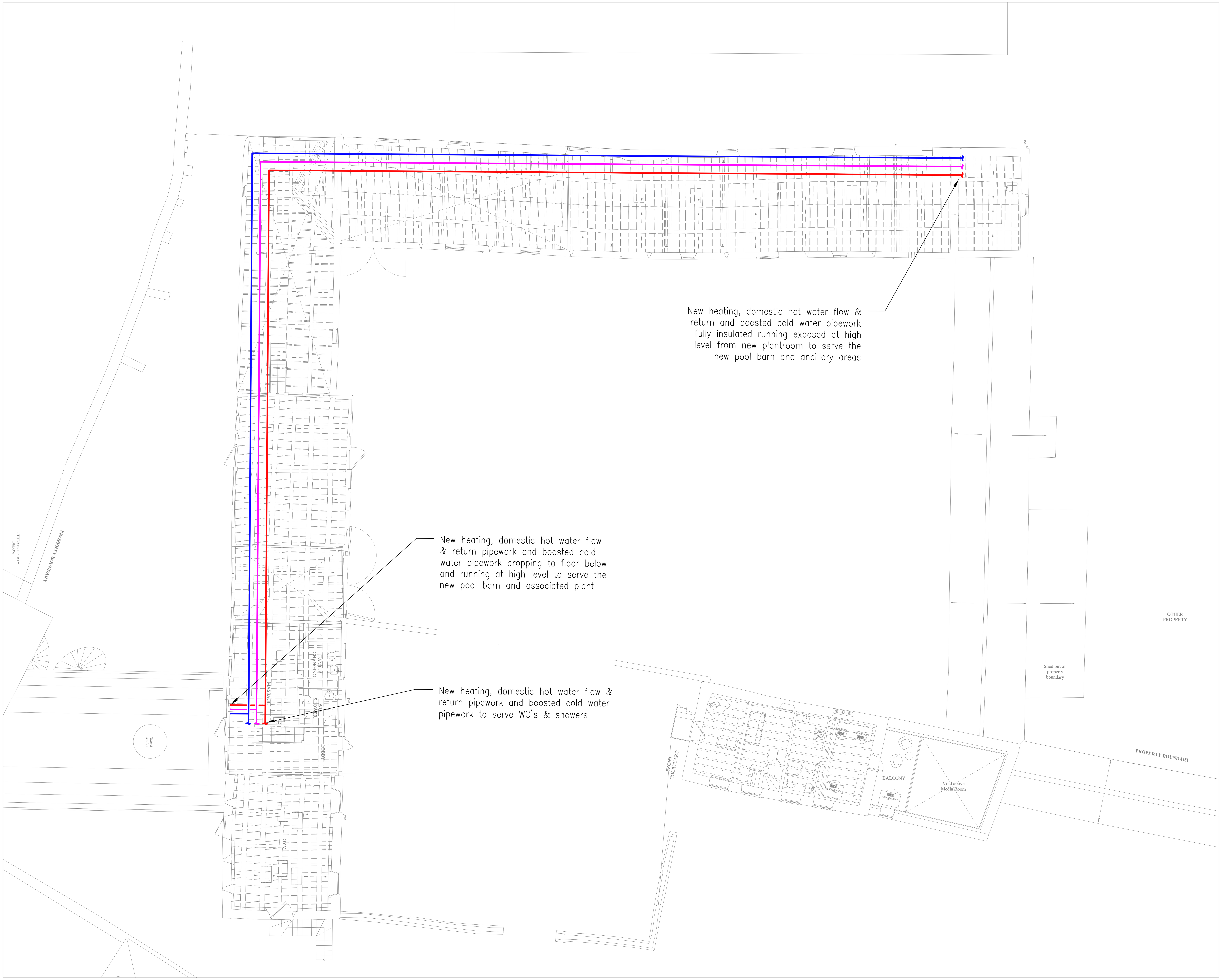

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GENERAL ARRANGEMENT PROPOSALS - MECHANICAL SERVICES FIRST FLOOR

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APPENDIX B – SUPPORTING ENERGY FEASIBILITY STUDY

SUPPORTING ENERGY FEASIBILITY STUDY

ASTON HALL

ON BEHALF OF

Giles Quarme Architects

Date March 2021

Ref: AP220027.7 Rev 1 – Energy Feasibility Study Information for Planning

Prepared By	CH/AY
Checked By	KG

TABLE OF CONTENTS

1 INTRODUCTION

1.1 BRIEF

A Plus Consulting were instructed by the owners of the above property to undertake an energy (feasibility) study aiming to support the pre-app submission to the local planning authority, whilst developing a fit for purpose strategy for the scheme's energy performance, taking into consideration the Client's objectives (i.e., autonomy, resilience, reduction of carbon footprint, future proofing), construction and operation constraints of the asset

The site includes the Stable Block and Main House. The current scheme only includes for the works to the Stable Block. Therefore, this study focuses on these, however it also considers a phased approach with modular systems that could be extended in the future to allow the addition of other buildings (main house).

The deliverables of this study should provide a comprehensive document which will sets out the Client's aspirations and aims for the energy performance of the asset and form the basis for any future design development. The study will accompany the pre-application submission to the Local Planning Authority.

A Plus' brief covers the following:

- Establish heat and power energy loads for Stable Block and Mai House using energy benchmark data and floor areas plus usage type
- Outline possible technologies options, including renewables, low and zero carbon heat and power sources. Main technologies to be considered:
  - Air Source Heat Pumps
  - Ground Source Heat Pumps (open and closed loop)
  - PVs
- Liaison with the Client and professional team to establish priorities the strategy is set to realise as well as identify any restrictions/constraints
- Comparison of all viable options with respect to autonomy, capital costs, running costs and environmental impact, to allow the Client to make an informed decision. Where applicable the evaluation will identify grants available such Renewable Heat Incentive and Feed in Tariffs
- Advise on the need for engaging specialists for any identified intrusive inspection or testing that may be required
- Produce a report based on the findings and observations from our assessments and review, identifying preferred solutions/technologies and recommendations for the next steps

The report includes for various options that can be applied and takes into consideration the suitability and complexities involved for each of the options. The recommendations provided in this report are at conceptual design level and obviously will need to be further developed in the next design stages, before any of the associated costs and timescales can be firmed up.

1.2 RESERVATIONS

A site survey and inspection were carried out on 3rd March 2021. The general findings, comments and recommendations within this report have been produced following a visual inspection of the building services installation by the surveying engineers and conversations/meetings with the client and professional team.

This report has been prepared for the owners of the property and A Plus Consulting do not accept responsibility for this report's used by any other party or for different purposes than the ones it was produced for.

1.3 RECORD INFORMATION

During our site survey and inspection, we did not find any record information related to the existing MEP services installations.

There are no other record or as-built drawings identifying the different services and routes. Similarly, there are no Operation & Maintenance manuals, or maintenance service records available or a User's Guide to identify the different systems and/or controls.

2 RENEWABLE ENERGY SYSTEMS – LONG LIST

The feasibility study has considered various renewables technologies solutions. Renewable energy, refers to energy that comes from natural sources or processes that are constantly replenished, including carbon neutral sources like sunlight, wind, rain, tides, waves, and geothermal heat.

Currently the buildings at Aston Hall are served by:

Main House - 2No oil fired boilers and there are no cooling provisions.
Cottage – LPG fired boiler and there are no cooling provisions.
Stable Block – No heating provisions.

The most suitable solutions have been assessed. The table below outlines a number of renewable technologies that have been considered for the site and identifies those which we consider to be technically and operationally viable.

Technology	Key Considerations	Technical viability
Biomass  Thermal energy	• Best suited for relatively continuous operation. • Requires a large plant room and fuel store • Considered as nearly carbon neutral provided the fuel comes from a sustainable source. • Needs good access to site for fuel deliveries • Works with traditional radiator heating systems. *Not recommended - an energy centre and large fuel store facility would need to be constructed. Site access needs consideration as frequent deliveries of (wood/pellets) would be required. Generally, cost less to install than ground source heat pump systems but have much higher running and operational cost and require more maintenance. The fuel is delivered; therefore, the running costs are reliant on third party availability, and the pellets/logs/woodchip will need a significant amount of space to be stored. The user/owner will need to be relatively hands on to keep the system operating and the client's intended pattern of usage would require a more responsive and less maintenance intensive solution. Additionally, government funding has all but disappeared for biomass systems due to their higher CO_2 emissions and the impact they have on air quality.*	✘

Technology	Key Considerations	Technical viability
Ground Source Heat Pump (GSHP)  Thermal energy	• Requires space for ground collector- with boreholes on horizontal trenches. • Heat pumps are most suitable for low temperature heating systems such as underfloor heating. • The capital cost of GSHPs is significantly higher that fossil-fuel boiler. • Greatest carbon savings when combined with renewable electricity-generating technologies. *Viable in principle – Local ground conditions will need to be tested to accurately assess the anticipated output and extent of the system required. As suitable space for an energy centre would need to be established to house the heat pumps and ancillaries and location for boreholes to be agreed*	✓

Technology	Key Considerations	Technical viability
Water Source Heat Pump (WSHP)  Thermal energy	• Requires large body of water from which to extract heat. • Open loop systems generally not recommended because of higher maintenance requirements and regulatory issues. • Closed-loop systems much simpler to implement. • Can be more efficient than ground-source systems • Lower cost than ground-source system *Not recommended- Initial research has shown that the site is situated on the edge of an area where the underlying strata is overly complex and variable. The geology changes almost along the road past Aston Hall. Records of wells drilled south of the main road appear quite productive and offer good groundwater flows. Wells drilled north of the road appear to produce water too, but these are limited to small consumers only, mainly for domestic use and not sufficient to support a site wide WSHP solution.*	✗

Technology	Key Considerations	Technical viability
Air Source Heat Pump (ASHP) Thermal energy	• Requires a suitable location for the external unit • The noise generated by the external unit must be considered. • Efficiency and output greatly affected by external air temperatures. • Lower capital cost than GSHPs and WSHPs • Poor efficiency when running at higher temperatures. *Viable in principle – Only recommended for use in existing 'historic' buildings when heating system can be replaced with underfloor heating or similar, not ideal with existing radiators as efficiency likely to be poor. Longer radiators required when comparing to conventional fossil fuel systems. Practicalities on historic buildings could dictate the use of radiators at 1st floor level. Location of external units to be considered and treated in terms of acoustics and aesthetics.*	✓
Combined Heat & Power (CHP) Thermal and electrical energy	• CHP requires predictable and fairly constant electricity and heating loads for best performance. • CHP units are best suited for hotels, residential homes, student accommodation, hospitals, and schools. • The unit should be sized on heat demands, rather than electrical requirements - units are usually sized on the building's hot water load as this is continuous throughout the year. *Not recommended as site and the client's intended pattern of use do not offer consistent electrical or hot water load.*	✗
Solar Thermal Thermal energy	• Most effective in a south-facing position on an incline of 30-40 degrees. • Panel locations should be clear of obstructions and over shading. • Requires space for a hot water cylinder close to the collectors. • Most economically viable in buildings with a high hot water demand or where a building is not on the national gas grid. • Typically, only sized to cover 50-60% of hot water demand. *Not recommended – Restricted to hot water generation only. Not suitable for site wide strategy, as hot water will need to be produced locally.*	✗
Photovoltaic (PV) Electrical energy	• The position of the PV array will affect the energy generation and, consequently the carbon and financial savings. • PV panels may require cleaning to avoid a reduction in efficiency. • PV panels should be free from shading from adjacent buildings/trees. • Permission is required from the DNO (Distribution Network Operator) to connect the array to the grid (the cost of this grid connection is dependent on the size of the array and its location on the grid). *Viable for generating electrical energy if suitable location(s) can be found on site. Potential to combine with on-site battery storage so that the full amount of electricity generated can be used by the owners. Planning considerations due to the site's locality and AONB status.*	✓

Technology	Key Considerations	Technical viability
Wind Electrical energy	• Rural areas are better suited than urban areas as the wind speeds are higher and less turbulent. • Pay-back periods are strongly dependent on wind conditions plus the length of cabling required to connect the turbine to the building. • Planning permission is required and is often a contentious issue. • Site-specific wind measurements required to predict performance accurately. *Not recommended - Planning would be very contentious, and performance very uncertain without significant site monitoring beforehand.*	✘
Microhydro Electrical energy	• Requires a water course with sufficient (and reliable) flow or height difference • Various types of turbines possible • May require more significant infrastructure e.g., a dam or penstock arrangement. *There are overflows present in the estate, but they appear to be of low flow rate, with a small height difference, and are unlikely to be reliable in the summer.*	✘

Short List

The following systems have been identified as viable for a site-wide energy strategy:

- Ground Source Heat Pumps
- Air Source Heat Pumps
- Photovoltaic (PV)

The following sections will outline how each technology could be implemented, and the predicted performance in terms of capital expenditure, running costs savings and subsidies.

3 FINANCIAL ANALYSIS METHOD FOR BUDGET COSTS

The financial analysis carried out for each of the options below is based on the following:

- Current government tariffs and rates (in relation to RHI)
- We would highlight the sensitivity of such calculations, and the uncertainties in quantities such as fuel prices, inflation, and system performance.

The identified costs:

- Are approximate. The figures provided have been calculated using current industry-average data. No detailed measurements have been carried out and therefore should be considered as estimates
- Cover the systems reviewed only and not any costs associated with distribution, upgrades and buildersworks. These will be assessed during the conceptual design stage.
- Do not allow for any upgrades to the site's existing utilities and infrastructure (i.e., water and electricity). These will be assessed and quotes from the relevant operators will be obtained during the conceptual design stage.
- Have to be tested by the Client by specifying the work in detail and obtaining competitive tenders from appropriate contractors. The current appointment is not a substitute for such exercise.
- Are given at current prices. No adjustments have been made for future inflation
- Assume works are completed during normal hours and as a single continuous exercise.
- Exclusive of VAT, prelims, OH&Ps and professional & statutory fees.

4 RENEWABLE HEAT INCENTIVE

The Domestic Renewable Heat Incentive (Domestic RHI) is a government financial incentive to promote the use of renewable heat. The scheme pays owners of eligible systems for heat produced. People who join the scheme and stick to its rules receive quarterly payments (tax free and index linked to CPI) for 7 years for the amount of clean, green renewable heat their system produces.

There are restrictions on what the heat produced can be used for. Heat pumps must provide space heating or space and domestic hot water heating. Space heating must be delivered using a liquid medium, such as through an underfloor heating system or a radiator. Domestic hot water heating is where heat is generated to supply hot water for domestic purposes. This does not include space heating or heating a swimming pool.

The RHI scheme is regulated and run by Ofgem. To qualify, the renewable technology must only heat a single domestic property which has a domestic Energy Performance Certificate (EPC). The property could have an integral home office or studio etc and will still be eligible to apply to the Domestic RHI if the property's EPC covers it. Where the renewable technology provides heat to a main house with a domestic EPC and outbuildings that form part of the same property (e.g., garages, pool houses, sheds, games rooms and gyms) it is also eligible to apply for the Domestic RHI. This includes outbuildings that have a mixed use, such as workshops or studios that have the same EPC as your main house, or that cannot have a separate EPC.

The RHI is payable up to 30,000kWh (for GSHP) and 20,000kWh (for ASHP) annually at a rate set by the regulator (currently 21.29p/kW). The amount of the heat demand that is eligible for the RHI is taken into consideration before the payment amount is finalised.

The Stable Block conversion could qualify for the Domestic RHI, however having contacted Ofgem they have advised that each application is reviewed on a case-by-case basis to determine eligibility, taking all the factors relevant to that specific application into account. Therefore, they cannot state that any application will gain accreditation until a full application with all the relevant evidence is received and reviewed.

The Domestic RHI in its current form will come to an end in March 2022 and will only apply to projects/schemes that are commissioned and registered before March 2022.

The UK Government is due to be review the scheme in 2021 but has not yet announced the results of this review or an extension for the scheme. There is speculation that a new scheme, with reduced guaranteed tariffs, will be introduced. It is unknown when that will be, therefore the benefits of the Domestic RHI for Aston Hall cannot be guaranteed, at this stage.

Under the rules set by Ofgem, if a system serves more than one domestic property, it is eligible for the Non-Domestic RHI scheme. This scheme is better suited to large historic buildings and estates (suitable for Aston Hall), with higher payments available. The details of this scheme can be summarised as:

- Eligible systems include heat pumps (air, ground, water), solar hot water and biomass
- Payments are made for every unit of heat (kWh) produced by the system, for 20 years after installation.
- Payments are made at a fixed tariff rate available at the time of application but are adjusted for inflation.
- Heat limits are applied to prevent abuse of the system (e.g., creating artificial heat loads in order to attract payments).

However, the Non-Domestic Renewable Heat Incentive closes to all new applicants on 31st March 2021, and systems must be operational and commissioned by this date to be eligible. The UK Government is due to be review the scheme in 2021 but has not yet announced the results of this review or an extension for the scheme. There is speculation that a new scheme, with reduced guaranteed tariffs, will be introduced. It is unknown when that will be, therefore the benefits of the Non-Domestic RHI cannot be considered for this scheme.

5 RENEWABLE ENERGY SYSTEMS –ANALYSIS

Aston Hall

We have estimated the energy demands of the existing building based on:

- Rules of thumb for space heating requirements of building of this age.
- Hot water calculated on the basis of the number of occupants in each, and typical daily consumption figures.
- Electrical consumption based on data for average UK buildings.

These estimates will be further refined as the project evolves and there will be an opportunity to produce detailed calculations based on thermal modelling and overall load assessments during the design stage.

Stable Block

The refurbished buildings are assumed to be highly insulated, with reduced space heating requirements. The energy consumption for the new buildings has been estimated based on:

- Rules of thumb for space heating requirements of buildings of this age
- Hot water calculated on the basis of the number of occupants in each, and typical daily consumption figures
- Electrical consumption based on data for average UK buildings.

These estimates will be further refined as the project evolves and there will be an opportunity to produce detailed calculations based on thermal modelling and overall load assessments during the design stage.

5.1 GROUND SOURCE HEAT PUMP (GSHP)

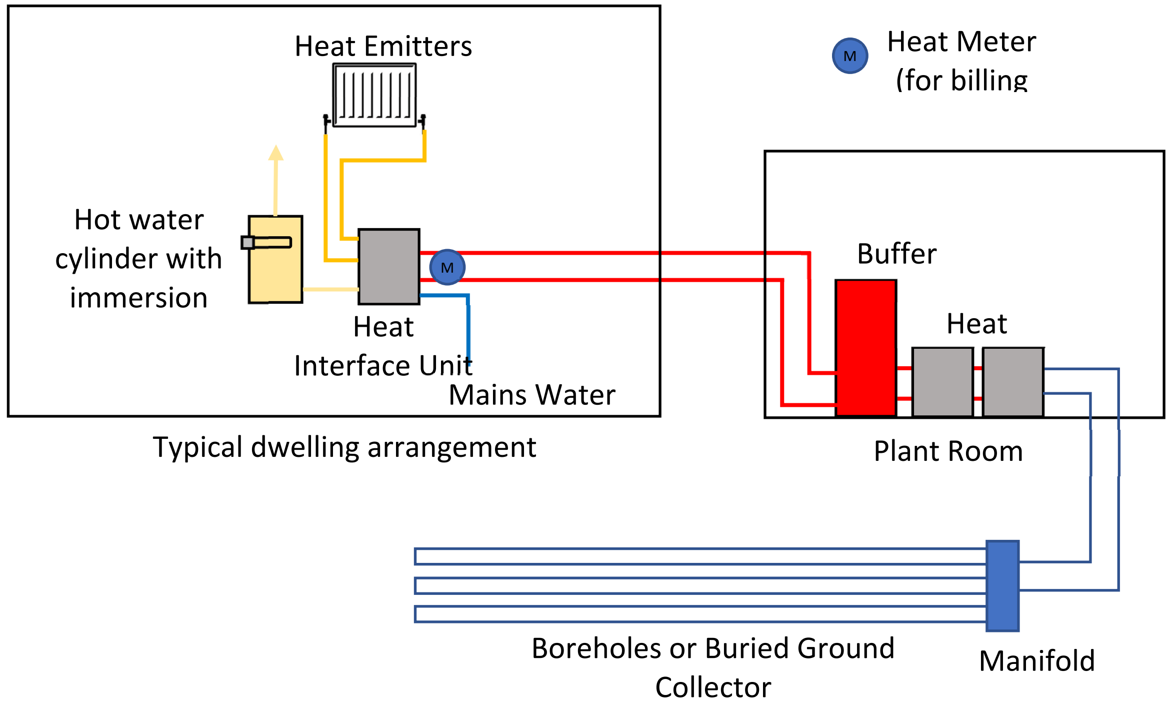
GSHPs transfer heat from the ground into a building to provide space heating and/or hot water. Under the surface, the ground tends to be at a constant temperature of around 12°C throughout the year. Through the use of a refrigerant cycle this constant low-grade heat can be harnessed to provide a useful level of heat for a building.

A closed loop GSHP installation consists of plastic piping which is buried in the ground and connected to a pump. This can either be a vertical system where pipes are laid in boreholes, or a horizontal system where pipes are laid in trenches. A mixture of water and antifreeze is passed through the looped pipes where it absorbs heat from the ground. This fluid then flows into an electrically powered heat pump, comprising a compressor and heat exchangers. The generated heat is then transferred to low temperature heating systems such as underfloor circuits. GSHPs can also provide low carbon cooling by reversing the refrigerant cycle.

GSHPs are a low carbon technology rather than a renewable system, as they require electricity to run the pumps and extract the energy from the ground. The Coefficient of Performance (CoP) varies depending on the system but a typical GSHP is likely to achieve a CoP of approximately 3.7, i.e., 3.7 units of heat energy is obtained for every 1 unit of electrical energy consumed. Key considerations for GSHPs:

- The feasibility of using a GSHP is dependent on whether there is sufficient space for the piping circuit and whether the geology is suitable for either boreholes or trenches.
- Heat pumps deliver heat most efficiently at around 30°C which makes them most suitable for low temperature heating systems such as underfloor heating.
- The capital cost of GSHPs is significantly higher that fossil-fuel based solutions.
- Greatest carbon saving is achieved when combined with renewable electricity-generating technologies.

Schematic summarises the proposed strategy for the heat pump system



Viability for Aston Hall

Ground Source Heat Pump Option (Closed Loop)

Stable Block

There is a considerable area of land available on the site, which means that a borehole (vertical) and option could be feasible. The indicative site layouts attached to the study identify potential locations for the boreholes and ground array.

Between the entertainment areas, office, and the pool, we estimate the peak thermal load to be approximately 70kW with an annual energy requirement of approximately 230,000kWh.

With this in mind, we would propose an 80kW ground source heat pump system with 1500L hot water cylinder and 1500L buffer tank. A cooling buffer tank will also be required depending on the final design. This could be connected to 16no. 145m boreholes (approximate layout below).

The total cost of this, including the boreholes, will be approximately -£220k, the annual savings vs oil will be at least £7,000 and the carbon reduction will be in excess of 70%.

A summary table of the whole life financial assessment for the option is provided below. It includes the contribution of the current RHI for illustration purposes as there is uncertainty about the availability and longevity of the scheme as described in section 4 of the report. Also, worth highlighting that the figures do not consider the full utilisation of the energy generated by the PVs, therefore the potential savings on running costs can be greater.

Heat pump capacity (kW)	Heating energy requirement (kWh)	Renewable heat (kWh)	Annual RHI subsidy	Lifetime RHI subsidy	Annual fuel cost saving vs Oil	Lifetime fuel cost saving vs Oil	Lifetime RHI subsidy and savings
80	230,000	172,500	£5,200	£37,000	£7,000	£140,000	£177,000

An important item to consider for a site like this is the plant room space, a plant room measuring approximately 9m x 4m with a clear height of at least 2.7m will be needed. Furthermore, there must be a consideration to the weight of the items which will need to be carefully thought through if navigating steps to a basement or first floor plant room. With regard to the proposed boreholes' layout, we include an image showing the area needed for the boreholes (approximately 80m x 12m) and an indicative site representation can be found in Appendix A.

Heat pumps of this scale require a substantial 3-phase supply. The existing supply to the building is not sufficient and will need to be upgraded as part of the conversion works. Firm quotes for the upgrade works will be obtained from the relevant network operator during the design stage.

Indicative space requirement for GSHP boreholes (Stable Block only)

The equivalent horizontal collector array is likely to cost a little less than the boreholes (depending on the cost of the trenching contractor and whether there is a requirement for sand etc.) but this option clearly requires a much greater amount of land. An example for the equivalent horizontal collector (90m x 150m) can be found below and an indicative site representation in Appendix A.

Indicative space requirement for GSHP horizontal collectors (Stable Block only)

Main House

With regards to future proofing of the site, and the inclusion of the main house to a GSHP scheme, we estimated the peak thermal load to be approximately 60kW and an annual energy requirement of 136,000kWh.

These requirements could be covered individually by a 65kW ground source heat pump, 1000L hot water cylinder and 1000L buffer tank with 12no. 145m boreholes.

The total cost of this is likely to add a further £180k to the project depending on the location of the plant room. The annual savings vs oil will be at least £4,500 and the carbon reduction will be above 70%.

A summary table of the whole life financial assessment for the option is provided below. It includes the contribution of the current RHI for illustration purposes as there is uncertainty about the availability and longevity of the scheme as described in section 4 of the report. Furthermore, to qualify for the RHI scheme, the renewable technology must only heat a single domestic property which has a domestic Energy Performance Certificate (EPC) including any outbuildings that form part of the property and it is capped at 30,000 kWh. Therefore, if the installation for the Stable Block qualified for the RHI the future installation for the Main House would not qualify for the scheme. Also, worth highlighting that the figures do not take into account the full utilisation of the energy generated by the PVs, therefore the potential savings on running costs can be greater.

Heat pump capacity (kW)	Heating energy requirement (kWh)	Renewable heat (kWh)	Annual RHI subsidy	Lifetime RHI subsidy	Annual fuel cost saving vs Oil	Lifetime fuel cost saving vs Oil	Lifetime RHI subsidy and savings
65	136,000	102,000	£5,200	£37,000	£4,500	£100,000	£137,000

The area needed for the boreholes will be approximately 55m x 12m and the equivalent horizontal collector would be 90m x 120m. An indicative site representation can be found in Appendix A.

A plant room measuring approximately 8m x 4m with a clear height of at least 2.7m will be needed.

Heat pumps of this scale require a substantial 3-phase supply. The existing supply to the building is not sufficient and will need to be upgraded as part of the works. Firm quotes for the upgrade works will be obtained from the relevant network operator during the design stage.

Modifications to Existing Heating and hot Water Systems

Worth highlighting that for the proposed GSHP system a heat interface unit would be installed in the main house, which would replace any existing boiler. The heat pump options would be unable to heat domestic hot water legionella-safe temperatures (60degC), so a hot water cylinder with an electric immersion heater would be installed to 'top-up' the temperature. The immersion heat would be fitted with a time clock to heat the water (for example) twice per day. This would minimise the electrical energy use of the system. This approach would also allow the heat pump heating temperature to be varied according to the external conditions- weather compensation. Supply of the LTHW at a lower temperature during milder weather would significantly increase heat pump efficiency.

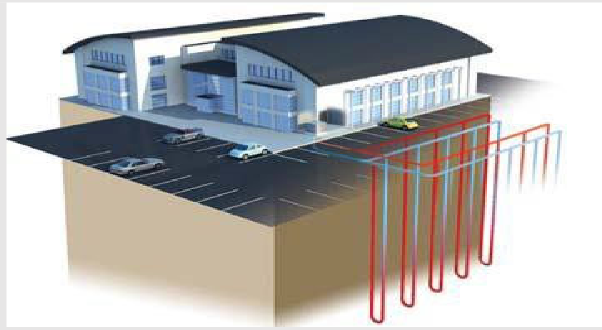
Additionally, the existing radiators in the main house are likely to need to be upgraded to work with the lower water temperatures. The use of double panel compact radiators would help minimise the impact on space in the room.

There may be some savings to be made if the GSHP system is oversized, as part of the initial works for the Stable Block, to cover the future requirements of the site. Our recommendation would be not do this however, as the system will require a far larger incoming electrical supply (which may be difficult to obtain) and will be vastly oversized in the short term until the main house is redeveloped. A more cost effective and better long-term solution would be to separate the two systems to operate independently. This will avoid the issues described above whilst also allowing the house to operate completely independently of the other buildings on site – something that may be important if the clients ever choose to move on.

A potential cost-effective approach to be explored during the design stage, would be the inclusion of the boreholes/horizontal collectors for the House's GSHP in the initial works. In any GSHP installation the drilling (boreholes) and trenching (horizontal collectors) are the most expensive parts of the installation. Therefore, there could be some economies of scale bringing these works forward and maximising the opportunity to utilise the drilling/trenching apparatus once.

A ground investigation and thermal response testing would be recommended before the commencement of any detailed design work, so that the ground conditions and anticipated performance can be confirmed. Furthermore, any potential issues/challenges with regards to the drilling of the boreholes can be established and assessed ahead of any design works and installations.

Horizontal ground loop.



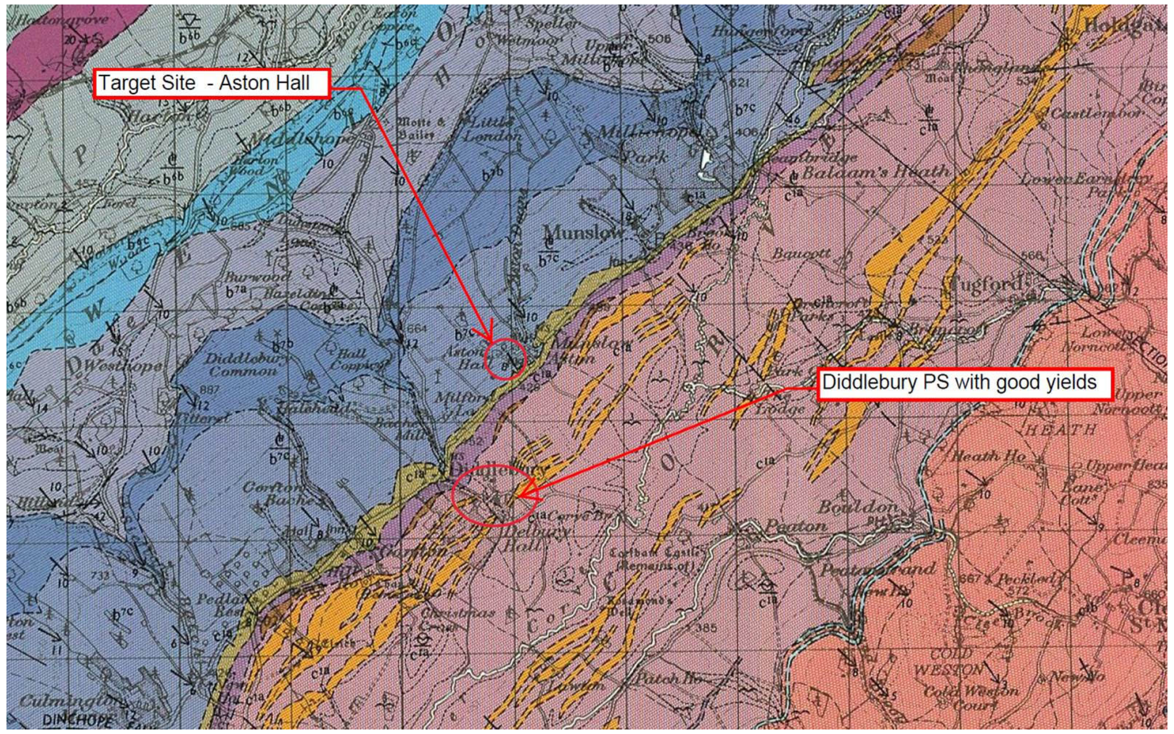
Vertical borehole system.

Typical GSHP unit which connects to the horizontal or vertical borehole system.

Ground Source Heat Pump Option (Open Loop)

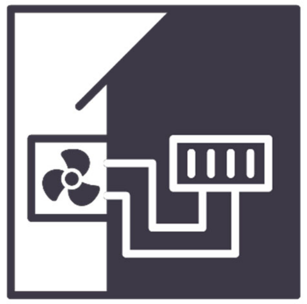
The site is well south of the highly productive Triassic Sandstone area which are generally found to the north of Shrewsbury.

Looking at the geological sheet for the area, the underlying strata is overly complex and variable. Below is a small image extract to show the differing geological conditions with the site marked along with known wells drilled in Diddlebury. The wells in Diddlebury are quite productive and offer good groundwater flows but as it can clearly be seen, the geology changes almost along the road past Aston Hall. There are wells drilled north of the road that produce water too, but these are limited to small consumers only as opposed to the Diddlebury Pumping Station which were designed to deliver high flows.



There are wells both north of Aston Hall producing water and south (Diddlebury especially) too so open loop could remain as an option for now. However, in order to be able to offer meaningful advice towards the viability of an open loop system at the site, a more detailed and complex assessment than might normally be achievable during an initial feasibility, would be required. This would include a hydrogeological investigation to offer definitive answers as to what can realistically be expected in the locality. Due to the locality's uncertainty on groundwater flows, we do not recommend investigating the open loop option further.

5.2 AIR SOURCE HEAT PUMP (ASHP)



Much like a GSHP, an ASHP is considered a low carbon technology because electrically powered heat pumps and exchangers extract heat from outside air. ASHPs work by having an external evaporator unit with a fan linked to an internal condenser unit to release the heat.

ASHPs come in a range of sizes, performances and designs and are sub-categorised into two different types:

1. Air-to-water systems transfer heat to a wet heating system. As ASHP's heat water to a lower temperature than a standard boiler system they are more suited to under floor heating systems.
2. Air-to-air systems produce warm air which is circulated by fans to heat the space. This requires an air distribution system within the building rather than conventional 'wet' heat emitters. A separate hot water supply is also required.

An ASHP will have a lower Coefficient of Performance than a GSHP (typically around 2.5) due to the lower average temperature of outside air and greater variance across the year. The cost of an ASHP is however much lower as there is no need for any expensive ground works. Key considerations for ASHPs:

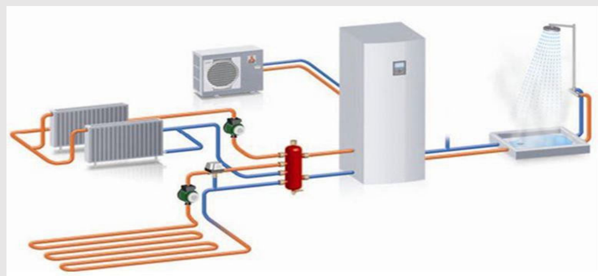
- There must be a suitable location to mount the external unit to the building and planning permission may be required.
- The noise generated by the external unit must be considered as part of the design.
- Like GSHPs, ASHPs are most effective when providing space heating via under-floor heating systems designed to operate at temperatures of around 30°C-40°C.
- ASHPs are easier and cheaper to install than GSHPs however GHSPs are more efficient

Viability for Aston Hall

Suitable space could be found on site for the external units. Noise and aesthetics would be a consideration and suitable treatment can be developed in collaboration with GQA. Just like a GSHP, the lower temperatures generated by the ASHP means the most efficient heat emitter type would be low temperature under floor heating. The capital cost is relatively low, and there are significant carbon savings, however long-term financial savings are unlikely to match the GSHP option due to the cost of electricity.

Outdoor units of an ASHP system (intake).

Outdoor units of an ASHP system (discharge)



Shows a typical air to water heat pump system.

Stable Block

Between the entertainment areas, office, and the pool, we estimate the peak thermal load to be approximately 70kW with an annual energy requirement of approximately 230,000kWh.

With this in mind, we would propose an 100kW air source heat pump system, consisting of 5No 20kW ASHPs with 1500L hot water cylinder and 1500L buffer tank. A cooling buffer tank will also be required depending on the final design.

The total cost of this, will be approximately £120,000, the annual savings vs oil will be at least £4,800.

A summary table of the whole life financial assessment for the option is provided below. It includes the contribution of the current RHI for illustration purposes as there is uncertainty about the availability and longevity of the scheme as described in section 4 of the report. Also, worth highlighting that the figures do not take into account the full utilisation of the energy generated by the PVs, therefore the potential savings on running costs can be greater.

Heat pump capacity (kW)	Heating energy requirement (kWh)	Renewable heat (kWh)	Annual RHI subsidy	Lifetime RHI subsidy	Annual fuel cost saving vs Oil	Lifetime fuel cost saving vs Oil	Lifetime RHI subsidy and savings
100	230,000	153,500	£3,500	£24,500	£4,800	£96,000	£120,500

Main House

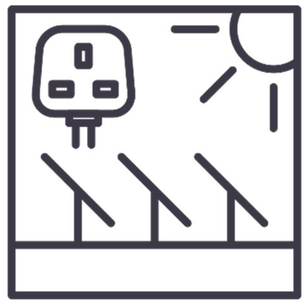
The inclusion of the main house to a ASHP scheme, we estimated the peak thermal load to be approximately 60kW and an annual energy requirement of 136,000kWh. These requirements could be covered by an 88kW ASHP system consisting of 4No ASHPs with 1000L hot water cylinder and 1000L buffer tank.

The total cost of this, will be approximately £105,000, the annual savings vs oil will be at least £4,200.

A summary table of the whole life financial assessment for the option is provided below. It includes the contribution of the current RHI for illustration purposes as there is uncertainty about the availability and longevity of the scheme as described in section 4 of the report. Furthermore, to qualify for the RHI scheme, the renewable technology must only heat a single domestic property which has a domestic Energy Performance Certificate (EPC) including any outbuildings that form part of the property and it is capped at 20,000 kWh. Therefore, if the installation for the Stable Block qualified for the RHI the future installation for the Main House would not qualify for the scheme. Also, worth highlighting that the figures do not take into account the full utilisation of the energy generated by the PVs, therefore the potential savings on running costs can be greater.

Heat pump capacity (kW)	Heating energy requirement (kWh)	Renewable heat (kWh)	Annual RHI subsidy	Lifetime RHI subsidy	Annual fuel cost saving vs Oil	Lifetime fuel cost saving vs Oil	Lifetime RHI subsidy and savings
88	136,000	90,000	£3,500	£24,500	£4,200	£84,000	£108,500

5.3 PHOTOVOLTAICS (PV)



PV arrays are made up of semi-conductor solar cells which convert sunlight into electricity. Energy from sunlight causes an electrical current to flow between different atomic energy levels within the solar cells. PV panels are made of solar cells, and several panels create a PV array.

PV systems require only daylight to generate electricity, although more energy is produced with direct sunlight. This mean energy can be generated in all parts of the UK even in overcast or cloudy conditions. Ideally, PV panels should face between south-east and south-west, at an elevation of about 30-40° but even flat roofs receive 90% of the energy of an optimum system. Key considerations of PV:

- PV panels may require regular cleaning to avoid a reduction in efficiency, although if the array is tilted by more than 15° the panel should be able to 'self-clean' with rain.
- The position of the PV array will affect the energy generation and, consequently the carbon and financial savings.
- The location of the panels should be free from shading from adjacent buildings/trees.
- It is common for the PV array to be connected to the grid so that an export tariff from the Feed in Tariff scheme can be received. To do this permission is required from the DNO (Distribution Network Operator) and the cost of this grid connection is dependent on the size of the array and its location on the grid.

Viability for Aston Hall

There is available space for PV on the Stable Block south facing roofs and also for field PV arrays. The study assesses the size of the PV, and the battery storage system working in conjunction with the PV in order to fully utilise the PV output. The battery storage would deliver a significant element of grid autonomy and supply to the emergency uses on the scheme.

Load Assessment

Based on the client's brief on how they will be using the Stable Block and Main House, we decided to use daily consumption figures to express the anticipated energy usage.

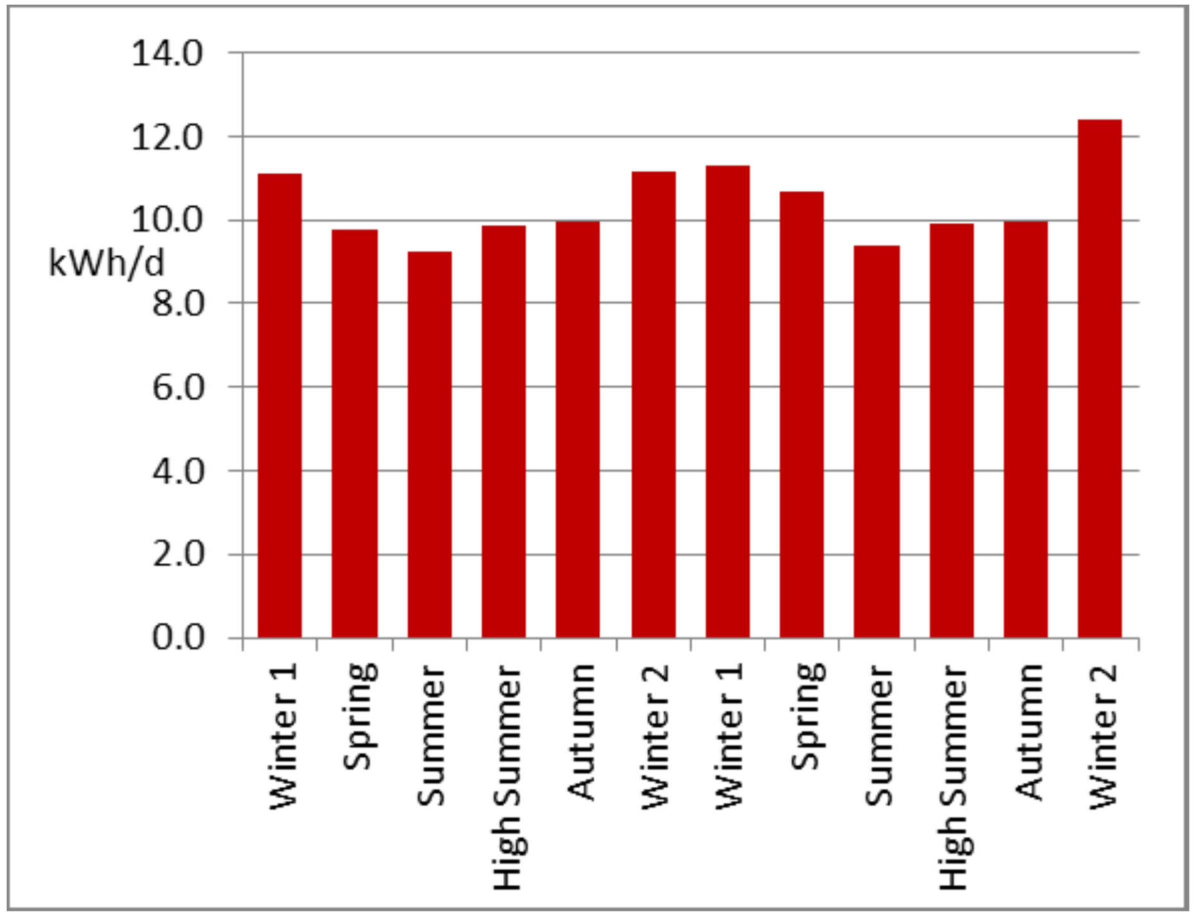
To estimate the figure, we assessed UK Power Network (UKPN) historical electricity consumption data for properties with 5+ bedrooms. The stated 7,100kWh figure measures the average annual electricity usage for properties across greater London, this equals to about 20kWh per day if we assume that most of the houses in UKPN's data pool are fully occupied throughout the year.

The demand could vary significantly based on the occupancy, usage, seasons etc. As part of the study, we also cross referenced with the Department of Energy & Climate Change Household Electricity Survey, and we applied a 5x factor on the UKPN average daily consumption figure to get the figure for the main house. Without any actual load monitoring data available, this estimate figure should provide a solid starting point for the feasibility study.

We have broken down the anticipated demand for the Stable Block and Main House. We have also allowed 50kWh for car charging, this is based on the assumption that the clients and their guests will arrive at the property from remote locations and vehicles will require longer charging (50kWh will allow average 150Miles range). This of course can be reduced to suit the client's specific requirement.

AREA	DAILY ELECTRICITY DEMAND
Main House	100 kWh
Stable Block	60 kWh
Car Charging	50 kWh
TOTAL	210 kWh

We have also researched the seasonal impact to the energy consumption. We expected the summer load will be lower than the winter load for properties without comfort cooling. A study carried out by the University of Strathclyde monitored a number of houses throughout the country for a duration of two years. The average daily consumptions for different seasons are shown in the graph below.



A Specification for Measuring Domestic Energy Demand Profiles – University of Strathclyde

From the graph, the seasonal variation is relatively small. The winter demand is higher than summer demand. The increase in winter is mainly due to space heating and reduced daylight during winter that consequently produce higher demands on small power and lighting. However, the differences are not massive. Particularly for this scheme, as there will be a requirement for cooling in the scheme and in order to simplify the model at this stage, we have not taken seasonal variation into consideration when calculating the daily load. During the next stage, a more detailed thermal load assessment will be carried out to simulate the seasonal variation in thermal demand and allow a more accurate calculation of the anticipated loads.

We understand that the client is likely to stay in the property for 2-3 consecutive days at a time. For each short stay, we assumed that house will be intensely used and allow maximum consumption. Equally we have assumed that for extended periods, where the buildings are not occupied, there will be minimal energy consumption.

Battery Assessment

We understand the client wishes to include batteries' provision to accommodate 2 days of the average electrical demand. We feel this is a sensible approach as we understand that the client is likely to stay in the property for 2-3 consecutive days at a time. From our study, we allow a battery of **420kVA** capacity for the scheme.

The battery should be enough to provide most of the electricity required during each stay (2-3 days). The battery will however not be designed to allow the house to run in island mode, and reliance on the grid will be required. The battery would provide full backup for the electrical systems within the properties if the grid failed, however, it will primarily be designed to store the renewable energy generated by the PV and hence minimise the electricity import from the grid.

It is worth highlighting that all battery systems considered are modular, so it is the capacity can be extended in the future, if required.

We are listing below the battery manufacturers whose products are readily available on the market:
- BYD: 60kWh per module
- SMA: 67kWh per module
- Tesla Powerpack 232kWh per module with built-in inverter
- Alfen >137kWh

We have spoken with a number of battery specialist, and we understand that a typical cost is just under £800 per kWh including inverters, setup, installation, fire protection, testing and commissioning. This would result in an overall cost of £335,000 We also understand the client can source batteries from other manufacturers at a competitive cost. During the next stage we can discuss this with the client and the specialist and explore different models to deliver the battery system e.g., employ the specialist to provide system integration and installation only with the equipment free issued by the client.

PV solar

- PV panel should be sized based on the capacity of the battery, to minimise exporting into the grid.
- PV generation fluctuates with seasons, we will work up the PV sizing based on the Sprint/Autumn generation profile (e.g., around the average monthly generation). We have included the PV seasonal profile for reference.
- The ratio depending on the type of PV panel and how the client wants to use the building.
- Energy generated by PV will prioritised for the building energy usage, any excess will be stored in the battery and if any additional electricity will be exported to the grid.

PV Seasonal Profile												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average normalised case	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Fill factor – Linking seasonality and the associated PVs' output	0.36	0.54	1.06	1.32	1.44	1.62	1.68	1.38	1.08	0.72	0.5	0.29

Based on the above and the client's intended use of the property, we have developed two scenarios for consideration:

1. For the Short Charge scenario, we assess 55kWp of high efficiency PV panels, which generate an average of 130kWh per day (typical sprint/autumn day). This will allow the PV panel to fully charge the battery system in 3 – 3.5 days if energy consumption in the property is minimal (not fully occupied).
2. For the Long Charge scenario, we reduce the capacity of the PV to 35kW, so it will take the PV just over 5 days to charge the batteries. This will be sufficient if the client is looking to use the property predominately during weekends.

Scenario	Capacity of PV /kW	Average daily generation /kWh	No of days to fill the battery /days	Required area for standard free standing PV panels
Short Charge	55	130	3.3	550
Long Charge	35	83	5.1	350

During summer, the PV generation will be much higher, and it will take less time for the battery to be charged up. This could match well any increased demand if the client is looking to use the house more frequently in summer months.

The estimate costs for the free-standing PV arrays would be £55,000 and £35,000 for the short and long charge options, respectively. The costs will vary depending on the finlaised configuration of the arrays and their location (distance from the property).

We also list the free PV area that would be required for the two scenarios, the space allowance includes the panels, associated supports and the access areas. Indicative site layouts including the assessed PV provisions can be found in Appendix A. The space is for the feasibility study and planning only and can be developed in the detail design stage to optimise location, orientation, and footprint.

The PV panels can be installed as free standing as well as integrated with the roof.

- PV roof tiles for the new half south-facing roof of the barn (around 120m2 available roof space)
- PV slate for the new half south-facing roof of the barn (around 120m2 available roof space)
- Free standing highly efficient PV panels in non-shaded area.

The breakdown of the areas and budget costs are listed below:

Short Charge	PV roof tiles	PV roof slates	Free Standing PV Array
Installation capacity	15kWp	8kWp	32kWp
Area required	120m2	120m2	320m2
Budget Costs	£15,000	£48,000	£32,000

Long Charge	PV roof tiles	PV roof slates	Free Standing PV Array
Installation capacity	15kWp	8kWp	12kWp
Area required	120m2	120m2	120m2
Budget Costs	£15,000	£48,000	£12,000

We have included an image for each type of PV panels in the section below.

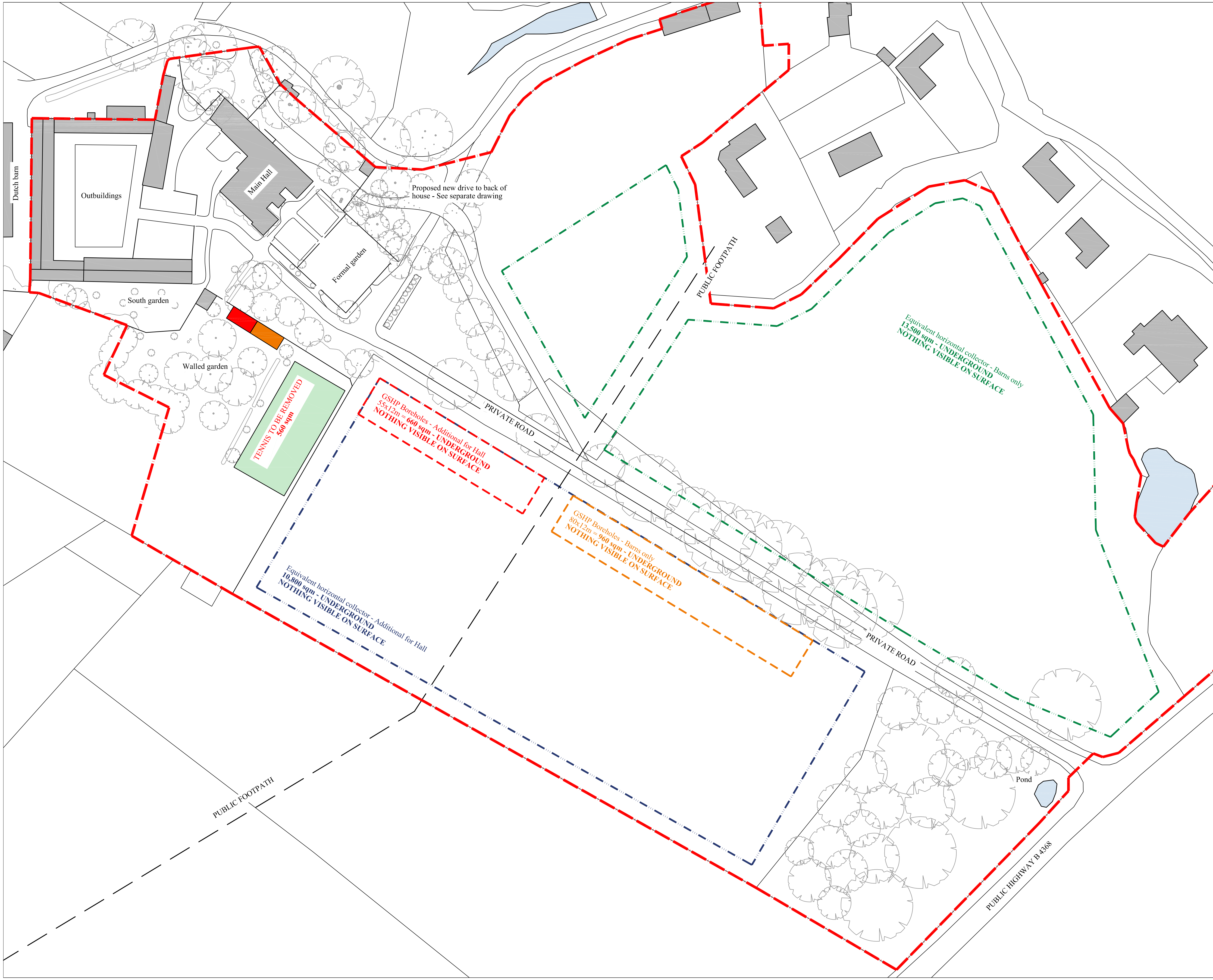
The PV roof tiles, and roof slate can be fully integrated with the roof which can be attractive, however there are not as efficient as the free-standing PV panels, therefore, if the PV roof tiles and slates are to be used, the total areas of the PV will need to increase due to the reduced efficiency.

This example shows a PV slates. GB Sol slates current dominate the UK market. They are very discrete, used on listed buildings, and can be continuous in order not to see a border between regular slates. The efficient of the slates is lower than stand PV panels, and the costs are significantly higher.

This example shows a typical roof PV tile. Standard panel is mounted on the GSE mounting system. Similar to PV slates, the PV tiles also form part of the roof structure. The costs are comparable with the standard PV.

This example shows a field array of PV and is a common method when a large amount of PV is required, and suitable land is available.

APPENDIX A – INDICATIVE SITE PLANS



Notes

This drawing has been based on survey information provided by others.
All dimensions and setting out must be verified on site before commencement of the work, and any discrepancies notified to the architect.
All windows and doors are to fit into existing openings unless stated otherwise.
All dimensions are in millimetres unless stated otherwise.

Drawing Notes:

- Surveyed and drawn by James Brennan Associates Chartered Surveyors for Arrol Architects Ltd - Issue date December 2020.
- Survey grid is OS GPS & levels are related to ordonance survey GPS datum.
- Units are meters.
- Survey accuracy with a scale of 1:100.

Part of this plan is not surveyed but deducted from OS map.

KEY

- Property boundary
- Plantroom for barns only Circa 9x4m - Clear H 2.7m
- Additional plantroom for Hall Circa 8x4m - Clear H 2.7m
- GSHP Barns only Closed loop collectors in bore holes 80x12m = 960sqm
- GSHP Additional for Hall Closed loop collectors in bore holes 55x12m = 660sqm
- Equivalent horizontal collector Barns only 150x90m = 13,500sqm
- Equivalent horizontal collector Additional for Hall 120x90m = 10,800sqm

N

1:1000 0 10 20 30 40m

PRE-APP SUBMISSION

Rev	By	Date	Description

Drawing Number: 9801 SK GSHP Masterplan
Rev: ~

Project
Aston Hall Barns
Job No. 9801

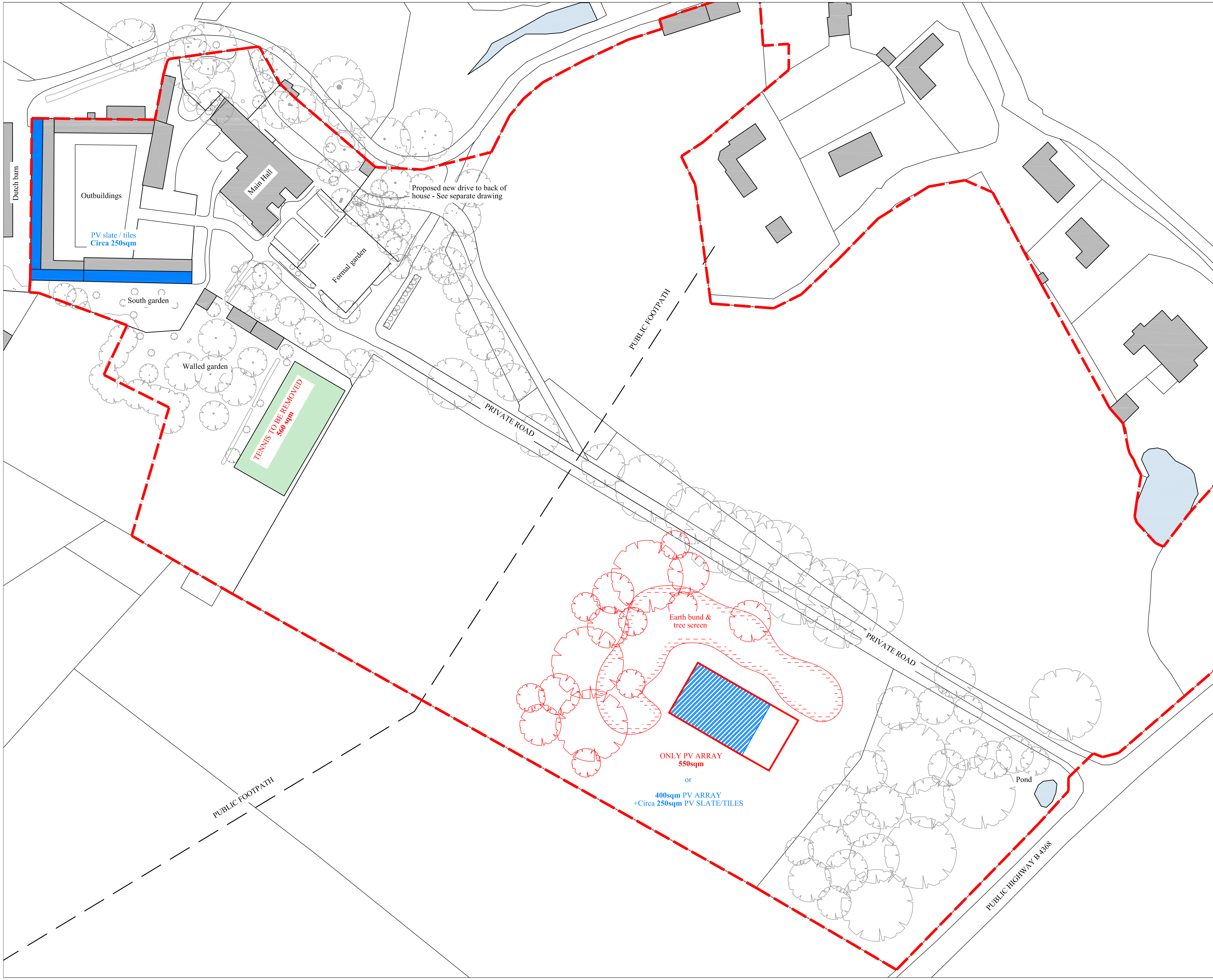
Title
GSHP - Ground installations

Drawn: GB | Checked: GQ
Date: 02 2021 | Scale: 1:1000 @ A3

Giles Quarme Architects
Historic Building Architects & Consultants

7 Bishops Terrace
London
SE11 4UE

020 7582 0748
www.quarme.com
mail@quarme.com



Notes

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Drawing Notes:

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- Units are meters.
- Survey accuracy with a scale of 1:100.

Part of this plan is not surveyed but deducted from OS map.

KEY

- Property boundary
- PV array only 550 sqm (33x16.5m)
- PV array combined with PV slate/tiles on roof 400 sqm (24x16.5m)
- PV slate/tiles Circa 250sqm (South & West slope)

NOTE: Calculations based on 3 days battery recharging.

N

1:1000 0 10 20 30 40m

PRE-APP SUBMISSION

Rev	By	Date	Description

Drawing Number: 9801 SK PV Masterplan
Rev: ~

Project: Aston Hall Barns
Job No. 9801

Title: PV - Ground / Roof installations

Drawn: GB
Checked: GQ
Date: 02 2021
Scale: 1:1000 @ A3

Giles Quarme Architects
Historic Building Architects & Consultants

7 Bishops Terrace
London
SE11 4UE

020 7582 0748
www.quarme.com
mail@quarme.com