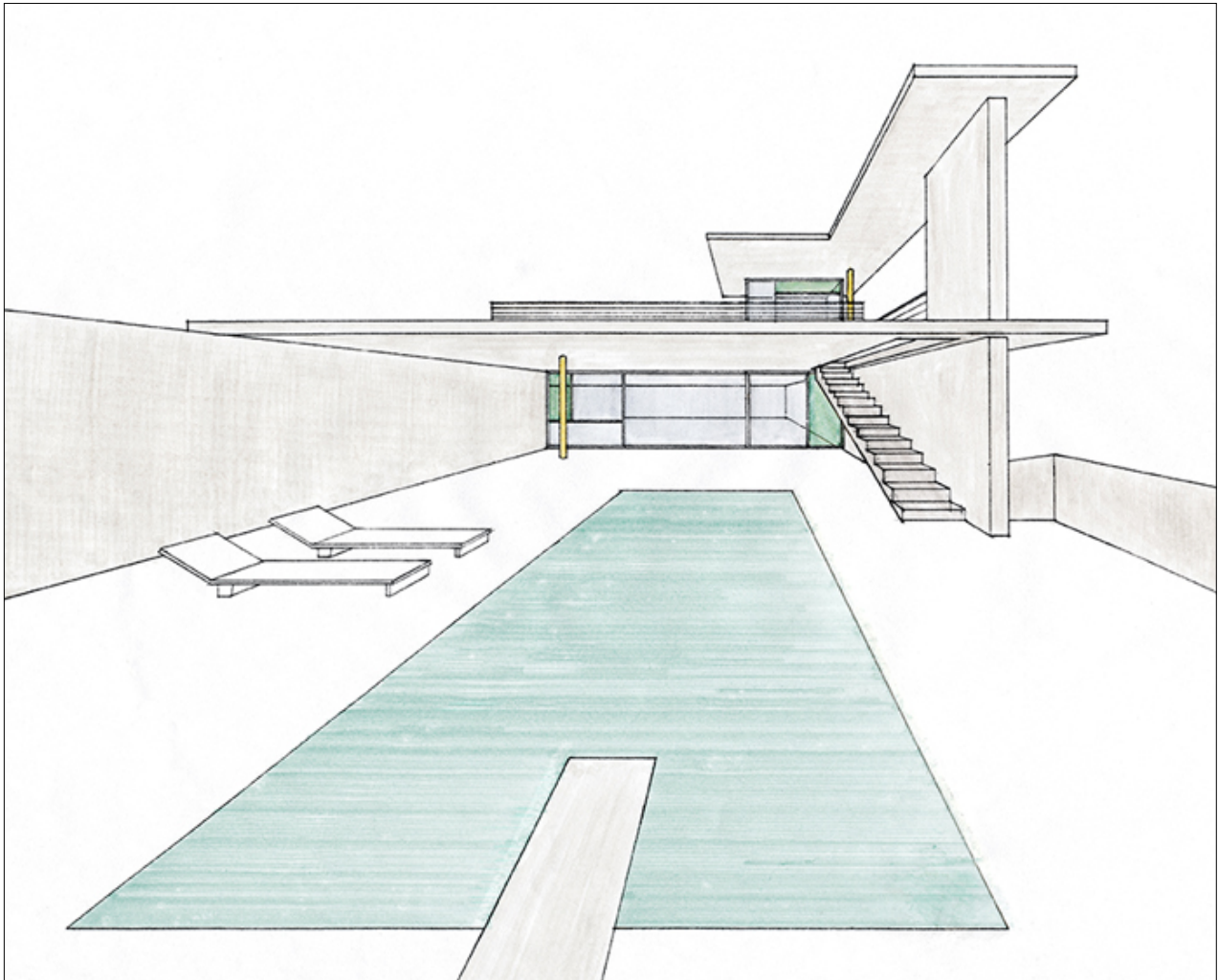




Building Services 2

Prepared for: Ian Brown

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Submission date: 21 January 2026

INTRODUCTION

This report presents the Mechanical and Electrical (M&E) services design for a proposed new-build domestic dwelling located in Wales, identified as House Type HT 641. The dwelling is a two-storey, four-bedroom house with an approximate gross internal floor area of 110 m². The purpose of the report is to demonstrate the selection, justification, and integration of appropriate mechanical, electrical, ventilation, and public health services for a typical Welsh new-build home.

This submission has been prepared as a university academic assignment and therefore clearly states all assumptions made during the design process. While the report is influenced by a professional M&E consultancy format, it does not interpret a full commercial design. The emphasis is placed on technology selection, regulatory compliance, building performance, and whole-life implications, rather than detailed construction-level calculations.

The services strategy has been developed in accordance with Welsh Building Regulations, the Welsh Housing Quality Standard (WHQS 2023), and current industry best practice guidance, particularly from the Chartered Institution of Building Services Engineers (CIBSE). In addition, the principles of the Passivhaus standard are referenced as a performance benchmark for low-energy building design, rather than as a mandatory certification requirement. This approach enables the design to target high levels of energy efficiency and occupant comfort without the cost and complexity associated with formal Passivhaus certification (Passivhaus Institut, 2015; UK Passivhaus Trust, 2022).

REGULATORY AND POLICY CONTEXT

The Welsh Government has established a clear policy direction towards low-carbon housing and reduced operational energy use. New dwellings are expected to contribute to national decarbonisation targets while remaining affordable and comfortable for occupants. These objectives are embedded within the Welsh Building Regulations and reinforced by the Welsh Housing Quality Standard.

The proposed services design responds directly to the requirements of Approved Document L (Wales), which promotes energy efficiency and low-carbon heating systems (Welsh Government, 2022). Approved Document F (Wales) governs ventilation provision and recognises that airtight dwellings require mechanical ventilation to maintain indoor air quality (Welsh Government, 2020). Approved Document G (Wales) informs the design of domestic hot water systems, including scald protection and water efficiency (Welsh Government, 2021). Approved Document H addresses above and below ground drainage systems and access for maintenance (HM Government, 2021). Approved Document B (Wales) requires domestic fire suppression systems in all new dwellings, making sprinkler installation a mandatory design consideration (Welsh Government, 2019).

The Welsh Housing Quality Standard further requires homes to be economical to heat, thermally comfortable, environmentally responsible, and durable over their lifespan (Welsh Government, 2023). These combined regulatory and policy drivers support low-temperature heating systems, mechanical ventilation with heat recovery, efficient hot water provision, and high-efficiency electrical systems.

DESIGN ASSUMPTIONS AND LIMITATIONS

As stated previously, this is an academic design exercise, several assumptions have been made. The dwelling is assumed to achieve high fabric performance consistent with current Welsh Building Regulations, including good levels of insulation and airtightness. Occupancy is assumed to reflect a typical family household with standard patterns of space heating and domestic hot water use. Ground conditions are assumed to be suitable for infiltration drainage, subject to confirmation through site investigation.

HEATING SYSTEM DESIGN

System Selection and Rationale

The dwelling is heated by an air source heat pump (ASHP) serving a hybrid heat emitter system comprising wet underfloor heating at ground floor level with additional low-temperature radiators at ground floor level, where as the first floor comprises of only low-temperature radiators. Domestic hot water is provided via an indirect hot water cylinder heated by the ASHP.



Air source heat pumps are prioritised within Approved Document L (Wales) as a low-carbon heating solution capable of delivering significant reductions in operational carbon emissions compared with fossil fuel systems (Welsh Government, 2022). ASHPs typically achieve seasonal coefficients of performance between 3 and 4, meaning that three to four units of heat are delivered for every unit of electrical energy consumed (CIBSE, 2023). This makes them particularly suitable for new-build dwellings with good fabric performance.

Ground Floor Underfloor Heating

Wet underfloor heating is installed within the insulated ground floor slab and serves the lounge, kitchen/dining area, hall, and associated ancillary spaces. The system is divided into two independently controlled zones to reflect different patterns of occupancy and heat demand.

Underfloor heating operates at low flow temperatures, typically between 35 °C and 45 °C, making it highly compatible with heat pump technology (CIBSE, 2021). The system provides even radiant heat distribution, reduces stratification, and improves perceived thermal comfort. This allows lower internal air temperatures to be maintained while achieving the same comfort levels, reducing energy consumption (CIBSE, 2020).

The use of underfloor heating aligns with Passivhaus-informed design principles, which emphasise low heat demand, reduced distribution losses, and improved comfort through radiant heat transfer (Passivhaus Institut, 2015). A recognised limitation of underfloor heating is its slower thermal response; however, this is mitigated through continuous low-temperature operation and effective zoning and controls.

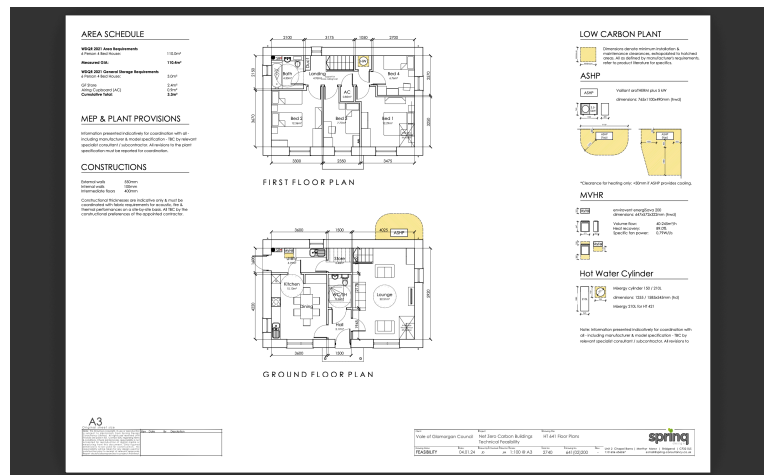
First Floor Radiators

Low-temperature steel panel radiators are provided to all first-floor bedrooms, the bathroom, hallway, and utility spaces. Radiators are selected and sized to operate efficiently at reduced flow temperatures consistent with ASHP operation, in accordance with CIBSE domestic heating guidance (CIBSE, 2021).

Thermostatic radiator valves are installed throughout to provide local temperature control and prevent overheating. This approach avoids complex first floor floor build-ups while maintaining acceptable system efficiency. Although radiators operate at slightly higher temperatures than underfloor heating, careful sizing ensures that overall heat pump performance remains efficient. Please refer to Appendix A

Heating Controls

Time and temperature zoning is provided via programmable room thermostats controlling the underfloor heating zones, while weather compensation is managed by the ASHP controller. Weather compensation adjusts flow temperature in response to external conditions, improving seasonal efficiency and comfort (CIBSE, 2020).



This control strategy complies with Part L requirements for energy-efficient control systems and supports WHQS objectives by reducing energy consumption and running costs.

DOMESTIC HOT WATER SYSTEM

Domestic hot water is provided via an insulated indirect hot water cylinder with a storage capacity of approximately 180–210 litres. The cylinder is heated by the air source heat pump and specified with high-performance factory applied insulation to minimise standing heat losses.

Approved Document G (Wales) requires measures to prevent scalding and promote efficient water use. Thermostatic mixing valves are therefore installed to limit outlet temperatures at sanitary fittings (Welsh Government, 2021). While heat pump-heated cylinders can have longer reheat times than gas-fired alternatives, appropriate cylinder sizing and control strategies mitigate this limitation (MCS, 2021).

VENTILATION STRATEGY

System Selection

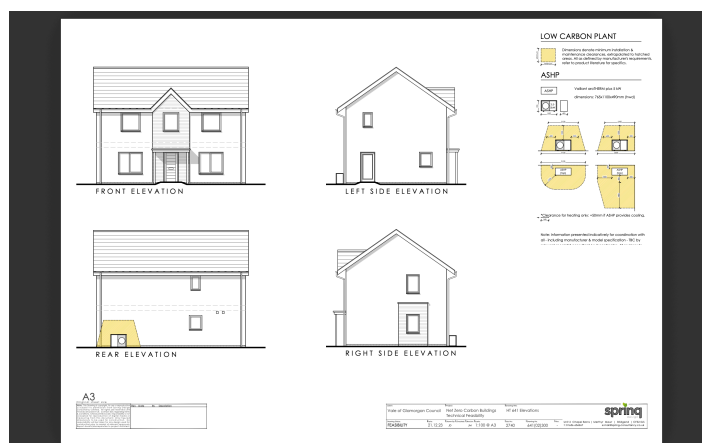
A whole-house Mechanical Ventilation with Heat Recovery (MVHR) system is specified to serve the dwelling. In airtight buildings, natural infiltration is insufficient to maintain acceptable indoor air quality, and Approved Document F (Wales) therefore necessitates mechanical ventilation (Welsh Government, 2020).

MVHR systems recover heat from extracted air and transfer it to incoming fresh air, achieving heat recovery efficiencies of up to 90% (CIBSE, 2020). This significantly reduces ventilation heat losses and contributes to reduced space heating demand.

System Layout and Performance

Supply air is delivered to habitable spaces including the lounge and bedrooms, while extract air is removed from moisture- and pollutant-generating spaces such as the kitchen, utility room, WC, and bathroom. Ductwork is routed through ceiling voids and service zones to minimise visual impact and coordination conflicts, in line with CIBSE Guide B2 (CIBSE, 2020).

Although MVHR systems have higher capital costs than extract-only systems, whole-life assessments demonstrate that reduced heating demand, improved indoor air quality, and enhanced comfort justify the investment (CIBSE, 2020; NHBC, 2021). A key limitation is the requirement for regular maintenance, including filter replacement, to maintain system performance.



Drainage Design

Above-ground drainage is designed in accordance with Approved Document H and comprises a single soil vent pipe serving all sanitary appliances venting vertically through the roof. Branch connections are trapped, and rodding access is provided at the base of the stack to facilitate maintenance and blockage clearance (HM Government, 2021).

Below ground drainage is arranged as separate foul and surface water systems. Waste pipes are laid to a consistent fall of approximately 1:40 toward inspection chambers located at changes in direction and junctions. Surface water is discharged to a soakaway system, subject to confirmation of ground conditions. Soakaway design follows the principles set out in BRE Digest 365, which provides guidance on infiltration testing, sizing, and minimum distances from buildings (5 meters) (BRE, 2016). This approach aligns with sustainable drainage principles and reduces the burden on public sewer infrastructure (CIRIA, 2015).

Fire Suppression System

In Wales, domestic fire suppression systems are mandatory in all new dwellings under Approved Document B (Wales). A residential sprinkler system is therefore installed throughout the dwelling, incorporating concealed sprinkler heads within circulation spaces and habitable rooms, together with a dedicated control valve and test point (Welsh Government, 2019).

Evidence indicates that domestic sprinkler systems significantly reduce fire-related fatalities and property damage, improving overall building resilience and occupant safety (Welsh Government, 2016). While sprinkler systems introduce additional capital cost, their inclusion is a regulatory requirement and contributes positively to whole-life performance. Sprinkler system responsibility falls with the Fire safety consultant. Confirmation is required through a Fire strategy in conjunction with this report.

ELECTRICAL SERVICES

Lighting

Lighting throughout the dwelling is provided using high-efficiency LED luminaires. LED lighting offers high luminous efficacy, long service life, and low maintenance requirements, supporting Part L energy targets and whole-life cost reduction (CIBSE, 2020).

Lighting circuits are zoned by floor, with switching located logically at room entrances and circulation points to improve usability and energy efficiency. External lighting is specified with appropriate ingress protection ratings.



Small Power and Telecoms

Socket outlets are provided throughout the dwelling in quantities exceeding minimum regulatory requirements due to the lack of presents of the client, supporting modern living patterns and WHQS functionality standards. Dedicated fused spurs are provided for fixed appliances and mechanical systems.

Structured data cabling and television outlets are installed to the living room rooms to support home working, digital connectivity, and future smart energy systems. The property will function via wireless internet (WI-FI). Although this doesn't future-proofs the dwelling, the hopes are for technology to improve, therefore compensate for the lack of digital outlets.

Life Safety Systems

Mains-powered, interlinked smoke alarms are installed throughout the dwelling, with a heat detector provided within the kitchen. This arrangement provides comprehensive life safety coverage and integrates with the sprinkler system to enhance occupant protection.

Whole-Life Performance and Sustainability

Although the proposed services strategy results in higher initial capital costs due to the inclusion of an ASHP, underfloor heating, and MVHR, it delivers significantly reduced running costs, very low operational carbon emissions, and excellent thermal comfort. The system is compatible with a future decarbonised electricity grid and supports long-term sustainability objectives (CIBSE, 2020; Welsh Government, 2023).

Whole-life assessment demonstrates that reduced energy consumption and maintenance costs can offset higher initial expenditure over the building's lifespan, supporting WHQS affordability metrics.

Critical Evaluation of Alternative Systems

Alternative services strategies were considered, including gas boiler heating with radiators, direct electric heating, and underfloor heating to both floors. Gas boiler systems offer lower capital cost but are incompatible

with long-term carbon reduction targets and Welsh policy. Direct electric heating has low initial cost but results in high running costs and poor affordability. Full underfloor heating would offer optimal thermal performance but at increased capital cost and construction complexity.

The selected hybrid ASHP, UFH, and radiator strategy provides the most appropriate balance between performance, cost, and constructability.

Conclusion

This Mechanical and Electrical services design provides a robust, regulation-compliant, and future-proof solution for a modern Welsh dwelling. By combining an air source heat pump, ground floor underfloor heating, low-temperature radiators, mechanical ventilation with heat recovery, efficient domestic hot water provision, and modern electrical systems, the design meets the intent of Welsh Building Regulations, WHQS requirements, and Passivhaus-informed performance benchmarks.

The proposal prioritises carbon reduction, occupant comfort, affordability in use, and long-term sustainability, demonstrating best-practice domestic building services engineering appropriate to Wales's low-carbon housing agenda.

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APPENDICES

APPENDIX A – PRODUCT SPECIFICATION SCHEDULE

The following products are representative examples selected to demonstrate appropriate technology choices for the proposed dwelling. Equivalent products from alternative manufacturers may be used, subject to compliance with relevant standards.

System	Item	Product Description	Manufacturer	Example Product	Web Link
Heating	Air Source Heat Pump	Monobloc ASHP suitable for low-temperature heating and DHW	Mitsubishi Electric	Ecodan Monobloc (≈8.5 kW)	https://les.mitsubishielectric.co.uk/products/renewable-heating/air-source-heat-pumps/ecodan
Heating	UFH Pipe	16 mm multilayer underfloor heating pipe (oxygen barrier)	Uponor	Comfort Pipe PLUS 16x2.0 mm	https://www.uponor.com/en-gb/products/heating-and-cooling/underfloor-heating-pipes
Heating	UFH Manifold	Stainless steel manifold with flow meters	Uponor	Vario S Manifold	https://www.uponor.com/en-gb/products/underfloor-heating-manifolds
Heating	UFH Controls	Programmable room thermostat (zoned control)	Heatmiser	neoStat V2	https://www.heatmiser.com/en/neo/
Heating	Radiators	Low-temperature steel panel radiators	Stelrad	Compact Type 21 / 22	https://www.stelrad.com/radiators/compact/
Heating	Towel Radiator	Chrome ladder towel radiator	Reina	Diva	https://www.reinaradiators.com/products/diva/
DHW	Hot Water Cylinder	ASHP-compatible insulated cylinder	Joule	Cyclone HP – 210 L	https://www.joule.ie/products/cylinders/heat-pump-cylinders/
Ventilation	MVHR Unit	Whole-house mechanical ventilation with heat recovery	Zehnder	ComfoAir Q350	https://www.zehnder.co.uk/en/ventilation/comfort-ventilation-units/comfoair-q

Ventilation	MVHR Ducting	Semi-rigid radial duct system	Zehnder	ComfoTube 75	https://www.zehnder.co.uk/en/ventilation/ducting-systems
Ventilation	Supply/Extract Valves	Ceiling mounted supply and extract air valves	Zehnder	ComfoValve Luna	https://www.zehnder.co.uk/en/ventilation/air-distribution/air-valves
Electrical	Socket Outlets	White moulded switched socket outlets	MK Electric	Logic Plus	https://www.mkelectric.com/products/wiring-devices/logic-plus
Electrical	Light Switches	1G / 2G / 3G light switches	MK Electric	Logic Plus	https://www.mkelectric.com/products/wiring-devices/logic-plus
Electrical	Consumer Unit	Consumer unit with surge protection	Hager	Design 10 CU	https://www.hager.co.uk/consumer-units
Electrical	Smoke Alarm	Mains-powered optical smoke alarm	Aico	Ei3016	https://www.aico.co.uk/product/ei3016/
Electrical	Heat Alarm	Mains-powered heat detector (kitchen)	Aico	Ei3014	https://www.aico.co.uk/product/ei3014/
Electrical	Cooker Switch	45A cooker control unit	MK Electric	Logic Plus 45A	https://www.mkelectric.com/products/logic-plus
Drainage	Soil Pipe (Above Ground)	110 mm uPVC soil and vent pipe	Polypipe	Terrain System	https://www.polypipe.com/above-ground-drainage
Drainage	Underground Drainage	110 mm uPVC foul drainage system	Brett Martin	Underground Drain	https://www.brettmartin.com/drainage/underground-drainage
Drainage	Inspection Chamber	450 mm inspection chamber	Brett Martin	IC Base	https://www.brettmartin.com/drainage/inspection-chambers
Drainage	Soakaway System	Modular geocellular soakaway crates	Polypipe	Polystorm	https://www.polypipe.com/underground-drainage/soakaways
Fire Safety	Sprinkler System	Domestic residential sprinkler system	Generic (BS 9251)	Concealed heads	https://www.gov.wales/fire-safety-guidance-domestic-sprinklers

Appendix B – Electrical & Small Power Item Tally

SMALL POWER

- Single switched socket outlets: **12 no.**
- Double switched socket outlets: **18 no.**
- Switched fused spur (towel rail): **2 no.**
- Switched fused spur (fixed appliances): **3 no.**
- Cooker control switch: **1 no.**
- Consumer unit: **1 no.**

LIGHTING & CONTROLS

- Ceiling light points (pendant/LED): **14 no.**
- Internal wall lights: **3 no.**
- External wall lights: **2 no.**
- LED batten (kitchen): **1 no.**
- 1-gang light switches: **6 no.**
- 2-gang light switches: **5 no.**
- 3-gang light switches: **2 no.**

LIFE SAFETY & TELECOMS

- Combined smoke/heat detector & sounder: **5 no.**
- TV aerial outlets: **3 no.**
- Cat 5/6 data outlets: **4 no.**
- Doorbell push: **1 no.**
- Doorbell chime: **1 no.**

Appendix C – Technical Description of Systems & Materials

HEATING PIPEWORK

Underfloor heating pipework consists of 16 mm multilayer PERT/AL/PERT pipe, clipped to insulation panels within the ground floor slab. This pipe type offers low thermal expansion, oxygen diffusion resistance, and long service life. First floor heating pipework to radiators is assumed to be insulated plastic barrier pipe routed within floor voids and partitions.

HOT & COLD WATER SERVICES

Domestic hot and cold water services are distributed using insulated plastic barrier pipework (e.g. PEX or multilayer). Pipework is routed through ceiling voids and service zones, with vertical risers feeding the first-floor bathroom and cylinder. Insulation is provided to reduce heat loss and prevent condensation.

DRAINAGE PIPEWORK

Above-ground drainage uses 110 mm uPVC soil pipe with solvent-welded joints. Branch connections are trapped and ventilated via a single soil vent stack. Below-ground foul drainage uses 110 mm uPVC pipework

laid to a minimum fall of 1:40, in accordance with Approved Document H. Inspection chambers are provided at changes in direction and junctions.

Surface water drainage is discharged to a modular soakaway system, located at a suitable distance from the dwelling in accordance with BRE Digest 365. Final soakaway size and depth are subject to infiltration testing.

MVHR DUCTWORK

MVHR ductwork comprises 150 mm diameter main ducts reducing to 75 mm semi-rigid radial branches.

Ducts are routed through ceiling voids and partition walls to minimise visual impact. Acoustic attenuation is provided where required to reduce noise transmission.

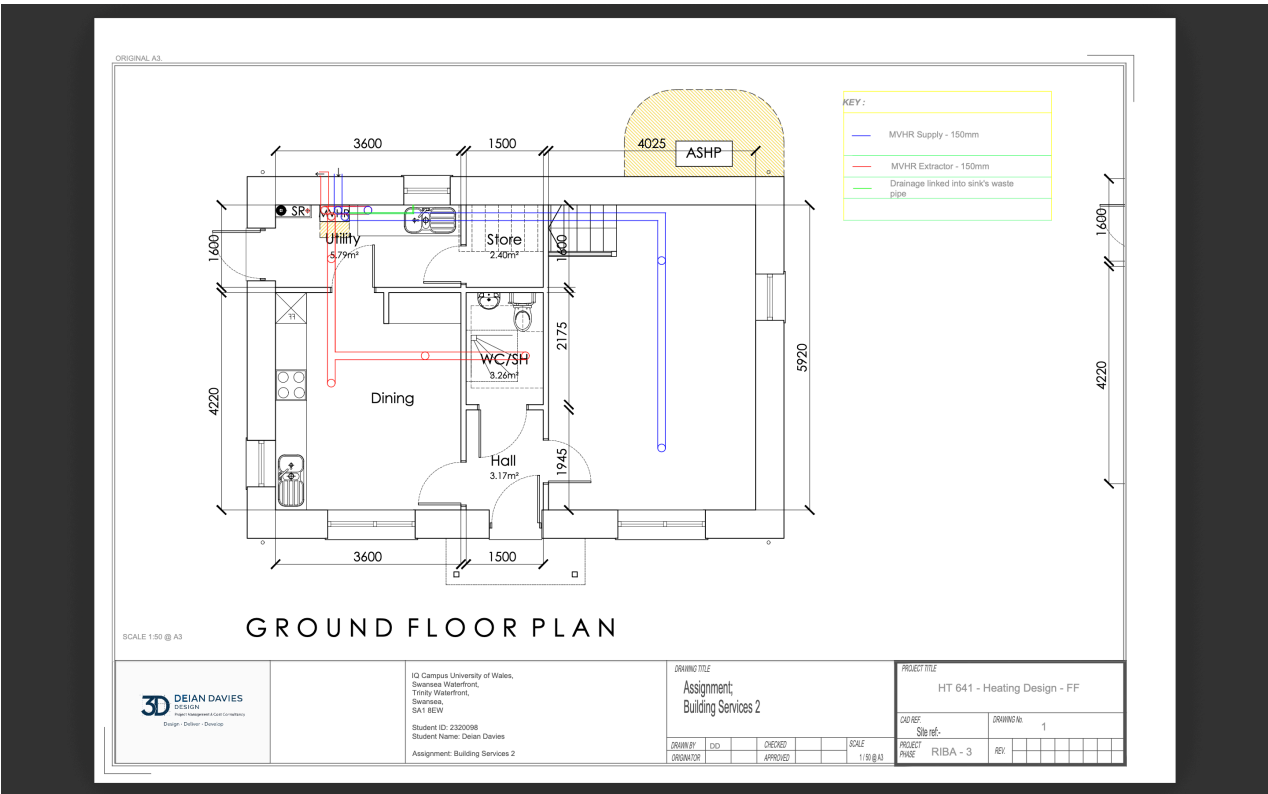
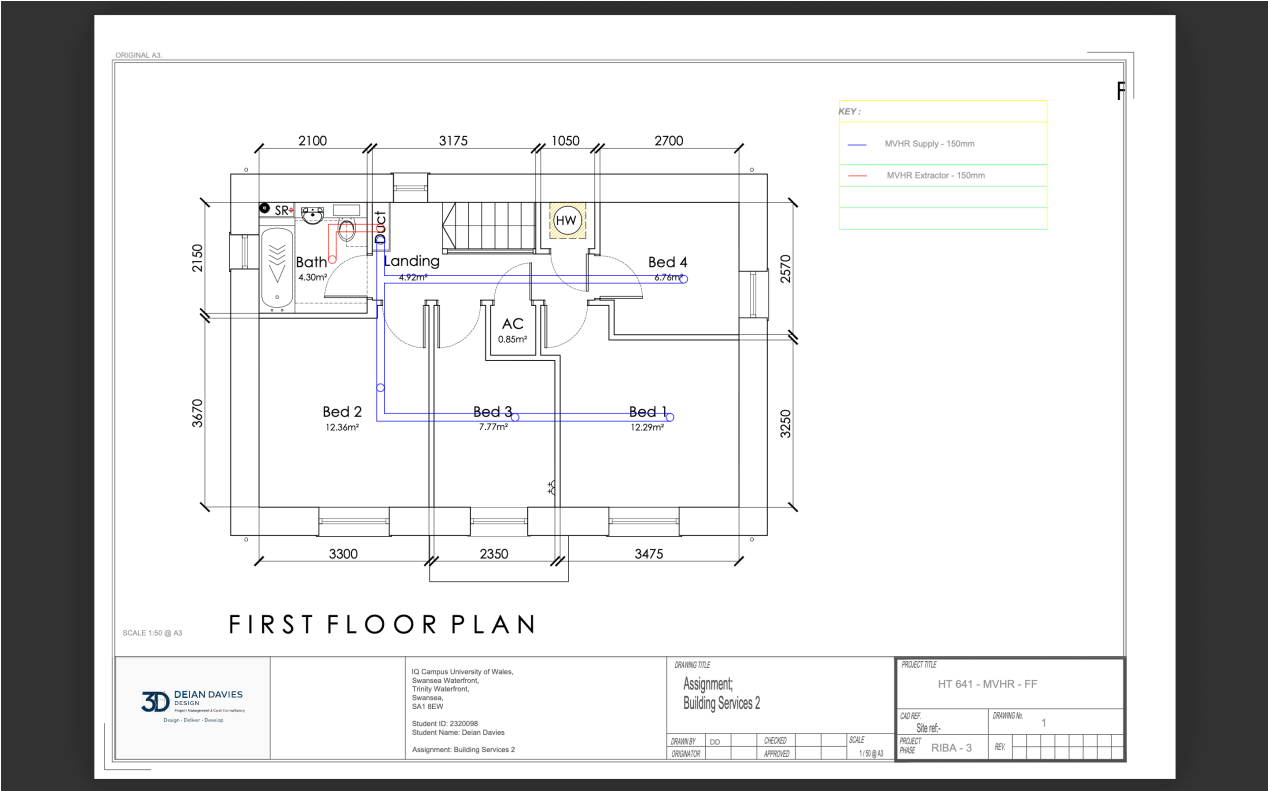
FIRE SUPPRESSION

A residential sprinkler system is installed in accordance with Approved Document B (Wales). It's assumed that the system uses concealed sprinkler heads supplied from a dedicated domestic water connection, with an isolation valve and test point provided. This is subject to a fire strategy report.

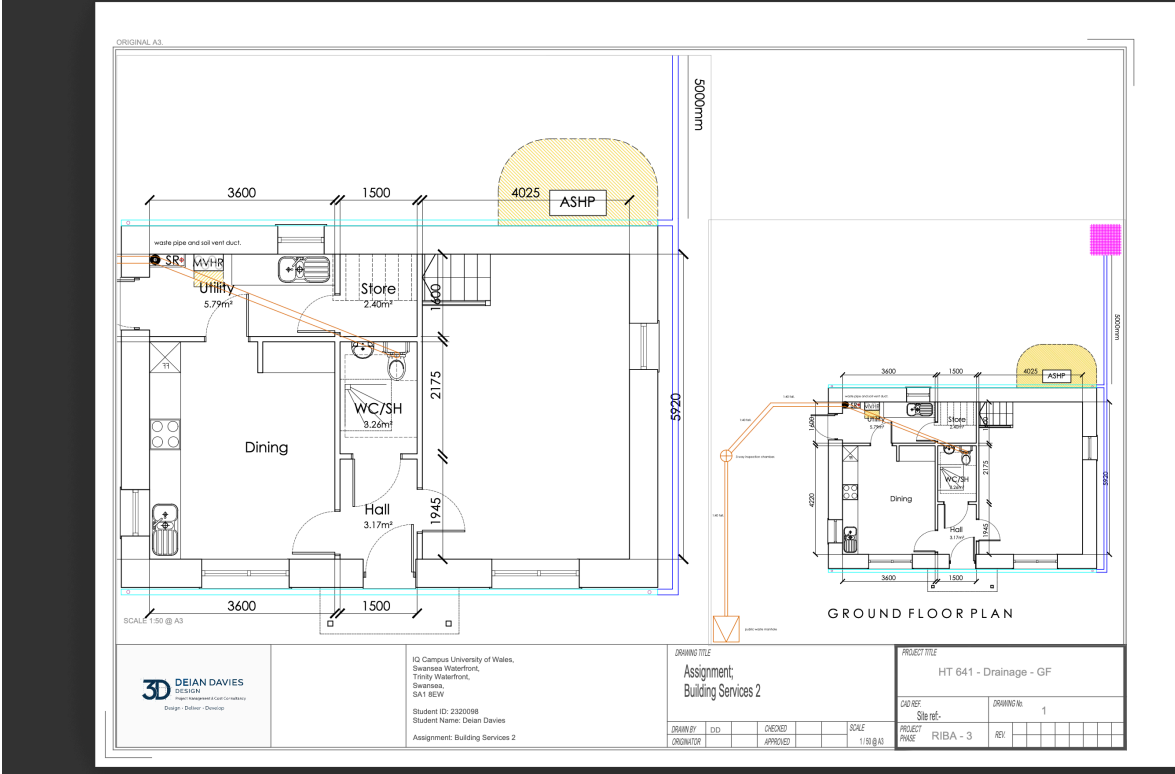
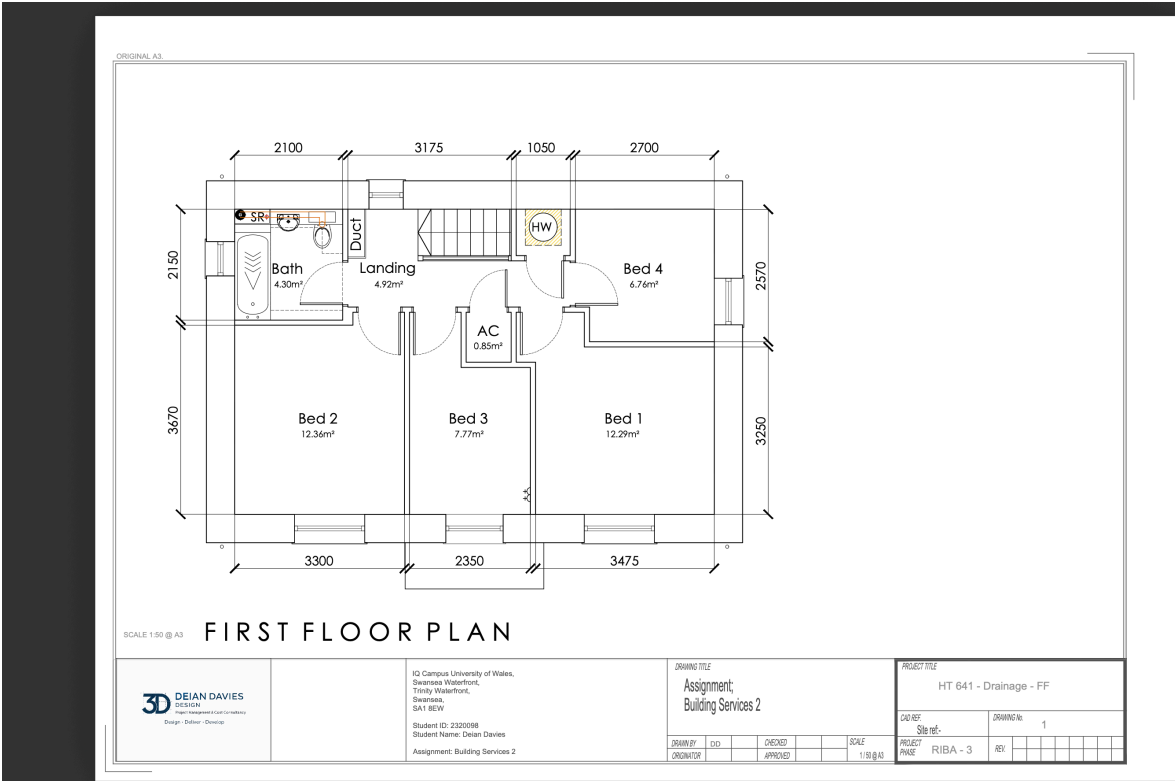
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Appendix D - M&E Drawings

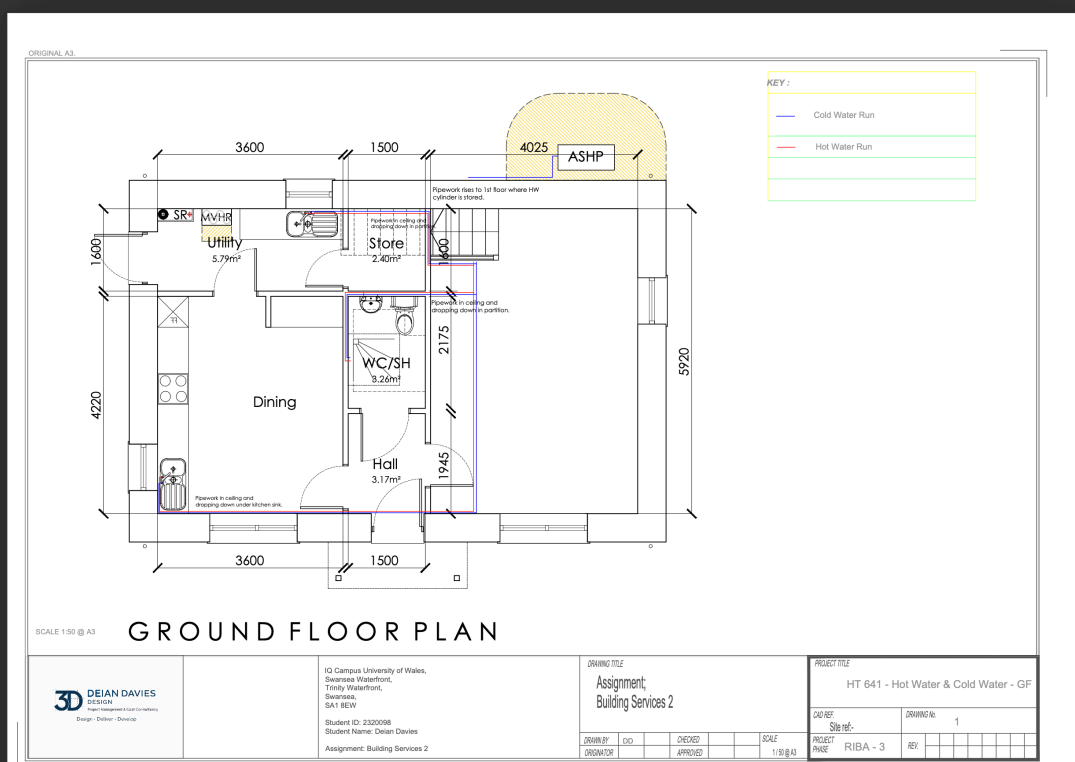
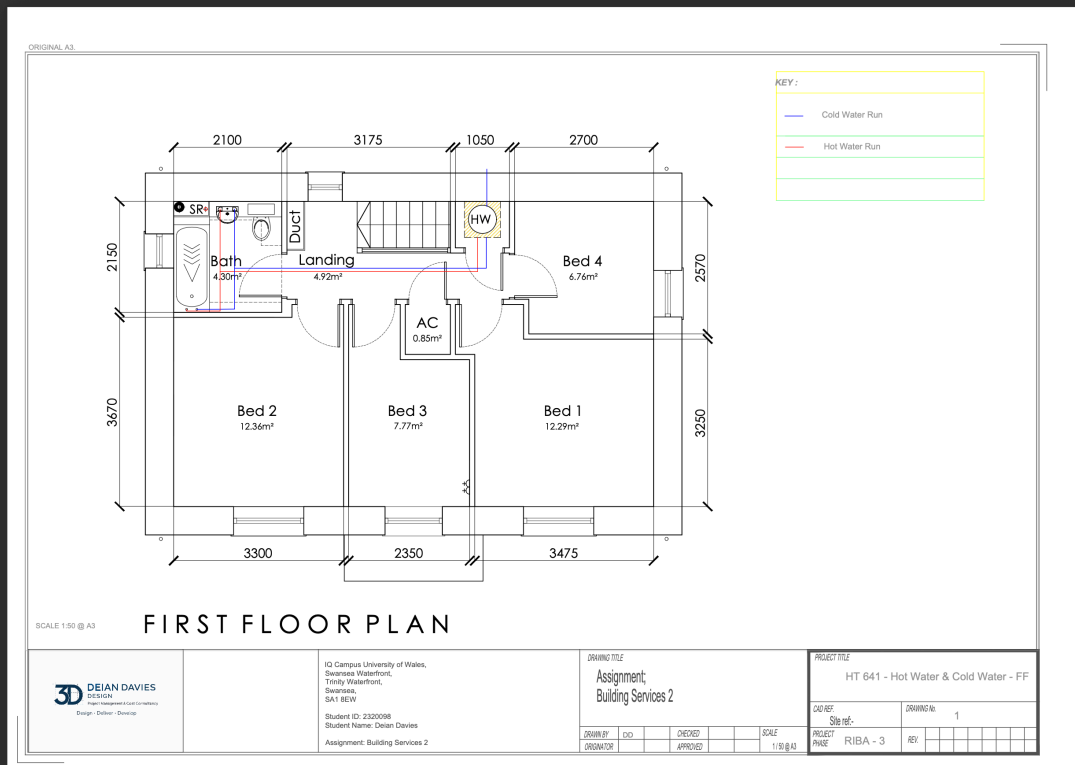
MVHR



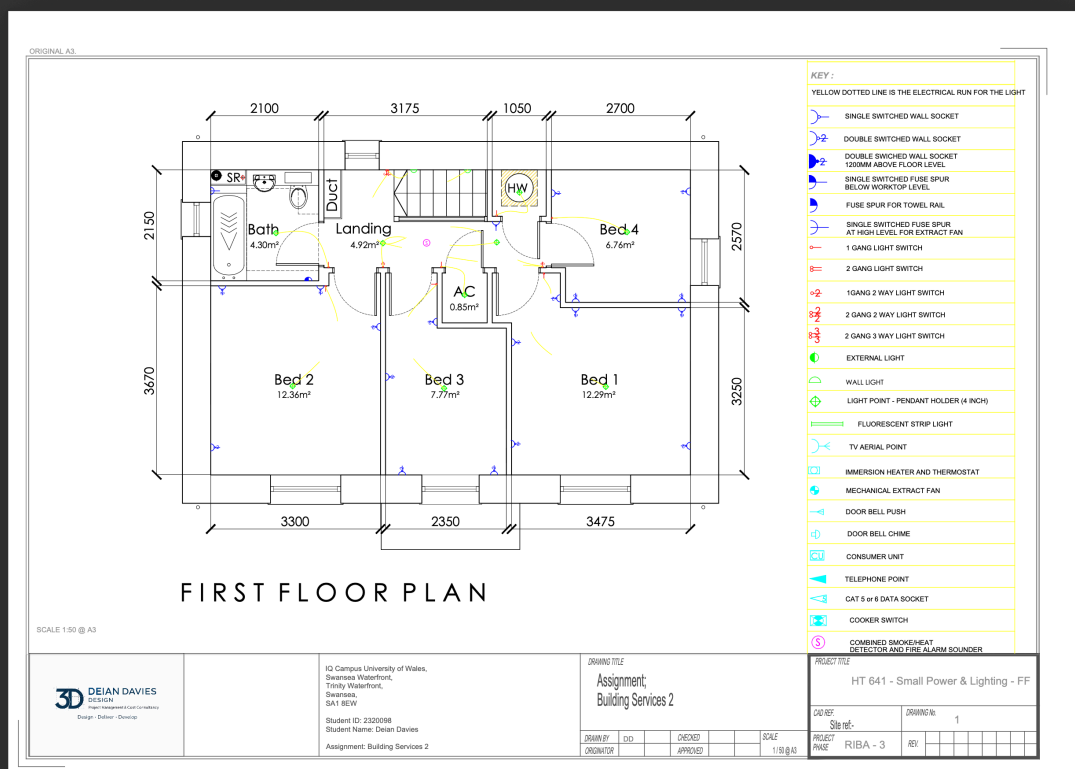
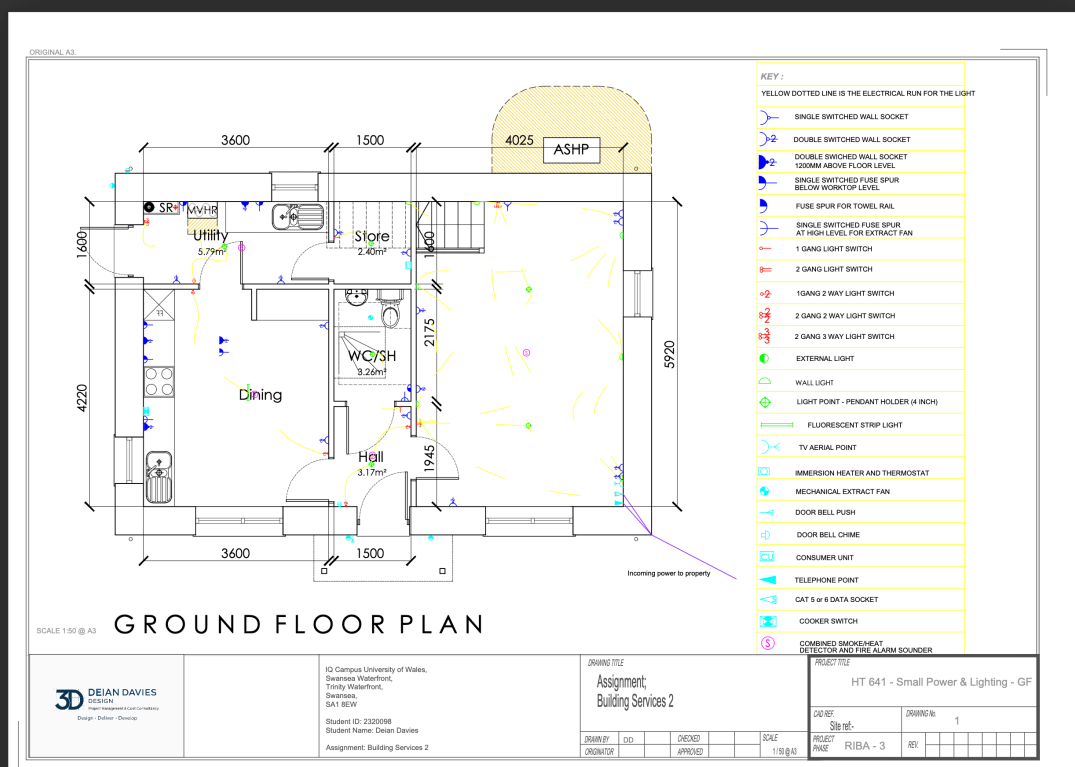
ABOVE AND BELOW DRAINAGE



HOT AND COLD WATER RUN



SMALL POWER AND LIGHTING



HEATING

