Active Building Centre

Stroud District Council

Zero Carbon Public Estate programme

Building Performance Evaluation Report

STROUD DISTRICT COUNCIL

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Introduction

The Zero Carbon Public Estate Project is about rationalising, repurposing and retrofitting the public estate to create new homes, jobs and work towards a net zero carbon future. The project will explore how the public estate in Stroud can deliver these aims whilst reducing carbon emissions, providing a model that is replicable and scalable for others to use.

In line with this the Active Building Centre (ABC) was commissioned by Stroud District Council (SDC) to support this work by assessing the feasibility of upgrading the more traditional (pre1920) buildings in the OPE project, including producing a methodology as a learning tool to take forward the retrofitting of older commercial properties.

Project Details

Project title: One Public Estate

Primary ABC project team:

- Dr Jo Atkinson – Head of Building Engineering
- Gayathri Nair – Building Physics Engineer
- Deepak Sadhwani – Building Physics Engineer
- Aly Farrag – Building Physics Engineer

The ABC is delivering support to SDC over two work-packages:

Work package 1 – Pre-feasibility study

- Initial desk-based study of four buildings (Old Town Hall, Ebley Mill, Subscription Rooms and Lansdown Hall)
- Develop methodology to assess the feasibility of upgrading the existing estate

Work-package 2 – Feasibility study

- Test the methodology on a pilot building (Old Town Hall)

The feasibility study includes an on-site survey to assess the Old Town Hall to identify potential upgrade measures, an appraisal of the existing and post-upgrade energy performance, and the whole life carbon (WLC) and lifecycle costs (LCC) of the upgrade measures.

Building Performance Evaluation

The initial desk-based study and the on-site survey incorporate the requirements set out in the British Standard for undertaking a Building Performance Evaluation (BPE). The most relevant British Standard is BS 40101: 2022 Building performance evaluation of occupied and operational buildings (using data gathered from tests, measurements, observation, and user experience) – Specification. The desk-based study followed the approach for a preliminary BPE. This resulted in identifying that an investigative BPE was required as part of the feasibility study.

An investigative BPE is not prescriptive in the assessments that are undertaken. It therefore allows for the focus to be on key aspects of the building that may need to be assessed. The preliminary BPE identified that the condition of the Old Town Hall dictated that this needed to be a key focus of the site survey.

Therefore, **the purpose of the BPE is to identify degradation in the building fabric or any areas of concern, that can contribute towards the poor thermal performance of the building.** It also aims to understand the interior and exterior environments of the building. These insights can provide further understanding of the building performance. The findings from this study can then be used as the basis for rectifying the identified issues within the building.

This report sets out the results of the full BPE for the Old Town Hall and includes:

- Property details for the Old Town Hall, including the building parameters
- A summary of the occupant survey results
- The energy performance (this is being supplemented by additional energy and thermal modelling)
- The investigative BPE survey methodology
- The findings from the survey
- Advice on the way forward

The Old Town Hall: Building parameters

The Old Town Hall is a Grade II* listed building located in The Shambles, Stroud, Gloucestershire. The building faces West. It is owned and managed by Stroud District Council (SDC).

Figure 1: Map to identify location of the Old Town Hall

Originally built in 1596, it had a large extension added in the mid-19th century. The extension almost doubled the size of the building. At 427 years old it has been used for a variety of different purposes, including a marketplace, spinning house and school[1]. Today, its primary use is as a shared community building, comprising offices, a large meeting room / hall and outdoor market storage.

Figure 2: View from the Church gate (front)

Figure 3: View from Church Street car park (rear)

1 https://www.british-history.ac.uk/vch/glos/vol11/pp104-111

The total internal floor area of the building is circa. 462 square meters across two floors. It has the capacity to accommodate up to 88 occupants; 60 people in the meeting room, 16 people in the first-floor offices and 12 people in the ground floor offices. Currently the building is not operating at full capacity. Only the ground floor offices have tenants, and they use them on Mondays and Fridays. The meeting room is leased to local community groups and residents on an ad-hoc basis, as required.

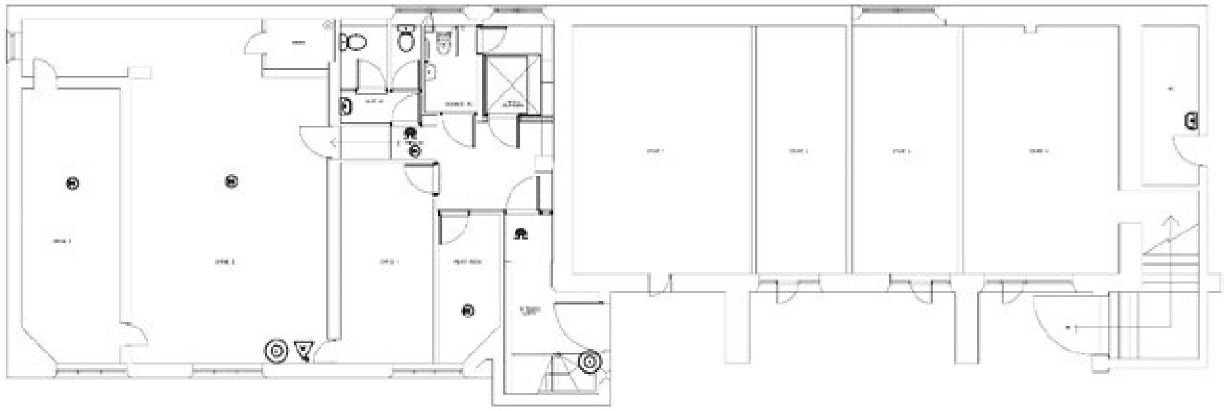


Figure 4: Ground Floor plan of the Old Town Hall

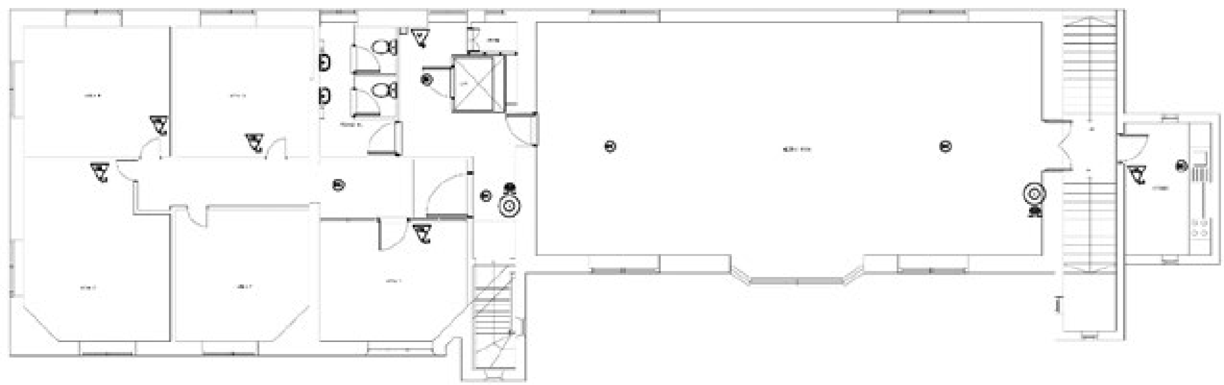


Figure 5: First Floor plan of the Old Town Hall

A summary of the general building parameters collected as part of the preliminary BPE are set out in Table 1 below. These details were obtained from SDC via a checklist setting out the information ABC required. Additional information provided included previous condition survey reports undertaken in 2007 and 2016. The details of any actions and recommendations implemented, which were set out in these reports, were cross-checked with SDC to establish a current indicative status of the building.

Table 1: Old Town Hall Building Parameters summary.

Type	Community building
Owner	Stroud District Council
Purpose	Town Hall (public building) – Offices, rooms to hire for events and market stall storage
Age	Built-in 1596
Heritage status	Grade II* listed
Extensions	Added in mid-1800s
Location	The Shambles, Stroud, GL5 1AP
Orientation	West facing
Condition	Different areas are poor, satisfactory and good (2007 and 2016 reports)
Floor Area	462 sq meters (internal floor area)
Number of floors	Two floors
Building Occupancy	Hours: 08:00-18:00 Capacity: 88 occupants • Ground Floor Offices- 12 persons • First Floor Offices- 16 persons • Meeting room- 60 persons Note: currently, the building is not occupied at full capacity

From the information provided by SDC, an overview of the construction and systems were established, as set out in Table 2 below. This information concluded that the Old Town Hall is of traditional construction. This means that traditional materials, including stone, lime, slate and timber were used to build the Old Town Hall. However, the previous survey reports indicate that modern materials have been used in works that have been undertaken in the last century.

Table 2: Construction and systems parameters

External Walls	Type: Solid Stone Thickness: 300-610mm (no insulation)
Roof	Type: Mix of timber framed pitched tiled and slated roofs and timber framed bituminous felted and lead-covered flat roofs Thickness: Insulation of 250 mm glass fibre in the pitched roof and 100 mm Celotex in the flat roof
Floor	Mix of solid and suspended timber floors
Heating	Primary space heating type/ fuel: Gas condensing boilers (mains gas) Secondary space heating type/ fuel: Oil and electric freestanding / portable heaters Comments: Traditional cast iron radiators fed from single pipe system- TRVs to radiators. Boiler timer clock
Ventilation	Natural
Lighting	Halogen and Tungsten fittings to the meeting room and main hall, respectively
Hot water	Instantaneous water heaters
Lift	1-platform passenger lift

Occupant Survey

An occupant survey is a fundamental part of a BPE. It is an effective method for establishing perceptions and experiences of the people who use the buildings being assessed. The ABC developed an occupant survey questionnaire, based on the example set out in BS 40101. The questionnaire focuses on elements of the building which relate to the thermal performance. This is due to these elements having a direct correlation with the carbon emissions associated with the use of the building.

This section provides a summary of the responses received from Old Town Hall occupants. The occupant survey was prepared and shared using Survey Monkey. SDC forwarded the survey to users and facilities managers.

The survey used a mix of multiple-choice questions, a Likert scale rating and free text to provide responses. Questions covered the following key experiences for the occupants:

- Performance of the building in use
- Comfort and indoor environment
- Installed services and systems.
- General comments

One frequent user of the building and one who is completely anonymous, both participated in the survey. Given the low occupancy of the building, this number represents a good response rate for the Old Town Hall.

Performance of building in use

This section of the survey aimed to understand the user's overall satisfaction with the building's general services and condition. The responses to these questions used a mix of Likert scale ratings and free text. A summary of the responses is illustrated in Figure 6 below.

The users rated the overall satisfaction with the physical building and its general building services as poor. However, when asked about the presence of mould or damp within the building, only one user responded. They stated that in their opinion there is a very low chance of mould or damp in the building. Users also commented that the building was continuously cold, with one highlighting that the windows were painted over and therefore unable to be opened. The apparent poor acoustics of the building was also a point of concern for a user. Overall dissatisfaction with the heating system was also stated.

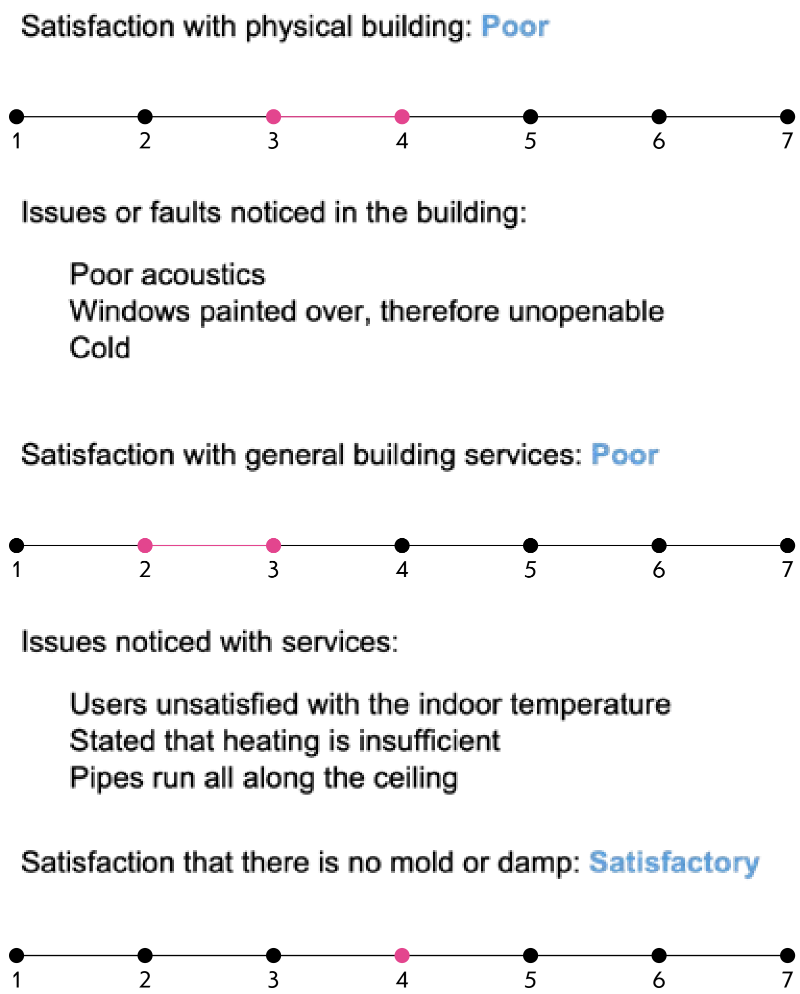


Figure 6: Summary of responses about the performance of building in use

Comfort and Indoor Environment

This section aimed to understand the user's overall satisfaction with the indoor environment and the quality of the space. The questions were answered as a mix of Likert scale ratings and free text. A summary of the responses is illustrated in Figure 7 below.

It was evident from the responses that overall, the users were unsatisfied with the indoor environment. The users rated the indoor comfort as poor, or at best, satisfactory, while they rated the indoor temperature as very poor. Overall satisfaction with indoor humidity is positive. However, the inconsistency of these responses could be due to the occupants not fully understanding how to rate humidity. Humidity is not something that can be easy for people to understand. The quality of the light conditions was deemed to be poor. The quality of the indoor sound environment was rated as satisfactory to poor. Other concerns the users highlighted were that the controls of the systems are extremely complicated and that the heating is insufficient.

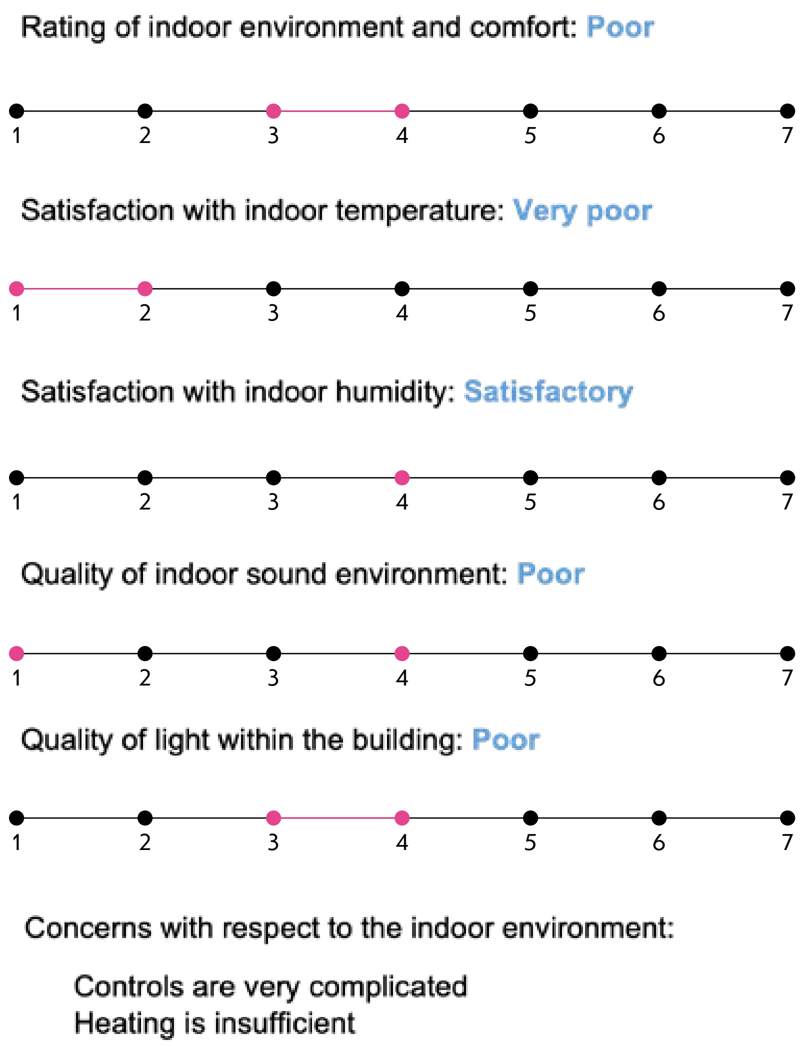


Figure 7: Summary of responses about the comfort and indoor environment

Installed Services and Systems

This section aimed to understand the user's overall satisfaction with the installed services and systems in the building. The questions were answered as a mix of Likert scale ratings and free text. A summary of the responses is illustrated in Figure 8 below.

The users rated the space heating and hot water system as poor. The lighting system and ventilation within the building were rated satisfactory to poor. The satisfaction with the systems for cooling, on-site energy generation and monitoring and feedback was rated very poor. However, it should be noted that the Old Town Hall does not have any on-site energy generation so the users should not have responded to this question.

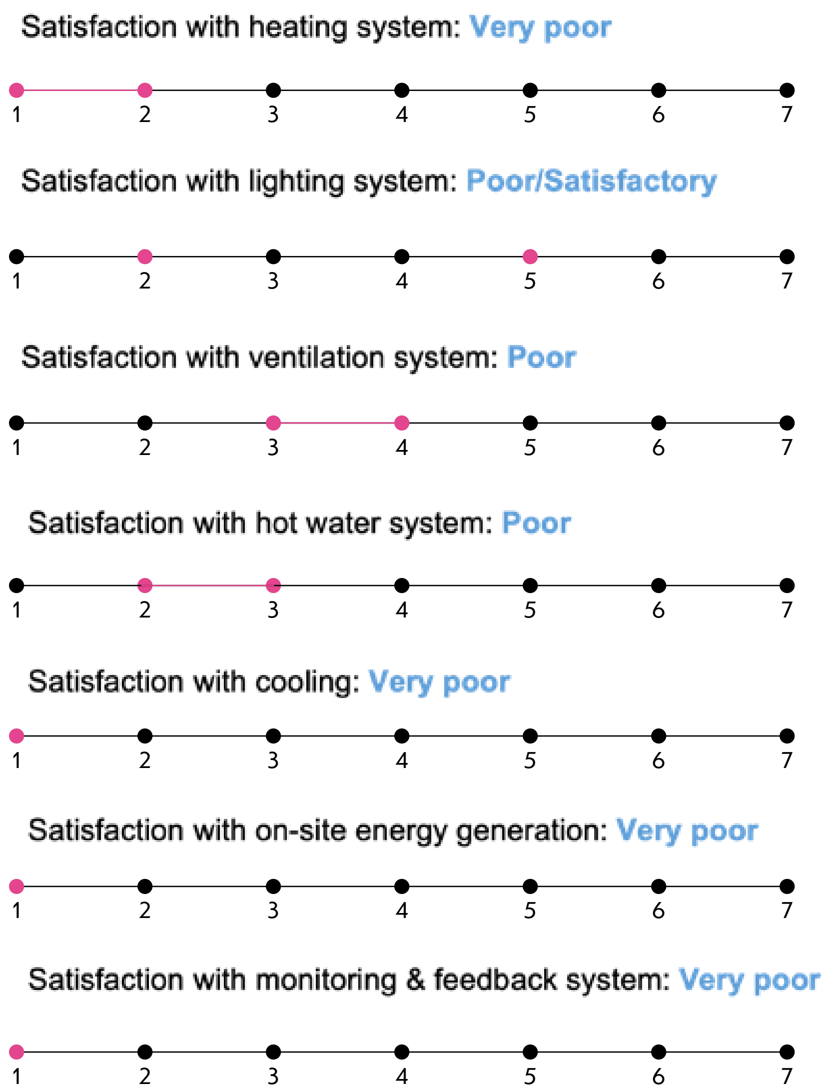


Figure 8: Summary of responses about installed services and systems

General comments

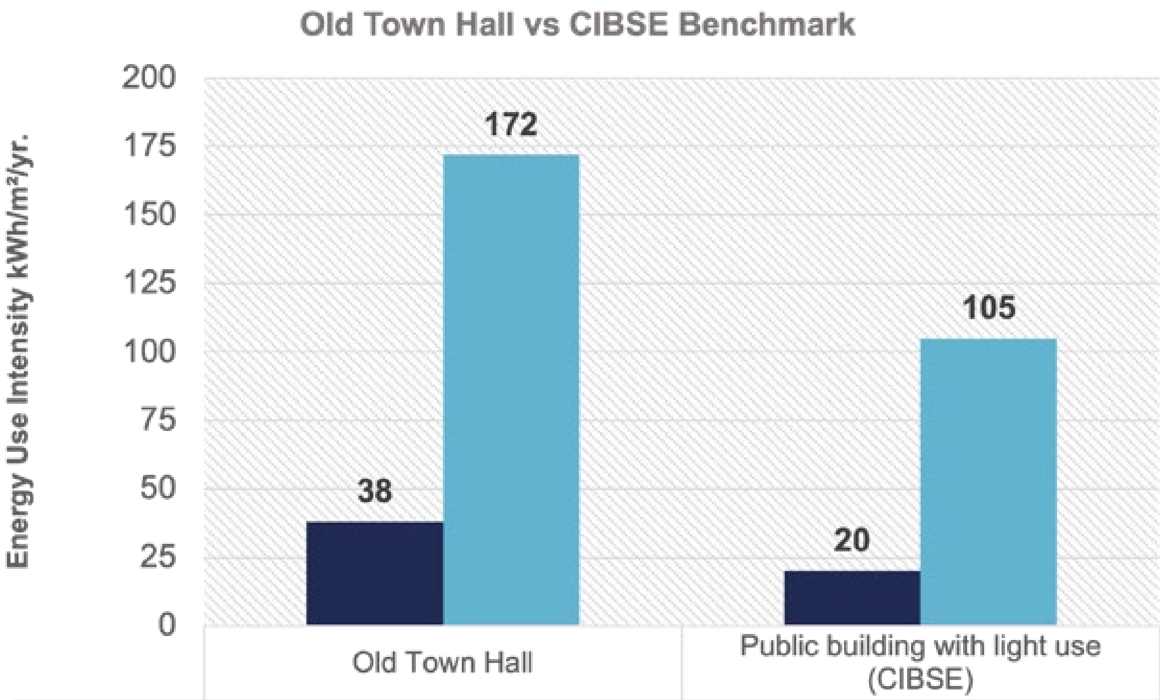
The users noted that the access is poor. They suggested that better awareness among users of shared spaces may be a solution. They also highlighted that fire exits and toilets are often blocked when the upper unit is in use.

Energy Performance

The Old Town Hall has been categorised as a public building with light use due to the limited occupancy (number of occupants and hours of operation), as per the information provided by Stroud District Council.

The primary space heating is provided by two mains gas condensing boilers and distributed via a single pipe system supplying traditional and conventional radiators. Secondary space heating is provided via portable electric heaters that tenants use in the winter. Domestic hot water (DHW) is provided by electric instantaneous water heaters, located in the kitchens and WCs. Ventilation is provided naturally. The lighting system is mainly comprised of fluorescent fittings in the offices and halogen fittings in the meeting room. There is a lift providing vertical transportation between the ground and first floors.

The Display Energy Certificate (DEC) issued 11 October 2019 shows an operational C rating, scoring 73. The typical score of a public building is 100, with a D rating. However, this rating is likely to be for a typically utilised public building. Therefore, given the low occupancy and utilisation of the Old Town Hall, this indicates a poor energy performance.



	Old Town Hall	Public building with light use (CIBSE)
Electricity	38	20
Fossil Fuels	172	105

Figure 9: EUI- Old Town Hall vs. CIBSE Benchmark

Figure 9 shows the comparison of the Energy Use Intensity (EUI) between the Old Town Hall and the CIBSE Benchmark for a public building with light use. This typology was deemed appropriate for the Old Town Hall given the low occupancy and utilisation. The data illustrates that the current EUI of electricity in the Old Town Hall is nearly twice that of the CIBSE TM46 benchmark. The current EUI of fossil fuels (mains gas) in the Old Town Hall is almost 70 kWh/m^2/yr more than the CIBSE TM46 benchmark.

Given the low occupancy and utilisation of the Old Town Hall, this energy use is high and therefore supports the analysis above for the energy rating.

The Survey

This section sets out the approach and details of the survey at the Old Town Hall. Following the completion of the preliminary BPE, it was concluded that an investigative BPE was required for the Old Town Hall. Aligned to BS 40101, the investigative BPE focused upon collecting data about the condition of the building, which has a direct impact on thermal performance. Due to the age of the Old Town Hall, building pathology, aligned to BS 7913, was incorporated throughout the BPE.

Survey details:

- Date: 16 January 2023
- Weather: dry, cold (1°C at 09.00 and 4°C at 12.00)
- Evaluators:
    - Dr Jo Atkinson – Head of Building Engineering
    - Gayathri Nair – Building Physics Engineer
    - Deepak Sadhwani – Building Physics Engineer
    - Aly Farrag – Building Physics Engineer

The approach taken consisted of collecting data using these methods:

1. 3D scan to record the geometry of the building
2. Visual inspection
3. Environmental readings
4. Thermographic survey
5. Moisture readings

A 3D scan was included due to the lack of existing drawings of the building, which provided accurate dimensions. An airtightness test was not included in the survey. It was deemed that the building could not be sealed sufficiently to complete an airtightness test.

3D Scan

The 3D scan of the building was captured using the Leica Geosystems handheld imaging scanner. The Leica Geosystems BLK2GO imaging scanner combines LiDAR[1] SLAM,[2] visual SLAM and IMU.[3] The scanner records to a ±10mm accuracy and produces a point cloud data file, which can be used to produce a 3D model in a compatible CAD[4] or BIM[5] package. Once the 3D model is produced it can be used to support further assessments, and ongoing asset management. Further assessments include a measured survey, energy and thermal modelling, and whole life carbon and life-cycle costing.

1 Light Detection and Ranging
2 Simultaneous Localisation and Mapping
3 Inertial Measurement Unit
4 Computer Aided Design
5 Building Information Modelling

Prior to undertaking the scan, a walk-through the building was completed to plan the route and decide how the building would be divided; this was recorded onto a floor plan drawing. An anchor location was chosen to return to between each area to ensure there was sufficient overlap between scans. The building was scanned internally and externally.

Upon completion of the scan, the data was uploaded to the software where it was checked. If necessary, areas were repeated to ensure a complete and comprehensive scan of the whole building was achieved.

Construction review

The construction review was undertaken through a visual inspection, supported by environmental data, thermography, and moisture readings.

Visual Inspection

Commencing with the outside of the building prior to moving to the inside, a visual inspection was undertaken. All rooms and spaces were entered in a logical order. Photographs were taken to record information about the building to be included in this report. The focus of the visual inspection were aspects that can have an impact on the thermal performance of the building. Notes were taken to accompany the photographs to aid interpretation.

Environmental Data

The environmental data recorded includes air temperature, relative humidity, wet bulb temperature, average dew point temperature, and moisture readings within each internal space. This data was captured using a FLIR EM54 (environmental meter attached to a tripod) and a FLIR MR285 (infrared moisture meter).

Upon entering each room or area, the FLIR EM54 was set to temperature and relative humidity and left to acclimatise whilst undertaking the visual inspections. The FLIR EM54 was then switched to record the wet-bulb temperature and average dew point temperature. This process was repeated for all the internal rooms and spaces in the Old Town Hall.

Thermography

An internal thermographic inspection was carried out in the property as part of the survey, using a FLIR T530 infrared (IR) camera. Where potential anomalies were identified, IR were taken in the respective rooms. IR images were captured to record thermal patterns that identify potential heat loss, primarily through thermal bridging and air leakage. For internal thermographic surveys, all colours below the green in the scale on the side of the image represents surfaces being colder than the ambient air temperature. Additional IR images were captured to record the Ambient Air Temperature (AAT) and Radiant Air Temperature (RAT) for each surface direction. This data is used as part of the analysis process to interpret the IR images, alongside the environmental data captured. Each IR image is accompanied by a photograph to aid interpretation and analysis. The location of each image was also recorded.

A thermographic survey is a great tool for illustrating heat loss. In a thermographic image from an external survey, the white, red and yellow colours indicate greater heat loss in respective locations of the building fabric. In an internal thermographic survey, cold areas are represented by blue, purple and black colours. Thermography should only be undertaken by appropriately trained persons with a comprehensive understanding of building fabric. This should be in accordance with BS EN 13187.

Moisture readings

Moisture readings were taken on the internal surface of external and some ground floor partition walls in most of the rooms and spaces. These were recorded using the FLIR MR285. The location of each reading was recorded on a copy of the floor plans. Readings over 16% indicate the possibility of damp and over 20% indicates potential water ingress. All locations with readings over 16% require further inspection.

Survey results

This section sets out the results of the survey. Commencing with the outputs from the 3D scan, this is followed by the construction review. This brings together the results from the visual inspection, internal environmental data, thermography, and moisture readings for each space. The section concludes with a summary of the results.

Building geometry

The point cloud image from the 3D scan is set out in Figure 10 below. A Revit model of the Old Town Hall is illustrated in Figure 11 below.

Figure 10: Point cloud image of the Old Town Hall

Figure 11: Revit model of Old Town Hall

Construction Review

Commencing with results from the visual inspection of the outside of the Old Town Hall, the construction review then discusses the data collected for each of the internal spaces. The external areas include the four ground floor stores which are used by the market holders, and one further space (disused outside WC) on the side of the building. The internal spaces include the offices, meeting room (hall), WCs and circulation spaces.

External areas

Figures 12 through to 35 are photographs taken of the outside of the Old Town Hall. Figures 12 to 23 are of the front of the building. Figures 24 to 26 are of the old WC and the walkway, which is directly under the first-floor kitchen. Figure 27 to 33 are of the rear of the building. Figures 34 and 35 are of the north wall, facing the church.

Figure 14 illustrates the crack the runs from the parapet down to entrance door for the ground floor office on the front facade. There is extensive water staining on the stonework on the front of the building, evident in Figures 17 to 19 and Figure 21. Figures 20 through to 23 and 27 show vegetation growth, which appear to be in the stonework and the gutter in Figure 21.

Vegetation growth indicates high moisture content and can damage mortar joints, allowing water ingress. For the gutter, it can block rainwater run-off and cause it to overflow and run down the surface of the wall. Excess water on the surface of the wall, illustrated by staining, can increase the risk of water ingress into the internal surface.

Figures 22 and 23 illustrate some blistering and delamination of the stonework, and mortar joint decay. This could indicate that the embedded iron cramps are corroded and therefore expanding. Additionally, there appears to be some salt crystallisation.

Figures 28 and 29 illustrate pointing in the stonework that appears to be cement based. Figure 33 illustrates water staining on the rear wall. Figures 34 and 35 illustrate further vegetation growth on the north wall, facing the Church. **The general condition of the external areas is satisfactory to poor, with areas that are very poor.**

Figure 12: Front view, from Church end

Figure 13: Front view, main entrance door

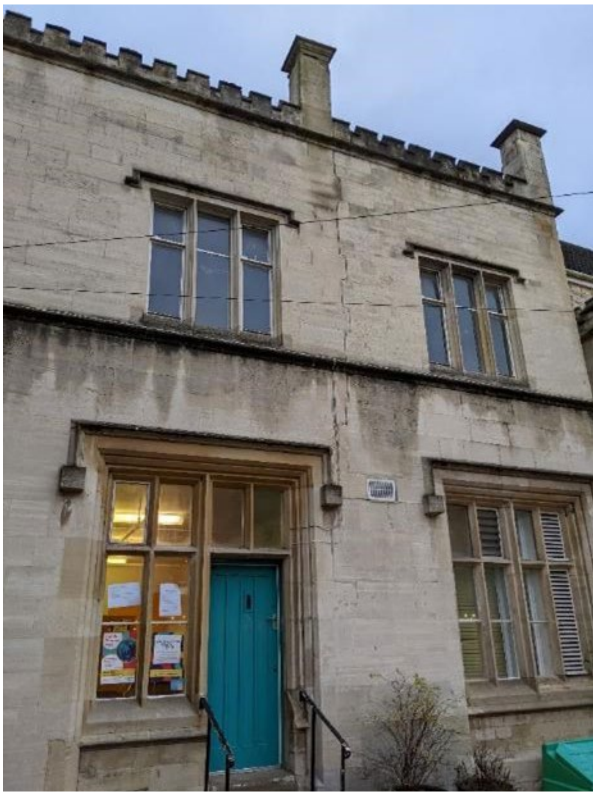


Figure 14: Front view of 16th Century addition

Figure 15: Entrance door to office in 16th Century addition

Figure 16: Front entrance and storage entrances

Figure 17: Storage entrances and exit from stairway (far right door)

Figure 18: Top of left buttress when facing the building

Figure 19: Top of right buttress when facing the building

Figure 20: Vegetation growth in stonework of parapet, visible from front of the building

Figure 21: Corroded guttering, vegetation growth and staining at front of the building

Figure 22: Blistering and delaminating stonework at the front of the building (near archway)

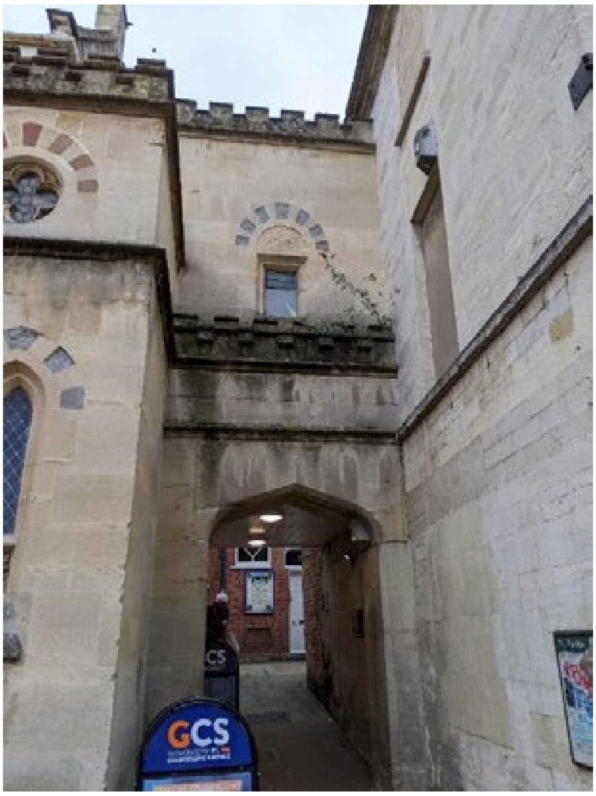


Figure 23: Archway and walkway under first floor kitchen, with vegetation growth in stone cornicing

Figure 24: Door to old outside WC, in walkway under first floor kitchen

Figure 25: Storage in old outside WC, accessed from walkway under first floor kitchen

Figure 26: Walkway under first floor kitchen, facing rear of building

Figure 27: Rear wall of first floor kitchen above walkway

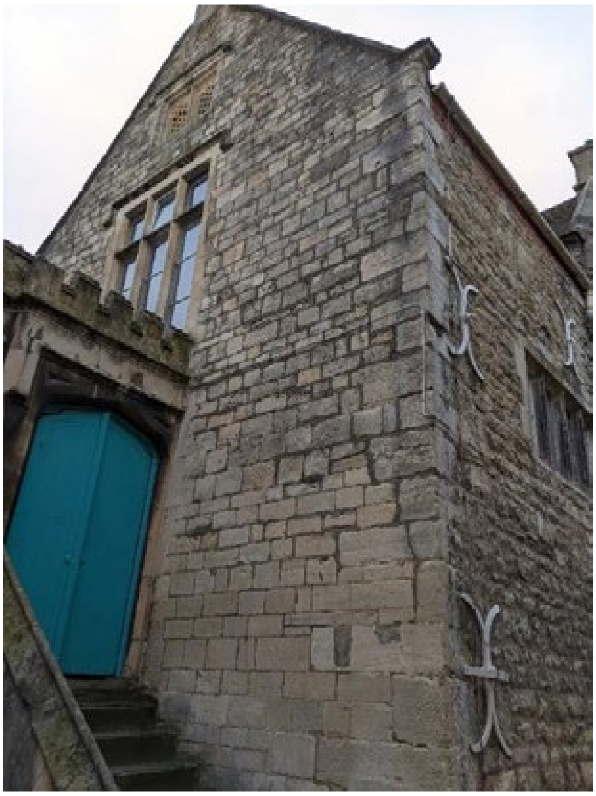


Figure 28: Exit from corridor between first floor meeting room and kitchen, and south wall of meeting room

Figure 29: Steps and exist from corridor between first floor meeting room and kitchen

Figure 30: Rear wall

Figure 31: Rear wall, looking down Church Street

Figure 32: Rainwater pipe sunk into rear wall

Figure 33: Rear wall of original 16th Century part of building

Figure 34: North wall, facing Church

Figure 35: North wall, with extensive vegetation growth

Ground Floor Stores

There are four stores accessed from the outside of the building, used by the market stall holders to store their stock. Some of the building services run around the top of the stores, near the ceiling, primarily pipes. These pipes appear to include heating, hot and cold water and waste water.

Store 1

It was difficult to see many surfaces in Store 1 due to the quantity of items being stored. The brick wall in Figure 36 is stretcher bond, indicating it could be single skin. The bricks are also relatively modern. The timber beam in Figure 37 shows some signs of decay.

Figure 36: Partition wall

Figure 37: Ceiling and timber beam

Store 2

As for Store 1, it was also difficult to see surfaces in Store 2 due to the quantity of items being stored. Figure 38 is the other side of the wall shown in Figure 36 above. Figure 39 is the other partition wall. It is a solid wall with a mix of Flemish and common brick bond. The mortar joints appear to be in relatively poor condition.

The stone frame entrance to the store has cracking, erosion and delamination visible, as shown in Figures 40 and 41. The timber holding the door hinge appears to be decaying, as shown in Figure 42.

Figure 38: Partition wall

Figure 39: Partition wall

Figure 40: Store 2 entrance

Figure 41: Store 2 entrance

Figure 42: Store 2 entrance door hinge

Store 3

Figures 43 to 46 show the entrance to store 3. The photographs illustrate the apparent use of cement from previous repairs to the stone frame entrance.

Figure 43: Entrance to Store 3

Figure 44: Entrance to Store 3

Figure 45: Entrance to Store 3

Figure 46: Entrance to Store 3

Store 4

There are several services in this store, including hot and cold water, waste pipes and electricity, most of which can be seen in Figure 47. Three of the walls in this store appear to have been covered with gypsum plaster and all four have been painted with an impervious paint. Figures 48 to 50 illustrate evidence of salt crystallisation, blistering and delamination within the plaster, which is consistent with moisture penetration. Figures 51 and 52 show the timber beam, which appears to have been subjected to severe decay.

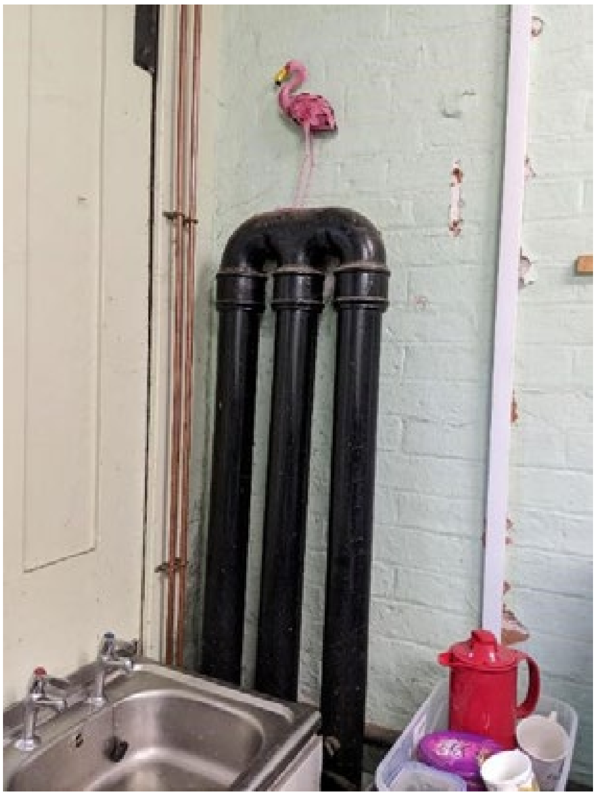


Figure 47: Services in Store 4

Figure 48: Salt crystals on surface of wall in corner

Figure 49: Blistering of plaster behind the paint

Figure 50: Delamination of the gypsum plaster

Figure 51: Timber beam in Store 4

Figure 52: Evidence of timber decay

Ground Floor Offices

There are three offices on the ground floor. Office 1 is unoccupied. Office 2 and 3 are merged and occupied by the same tenant.

GF Office 1

The environmental data for the ground floor office 1 were recorded as:

- Internal temperature: 14.8 °C
- Relative humidity: 45.9 %
- Wet Bulb temperature: 9.6 °C
- Dew Point temperature: 3.2 °C

There is a large window with a louvred pane in the top centre casement (Figure 53). This appears to be the only access to natural ventilation. **However, the window has secondary glazing, which does not appear to be openable.** If the secondary glazing is not openable then access to the openable window and louvred pane will not be possible. **There is a crack in the wall and ceiling** (Figure 54).

The radiator appears to have been turned down due to the room being unoccupied (see Figures 55 and 56). However, the large bore central heating pipe travels through the room to provide space heating to Office 2 and 3 on the other side of the wall. **The heat being emitted from this un-lagged pipe appears to be significant** (Figures 55 and 57). Despite this apparent heat gain, the internal temperature is low at below 15°C. This is likely to be due to the heat loss through the window, in particular the louvre (Figure 53), the wall below the window (Figures 55 and 56), and the vent in the top right corner (Figures 57 and 58). **The general condition of GF Office 1 is poor.**

Figure 53: Window in GF Office 1

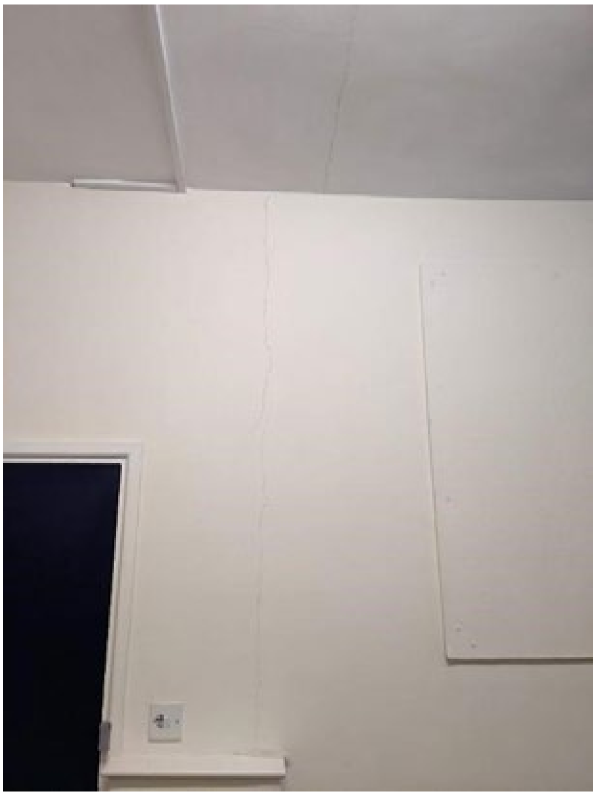


Figure 54: Crack in wall and ceiling in GF Office 1

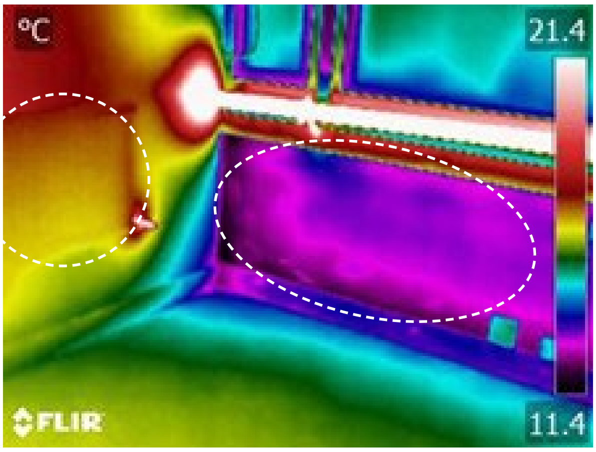


Figure 55: IR image showing wall under window in GF Office 1

Figure 56: Photograph showing wall under window in GF Office 1

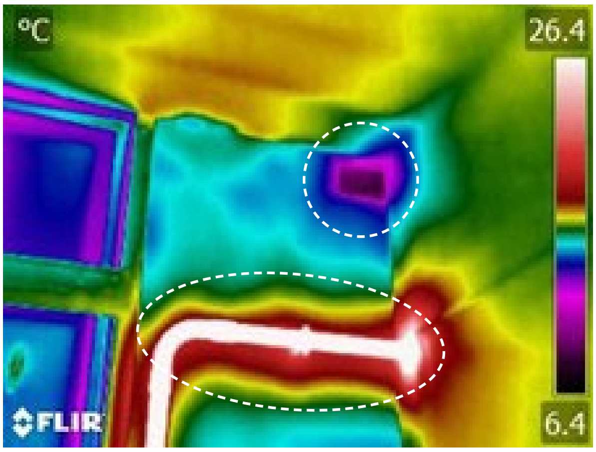


Figure 57: IR image showing vent and hot water pipe in GF Office 1

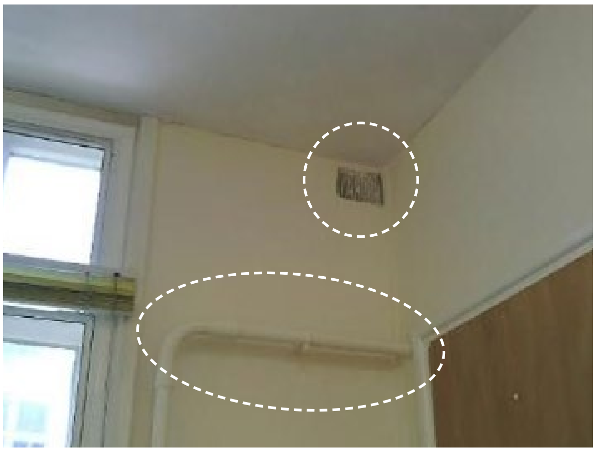


Figure 58: Photograph showing vent and hot water pipe in GF Office 1

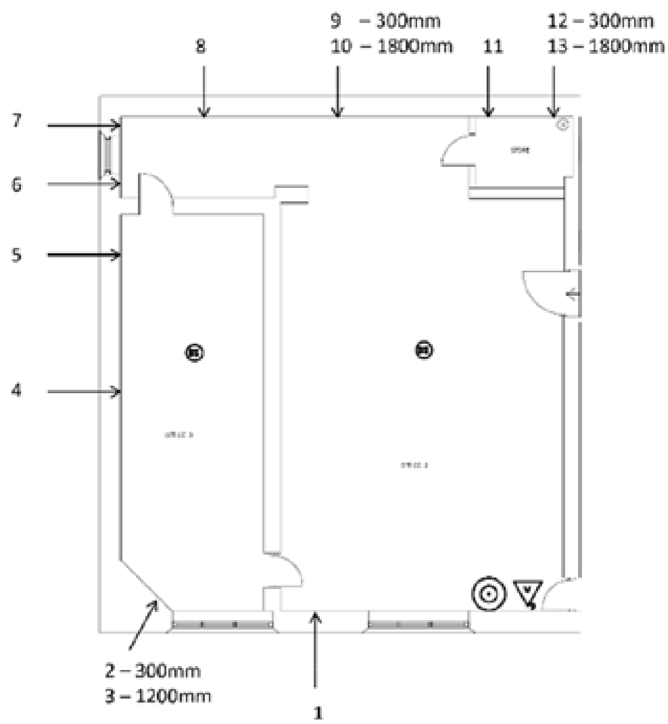
GF Office 2 and 3

The environmental data for the ground floor office 2 and 3 were recorded as:

- Internal temperature: 17.1 °C
- Relative humidity: 52 %
- Wet Bulb temperature: 12.1 °C
- Dew Point temperature: 7.5 °C

The moisture readings were recorded according to the locations set out in Table 4 below. The readings indicate that there is potential water ingress in the walls. The readings in locations 6 to 11 and 13 could be lower due to the dry lining that is on these walls (see below in reference to Figures 75 and 77). Location 12 could be where the adhesive is bridging between the existing wall and the plasterboard lining. **These high moisture readings require further investigation.**

Table 3: Moisture readings for GF Office 2 and 3, and adjoining spaces (store is used as kitchenette)



Location Tag	1	2	3	4	5	6	7
Moisture Reading	100%	65%	44.3%	66.7%	55.2%	37%	28%
Location Tag	8	9	10	11	12	13	-
Moisture Reading	33.6%	31.8%	100%	34.2%	87.5%	26%	-

The heating system pipes are a dominant feature in Office 2 as it is suspended from the ceiling and travels from Office 1 and into Office 3 above the entrance door (Figures 59 and 60). The pipe continues to be suspended from the ceiling in GF Office 3 and into the storage area behind, which is accessed via Office 2 (Figures 61 and 62). The ceiling in Office 2 and storage area behind is brick and vaulted. The entrance door from outside and window, and their frames are timber (Figure 60). The window mullions in Office 3 are stone, with a steel casement holding the glass (Figures 63 and 64). Both windows are single glazed. There is an old steel shutter on the internal side of the window in Office 3.
This window is in a poor condition.

At the rear of Office 2 there is a store being used as a kitchenette (Figures 65 and 66). This appears to house the mains gas entry point and meter for the whole building. The kitchenette has an electric instantaneous hot water unit with pipes that are not lagged. **The ceiling of the kitchenette is of poor condition.**

Both offices had additional free-standing portable electric heaters, which is consistent with the information provided in the preliminary BPE and occupant survey (Figures 67 and 68). These heaters were not in use at the time of collecting the data. The environmental data was recorded within two to three hours after the offices had been in use. When these offices are in use, they are open to the public. Public access to the offices is via the entrance door at the front of the building, shown in Figure 60. Although the internal temperature is higher than Office 1, this is still low given that this space had been occupied.

Significant infiltration heat loss was identified in Office 2 and 3. There are gaps below and within the entrance door in Office 2, contributing to this heat loss (Figures 69 and 70). There is also heat loss from the vent at the bottom of the north external wall in Office 2 (Figures 71 and 72). Both are allowing uncontrolled infiltration of cold air into the internal spaces.

Several occurrences of thermal bridging appear to be present on the walls in these two offices and the storage areas at the rear. There are two areas identified at the top of the front external wall, just before entering Office 3 (Figures 73 and 74). **These require further investigation to identify the cause.** In the kitchenette there is several occurrences of thermal bridging (Figures 75 and 76). These are from: the 'dabs' where the dry lining has been fixed to the existing wall; the external wall to partition wall and ground floor junctions; and the mains gas pipe entry point. The thermal bridging at the external wall junctions is likely to be exacerbated by the dry lining. In the storage area behind Office 3, there appears to be thermal bridging around the window at the rear of the room, and in the rear corner. The latter appears to be at the junction between the dry lining plasterboards. **The general condition of GF Office 2 and 3 is satisfactory to poor, with areas that are very poor.**

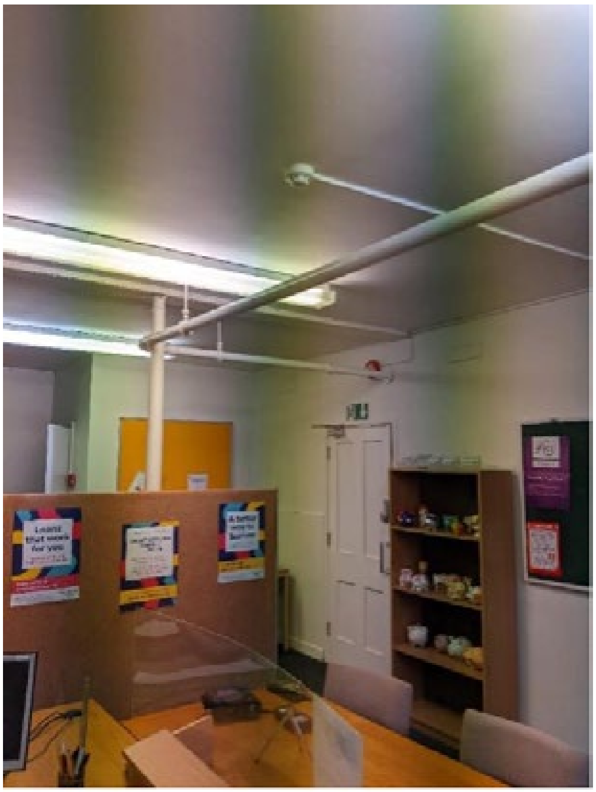


Figure 59: GF Office 2

Figure 60: Entrance door at front of building in GF Office 2

Figure 61: GF Office 3

Figure 62: Storage area behind GF Office 3 (accessed from Office 2)

Figure 63: Window frame in GF Office 3

Figure 64: Window frame in GF Office 3

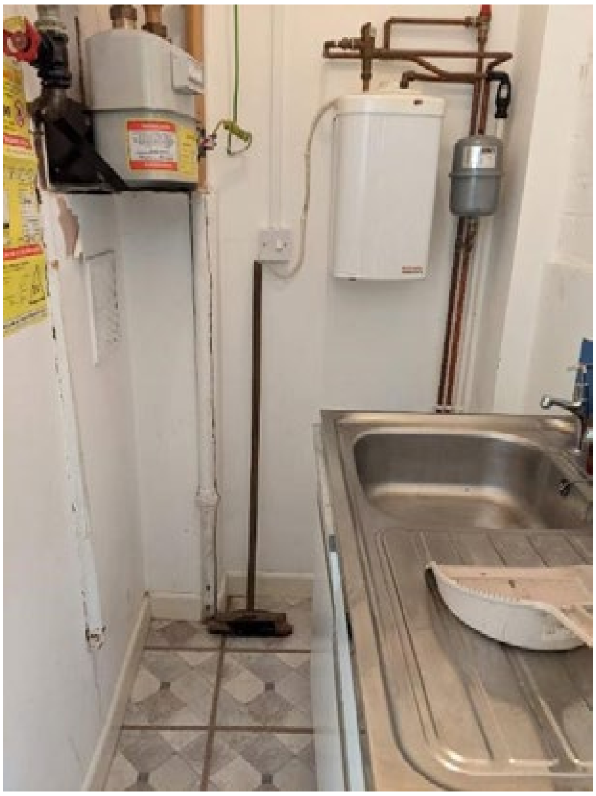


Figure 65: Kitchenette for GF Office 2 and 3

Figure 66: Ceiling of kitchenette for GF Office 2 and 3

Figure 67: Electric heating panel in Office 2

Figure 68: Instantaneous heater in Office 2

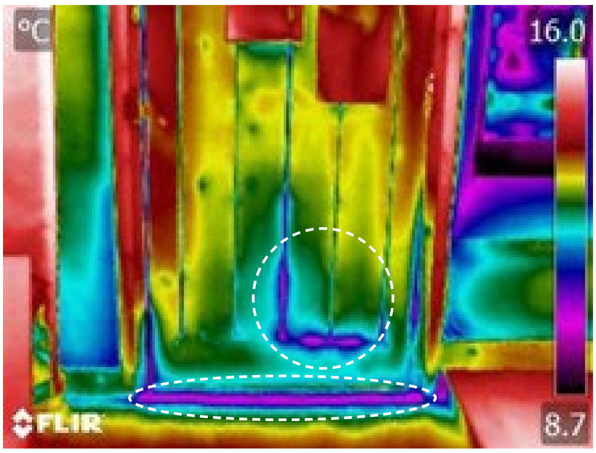


Figure 69: IR image showing bottom of entrance door into GF Office 2

Figure 70: Photograph showing bottom of entrance door into GF Office 2

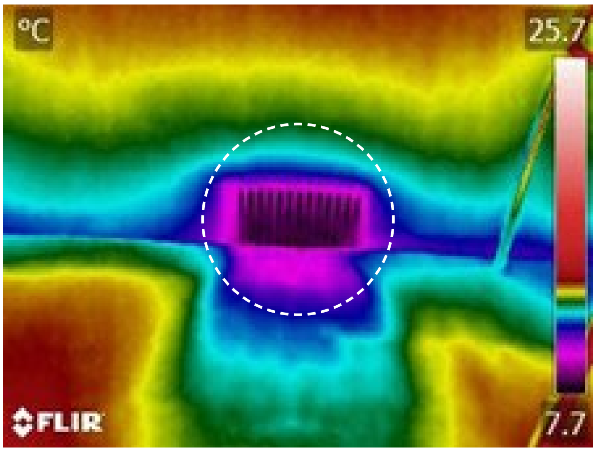


Figure 71: IR image showing vent at bottom of north external wall in GF Office 3

Figure 72: Photograph showing vent at bottom of north external wall in GF Office 3

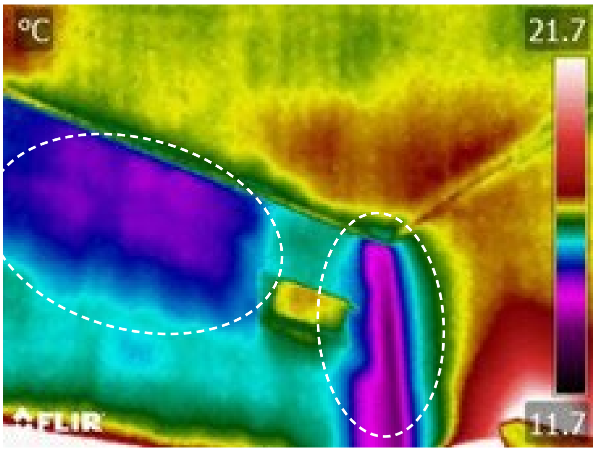


Figure 73: IR image showing top of external wall, next to door between Office 2 and 3

Figure 74: Photograph showing top of external wall, next to door between Office 2 and 3

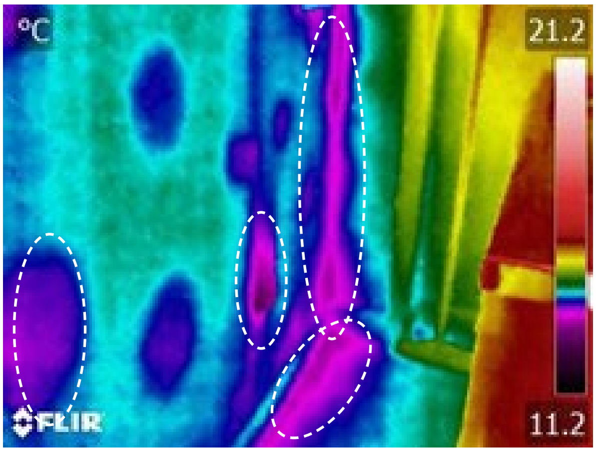


Figure 75: IR image showing heat loss through wall junction and plaster dabs.

Figure 76: Photograph showing wall and wall junction.

Figure 77: IR image showing heat loss through secondary glazing, wall junction and plaster dabs.

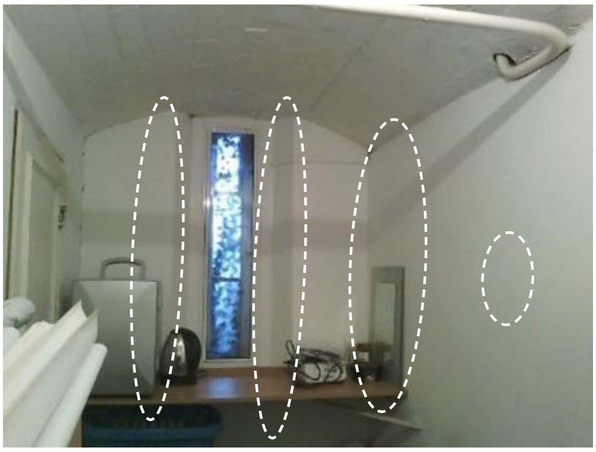


Figure 78: Photograph showing secondary glazing and walls in GF Office.

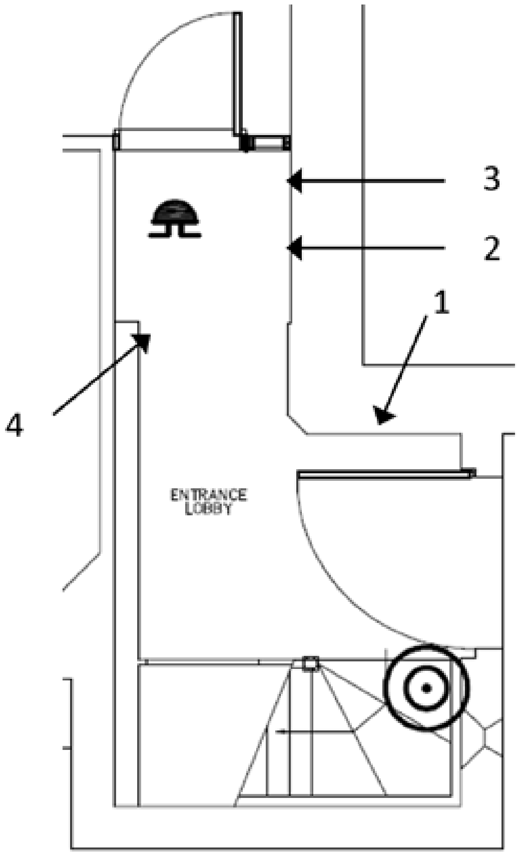
Ground Floor Entrance Lobby

The environmental data for the ground floor entrance lobby were recorded as:

- Internal temperature: 8.5 °C
- Relative humidity: 46.2 %
- Wet Bulb temperature: 4.4 °C
- Dew Point temperature: 2.4 °C

The moisture readings were recorded according to the locations set out in Table 5 below. The readings indicate that there is potential water ingress in the walls. The readings in all locations are very high. The addition of a solid concrete floor could be a contributory factor for these high readings as this is forcing ground moisture up the walls, where it cannot escape due to the impervious gypsum plaster and paint covering. **These high moisture readings require further investigation.**

Table 4: Moisture readings for GF entrance lobby



Location Tag	1	2	3	4
Moisture Reading	95.3%	91.1%	100%	73.5%

The main entrance door to the building is solid wood in a stone frame. **There are large gaps around the door,** illustrated by the visibility of light when the door is closed. The floor is tiled and there is timber panelling on the wall behind the door. **There is significant decay of the timber skirting** below the timber panelling and behind where it should be fixed to the wall. The decay is consistent with the high moisture readings. **The general condition of the GF entrance lobby is satisfactory to poor, with areas that are very poor.**

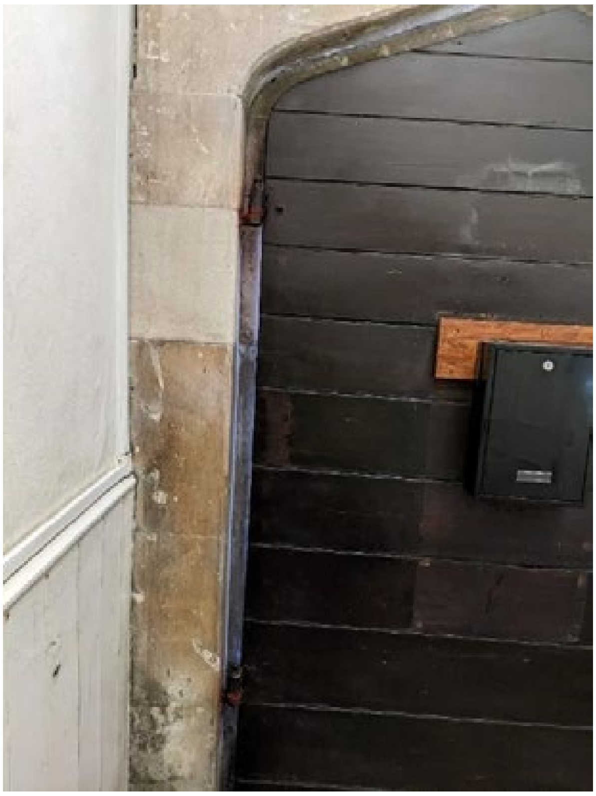


Figure 79: Main entrance door

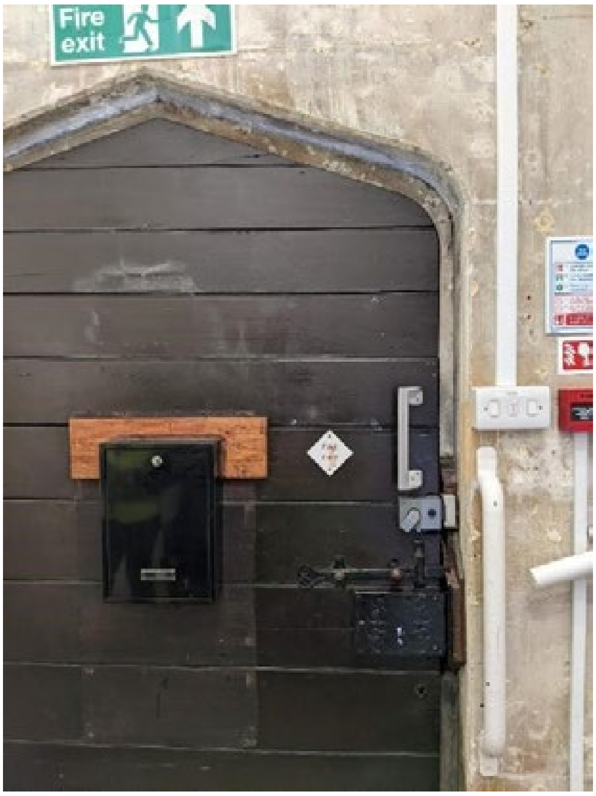


Figure 80: Main entrance door

Figure 81: Behind loose skirting

Figure 82: Back of loose skirting

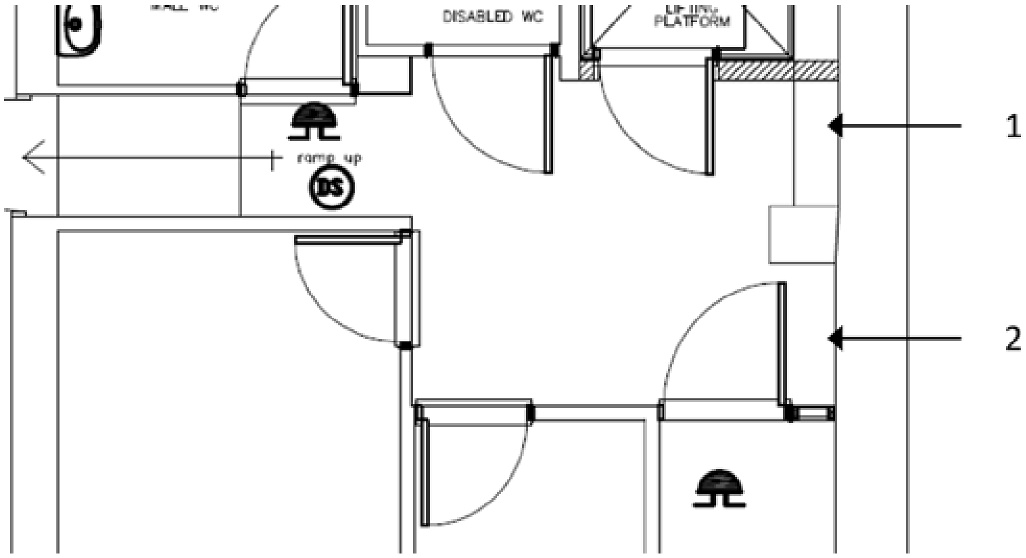
Ground Floor Circulation Space

The environmental data for the ground floor circulation space were recorded as:

- Internal temperature: 12.4 °C
- Relative humidity: 49.7 %
- Wet Bulb temperature: 8 °C
- Dew Point temperature: 2.2 °C

The moisture readings were recorded according to the locations set out in Table 6 below. The readings indicate that there is potential water ingress in the wall closest to the entrance lobby (location 2). The reading in this location is very high. As with the entrance lobby, the addition of a solid concrete floor could be a contributory factor for this high reading as this is forcing ground moisture up the walls, where it cannot escape due to the impervious gypsum plaster and paint covering. **These high moisture readings require further investigation.**

Table 5: Moisture readings for GF circulation space



Location Tag	1	2
Moisture Tag	30.6%	100%

On the ground floor, the entrance lobby leads to a small circulation space where the offices can be accessed. The floor changes to a solid concrete floor covered in an industrial standard lino (Figures 83 and 84). There is blistering and tide marks on the internal walls (Figures 83 to 86). This is consistent with an impervious floor material, such as cement, being retrofitted to the building which would have probably been built with a suspended timber ground floor. As a result, the ground moisture appears to be travelling up the walls by means of capillary action. This is further exacerbated by the addition of an impervious gypsum and painted wall covering. **The general condition of GF circulation space is satisfactory to poor.**

Figure 83: Floor of lobby and access to GF circulation space

Figure 84: Entrance door into GF circulation space

Figure 85: Water ingress into GF interior walls

Figure 86: Water ingress into GF interior walls

First Floor Offices

There are five offices on the first floor, and they are all currently unoccupied.

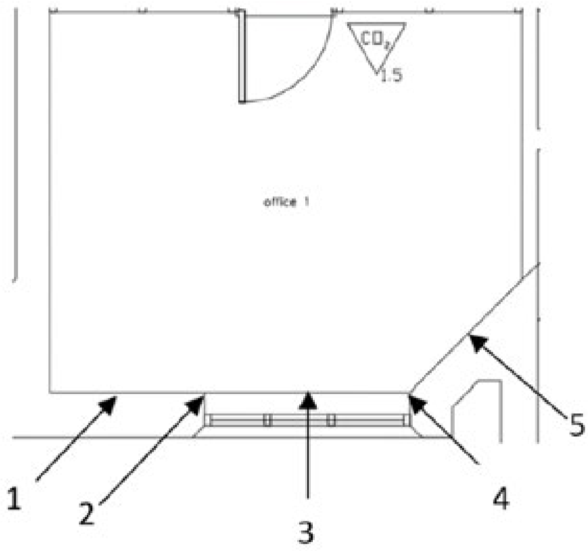
First floor office 1

The environmental data for the first-floor Office 1 were recorded as:

- Internal temperature: 15.2 °C
- Relative humidity: 51.5 %
- Wet Bulb temperature: 10.4 °C
- Dew Point temperature: 4.9 °C

The moisture readings were recorded according to the locations set out in Table 7 below. The readings indicate high levels of moisture in the external walls and in the chimney breast wall.

Table 6: Moisture readings for FF Office 1



Location Tag	1	2	3	4	5
Moisture Reading	30.3%	57.4%	31.5%	64.8%	42.4%

The first floor Office 1 has a large metal and timber framed window and a chimney breast. The walls are papered. The suspended intermediate timber floor has a hardboard covering. The openable section of the window is at the top left and right of the casement (Figures 83 and 84). They are hinged at the bottom and there are support frames restricting the opening gap at the top.

There is a vertical crack at the junction between the external wall and the chimney breast (Figure 83). There is significant heat transmission evident in the thermal image (Figure 91). The flue pipe for the boilers in the plant room below FF Office 1 is in the chimney breast. On the opposite side to the chimney breast are diagonal cracks with heat being transmitted through them (Figures 89 and 90). This is consistent with the location of the vertical crack visible on the front façade of the building, identified in Figure 14 above. There was also some movement under foot when walking across the floor, in the corner where there are diagonal cracks in the wall. There are gaps under the skirting at the bottom of the external wall and the partition wall. These gaps are allowing heat transmission, possibly from heating pipes under the floor. **A structural investigation should be undertaken to examine this further. The general condition of FF Office 1 is poor.**

Figure 87: Vertical crack at junction between external wall and chimney breast

Figure 88: Top right of window, showing hinged openable section

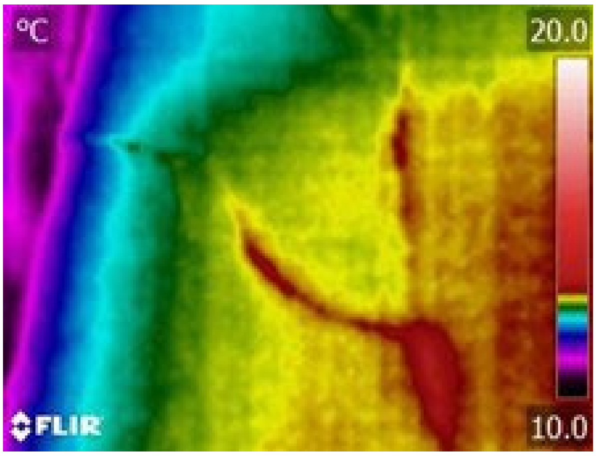


Figure 89: IR image showing heat transmission through diagonal cracks in wall

Figure 90: Photograph showing diagonal cracks in wall

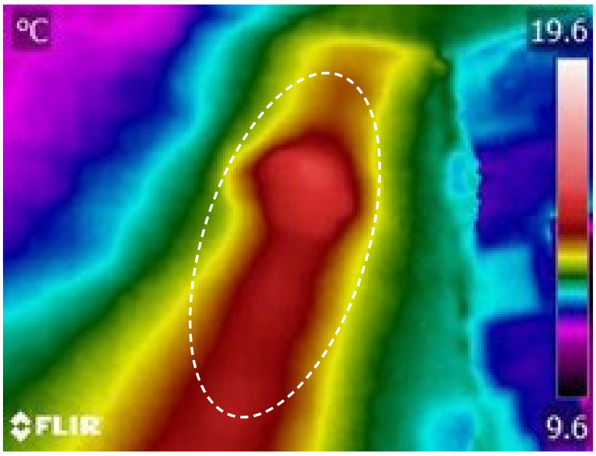


Figure 91: IR image showing heat transmission in chimney breast

Figure 92: Photograph showing chimney breast

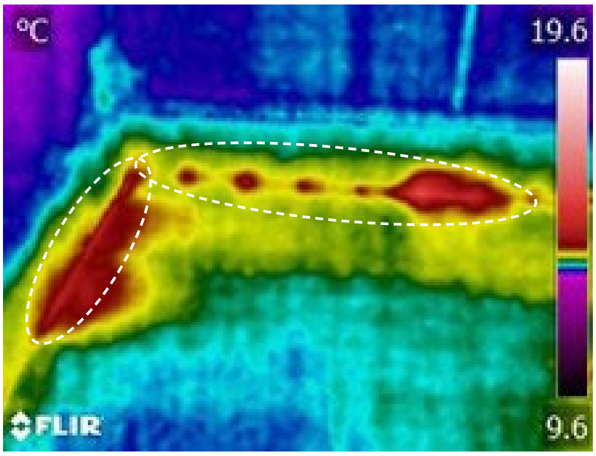


Figure 93: IR image showing heat transmission under skirting

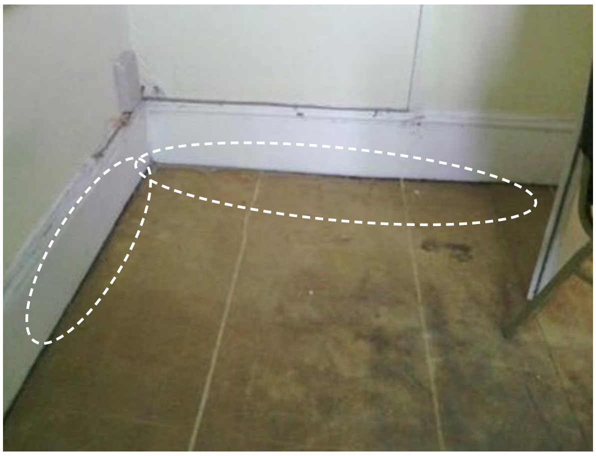


Figure 94: Photograph showing skirting

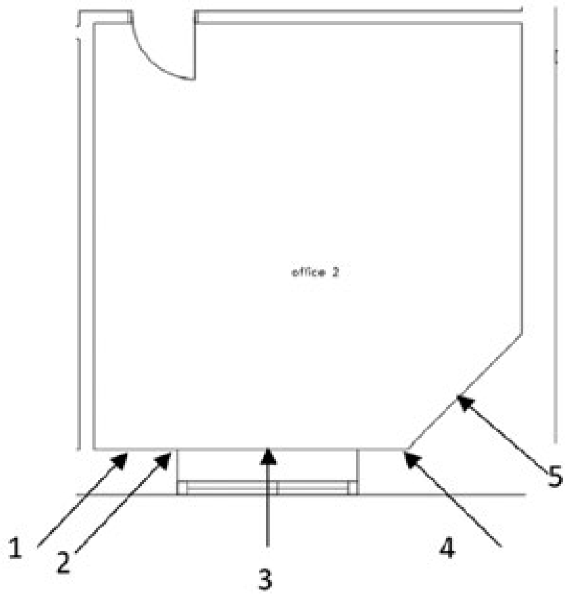
First floor office 2

The environmental data for the first-floor Office 2 were recorded as:

- Internal temperature: 15.8 °C
- Relative humidity: 51.6 %
- Wet Bulb temperature: 10.9 °C
- Dew Point temperature: 5.7 °C

The moisture readings were recorded according to the locations set out in Table 8 below. The readings indicate relatively low moisture levels compared to the rest of the building so far. However, they are still considered to be high, compared to recommended levels of less than 16%.

Table 7: Moisture readings for FF Office 2



Location Tag	1	2	3	4	5
Moisture Reading	28%	25.3%	25.3%	24.2%	40.1%

The first floor Office 2 also has a large metal and timber framed window and a chimney breast. This chimney breast has a vent near the top. The window has the same two top openable sections on the left and right. The walls are papered.

There is vertical crack between the partition wall and chimney breast (Figure 95). There is also a vertical crack in the corner between the partition wall for Office 1 and the corridor (Figure 96). Heat transmission can be seen in the location of the crack (Figures 99 and 100). **The cause of these cracks should be investigated by a Structural Engineer.** There are holes in the partition walls, which has exposed their structure (Figures 97 and 98). The partition walls appear to have been constructed using laths and lime plaster. The walls have since received a layer of gypsum plaster. There appears to be **gaps in the roof insulation,** illustrated by the cold spots in Figures 101 and 102. **The general condition of FF Office 2 is very poor.**

Figure 95: Chimney breast in FF Office 2

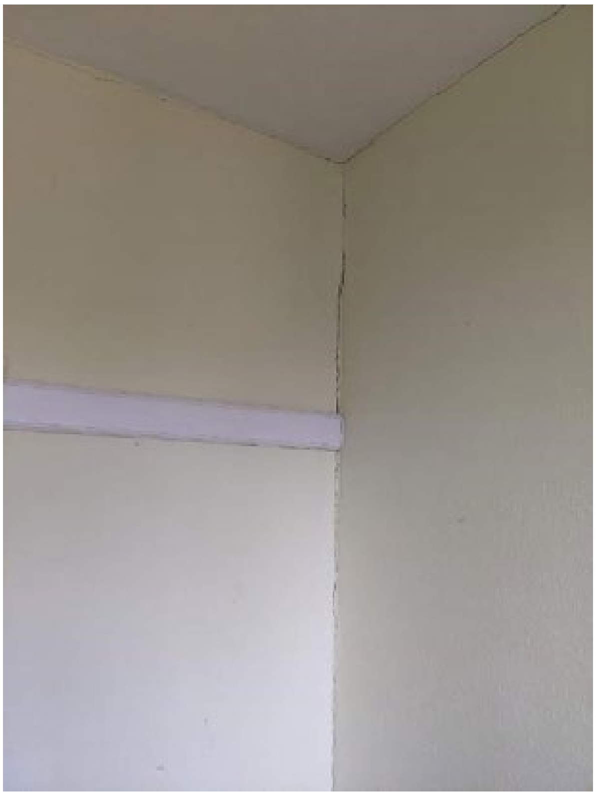


Figure 96: Junction between partition wall to FF Office 1 and corridor

Figure 97: Damaged wall covering and plaster underneath

Figure 98: Damaged wall cover and plaster underneath, exposing lathes

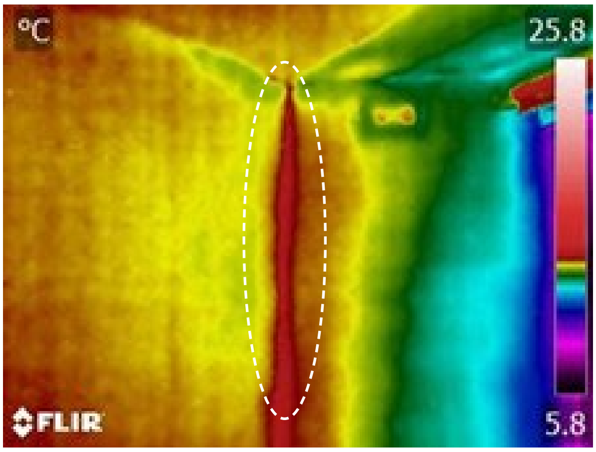


Figure 99: IR image showing heat transmission at junction between chimney breast and partition wall for FF Office 1


Figure 100: Photograph showing junction between chimney breast and partition wall for FF Office 1

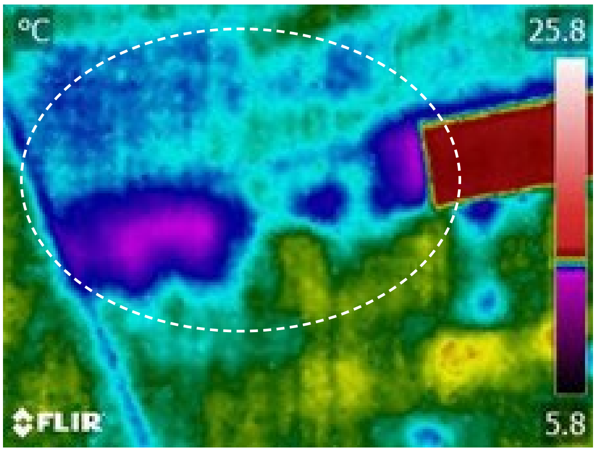


Figure 101: IR image showing cold spots on ceiling


Figure 102: Photograph showing ceiling

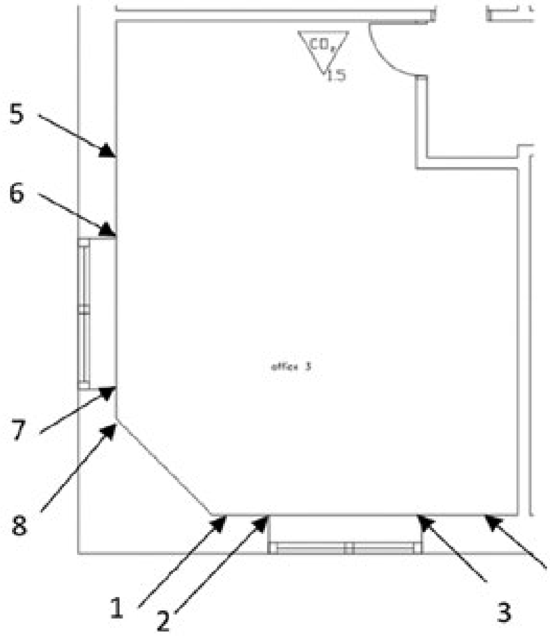
First floor office 3

The environmental data for the first-floor Office 3 were recorded as:

- Internal temperature: 16.5 °C
- Relative humidity: 49.5 %
- Wet Bulb temperature: 11.3 °C
- Dew Point temperature: 5.4 °C

The moisture readings were recorded according to the locations set out in Table 9 below. As with FF Office 2, the readings indicate relatively low moisture levels compared to readings on the ground floor and FF Office 1. However, they are still considered to be high, compared to recommended levels of less than 16%.

Table 8: Moisture readings for FF Office 3



Location Tag	1	2	3	4	5	6	7	8
Moisture Reading	25.3%	50.2%	39.8%	34%	33.6%	30.9%	30.3%	26.6%

On the external wall at the front of the building, there is a cold area in the corner junction with the roof and the partition wall with Office 2 (Figures 101 and 102). There are several cold spots indicating thermal bridging on the ceiling Figures 103 to 110. **There appears to be gaps in the insulation in the roof, thus requiring further investigation. The general condition of FF Office 3 is satisfactory to poor.**

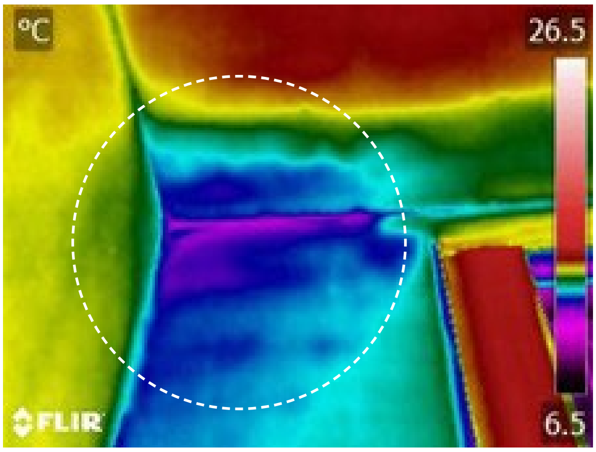


Figure 101: IR image showing large cold area at junction between roof, north wall and Office 2 partition wall

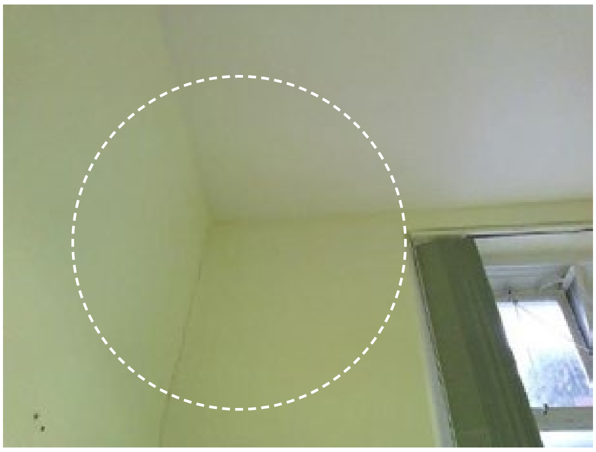


Figure 102: Photograph showing area at junction between roof, north wall and Office 2 partition wall

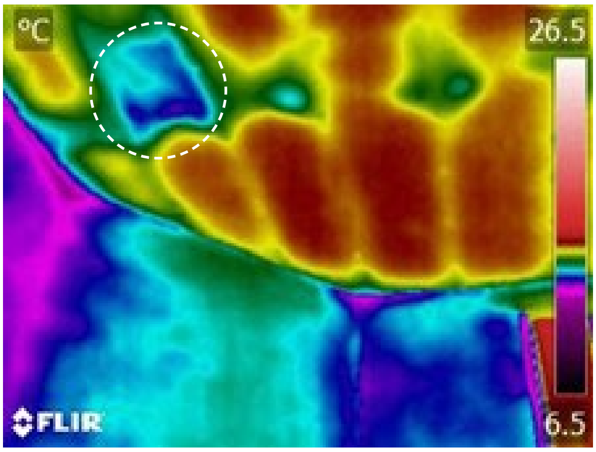


Figure 105: IR image showing ceiling in FF Office 3

Figure 106: Photograph showing ceiling in FF Office 3

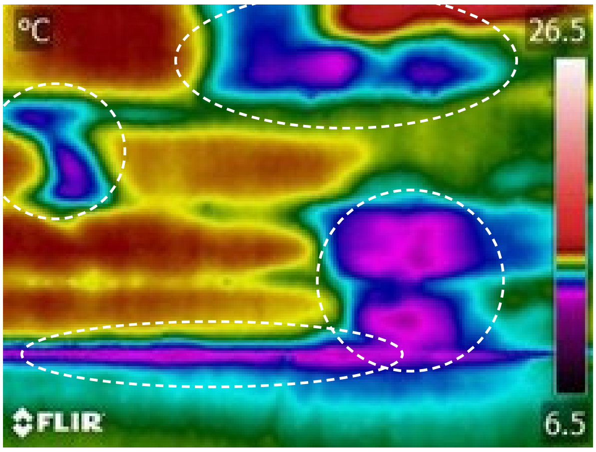


Figure 107: IR image showing ceiling in FF Office 3

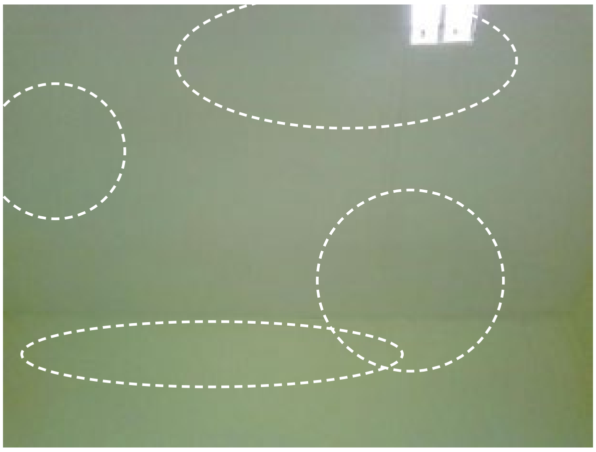


Figure 108: Photograph showing ceiling in FF Office 3

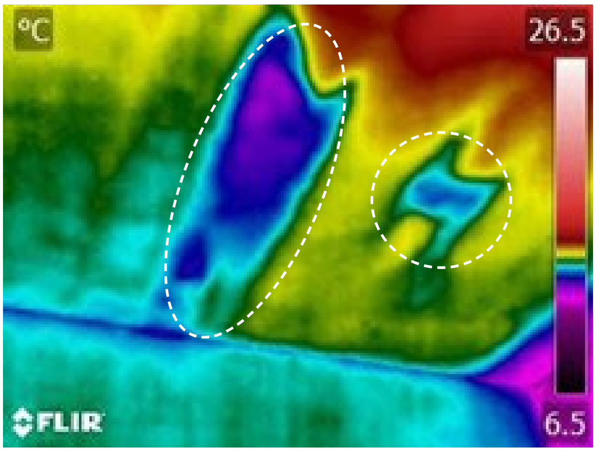


Figure 109: IR image showing ceiling in FF Office 3

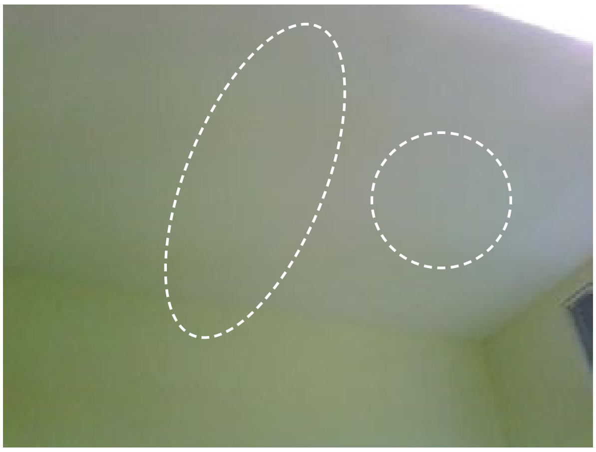


Figure 110: Photograph showing ceiling in FF Office 3

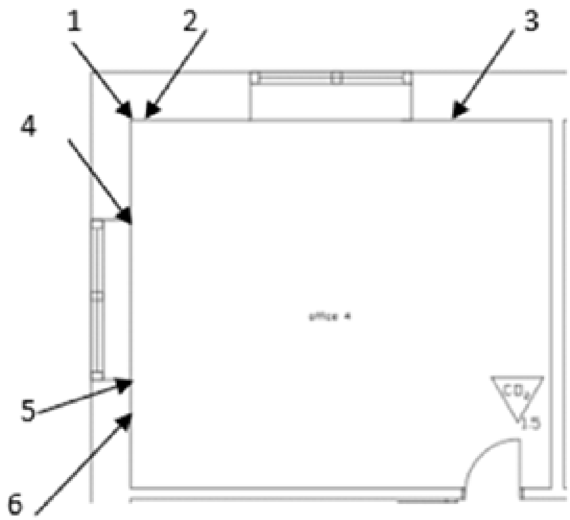
First floor office 4

The environmental data for the first-floor Office 4 were recorded as:

- Internal temperature: 15.5 °C
- Relative humidity: 52 %
- Wet Bulb temperature: 10.7 °C
- Dew Point temperature: 5.7 °C

The moisture readings were recorded according to the locations set out in Table 10 below. As with FF Offices 2 and 3, the readings indicate relatively low moisture levels compared to readings on the ground floor and FF Office 1. However, they are still considered to be high, compared to recommended levels of less than 16%.

Table 9: Moisture readings for FF Office 4



Location Tag	1	2	3	4	5	6
Moisture Reading	27%	25.8%	44.7%	28%	35%	34.4%

Office 4 on the first floor has two single glazed windows, one facing north on the side of the building and the other on the rear façade (Figures 111 and 112, respectively). The windows have timber mullions with metal frames. There is movement in the floor in the corner closest to the external wall and partition wall with FF Office 5 (Figure 113). **The ceiling has a large area of missing plaster, likely caused by it having got wet and falling away from the laths (Figure 114).**

There appears to be thermal bridging at the window reveal and the junction between the external wall and partition wall with FF Office 5 (Figures 115 and 116). There is a further hole in the ceiling causing significant heat loss (Figures 117 and 118). **The general condition of FF Office 4 is very poor.**

Figure 111: North facing window in FF Office 4

Figure 112: East facing window in FF Office 4 (rear)

Figure 113: Floor of FF Office 4

Figure 114: Ceiling in FF Office 4

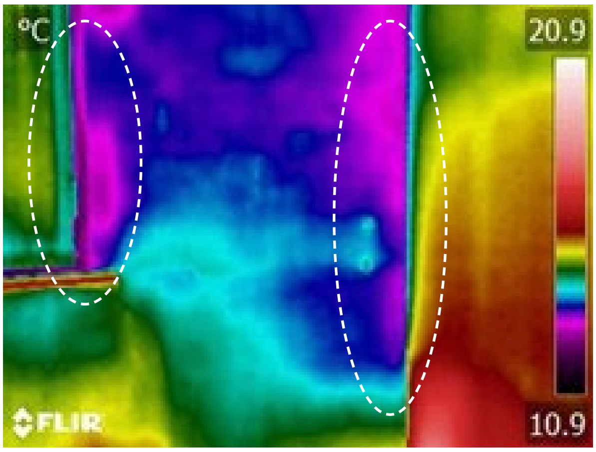


Figure 115: IR image showing window reveal and external wall to partition wall junction next to Office 5

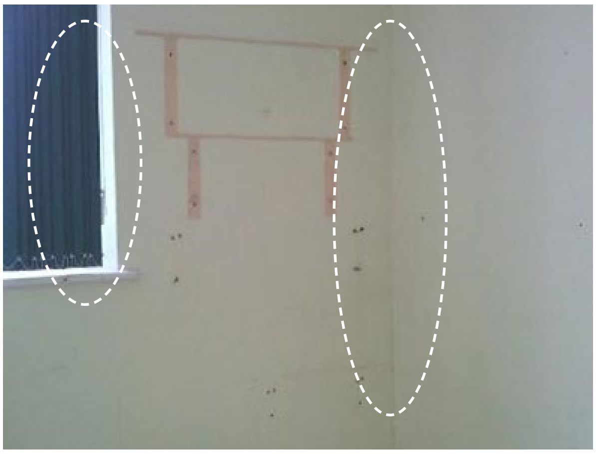


Figure 116: Photograph showing window reveal and external wall to partition wall junction next to Office 5

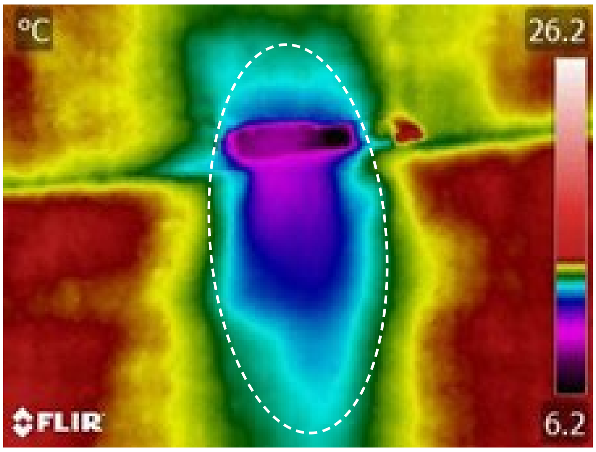


Figure 117: IR image showing hole in ceiling in FF Office 4

Figure 118: Photograph showing hole in ceiling in FF Office 4

First floor office 5

The environmental data for the first-floor Office 5 were recorded as:

- Internal temperature: 14.9 °C
- Relative humidity: 52.1 %
- Wet Bulb temperature: 10.2 °C
- Dew Point temperature: 5.4 °C

The moisture readings were recorded according to the locations set out in Table 11 below. As with FF Offices 2, 3 and 4, the readings indicate relatively low moisture levels compared to the readings on the ground floor and FF Office 1. However, they are still considered to be high, compared to recommended levels of less than 16%.

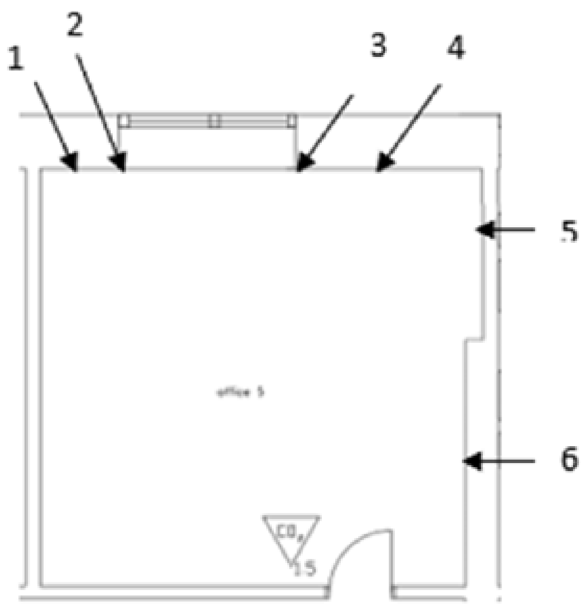


Table 10: Moisture readings for FF Office 5

Location Tag	1	2	3	4	5	6
Moisture Reading	49.5%	32.8%	36.2%	28.5%	24%	30%

Office 5 on the first floor has one single glazed window facing east at the rear of the building (Figure 119). It has timber mullions with metal frames. There is a **diagonal crack** from the window reveal (near the top) and the ceiling (Figure 120).

There is heat entering from under the partition wall for the first floor WC (Figures 117 and 118). There are also **gaps in the roof insulation,** evidenced from the cold spots in the ceiling (Figures 123 and 124). **The general condition of FF Office 5 is poor.**

Figure 119: Window in FF Office 5

Figure 120: Diagonal crack in wall of FF Office 5

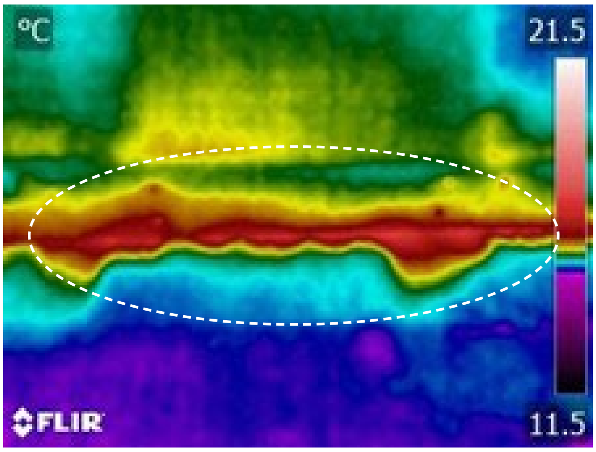


Figure 121: IR image showing bottom of partition wall for FF WC

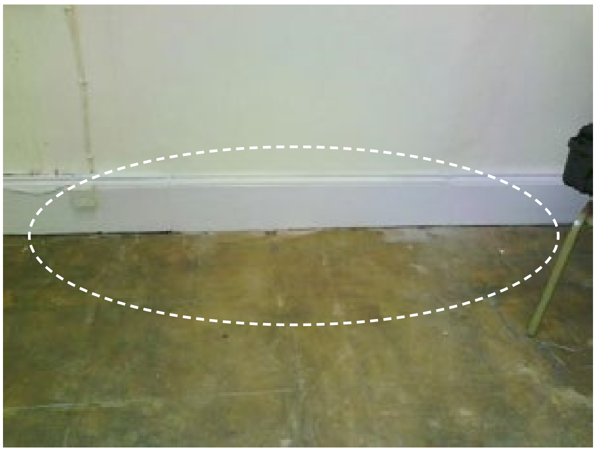


Figure 122: Photograph showing bottom of partition wall for FF WC

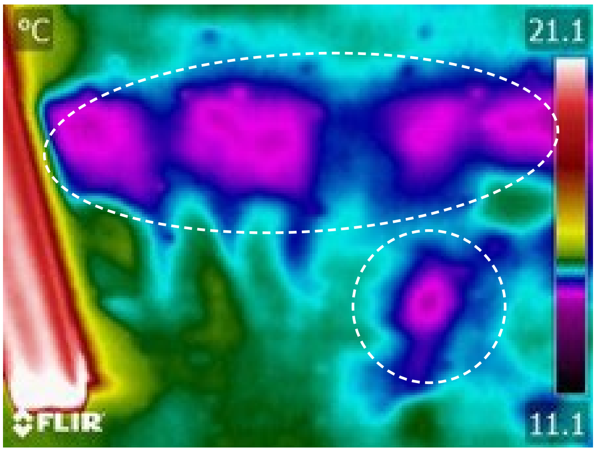


Figure 123: IR image showing ceiling in FF Office 5

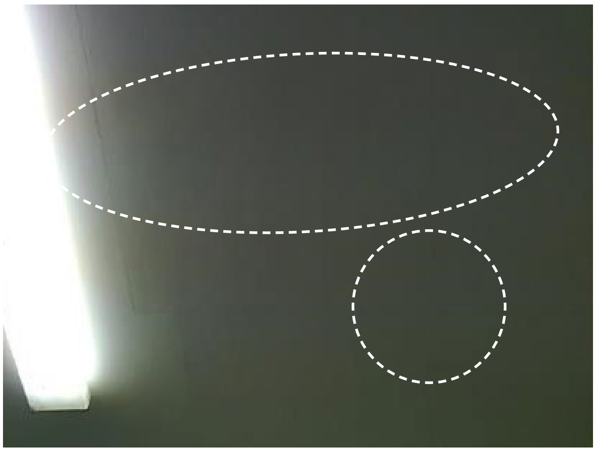


Figure 124: Photograph showing ceiling in FF Office 5

First floor corridor (hallway)

The environmental data for the first-floor corridor were recorded as:

- Internal temperature: 15 °C
- Relative humidity: 50.8 %
- Wet Bulb temperature: 10.3 °C
- Dew Point temperature: 4.9 °C

The first-floor corridor provides access to all five offices (Figures 125 and 126). There is a **diagonal crack above the door to Office 5 and vertical crack between the cross wall and internal partition wall** (Figures 127 and 128). Access to the roof space is via a hatch located in the corridor (Figures 129 and 130). From floor level, there appears to be mineral wool insulation in the roof space. There is a roof window, which provides access to the flat roof area. This was not accessed by the ABC team. **The general condition of the corridor appears to be satisfactory to poor.**

Figure 125: FF corridor providing access to all five offices

Figure 126: FF corridor providing access to all five offices

Figure 127: Diagonal crack above door to Office 5

Figure 128: Vertical crack between cross wall and partition wall

Figure 129: Chimney breast in FF Office 2

Figure 130: Junction between partition wall to FF Office 1 and corridor

First floor WC

The environmental data for the first-floor WC were recorded as:

- Internal temperature: 14.8 °C
- Relative humidity: 54.3 %
- Wet Bulb temperature: 10.4 °C
- Dew Point temperature: 5.7 °C

The window in the first floor WC is single glazed with timber mullions and frames (Figures 131). **There is a crack in the frame, large enough for light to get through** (Figure 132).

Figure 131: FF WC window

Figure 132: Crack in FF WC window frame

First floor Meeting Room (Hall)

The environmental data for the first-floor meeting room (hall) were recorded as:

- Internal temperature: 13.1 °C
- Relative humidity: 49 %
- Wet Bulb temperature: 8.5 °C
- Dew Point temperature: 2.7 °C

The moisture readings were recorded according to the locations set out in Table 12 below. The readings indicate very high moisture levels, indicating there is water ingress in large areas of the building fabric. This is consistent with the staining and the vegetation growth identified in external areas, set out above.

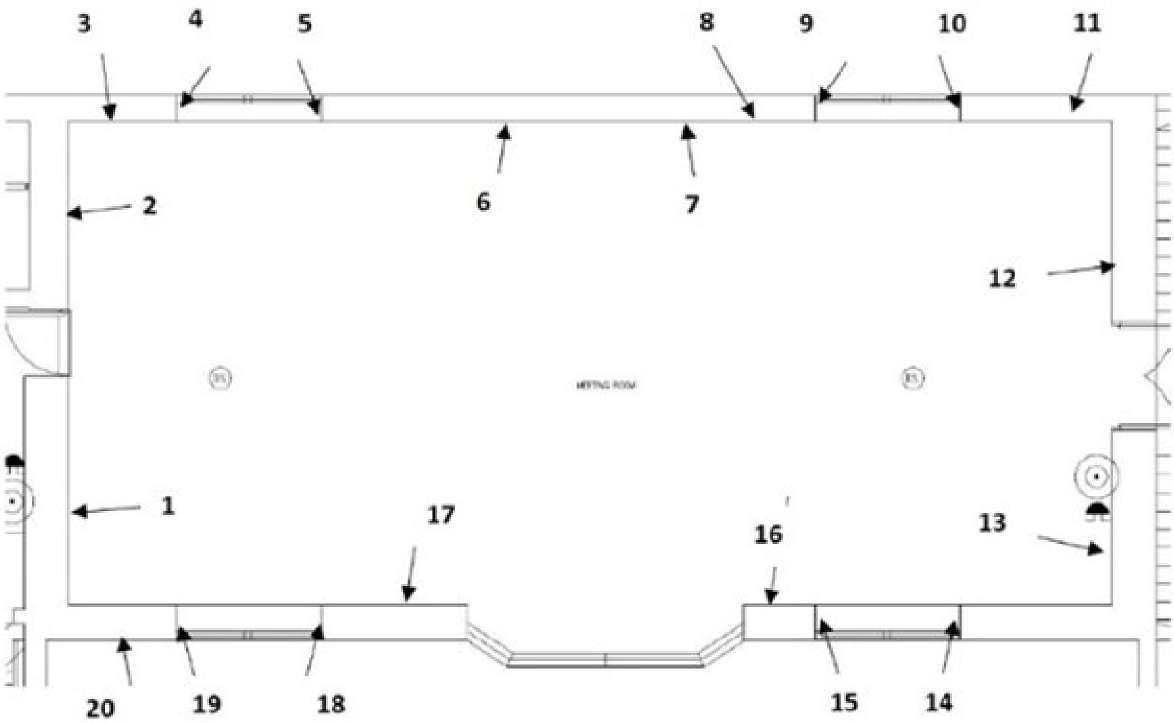


Table 11: Moisture readings for Meeting Room (Hall)

Location Tag	1	2	3	4	5	6	7	8	9	10
Moisture Reading	76.3%	87.8%	41.6%	49.7%	88.2%	59.3%	57.5%	49.5%	39.4%	32.3%
Location Tag	11	12	13	14	15	16	17	18	19	20
Moisture Reading	51%	39%	92%	81.4%	92.3%	72.7%	65.5%	98.5%	100%	56.8%

The meeting room (hall) is the main internal space of the original 16th Century building. It is a large space with a very high ceiling and visible ornate trusses. Although not completely visible, the roof structure appears to be a crown post roof truss with metal tie bar system (Figures 133 and 134). There is a large window in the south gable wall (Figure 135) and a smaller window in the north gable wall. The front façade has four large windows, and the rear has three slightly smaller ones. The windows are single glazed in stone mullions and metal frames. The mullions and frames appear to have been painted in a **glossy paint, that has now failed** (Figures 137 to 139). There are **water runs from the bottom of the top window,** above the main front window in the centre of the wall (Figure 140).

There are significant cold areas in the roof, as shown in Figures 141 to 146. The walls and roof appear to have been lined and / or covered in gypsum plaster and painted. The bottom of the walls are covered with tongue and groove timber panelling. **There is a large hole covered in polythene on the front wall of the building, which is allowing a significant amount of uncontrolled infiltrated cold air to enter the room** (Figures 147 and 148). T here is also **uncontrolled air infiltration around the door** that leads to the unheated space between the meeting and the kitchen (Figures 149 and 150). The floor of the meeting room appears to be cold (Figures 149 and 150). **The general condition of the meeting room appears to be satisfactory, with areas that are poor.**


Figure 133: Meeting room (main hall)


Figure 134: Meeting room (main hall)


Figure 135: Window above door to kitchen from the meeting room


Figure 136: Internal surface of front (west) facing external wall – main facade

Figure 137: Window in the rear (east) facing wall

Figure 138: Window in front (west) facing wall

Figure 139: Painted stone window mullion and sill

Figure 140: Water run marks from bottom of small window above main window of front (west) facing wall

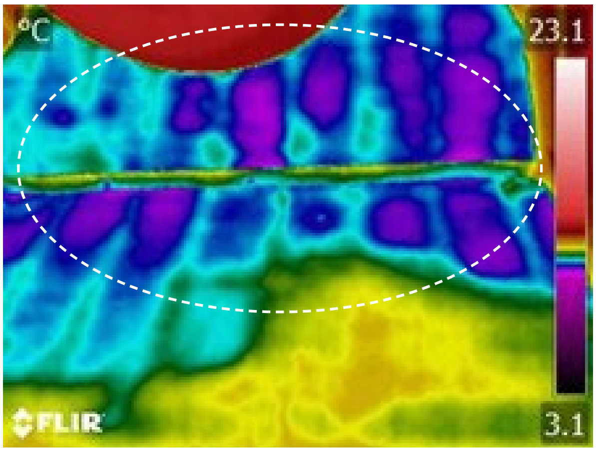


Figure 141: IR image showing ceiling in meeting room (main hall)

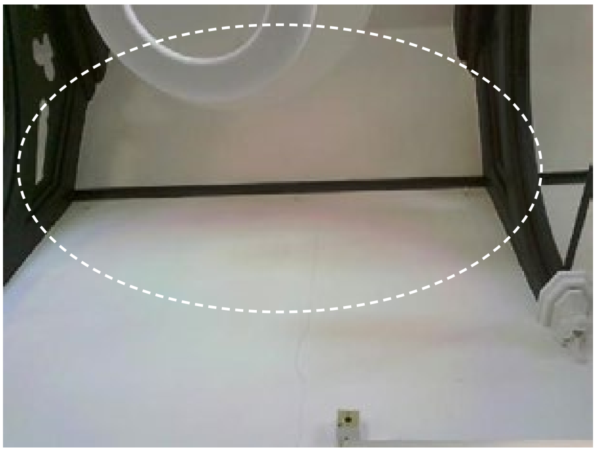


Figure 142: Photograph showing ceiling in meeting room (main hall)

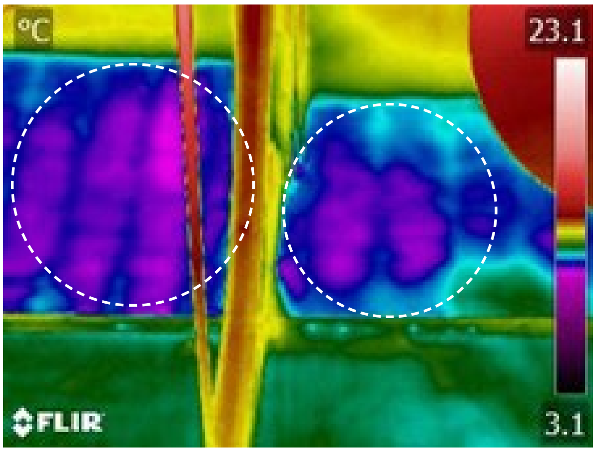


Figure 143: IR image showing ceiling in meeting room (main hall)

Figure 144: Photograph showing ceiling in meeting room (main hall)

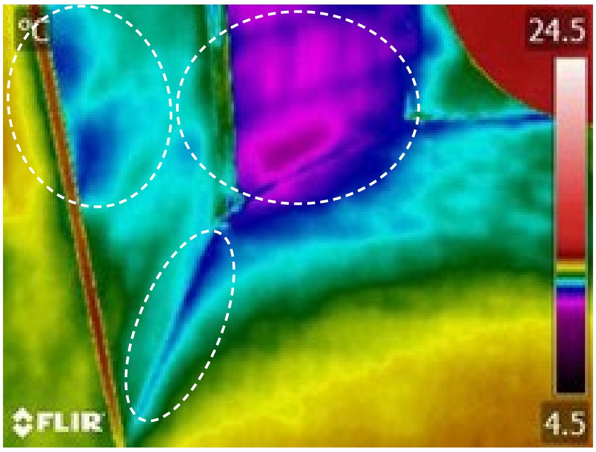


Figure 145: IR image showing ceiling in meeting room (main hall)

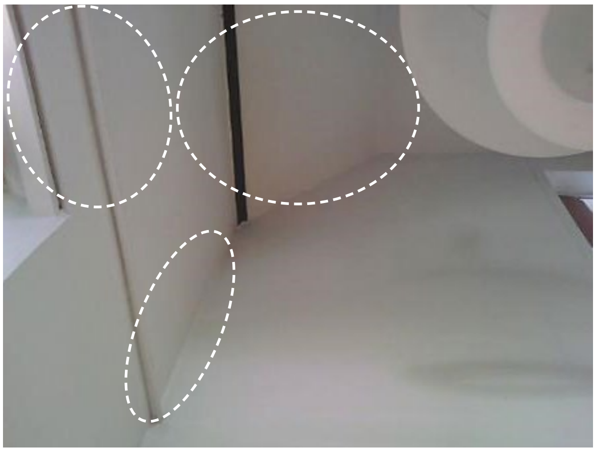


Figure 146: Photograph showing ceiling in meeting room (main hall)

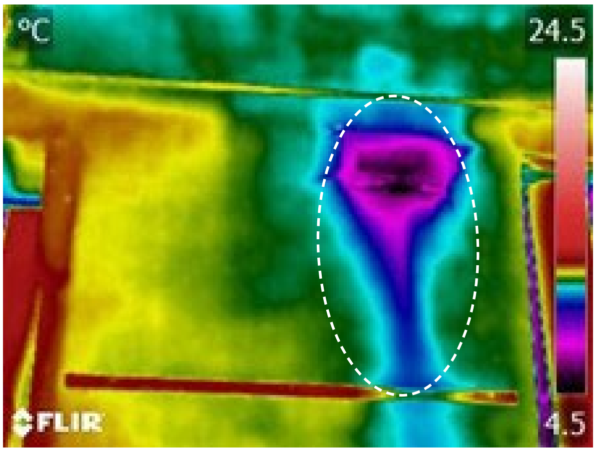


Figure 147: IR image showing air leakage through hole in the main façade wall (west facing)

Figure 148: Photograph showing hole in the main façade wall (west facing)

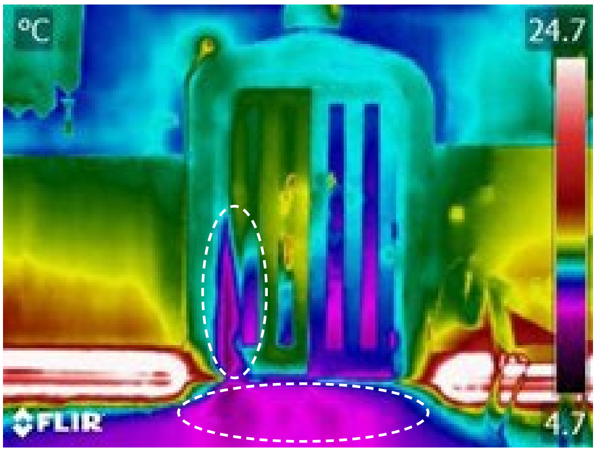


Figure 149: IR image showing air leakage through door into kitchen area and cold meeting room floor

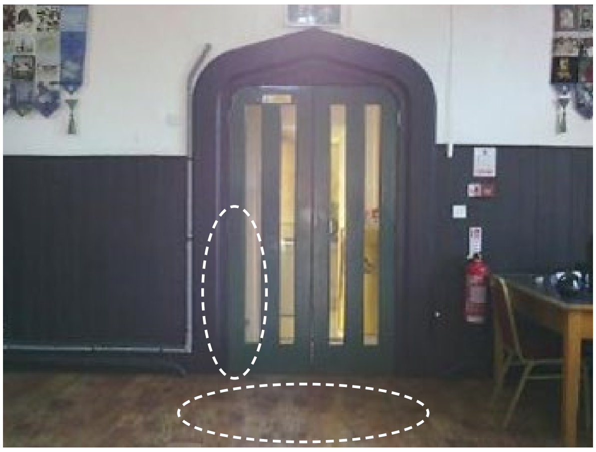


Figure 150: Photograph showing door into kitchen area and meeting room floor

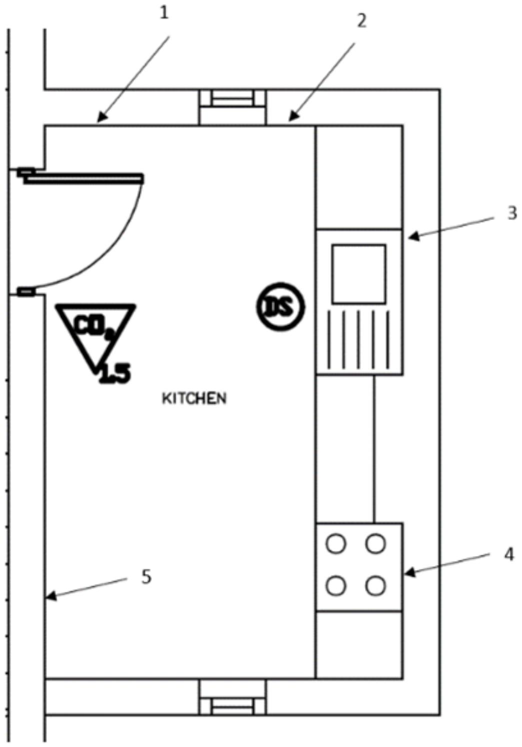
Kitchen

The environmental data for the first-floor kitchen were recorded as:

- Internal temperature: 9.8 °C
- Relative humidity: 51.6 %
- Wet Bulb temperature: 6 °C
- Dew Point temperature: 0.4 °C

The moisture readings were recorded according to the locations set out in Table 13 below. The readings indicate very high moisture levels, indicating there is water ingress in large areas of the building fabric. This is consistent with the staining and the vegetation growth identified in external areas, set out above.

Table 12: Moisture readings for Kitchen



Location Tag	1	2	3	4	5
Moisture Reading	45.7%	100%	100%	54%	68.5%

The kitchen is located above the external walkway and is accessed via an unheated space next to the meeting room. Opposite the entrance is a party wall, joining the building on the south of the Old Town Hall. The kitchen has a range of cupboards, a fridge, cooker with hood and sink (Figures 151 and 152).

There are **significant signs of water ingress, evidenced by the blistering and salt crystallisation on the surface of the walls.** This is particularly significant on the southern side of the rear window and behind the fridge (Figures 153 and 154). The walls appear to have been covered with impervious gypsum plaster and paint. These areas are consistent with the evidence of moisture with the growth of vegetation in the external areas. **The general condition of the meeting room appears to be very poor.**

There are no thermal images due to insufficient temperature difference between inside and outside.


Figure 151: Fridge, cupboards, and rear window in kitchen


Figure 152: Small kitchen in the front (west) facing wall


Figure 153: Kitchen window in the rear (east) facing wall


Figure 154: Wall behind fridge in kitchen

Emergency Stairs

There are internal and external emergency stairs form the unheated space between the meeting room and kitchen. These are the internal emergency stairs. Figures 155 and 156 show the door to access these emergency stairs.

The timber door sits in a stone frame. The stairs are made of concrete. The walls and ceiling appear to have been covered in impervious gypsum and paint. **There is significant staining on the walls and ceiling, with cracks in the plaster and paint** (Figures 157 to 160).
The paint has also started to peel off the ceiling (Figure 160).

Figure 155: Internal emergency stairs

Figure 156: Access door to emergency stairs from unheated space

Figure 157: Staining on lower part of wall for internal emergency stairs

Figure 158: Staining on upper part of wall for internal emergency stairs

Figure 159: Cracks in paint and plaster on walls of internal emergency stairs

Figure 160: Significant staining to ceiling and upper walls above internal emergency stairs

Energy systems

The main heating system is mains gas supplying two combination boilers (Figures 161 to 164). These supply a single pipe system of cast iron radiators throughout the building. The pipes are predominantly uninsulated.

Domestic hot water is provided via electric instantaneous point of use hot water units, located in each of the WCs, kitchenette, and kitchen (Figures 165 to 168). The DHW pipes are predominantly lagged with insulation.

Lighting consists of a mix of 2D compact fluorescent light fittings, 5′ T8 fittings, either single or double, and some single bayonet light fittings (Figures 169 to 172).

Figure 161: Mains gas boilers in plant room

Figure 162: Plant room

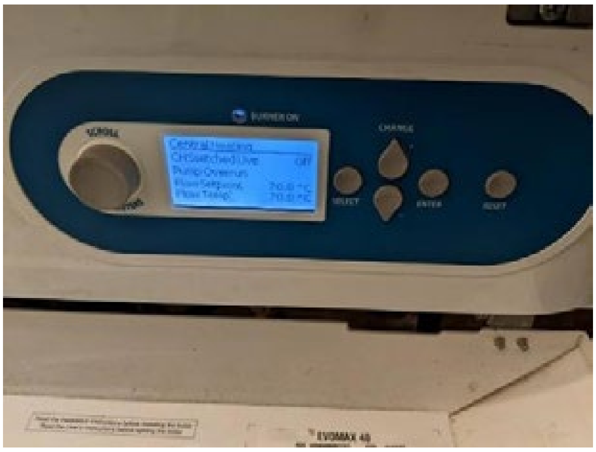


Figure 163: Control panel on gas boiler

Figure 164: Boiler information

Figure 165: Electric instantaneous hot water unit

Figure 166: Insulated hot water pipes

Figure 167: Mains gas meter and electric instantaneous hot water unit

Figure 168: Electric instantaneous hot water unit and insulated hot water pipes

Figure 169: CFL 2D light fitting

Figure 170: Bayonet light fitting

Figure 171: Single 5' T8 light fitting

Figure 172: Double 5' T8 light fitting

Summary of findings

Overall, the Old Town Hall is in a satisfactory to poor condition, with some areas that are very poor. The original 16th century building appears to be in a better condition than the 19th century addition. The primary causes for this status are water ingress, use of incompatible materials during previous works to the building and an inefficient heating system. Water ingress, high moisture content and the presence of unsuitable impervious materials appears to be exacerbating heat loss from uncontrolled infiltration and poor thermal performing building fabric. These incompatible materials applied to the building fabric are preventing any water and moisture in the structure to evaporate, thus trapping it within the walls. Single glazed windows with metal frames combined with thermal bridging within the building fabric are increasing space heating demand without improving the internal comfort for the occupants.

These findings are consistent with the occupant survey responses and go some way to explain the exceptionally high energy demand for a public building with such light use.

There is also evidence of significant structural movement in the 19th century addition, which requires further investigation.

Advice on Way Forward

Before any thermal upgrade measures are implemented, the condition of the building needs to be improved by undertaking the necessary repairs. **First and foremost, the structural issues identified should be fully investigated and rectified.** This should then be followed by other **essential repairs and remedial works, such as broken window frames, and the removal of unsuitable materials.** The building can then be left to dry out before the application of compatible materials to replace the ones removed. This process should rectify high moisture content in the walls and can start to improve the thermal performance of the building. Alongside this process the energy efficiency improvements can be implemented. These have been identified in the energy and thermal modelling, which should be reviewed in conjunction with this BPE report.

This section sets out some of the key actions that can be taken to improve the condition and thermal performance of the Old Town Hall:

External areas

1. Remove vegetation growth from roof, gutters, and walls
2. Clean out gutters and drains to remove debris build up
3. Repair rainwater fittings to ensure water does not run down the building fabric surfaces
4. Remove cement pointing and render, and replace with lime
5. If any stonework needs extra weather protection, use a lime-based product, such as limewash
6. Ensure service entry points are fully sealed using compatible materials, such as lime mortar (not expanding foam or silicone); this will reduce uncontrolled air infiltration
7. Ensure grills for under floor ventilation are repaired and maintained
8. Ensure there is adequate cross-ventilation under suspended timber ground floors

Internal rooms and spaces

9. Remove impervious materials that have been added to, or used to replace, original building fabric (roof, walls, windows, and floors) which prevents absorption and evaporation of moisture; these include concrete, cement render, gypsum plaster and plastic or oil-based paints, such as gloss and emulsion
10. Replace with limecrete, lime plaster, limewash and clay paint
11. Repair holes in walls and ceilings when reinstating lime plaster
12. Repair broken window frames and doors
13. Replace broken glass
14. Any inoperable windows should be reinstated as openable to allow for natural ventilation
15. Add draught proofing to windows and doors to reduce uncontrolled air infiltration

Energy systems

16. Add pipe lagging to heating system pipework
17. Review heating controls with occupants to identify the specific challenges they experience
18. Consider adding hemp to lime plaster to improve the thermal performance of the external walls

General

19. Clean windows and rooflight to maximise access to daylight and reduce need for artificial lighting
20. Review results of energy and thermal modelling, whole life carbon and life-cycle cost assessments, alongside this report to develop a suitable decarbonisation project for the Old Town Hall
21. A maintenance strategy aligned to BS 7913 should be developed and implemented, which should specify preventative rather than corrective action with minimum intervention, and repair over replacement
22. Establish a conservation manual as a permanent, standing document that contains essential information on the historic building, its history and architecture, materials and construction

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