The Morton Partnership
Structural Engineers

Registered in England No. 2727193

Old Timber Yard House, 55 The Timber Yard
Drysdale Street, London N1 6ND
Tel: 020 7324 7270 Fax: 020 7729 1196
Email: london@themortonpartnership.co.uk
www.themortonpartnership.co.uk

STRUCTURAL ASSESSMENT REPORT OF AYR STATION HOTEL AYR

SAVE BRITAIN'S HERITAGE

Client: SAVE Britain's Heritage
70 Cowcross Street
London EC1M 6EJ

Prepared by: The Morton Partnership Ltd
Old Timber Yard House
55 The Timber Yard
London N1 6ND

Date: September 2023

Reference: EJM/CH/21948~srep rev 2

EXECUTIVE SUMMARY

CONTENTS:

APPENDICES:

Revision	Date	Comments	Name
0	17/07/2023	Draft issue to SAVE	EJM
1	04/08/2023	Updated draft issued to SAVE	EJM
2	15/09/2023	Final Issue	EJM

EXECUTIVE SUMMARY

SAVE Britain's Heritage commissioned this Condition Report and separate Costs Summary Report as an up-to-date record of the condition of Ayr Station Hotel. Together, these reports outline the scope of repairs and associated costs for making the building weathertight and structurally sound enough to remove the scaffold. These repairs have been costed by an independent Quantity Surveyor with an estimated timeframe for completing these works also provided.

Based on the inspection of areas accessible at Ayr Station Hotel, The Morton Partnership consider that it is practical to repair and bring the building back into long term sustainable use. They have been assisted by Mann Williams in carrying out an Embodied Carbon Assessment. The key findings of the reports are as follows:

Scope of repairs

Besides the roof, most of the repairs required to the building envelope are localised, with much of the existing fabric likely to be capable of re-use. The two reports set out the following key areas of repair and associated costs required for each of the three constituent sections of the building: **1) South Range 2) Clock Tower & Link & 3) North Range**

a.	Roofs	d.	Dormers	g.	Below Ground Drainage
b.	Rainwater goods	e.	Masonry Elevations	h.	Internal repairs
c.	Chimneys	f.	Windows	i.	Basement repairs

Costs

- The Costs Summary Report prepared by Quantity Surveyors at Thornton-Firkin states that the total cost of repairs identified for the entire structure is £9.2 million. This figure includes all ongoing scaffolding hire costs and represents a comprehensive cost solution compared with £6.6 million estimated in December 2022 for demolishing just the South Range of the building.
- The full cost of repairs for the South Range, Clock Tower link and North Range are set out in the Cost Summary Report.

Phasing

- The Condition Report states that the heavy-duty loading design of the current scaffolding arrangement is capable of facilitating the vast majority of repairs identified for the South Range in the report.
- A period of 12 to 18 months is anticipated for completing these repair works and those pertaining to the remaining sections of the building is set out in the Cost Summary Report.

Background

- Being built of solid stone in a modular design, the fundamental structure of the building is immensely solid. The use of concrete jack arches and iron beam floors has enhanced the lateral stability to the structure and are good at resisting sound and fire. This form of construction is what has probably helped limit the impact of the recent fire.
- Many of the structural issues identified in Mott MacDonald's 2019 survey have been found to be non-critical and non-progressive, meaning the building has remained in a stable condition since that time.
- Most issues identified as requiring rectification have clear causes, including in the majority of cases, former water ingress as a result of defective rainwater goods or corroded structures built into the masonry of the hotel such as the iron girders supporting the station canopy.
- The scaffolding encapsulation around the South Range is attached to and entirely supported by the building itself.
- The scaffolding has stopped major water ingress, halted the progression of existing fabric damage and prohibited new and potentially critical deterioration occurring.

Carbon footprint

- A supplementary Embodied Carbon Assessment has been provided as part of the Condition Report by Mann Williams.
- It concludes (and on a conservative basis) that when compared against an equivalent refurbishment and reuse scheme, a new build scheme will emit 50% more total greenhouse gas emissions over its design and serviceable life.
- The Assessment shows that it would take until 2090 for the theoretically improved energy efficiency of the brand-new building to compensate for the combined carbon cost of demolition.

1.0 Introduction and Client Brief

1.1 We have been requested by SAVE Britain's Heritage [SAVE] to carry out a structural condition survey to Ayr Station Hotel.

1.2 SAVE are campaigning for the retention and re-use of Ayr Station Hotel, a large, fine and listed (Category B[1]) Victorian building situated alongside, and formerly part of the railway facilities.

1.3 Ed Morton of the Morton Partnership Ltd was requested by SAVE to visit the site and provide his expert view on the overall condition of the building, both from a visual assessment from accessible positions, as well as by reference to previous reports (see 1.6 below).

1.4 More specifically we have been requested to provide an up-to-date factual overview of the building's current structural condition and establish the anticipated scope, methodology and schedule of essential repairs required to make it weathertight and structurally safe enough to remove the scaffold. Full repair internally would be subject to further access and assessment.

1.5 Ed Morton is an Engineer Accredited in Conservation and has in excess of 30 year's experience working on historic, listed buildings and structures throughout the UK and abroad.

1.6 The reports reviewed in the process of compiling this report include the following:

- Building Structural Condition - Independent Report - Mott Macdonald – October 2019;
- Safety Works under Section 29 of the Building (Scotland) Act 2003 – November 2022;
- Feasibility Study – Atkins - February 2021.

1.7 The site was visited on the 21st and 22nd June 2023, with the weather being overcast with short rain showers on the first day and sunny on the second day. The survey was facilitated by and undertaken with the assistance and full knowledge of South Ayrshire Council with whom we shared the survey methodology with.

1.8 A Safe Systems of Work for the Survey and Inspection was prepared by Safety Frist Associates, Health and Safety Consultants, who had themselves conducted a site visit and inspection of the building on 12th April 2023. This work provided a methodology for the inspection of the building relating to its condition.

1.9 Unfortunately we were not able to access the majority of the building internally at the time of the inspection due to Health and Safety concerns. This included a recent fire at the end of May 2023 in a localised area of the south range. However, a reasonable proportion of the south range was visible from the access scaffold with boarding removed from windows with the assistance from contractor, CPMS Ltd, whose help we are grateful for.

1.10 A Dangerous Building Notice was issued on Network Rail Infrastructure Ltd, dated 25th July 2013 and required the steps to be taken which were '*To make safe by repair areas of loose slates, timber roof safety guard, defective masonry and timber windows indicated on the plan overleaf*'.

1.11 A second Dangerous Building Notice was issued on the 28th March 2018 which included:

- Make safe by repair areas of defective sandstone to all elevations and including gables, this will also require the removal of all vegetation.
- All downpipes and associated rainwater goods require to be checked for integrity and secured where required.
- All roofs Including mansard roof requires to be made safe by the removal of all loose slates and repair/removal of decorative ironworks.

[1] Category B - Buildings of special architectural or historic interest which are major examples of a particular period, style or building type. Historic Environment Scotland.

- All entrances to the hotel require to be secured against entry including doorway onto flat roof above the kitchen.
- The Station Hotel sign requires to be removed from the roof of the west elevation.
- All timber roof snow boards require to be removed from all roofs.

1.12 We understand no further intrusive or detailed surveys have been undertaken since the Building Structural Condition report by Mott MacDonald, published 3rd October 2019.

1.13 Additional information assessed in the preparation of this report has included:

- The original Architects' plans of 1885;
- Refurbishment plans from 1968;
- Plans of the existing scaffold shared by South Ayrshire Council.

2.0 Brief Description

2.1 Ayr Station Hotel was Category B Listed in 1980 on account of its Architectural or Historic Importance and as part of the wider listed station complex. The full list description, from Historic Environment Scotland's online list is repeated below, although it should be expected that these are not always completely correct:

Description

Andrew Galloway, dated 1885. 3-storey and attic French Renaissance hotel forming part of Ayr Station, with 4-storey and attic corner pavilion and lower single storey, single storey and attic and 2-storey sections to station. Coursed red sandstone. Bull-faced battered base course; channelled rustication to ground floor of principal elevation; architraved openings with projecting cills; dividing band courses; deeply moulded eaves cornice; pilastered sandstone rectangular dormers to attic, with deep entablatures, scrolls flanking; decorative iron brattishing to pavilion roofs.

STATION HOTEL

NW (ENTRANCE) ELEVATION: E Block: 11-bay; main entrance to penultimate bay to left; advanced, pilastered entrance porch; round-arched keystoned doorpiece; pilasters flank sidelights; balustraded parapet over, with dies; further entrances to re-entrant angles; tripartite stair windows to upper floors; pilastered 3-light window at attic; segmental pediment over; additional flat-roofed dormer to rear. Canted doorway to ground floor of centre bay, 2-leaf door with fanlight, flanked by 2 narrow windows; consoles support balcony to pilastered 3-light bowed window at 1st floor centre 2-leaf French window with fanlight and sidelights; bipartite window at 2nd floor; decorative segmental-pedimented roundel at attic, dated 1885. Timber door at ground floor of 3rd bay from right. Advanced modern addition obscuring 2 bays to outer right; bipartite attic windows with pedimented central heads to pavilion roof above. Regularly spaced single and bipartite windows ground, 1st and 2nd floors of remaining bays; regular fenestration to attic.

W Block: 10-bay with 3-bay canted corner pavilion; advanced; 2-bay right return adjoining East block (see above), regular fenestration. Squat pilasters to centre at ground floor of corner pavilion to right, supporting pilastered bipartite windows to each storey above, dies to parapet corner angles at attic; infilled doorway flanked by window to ground floor of bay to right, bipartite windows to remaining bays at all storeys, attic windows round-arched with pediment, clock faces to steep pavilion roof; alternating straight and segmental pediments at apex. 10-bay block: entrance at ground floor to outer right; tripartite window to ground floor of advanced pavilion bay to left; single and bipartite windows to remaining bays at ground, 1st and 2nd floors; regularly placed dormers to attic, with exception of bipartite attic window with segmental pediment to pavilion bay to left. Irregular fenestration to 2-storey block adjoining to left; and advanced bay to outer left. 3 recessed bays to far left with variety of timber doorways.

SE (PLATFORM) ELEVATION: E Block: 10-bay; infilled door and window openings to ground floor; platform canopy over 1st World War Memorial Plaque to outer right; round-arched openings to centre 6-bays at 1st floor, bipartite windows to 2 flanking bays to left and right; single and bipartite windows to 2nd floor; regularly placed dormers to centre 6 bays to attic floor; bipartite dormers in pavilion roofs to outer left and right. 4-bay right return with regular fenestration, adjoins W Block (see below).

W Block: 10-bay; variety of window and door openings to ground floor; canopy adjoining to bays to left; single and bipartite windows to 1st and 2nd floors; regularly spaced dormers to attic; bipartite dormer set in pavilion roof to right of attic. 2-storey block adjoining to right with irregular openings, scrolled wallhead stack to centre. Single storey blocks adjoining to outer right.

NE ELEVATION: variety of gables.

SW ELEVATION: symmetrical; blind pedimented openings to centre; segmental-arched gable broken by wallhead stack.

INTERIOR: good detailing includes coffered ceilings with coved cornices, pilaster strips to walling; panelled arches; timber dado panelling and composite marble fireplace; ornate lift shaft; carved stair newels; decorative strings; timber handrail.

STATION, FOOTBRIDGE AND CANOPIES

SE (ENTRANCE) ELEVATION: 15-bay, with recessed section to outer right. Near central double-pilastered, pedimented entrance; 2-leaf timber door; fanlight; single and bipartite openings to flanking bays to left and right. Arch to recessed canopied section to outer right.

NW (PLATFORM) ELEVATION: 24-bay; canopy extends to adjoin hotel to N (see above). Arched entrances to outer bays; square headed open entrance to centre; irregular openings to remaining bays. X-girder footbridge to N crossing platform; decorative cast-iron columns with curved decoratively pierced brackets to platform canopies.

SW AND NE ELEVATIONS: not seen 1999. INTERIOR: modern booking office.

Predominantly plate glass timber sash and case windows. Slate roofs with led ridges, including pavilion roof platforms; stone skews; gablet skewputts; corniced ridge stacks; circular cans. Cast-iron rainwater goods.

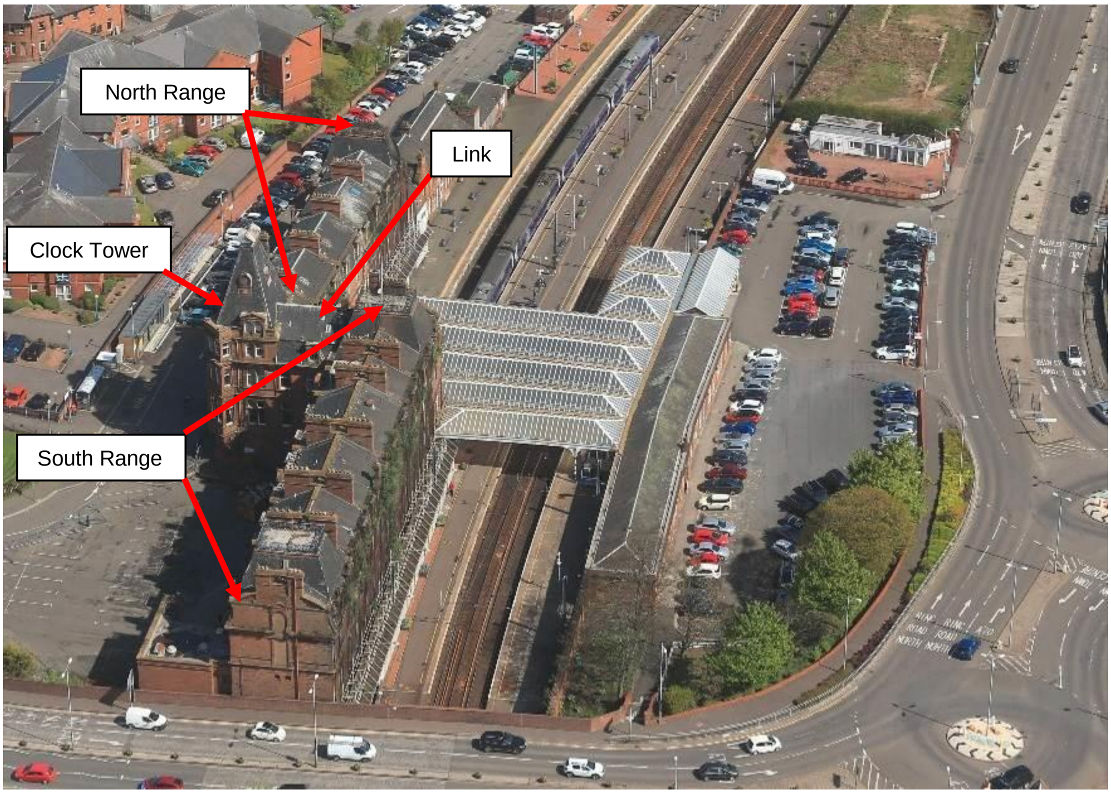
LAMP STANDARDS, GATEPIERS, RAILINGS AND BOUNDARY WALL: 2 pairs of iron gatepiers to main entrance; central pair with lamp standards atop delineate vehicular entrance; coped boundary wall enclosing site; railings atop to sections of walling.

Statement of Special Interest

Built by the Glasgow and South-Western Railway Company at a cost of £50,000, described by Groome as, "... a new and commodious station ... its platform covering an area of 3000 square feet, and in connection with it a large and handsome hotel." The work was superintended by Mr Robert Wilson, assistant engineer. Notable for the good interior detailing to the hotel and the impressive ironwork to the station canopies.

References: Bibliography
Ordnance Survey map, 1858 (earlier Townhead Station evident), Ordnance Survey map, 1896 (evident); AYR ADVERTISER (3/6/1886); FH Groome ORDNANCE GAZETTEER OF SCOTLAND, Vol 1 (1892), p98; JR Hume THE INDUSTRIAL ARCHAEOLOGY OF SCOTLAND, VOL 1: THE LOWLANDS AND BORDERS (1976), p46; John Strawhorn THE HISTORY OF AYR (1989), p176; Rob Close AYRSHIRE AND ARRAN (1992), p19; R&J Kennedy OLD AYR (1992), p5; Dane Love PICTORIAL HISTORY OF AYR (1995), pp11, 12, 22; NMRS Photographic Archive (A39957/A39958).

2.2 For the purpose of this report the building is split into the north range and south range with a short dog-leg between the two, with the clock tower rising up at the corner and south end of the north range. The rail lines are to the east of the hotel. Further referencing is included in appendix D.



Aerial View (Credit: Network Rail)

2.3 The south and north ranges comprise ground, first, second and third floor accommodation, the latter being contained within the mansard roof. There is a part basement under the south range. The corner tower has four floors of masonry with a further floor with the steep and tall roof over (see Appendix A: photographs 1 to 7).

2.4 The building is a substantial masonry structure, in red sandstone facing and we assume then mainly of brick main walls. Certainly, some internal images and off areas seen from the external inspection suggest this, although there also may be stone backings to walls.

2.5 The roofs are of timber construction with slate covering with chimneys rising up off masonry cross walls at regular intervals. Internal floors are of timber construction to the upper levels, and then at first floor appear to be of solid construction, with concrete jack arches between iron (assumed rather than steel) beams, and then deeper composite wrought iron beams as primary support. This allowed the wide-open spaces for the public spaces for the hotel to be formed. Where there are principal rooms at first floor level (principally in the south wing), then the floors over appear to be with deep ferrous beams and timber joists.

3.0 Structural Survey Detail

3.1 South Range - Scaffold

3.1.1 The entire south range is covered by scaffold (see photographs 8 to 10). We have been provided with copies of the scaffold drawings prepared by Zenith Consultants. It can be seen that the scaffold provided is not intended to provide any structural support to the building and in fact relies on the building itself for lateral stability. There are multiple fixings into the masonry from the scaffold to provide this lateral stability (see photographs 11 and 12).

3.1.2 The duel pitched temporary roof is tied through cables spanning across at approximately eaves level of the scaffold roof, and then below this are further restraint arrangements which wrap around the chimneys and then extend back to the scaffold (see photographs 13 and 14).

3.1.3 The design loadings are included on the drawings and suggest one level loaded at 3.0kN/m^2 (heavy duty) with one additional level at 0.75kN/m^2 (inspection/access). Thus, this scaffold could be used within these limitations for any repair work. This would allow repair work for masonry, re-roofing and repairs to windows etc. Loading bays may well be needed to be added to the west elevation within the car park for storage of slates and other materials for works. There are areas where dismantled stone is already laying on the scaffold which demonstrates this (see photograph 15).

Key Recommendation
The existing scaffold could be used within the loading limitations above for substantive repair work. This would allow repair work for masonry, re-roofing and repairs to windows etc. [3.1.3]

3.2 South Range

3.2.1 The regularised form of the structure, being a long rectangular box with substantial masonry external walls and thick cross walls at regular centres, which rise up above the roofs with chimneys is inherently robust.

3.2.2 The roof to the south range in large parts still has the slate roof coverings in situ (see photographs 16 and 17), although with obvious local slipped, broken and missing slates. Of course, the scaffold and temporary roof now affords protection to the original roof and has reduced the extent of decay. The simple and regular form will assist in how local temporary works can be designed, although from our inspection we expect these to be modest.

3.2.3 However, there are clear areas where water damage, through missing or defective areas of slates has occurred (see photographs 18 to 22). Whist timber repairs are required with the roof coverings removed these are not complex, although some local temporary support may be necessary. The water damage will continue down the buildings, but generally will diminish at each level.

3.2.4 The detailing of the roof structure is impressive with careful consideration and elaborative details introduced. For instance, at the change in pitch of the mansard roof from the shallow pitched upper slope to the steep pitch, which forms the third-floor rooms, there is a decorative cast iron flashing (see photograph 23). There are inevitably broken sections of these at positions (see photograph 24), but which could be used to re-cast broken and missing sections.

3.2.5 The stone pedimented dormer windows were inspected carefully (see photograph 25). The form of the construction can be seen most clearly to the east elevation where a section of the roof covering has been removed in an area of decay, with some of the stone removed at low level (see photographs 26 and 27). Cables have been installed as a temporary measure for lateral stability but are all loose.

3.2.6 Where exposed it can be seen that the dormer masonry is approximately 750mm wide (see photographs 28 and 29). Behind this is a timber frame wall which rises, and presumably supported off the joists below, or perhaps a thickening in the wall. The mansard rafters also descend down from this plate. At eaves level to the mansard this includes a substantial wall plate on which the upper rafters sit. This plate also supports the ceiling joists to the attic accommodation (see photographs 20 and 30). Interestingly, we noted masonry infill between the rafters, and we suspect this was installed as sound proofing to the east side where the railways ran.

3.2.7 It is unknown if there is any fixing between the eaves plate or ceiling joists and the back of the dormers. If these exist then they will provide lateral stability to the stone elements, and if they do not then these would be simple and effective in enhancing lateral restraint. Of course, the mansard rafters will tend to act as struts to the upper eaves plate which will help resist roof thrust.

3.2.8 However, from the scaffold we used a short spirit level, to check the out of plumb of each dormer to the east and west elevation of the south range, and the extent of out of plumb was generally negligible, suggesting there has been little or no lateral movement. The Mott MacDonald report refers to one dormer to the east elevation being 10-15mm out of plumb, however, with masonry of over 700mm thickness this is not sufficient to warrant structural concern. Regardless of this and as indicated above, enhancing the lateral stability of these dormers is simple.

3.2.9 Towards the north end to the west side, there is an added flat roofed dormer to the upper pitch (see photographs 31 and 32), which appears to be positioned above the lift and thus maybe related to a lift over-run. This may relate to later modifications to the elevator and doesn't appear on the 1968 elevation drawing from The National Archive.

3.2.10 There is a limited view into the roof structure here, which appears in not unreasonable condition in the local areas seen. The dormer has leadwork cheeks repaired and also is missing some flashings, but again it is under cover now so not deteriorating. The gutter below this dormer runs to a large pedimented dormer to the stair, and has had felt applied over leadwork with some stored building elements, such as pots and cast-iron sections (see photograph 33). A reasonable degree of repair will be needed to this dormer.

3.2.11 At the base of the mansard is a cast iron gutter which sits on a stone cornice (see photograph 34). The gutter has clearly been leaking, particularly at joint positions and this has then caused deterioration of the stone through moisture action and freeze/thaw action (see photographs 35 and 36). Some of the gutters have been broken to allow the scaffold standards to rise up – this is where there is a slight projecting bay to the main stair internally.

3.2.12 There will be a reasonable degree of stone repair needed to the cornice, and the gutter will need to be removed, cleaned, with sections repaired or replaced and then a new lining installed. In some locations there are later gutter amendments (see photograph 37), and short drops of downpipes into these gutters. These will need rationalising when the works are undertaken.

3.2.13 In general the external walls overall are not in unreasonable structural condition. There are of course some defects including cracking to occasional stone lintels over windows (see photographs 38 to 40), which is not unusual and can occur with minor movements of the building or as this is a natural material which can have defects in. These generally can be cross pinned in the normal way.

3.2.14 Generally, no evidence of iron cramps, dowels or fixings were noted to the masonry to the South Range. This is normally evidenced from corner cracking in stones close to joint positions and due to the marine environment, I would certainly have expected to see this after its in excess of 100-year life if they existed. In addition, the removed stone brackets to the sides of the dormers to the east side have no fixings but mortar joggle joints.

3.2.15 There are however some in-built steel, or possibly iron fixings which are causing issues. In some locations scaffold screw in sockets have been left in-situ, and then corroded causing fracturing of the stone (see photograph 41). Elsewhere, in-built iron beams of unknown use are causing similar damage (see photographs 42 and 43). Local areas of stone will need to be cut out and either replaced in their entirety or indented with sections.

3.2.16 Other stone is in a deteriorated condition due to defective downpipes (see photographs 44 and 45). These extend in places through ornamental or fake stone hoppers (see photographs 45 and 46). Where water ingress has occurred, this has encouraged vegetation growth, and where woody shrubs have rooted, in some places root expansion has led to failure of the stone (see photographs 47 and 48).

3.2.17 At one position a window appears to have been altered and possibly enlarged, as evidenced by an apparent modern mullion which we suspect is coloured pre-cast concrete (see photograph 49). Another mullion has some delamination (see photograph 50), whilst another window has a flat steel plate to the underside of the stone lintel (see photograph 51), which has started corroding and again possibly added due to an alteration. There is poor quality plastic (mortar repair) above the window where this plate has been added. At one position an eroding window head has had a temporary prop added (see photograph 52).

3.2.18 To the south gable the conditions are broadly similar. It was noted that the large window below the upper gable, that due to the coursing of the stone surround there appears to be a straight joint (see photograph 53), although it seems likely there will be some joggle joints concealed behind this or similar. There is no evidence of this causing an issue.

3.2.19 To the north elevation the scaffold and temporary roof do not afford complete protection to the west side and with the masonry heavily ‘greened up’ from moisture saturation (see photographs 54 and 55).

3.2.20 To the north east corner there is some more significant evidence of movement in the form of cracks running up both the north and the east elevation (see photographs 56 to 59). The Mott MacDonald report suggests this relates to some local subsidence, which may be the case – however we also noted that the cracks appear to align with the main station canopy beams, which appear to have corrosion to the built in ends (see photograph 60), which may be the cause of the damage seen above. These would need to be opened up to inspect, remove corrosion product and treat with paint.

3.2.21 To the west elevation towards the north ends below the cornice there is significant greening up and high moisture, some of which is still current from an area where the gutter has been broken (see photographs 60 and 61). This has allowed some water related fungus to grow. The main damage backs onto where the main stairs rise up, so it is likely there is less timber built in, as the stairs are assumed to be cantilevered stone or with iron stringers, although there could well be some damage at floor levels.

3.2.22 It was noted that the pointing to the elevations varies, with that to the publicly visible west elevations being very tight and likely lime putty joints (see photograph 62), whereas to the track side wider joints were employed (see photograph 63), some of which have been cement re-pointed.

3.2.23 The bay to the stair has curved stone lintels over the windows and indeed these are also curved in profile (see photographs 64 and 65) and run up behind some of the stone lintels.

3.2.24 The extent of architectural embellishment and carving in the public elevations is significant and of high quality reflecting the status of the building when constructed (see photographs 66 to 70).

3.2.25 At the north and south ends of the south range roof are short tower roofs with slate covered sides and shallow pitched lead covered roofs over (see photographs 71 and 72), although some of the lead is now missing. Generally, these appear in reasonable condition although with some loss of slates.

3.2.26 The upper timber floors (second and third floor levels) span from the external elevations across the width, but with intermediate support provided by the corridor walls (see photographs 73 and 74). Based on the Mott MacDonald report, and where we have inspected internally there are significant areas where we consider the floor joists can be retained (see photographs 75 to 77), although of course some repairs will be necessary, particularly where joist ends are built into saturated external walls. It should be understood that the building has been vacant for a significant length of time and with reduced ventilation which will allow failure of ceilings, but this doesn't necessarily mean floors cannot be retained and re-used.

3.2.27 We note that the Mott MacDonald report refers to 'sound deadening material' in some of the floors. This is not unusual in such buildings and often referred to as pugging. This will relate to sound separation particularly between public rooms and bedrooms over. The main beams are likely to be wrought iron and rivetted with plates and angles etc.

3.2.28 In the area of the recent fire we could see the first-floor structure over, and this appears to comprise main beams of riveted construction (as suggested above) and here with iron or steel joists apparent with concrete jack arches between (see photograph 78).

3.2.29 The ground floor is reported as being of similar construction to that described above, of iron beams and concrete jack arches between iron joists but elsewhere suspended timber.

3.2.30 Some degree of alterations is of course expected and looking at some of the beams downstands to the principal rooms, we suspect some removal of original walls has occurred. This is particularly clear to the east side where we suspect that there was a wall and corridor to help shield the room from the noise of the trains.

3.2.31 The elevator or lift rises up with the main stair rising around this (see photograph 79). The style and detailing perhaps suggests this enclosure may have been original, which would make it a very early example of an elevator in the United Kingdom. The lift car itself is likely to be modern.

3.3 <u>Clock Tower and Dog-Leg</u>

3.3.1 The tower at the junction between the north and south ranges has steeply sided sloped covered roofs with copper rolls to the corners and surmounted by a pedimented small roof with apparent lead running down to cast iron decorative weathering at the junction between the main capping and the roof (see photographs 80 and 81). The roof to the pediment cap cannot be seen but has an iron finial rising up possibly as a lightening conductor. There are areas of split lead, but overall, it does not look in unreasonable condition.

3.3.2 The roof itself is partly covered with netting and sheeting which make parts not visible, and clearly there are some lost and displaced slates throughout. There are dormer windows to three elevations with a mixture of cast iron and lead flashings, but difficult to see due to the netting.

3.3.3 To the north side there is a chimney and back gutter which has a roof projecting running up to it, which will enhance its lateral stability, although again covered with netting. We understand the upper part of the stack was removed for safety reasons. Where there are lost slates, it can be seen that there is a layer of underfelt. Whilst there are some areas of decay where water is entering, this is likely to be relatively nominal, and due to the steepness of the side roofs of the tower most of the water will extend down. There are gutters in lead running around the base of the tower which are in poor condition with debris and could be allowing water ingress in this critical area (see photographs 82 and 83).

3.3.4 The high-level stonework is heavily vegetated with open joints and is in a robust reddish sandstone. There is evidence of potential iron cramps or fixings to local areas (see photograph 84), particularly to the pedimented window to the south side at the base of the tower, and also some could be seen in copings with dog leg cramps linking these together as would be expected (see photograph 85).

3.3.5 The windows are generally in poor condition at low levels, with the jambs and cills affected by water ingress also some of the lower sashes and considerable repair will be necessary (see photograph 86).

3.3.6 From ground level and with binoculars, it was possible to partially view occasional ceilings which appear to be intact. As indicated before this is not unsurprising with the form of the roof.

3.3.7 Between the Tower and the South Range there is a slate covered pitched roof with a lead ridge and valley gutters where it abuts the adjoining structures (see photographs 87 and 88). This runs downs to an eaves so tends to discharge the water quite well, which then has a mansard roof below and again with a decorative cast iron weathering between the two.

3.3.8 The mansard roof then runs down to a large cast iron gutter at the base, which has a lead flashing between it. It was noted that the gutter has standing water in it (see photograph 89). There is a dormer window to the south side to this and which has lead flashings, but some secondary felt or similar weathering, presumably when leaks occurred (see photograph 90).

3.3.9 The lower elevations to both north and south are not fully protected by the temporary roof with their evidence to both of consequential water damage and greening up.

3.4 North Range

3.4.1 The north range mansard roof is covered with temporary sheeting to help reduce the risk of falling slates (see photograph 91). This extends down on the east elevation for the majority of the height of the building (see photograph 92), then with the bottom section concealed behind hoardings (see photograph 93). To the west side the sheeting covers the mansard roof only (see photograph 94).

3.4.2 The west elevation masonry shows signs of lack of maintenance and water ingress with considerable vegetation growth (see photographs 95 to 98) which has led to salt effervescence in areas.

3.4.3 To the west fire escape, some steels which are built in have corroded and caused excessive damage to the stonework (see photographs 99 and 100).

3.4.4 To the north range we could enter at ground floor level to the Old Scott Rail office, but not much of the structure can be seen due to lower suspended ceilings (see photograph 101). However, to the south end in the ticket office where suspended ceiling panels were missing, original lath and plaster ceilings can be seen, although these are missing in areas and reveal iron beams at regular centres with concrete jack arches between (see photograph 102), similar to that seen in the South Range. Riveted main iron beams were also noted.

4.0 Embodied Carbon Assessment by Mann Williams

4.1 We have approached Conservation Engineers, Mann Williams, who have undertaken a basic embodied carbon analysis comparing retention of the existing building with repairs and refurbishment to improve standards as much as practical, and against a new build on the same footprint and floor space, following demolition of the existing. The full report is included in appendix B.

4.2 A number of assumptions have been made, and a very conservative allowance for the extent of the existing building which would be retained, and a more detailed assessment would probably show greater embodied carbon savings.

4.3 Similarly, the assessments for a new build scheme are based on typical values for very well engineered structures that are fully compliant with best practice, products and detailing in terms of energy saving, insulation, MEP systems etc. Any deviation from such compliance would likely result in more onerous carbon emissions.

4.4 The report concludes that the new build scheme will emit more total greenhouse gas emissions over its design and serviceable life than the equivalent refurbishment and reuse scheme.

Key Recommendations
A new build scheme will emit more total greenhouse gas emissions over its design and serviceable life than the equivalent refurbishment and reuse scheme.

5.0 Comments on Mott MacDonald Reports

5.1 Below we have provided commentary on the reports produced by Mott MacDonald. These are not meant to be exhaustive but to give our view on various aspects raised.

5.2 Former Ayr Station Hotel – Building Structural Condition – 03 October 2019

5.2.1 *3.1 – General, Para 11*: Suggested settlement cracks may in fact be related to corroding main steels of the station canopies. The magnitude of these is not sufficient to warrant structural concern and would only do so if they are progressive in nature, which they do not appear to be.

5.2.2 *3.1 – General, Paras 12, 13, 14, 15*: The masonry defects are noted but commented on in more detail in sections below.

5.2.3 *3.2 – Building Perimeter Walls, Para1*: We concur that the construction is of solid construction, but evidence suggests that the inner backing walls may be brick as identified in some images. Regardless of if stone throughout or combined brick and stone, the solid walls are robust and thick and even with the dormer walls being greater than 0.75m wide.

5.2.4 *3.2 – Building Perimeter Walls, Para3*: The cornice and string cornices mentioned are standard features on thousands of historic and listed buildings. Many of the defects to the stone relate to concentrations of water where gutter joints etc. have failed.

5.2.5. *3.2 – Building Perimeter Walls, Para 5:* Some of the damage may relate to localised but apparent historic settlement/subsidence but also to corrosion of the ends of iron beams from the station canopy where these are built into the masonry. Whilst cracks may extend below ground level, corrosion jacking of the steel could also cause movement to extend down to this level.

5.2.6 *3.2 – Building Perimeter Walls, Para 6:* No evidence of any significant ‘substrate’ breakdown.

5.2.7 *3.2 – Building Perimeter Walls, Paras 7 and 8:* Cracks often relate to effects of in-built iron/steel or shrub root action. Occasional ones may relate to defects in the original stone, being a natural material.

5.2.8 *3.2 – Building Perimeter Walls, Paras 9, 10 and 11:* Efflorescence often relates to water ingress seeking a route of egress from the masonry and bringing salts with this. It does not necessarily lead to significant structural defects or distress.

5.2.9 *3.2 – Building Perimeter Walls, Para 12:* The wall is saturated from poor maintenance due to the rainwater, and this has led to significant corrosion of the in-built steel members to the added fire escape and consequential damage to the stonework.

5.2.10 *3.2 – Building Perimeter Walls, Para 15:* Stonework and mortar is eroded to an extent mainly where aggravated by ineffectual or non-maintained gutters. These can however be addressed through standard repairs.

5.2.11 *3.3 – Dormers, Paras 2 and 3 –* There is not any significant lateral movement. Even the most significant recorded movement (suggested as 15mm, although we did not find this extent) is not considered significant for the masonry of the dormer which is in excess of 700mm wide.

5.2.12 *3.3 – Dormers, Para 4* – We did not note the fractured inside face to the dormer reveal and were unable to identify this in the report photographic record.

5.2.13 *3.3 – Dormers, Para 5* – I disagree that the stone to the dormers is in poor to very poor condition.

5.2.14 *3.4 Historic (and other types of) Metal Insert* – The damage is clear and the iron or steel, where built in will need to be removed. This is not an uncommon defect for historic masonry buildings but can be easily managed through normal repairs of cutting out and removal of these. The main station canopy beams will need to be exposed to assess their condition. It is likely that the ends will require cleaning and treatment but are likely to have sufficient parent material to allow retention, but if not can be repaired with new sections or partner sections.

5.2.15 *3.5 Cross Walls, Chimney Stacks and Architectural Feature Arch Structures* – The chimneys and cross walls internally, where seen, or from the MM report appear in reasonable condition and form an important stiffening element to the building. I assume that is why the ties to the scaffold have used these elements to provide lateral stability to the external scaffold to the south range. Clearly some fabric repairs will be required above roof level but are not considered significant in nature or structurally required.

5.2.16 *3.6.1 Roof Structure - General* – We agree the buildings require re-roofing. As indicated the north section is in better condition than the south, but the south is now protected with the temporary roof so the condition will not have significantly degraded since that time.

5.2.17 *3.6.2 Roof Structure – Mansard Para 4* – We disagree that the there is significant damage throughout. There is clearly localised damage where slates are missing and affected by rainwater ingress, but these can be managed by local repairs. Some areas may require some local temporary propping as stated in our conclusions. We note that within the internal observations (clause 4.1, para 7), the MM report suggests in line 1 that the '*timber generally found to be unaffected by water'.* They do highlight some degradation of truss connections.

5.2.18 *3.6.2 Roof Structure – Mansard Para 5* – The rubble infill between rafters is probably to provide sound proofing between the accommodation and the track side. The vertical timbers off the wall inside the rafters provide additional support to the roof eaves and are not mentioned related to the support to the eaves plate, although some defects are mentioned to these within the internal inspection (defect WE3.14 for instance).

5.2.19 *3.6.2 Roof Structure – Mansard – Para 6* – see clause 4.3.30 to 4.3.33.

5.2.20 *3.7.3 Escape Staircase (and raised walkway) Gantry West Elevation* – Much of this damage relates to corroding steel in-built into the masonry, aggravated by water discharge from failed roof drainage.

5.2.21 *4.1 General, Para 1* – Some of the 'dark staining' is mould which is caused by excess moisture within a building. This can be through penetrating damp through defective fabric, leaks through internal pipes as well as by excessive condensation, the latter being the most significant cause. Condensation tends to be prevalent when a building is not well ventilated, and especially in traditional buildings with minimal insulation. Of course, the fact the building has not been occupied for a long period with no effective ventilation will have aggravated this. Long term and widespread mould, itself isn't a structural concern, but its presence can indicate conditions which might exist which could support wood decay fungi, although the extent of this is difficult to confirm.

5.2.22 *4.1 General, Para 2* – Ceilings have clearly collapsed, but this does not mean the structure is completely compromised.

5.2.23 *4.2.1 Building Perimeter and Cross Walls, Para 2 -* We agree higher spaces in the public reception rooms but there are substantial external and cross walls and no evidence that these have not been structurally adequate and worked for the in excess of 100 years life of the building.

5.3.24 *4.2.1 Building Perimeter and Cross Walls, Para 4* - We refer to our views in clause 5,2,21 above.

5.3.25 *4.2.1 Building Perimeter and Cross Walls, Para 6* - Accepted that there are a few window heads where steel support members (plates etc) have been introduced, but it should be noted that the number of windows is very limited.

5.3.26 *4.2.1 Building Perimeter and Cross Walls, Para 9* - As indicated on the report where openings formed to the ground and first floor in cross walls, there are assumed to be wrought iron composite beams. There is no evidence to suggest any structural defects with these.

5.3.27 *4.2.2 Suspended Floor (ground, first, second, third and fourth floors), Paras 4 and 5* - The MM report suggests that joist ends in the east elevation, where built in, are in poor condition. Whilst some will be below areas of water ingress, this is not wholesale, and I couldn't find reference in the MM report to this issue in the photographic survey.

5.3.28 *4.2.2 Suspended Floor (ground, first, second, third and fourth floors), Para 7* - Sound deadening material is common in historic structures related to either sound insulation or fire insulation.

5.3.29 *4.2.2 Suspended Floor (ground, first, second, third and fourth floors), Paras 11 and 12* – The form of construction of iron beams (we suspect wrought iron) and concrete jack arches is not uncommon in structures of this period. The MM report suggests the beams appear to be in reasonable condition where seen in the basement, which due to the atmosphere is likely to be the most vulnerable area. The floors above where there is improved air flow may be better.

5.3.30 *4.2.3 Roof Support Structure (including roof void below ridge level) Paras 1 to 3* – Whilst we accept there are areas of <u>local</u> decay, we do not consider these are extensive and can be dealt with by local pragmatic and standard repairs. We would emphasise these are not wholesale but local.

5.3.31 *4.2.3 Roof Support Structure (including roof void below ridge level) Para 4* – The eaves plate (referred to as horizontal 'header' beams is also supported by an inner timber frame wall, which is not mentioned here. Some of this is decayed but regardless helps spread the load.

5.3.32 *4.2.3 Roof Support Structure (including roof void below ridge level) Para 6* – No evidence of tying to the rear of the dormers was found, but timber wedges were found. Whilst no lateral support was identified, we did not see signs of lateral movement. Also, it would be simple to install further restraint at low cost by tying the dormers into the rood structure.

5.3.33 *4.2.4 Cast or Wrought Iron Columns* – This column is cast iron, which is a material more resilient to corrosion than wrought iron, and most often used as a compression member, as is the case here. It is also more resilient to corrosion and thus unlikely to be of significant structural concern.

5.3.34 *4.2.7 Lift Enclosure and Lift Support Structures* – It appears that the lift enclosure was integral to the original building and thus would be a very early example of an elevator. The lift car is likely to be a later alteration.

5.3.35 6 *Causation, 6.1 Primary and Secondary Defects Categorisation, Para 8* – It is generally accepted that vibration damage to historic buildings is limited due to the flexile nature of the construction material used of masonry set in lime mortar, with suspended floor structure internally.

5.3.36 We have not commented on the other causation clauses as they are responded to above.

5.3.37 *7.1 Concentrations of Stress and Vertical Settlement, Paras 1, 2 and 4* – Whilst we do not rule out foundation settlement, the movement seen may be related to corrosion if iron/steel beams are set into the masonry.

5.3.38 *7.1 Concentrations of Stress and Vertical Settlement, Para 8* – we disagree on the causation of the cracking which we suspect relates to in-built ferrous elements.

5.3.39 *7.2 General Deterioration of Structural Fabric* Paras 5 to 8 – The degradation of the masonry and mortar is noted, but is not considered to be a significant issue which cannot be addressed by normal masonry repairs and re-pointing of the mortar bedding and jointing.

5.3.40 *7.2 General Deterioration of Structural Fabric Paras 17* – We repeat the clause by MM – '*Cracks observed inside the building, on the upper floors were largely hairline on finishes and so considered to be cosmetic. There was little or no evidence that cosmetic cracks were reflective of movement or distress in underlying structural cracking'*.

5.3.41 *7.4 Consequential Impact of Defects on Structural Performance and Serviceability - See* clause 5.3.35.

5.3.42 *8 Compliance with Building Standards (Scotland)* – With any new use it will be necessary to consider and wherever possible meet the Standards, but with due regard to the listed status of the building. Depending on the use proposed, the Standards will need to be reviewed and the works implemented as appropriate or agreed.

6.0 Conclusions

6.1 Ed Morton has worked on historic buildings in extremely poor condition for over 30 years. This has included working on buildings in similar and indeed in much poorer condition than Ayr Station Hotel, and which have subsequently been brought back to beneficial and sustainable long-term use.

6.2 Based on the inspection of areas accessible at Ayr Station Hotel, we consider that it is perfectly practical to repair and bring back the building into long term sustainable use.

6.3 Whilst repairs are clearly required, the types of work required are not unusual for historic buildings and perfectly practical.

6.4 The roofs clearly all need re-covering but with existing slates re-used. Inevitably, there will be a shortfall but the existing can be re-used to the public facing west elevation, and with any shortfall taken up with new traditional Welsh or Scottish (subject to materials analysis) thick slate laid in the traditional manner.

6.5 Repairs to the timber roof structure will be needed, and whilst there are some areas of decay, in terms of the overall extent this is modest with much of the existing likely to be capable of re-use. Whilst we accept we haven't seen many areas, from the extent of missing slates and of course the fact the south range is now protected with a temporary roof, based on experience we believe this to be the case.

6.6 Concern was highlighted in the Mott MacDonald report related to the stone dormers, but our own assessment aided where roof coverings are missing at one point to the east side of the South Range, establishes this is not of significant concern, and if necessary tying this back into the roof structure is simple.

6.7 Generally, the masonry is not in bad condition overall, being a robust red sandstone with assumed brick backing walls. With any natural material there are areas of differential degradation or erosion as would be expected. Where the stone is affected by water ingress, mainly from leaking gutters, then the rate of degradation has increased due to water ingress and freeze thaw action. So, there are areas to cornices below the gutter which have been further degraded and there is effervescence and salt damage.

6.8 However, degraded sandstone does not mean it all needs to be replaced, and in line with good conservation practice we would not expect to replace all such degraded stone, instead assessing on an individual basis, defrassing, and then potentially leaving. Where repairs are required, these will include limited replacement, stone indents for failed areas and pinning of fractures etc.

6.9 Importantly, understanding the cause of fractures is necessary, and in many cases, these appear to relate to corroding steel or iron members which once protruded from the building, although the reason is not clear. The movement to the northeast corner of the South Range may be related to some settlement, although if this is the case it is not significant nor of an extent to warrant structural concern at this time.

6.10 Based on the approximate crack widths from the Mott MacDonald report in 2019 of October 2019, and from reviewing the photographs, these do not appear to be progressive. However, we think these again may relate to corrosion of iron beam ends where built in to the walls. These can be opened up, cleaned and treated in the normal way.

6.11 Internal timber floors will inevitably require some repair, and both these and the roof repairs will need some temporary support to achieve this. However, with the modular form of the building we do not see this being particularly problematic.

6.12 The concrete jack arch and iron beam floors are structurally useful where they exist, which appears to be over the main public spaces at ground and first floor levels. These will provide enhanced lateral stability to the structure and are good at resisting sound and fire. This form of construction is what has probably helped reduce the impact of the recent fire.

6.13 The scaffold around the South Range has been designed to accommodate suitable loads for the works anticipated, although loading bays may be needed for storage of materials such as slates etc. Some adaptions will of course still be necessary, but this should be a considerable cost saving in terms of erection costs.

6.14 It will be important to consider as part of the repair works future repairs and maintenance, particularly to the east track side. With careful planning during repairs, maintenance requirements can be reduced to a minimum and access provisions carefully considered. This will help reduce overnight track closures to minimise the impact on the working rail network.

6.15 Of course, the works will need to consider the works alongside the live railway line. However, this is also the situation with any demolition and new build.

7.0 Limitations

7.1 It should be stated that we have not inspected woodwork or other parts of the structure unless specifically detailed in the report, which are covered, unexposed or inaccessible and we are therefore unable to report that any such part of the property is free from defect.

7.2 This report has been carried out to the Client’s requirements and no liability is intended or will be accepted from any third party whatsoever.

7.3 The limits of liability are restricted to the contents of this report. No opening up or investigation of foundations etc was carried out, the inspection being visual only.

7.4 No checks on load bearing capabilities have been carried out.

APPENDIX A

Photographs

Photograph 1: North range west elevation

Photograph 2: North range west elevation

Photograph 3: North range west elevation with tower to south end

Photograph 4: North range east elevation with secondary buildings to north

Photograph 5: South range west elevation with scaffold structure

Photograph 6: South range, south and east elevation

Photograph 7: South range east elevation

Photograph 8: High level scaffold as seen over South range

Photograph 9: High level scaffold as seen over South range

Photograph 10: High level scaffold as seen over South range

Photograph 11: Fixing into masonry from scaffold

Photograph 12: Fixings into masonry from scaffold

Photograph 13: Restraint arrangement using chimneys and then tying back to main scaffold

Photograph 14: Restraint arrangement using chimneys and then tying back to main scaffold

Photograph 15: Dismantled stones laying on scaffold

Photograph 16: Roof covering to south range west elevation

Photograph 17: Roof covering to south range west elevation

Photograph 18: Local decay to roof structure through water ingress

Photograph 19: Local decay to roof structure through water ingress to east elevation

Photograph 20: Local decay to roof structure through water ingress to east elevation

Photograph 21: Local decay to roof structure through water ingress to east elevation

Photograph 22: Local decay to roof structure through water ingress to east elevation

Photograph 23: Cast iron weathering between roof pitches to south range mansard

Photograph 24: Broken section of cast iron weathering


Photograph 25: Pedimented dormer to west elevation


Photograph 26: Dormer to east elevation where structure fully exposed

Photograph 27: Dormer to east elevation where structure fully exposed

Photograph 28: Wall thickness at position where dormer exposed to east elevation

Photograph 29: Wall thickness at position where dormer exposed to east elevation

Photograph 30: Eaves detail to east elevation

Photograph 31: Added dormer to the west elevation above lift area

Photograph 32: Added dormer to the west elevation above lift area

Photograph 33: Flat gutter below dormer

Photograph 34: Cast iron gutter at base of mansard

Photograph 35: Damage to stone below gutter joint

Photograph 36: Damage to stone below defective gutter


Photograph 37: Gutter amendments


Photograph 38: Fracture to window head

Photograph 39: Fracture to window head

Photograph 40: Fracture to window head

Photograph 41: Damaged stone from old scaffold fixing

Photograph 42: Steel or iron beams built in and corroding causing damage to stone

Photograph 43: Steel or iron beams built in and corroding causing damage to stone

Photograph 44: Defective downpipe extending through fake 'stone hopper'

Photograph 45: Fake 'stone hopper' and defective downpipe

Photograph 46: Top of stone hopper

Photograph 47: Loss of stone due to root action of woody shrub above

Photograph 48: Root expansion causing fracture

Photograph 49: Apparent coloured pre-cast concrete mullion

Photograph 50: Failed face of stone mullion

Photograph 51: Steel plate flat bar over window

Photograph 52: Prop to eroded window head

Photograph 53: Window to south elevation with straight joint to main walling

Photograph 54: Significant moisture to west end of north elevation

Photograph 55: Significant moisture to west end of north elevation

Photograph 56: Movement cracks to north east corner

Photograph 57: Movement cracks to north east corner

Photograph 58: Movement cracks to north east corner

Photograph 59: Main station beam with apparent corrosion jacking to end

Photograph 60: North end of west elevation at junction with dog-leg

Photograph 61: Significant damp and current water damage

Photograph 62: Tight and possibly lime putty joints to public facing elevations


Photograph 63: Wider joints to track side elevations were less visible


Photograph 64: Curved stone lintels and curevd

Photograph 65: Steel or iron plate below fractured lintel

Photograph 66: Architectural detailing

Photograph 67: Architectural detailing

Photograph 68: Architectural detailing

Photograph 69: Architectural detailing

Photograph 70: Architectural detailing

Photograph 71: Tower roof to south end of South Range

Photograph 72: North tower roof to Southern Range

Photograph 73: Main floor joists visible where section of lath and plaster lost

Photograph 74: Part view of ceiling with joists in foreground still sound


Photograph 75: Suspended ceiling below earlier ceiling above and in reasonable condition


Photograph 76: Principal room with ceiling in reasonable condition but some plaster loss

Photograph 77: Principal room with ceiling in reasonable condition

Photograph 78: Iron/steel beams (red) and concrete jack arches and main beams (blue)

Photograph 79: Elevator and main stair at first floor level


Photograph 80: Clock Tower roof structure

Photograph 81: Head of tower with cast iron decorative weathering

Photograph 82: Gutter behind pediment to south elevation dirmer

Photograph 83: Loose flashings to tower roof

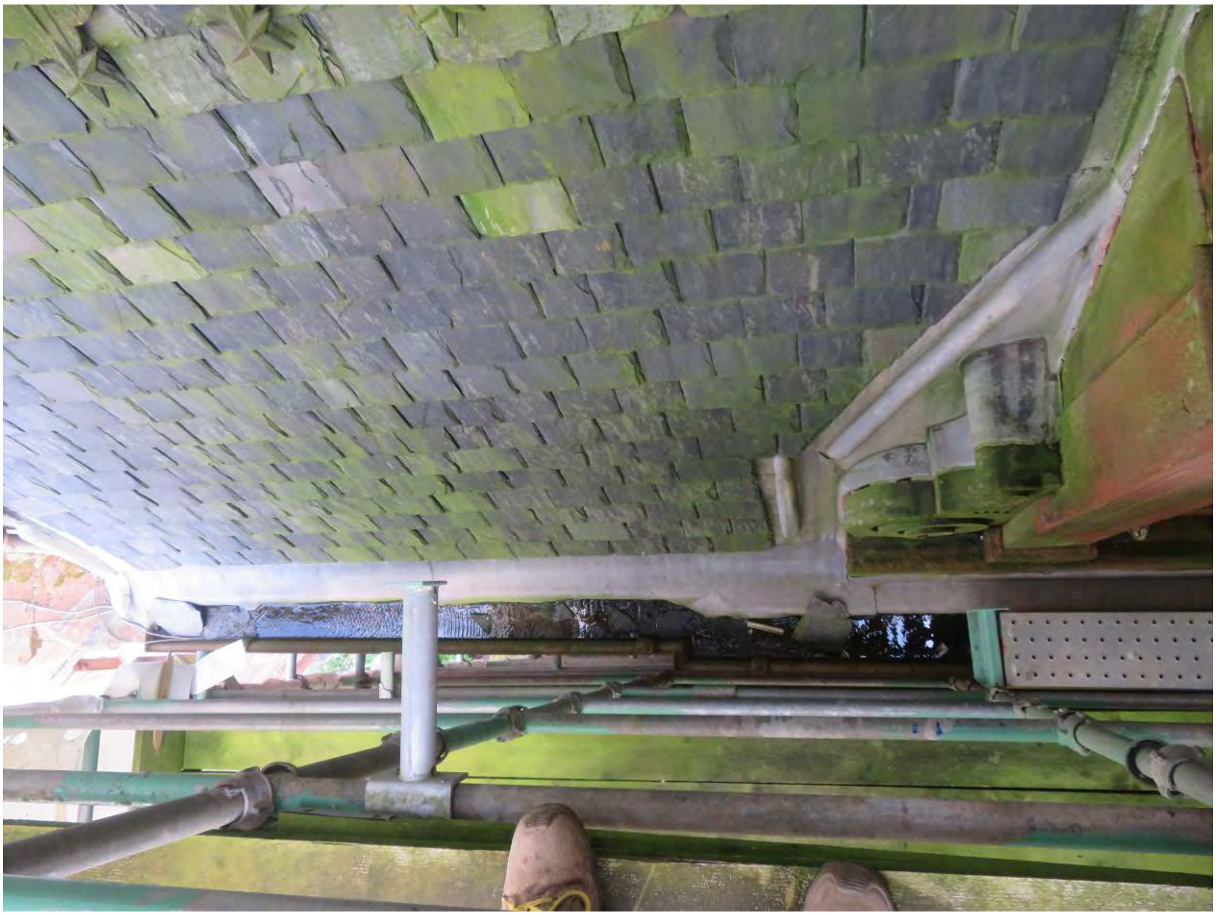
Photograph 84: Potential corroding fixing position

Photograph 85: Cramp to copings

Photograph 86: Windows to tower in relatively poor condition


Photograph 87: Roof to dog-leg between Tower and South Range to south side

Photograph 88: Roof to dog-leg between Tower and South Range to south side



Photograph 89: Standing water in gutter

Photograph 90: Head of dormer to dog-leg roof to south side

Photograph 91: Sheeting over North Range roof

Photograph 92: Sheeting to east elevation of the North Range

Photograph 93: Hoardings to lower section of east elevation to north range

Photograph 94: Sheet covering to west elevation of north range as seen from fire escape stair

Photograph 95: Vegetation growth to west elevation of North Range

Photograph 96: Vegetation growth to west elevation of North Range

Photograph 97: Vegetation growth to west elevation of North Range

Photograph 98: Vegetation growth to west elevation of North Range

Photograph 99: Cracking to door reveal from fire escape

Photograph 100: In-built steel causing stone damage where corroded

Photograph 101: Suspended ceilings in Scot Rail offices and Ticket Office

Photograph 102: Original ceilings seen above with iron joists and concrete jack arches

APPENDIX B

Embodied Carbon Assessment

Mann Williams Consulting Civil and Structural Engineers

Mann Williams Consulting Civil and Structural Engineers
7 Old King Street, Bath, BA1 2JW T 01225 464419

Ayr Station Hotel, Ayr, Scotland

Embodied Carbon assessment introduction report

Project Number:

Issue Date: July 2023

Revision: P1

Suitability: S2

Contents

Appendices

Quality Assurance

File Name: AyrStationHotel_EmbodiedCarbon_IB_10-07-2023

Document Issue Details:

Revision	**Issue Date**	**Issue Status**	**Distribution**
P1	10 July 2023	S2 - Information	Ed Morton

Prepared	**Checked**	**Approved**	**Date**
IB	JNA	JNA	07 July 2023

1.0 Introduction to Embodied Carbon

1.1 Distinction between Embodied and Operational carbon

1.1.1 According to the Intergovernmental Panel on Climate Change (IPCC) and as seen on Figure 1, global carbon emissions need to peak before 2030 and to start declining thereafter, to reduce the risk of exceeding the 1.5°C climate warming threshold.

1.1.2 The building and construction sectors globally account for approximately 37% of carbon emissions[1]. As such and in line with the above targets, relevant greenhouse gas emission reductions are required across the sector. This is also necessary on a national level for the UK to achieve its government target of net zero carbon emissions by 2050.

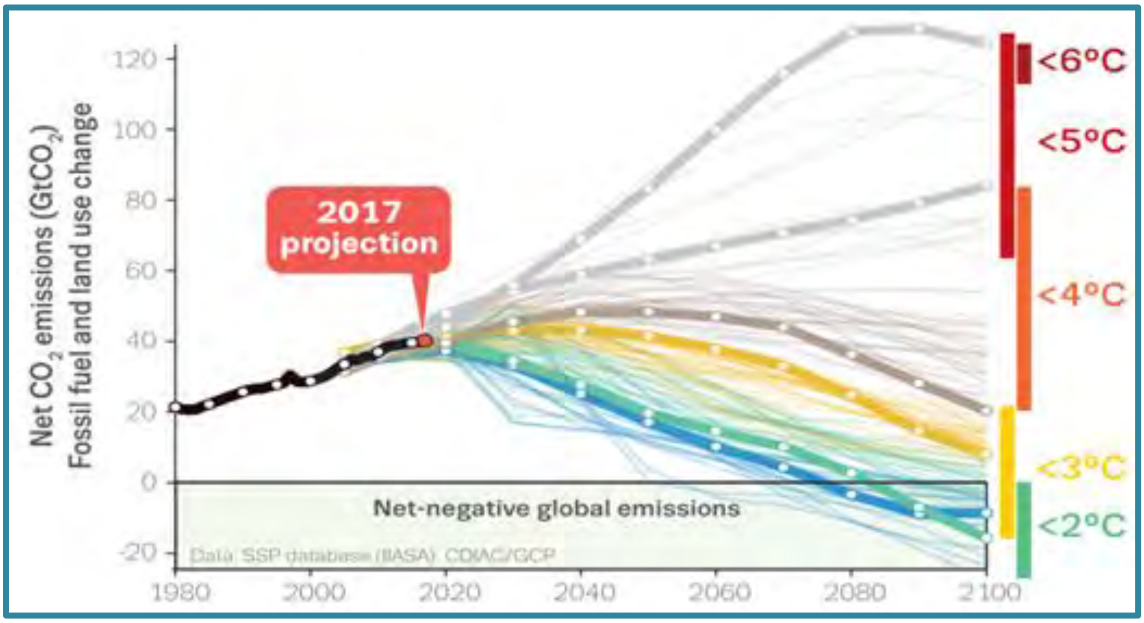


Figure 1 Global emissions pathways for climate warming scenarios[2].

1.1.3 The carbon emissions associated with a building lifecycle are split into two categories: embodied and operational carbon.

a) Embodied carbon is the greenhouse gas emissions associated with the construction processes throughout the whole life cycle of an asset. This includes the raw material manufacturing, transportation, and physical construction plus future refurbishment or maintenance. Each process is given a module or code as shown in Figure 2.

b) Operational Carbon is the greenhouse gas emissions arising from all energy and water consumed by the asset in use. These are given a module or code as shown in Figure 2 as well.

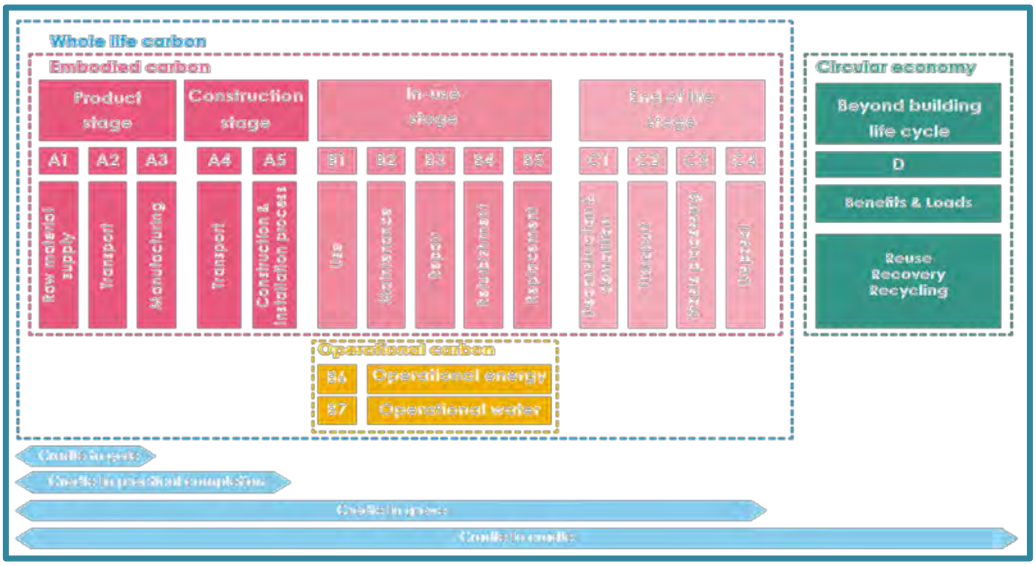


Figure 2 Extract from the London Energy Transformation Initiative Embodied Carbon Primer[3]. Display of modular information for the different stages of building assessment.

1.2 Recent progress and future outlook

1.2.1 Operational carbon has been the focus of many of the legislative efforts to reduce greenhouse gas emissions over the past 20 years. Recently embodied carbon has come to the fore as an additional significant way to reduce building associated emissions. The analysis and measurement of embodied carbon has improved significantly over the last 5 years and a growing body of case studies makes it possible for relatively accurate assumptions to be made about the possible emissions over time for a typical building structure.

1.2.2 Embodied carbon is also a measure of the "carbon stock" that is currently held within our existing buildings. These historic structures have already emitted the greenhouse gases associated with their construction and so any reuse of the elements either in situ or elsewhere may be considered a net benefit in terms of global carbon emissions. The Historic England Report "There's no place like old homes" shows that sympathetic and thorough retrofit can reduce operational emissions by up to 60%[4] while reaping the benefits of reduced embodied carbon.

2.0 Embodied Carbon impact analysis

2.1 Introduction

2.1.1 This section outlines the potential embodied carbon implications of carrying out refurbishment works to the derelict Ayr Station Hotel building in comparison to the option of demolishing and constructing a new fit for purpose structure. The assumptions made in the calculation of these figures are laid out below and are generally in line with the typical UK average values proposed by the Institute of Structural Engineers and the Royal Institute of British Architects in conjunction with a range of research partners and technical committee members.

2.2 Retaining and refurbishing existing structure

2.2.1 It is acknowledged that returning a disused historic building into service, while providing the required standards of comfort and functionality expected off modern day facilities, often necessitates undertaking refurbishment works. The extent of such works is usually dependent on the current state of the structure, along with the threshold of serviceability levels considered acceptable by the client and other relevant parties.

2.2.2 Given the lack of detailed information about the existing structure, material, detailing, make ups and volumes at Ayr Station Hotel some assumptions and simplifications have to be accepted. The following analysis is based on average figures provided by published literature in relation to the expected levels of carbon emitted by similar refurbishment works documented and studied as part of other case study projects.

2.2.3 Due to the historic character of the building, it is assumed that a significant portion of the existing fabric will need to be retained as part of a refurbishment scheme. For the needs of this initial assessment, a conservative assumption for the retained fabric would be in the order of 50% of the existing floor plan area at each level.

2.2.4 The carbon emissions generated by the necessary renovation works will be approximately quantified using a typical reduced rate for a renovated residential structure of 300kgCO_2e/m^2. This figure assumes only 50% retention of existing building fabric. Such assumption is considered particularly conservative in the case of Ayr Station Hotel, provided that its listed status would require a far greater percentage of retention, leading to an even lower amount of emitted carbon.

2.2.5 It is worth noting that the carbon emitted historically for the construction of the existing building does not form part of this study, given that it has no impact on current or future works. This could be considered as a net saving compared to the demolition scheme.

Table 1 Existing floor area of Ayr Station Hotel and expected CO_2e emissions based on 50% retention of existing fabric (based on an embodied carbon emission rate of 300kgCO_2e/m^2).

Scheme 1: Retain and refurbish		
Level	Floor area (m^2)	Embodied Carbon Impact/kgCO_2e
Ground floor	2380	714000
Frist floor	2380	714000
Second floor	2070	621000
Third floor	1870	561000
Fourth floor	75	22500
Total	8775	2632500

2.3 Demolition and new built replacement

2.3.1 This analysis considers the proposed new development of a mixed use residential and commercial space, constructed using a conventional steel frame in place of the existing listed masonry building. It is envisaged that the new building will be matching the square meterage of the existing structure on plan. Note that the demolition works have been omitted from this analysis but would be assumed to have a further negative impact on the embodied carbon output of the new scheme.

2.3.2 The analysis is based on the design guidance referenced in Appendix 2 and will use the whole building RIBA embodied carbon target for a building constructed in 2020 which states a typical embodied carbon rate[5] of 600kgCO_2e/m^2.

2.3.3 The cradle to practical completion whole building embodied carbon analysis for this scheme is displayed below on the basis of the existing structure being completely removed and replaced. It is assumed that a new building would aim to achieve the same square meterage as the existing building, as a minimum threshold for comparison.

Table 2 Assumed target floor area of a new development at the Ayr Station Hotel site and expected CO_2e emissions based on 100% demolition of existing fabric and full replacement with new construction (based on an embodied carbon emission rate of 600kgCO_2e/m^2).

Scheme 2: Demolish and replace		
Level	Floor area (m^2)	Embodied Carbon Impact/kgCO_2e
Ground floor	2380	1428000
Frist floor	2380	1428000
Second floor	2070	1242000
Third floor	1870	1122000
Fourth floor	75	45000
Total	8775	5265000

2.4 Embodied carbon comparison between two schemes

2.4.1 Figure 3 helps visualise the difference between Scheme 1: Retention and refurbishment and Scheme 2: Demolition and new construction, in terms of the expected embodied carbon emissions (excluding operation carbon emissions during the asset's lifetime. Refer to the following paragraphs).

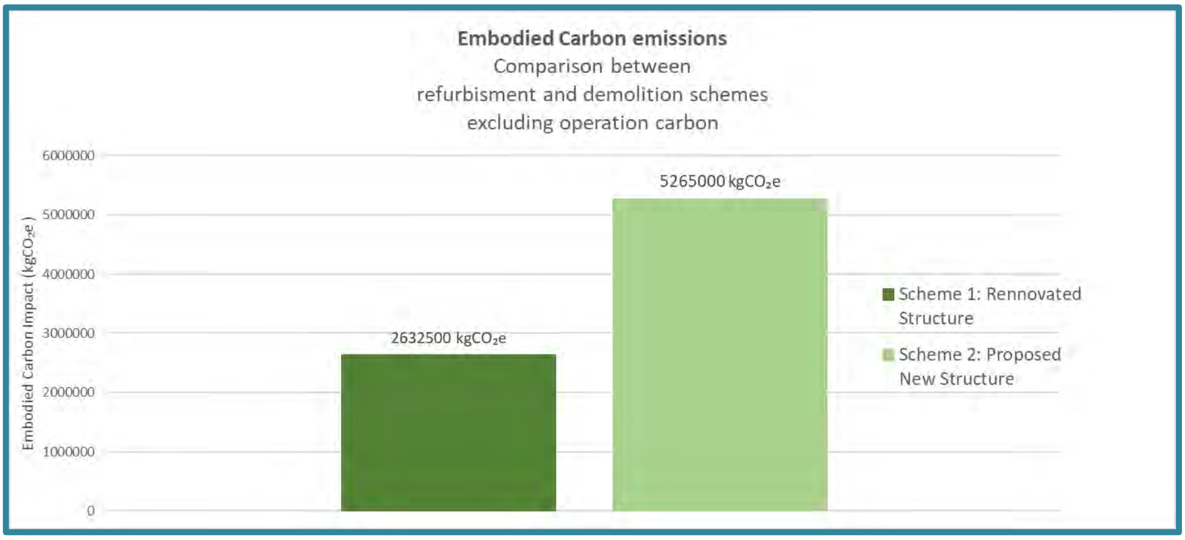


Figure 3 Comparison of Embodied Carbon emissions (in kgCO_2e) between the options of retaining and refurbishing Ayr Station Hotel and demolishing the existing structure followed by construction of a modern building providing the same square meterage.

2.4.2 It is apparent that the refurbishment works cut the required embodied carbon emissions to nearly 50% compared to the demolition scheme.

3.0 Operational Carbon analysis

3.1 Introduction

3.1.1 The embodied carbon emissions associated with the construction and manufacturing activities, are only one aspect that needs to be considered. A comparative study between a retention and refurbishment scheme against a demolition and new built proposal, would necessitate a review of the expected operation carbon emissions throughout the asset's life.

3.1.2 It is acknowledged that a refurbished building might not be able to achieve the same level of operational energy and water use efficiency as a purpose-built new structure. However, having an overview of the difference between the two situations over time can help in forming a more holistic understanding of the benefits or weaknesses of each proposal.

3.2 Operational carbon comparison

3.2.1 The operational carbon analysis presented herein is based on the comparable case study of Rugby Radio Station refurbishment as published by the Architects Journal (AJ). The project features large scale retrofit of an existing masonry structure and as such it is considered an appropriately similar structure in principle to the existing Ayr Station Hotel.

3.2.2 The Rugby Radio Station post completion analysis resulted in an achieved ongoing carbon emissions of 8.1kgCO2/m2/yr[7] for the renovated structure. The equivalent value for the typical new build structures on site is 3.6kgCO2/m2/yr[7].

3.2.3 Based on the above values and the square meterage of the existing building at Ayr Station Hotel, it is possible to estimate the operation carbon emitted over the building's serviceable life. It is assumed that in the case of Scheme 2, a new building would provide the exact same floor plan area as the existing structure. The comparison shown on Figure 4 is limited to 50 years post completion of a potential refurbishment or construction project, to reflect the expected life span of the building.

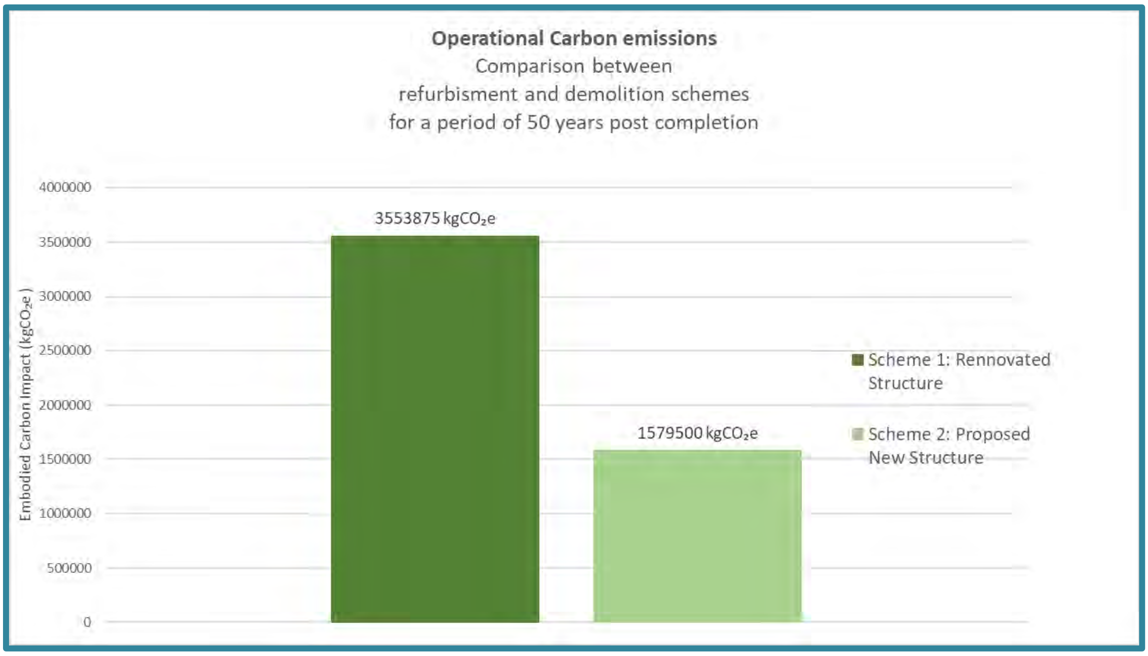


Figure 4 Comparison of Operational Carbon emissions (in $kgCO_2e$) between the refurbished version of Ayr Station Hotel and a brand new building providing the same square meterage.

4.0 Comparative study of embodied carbon emissions

4.1 Combined embodied and operational carbon consideration

4.1.1 Although an isolated assessment of the embodied carbon or operational carbon figures provides an initial view of weaknesses and advantages, making a fully informed decision would need review of the combined effect for each scheme.

4.1.2 To achieve such overview, Figure 5 plots the cumulative carbon emissions throughout the design life of the building, (embodied + operational carbon) over time.

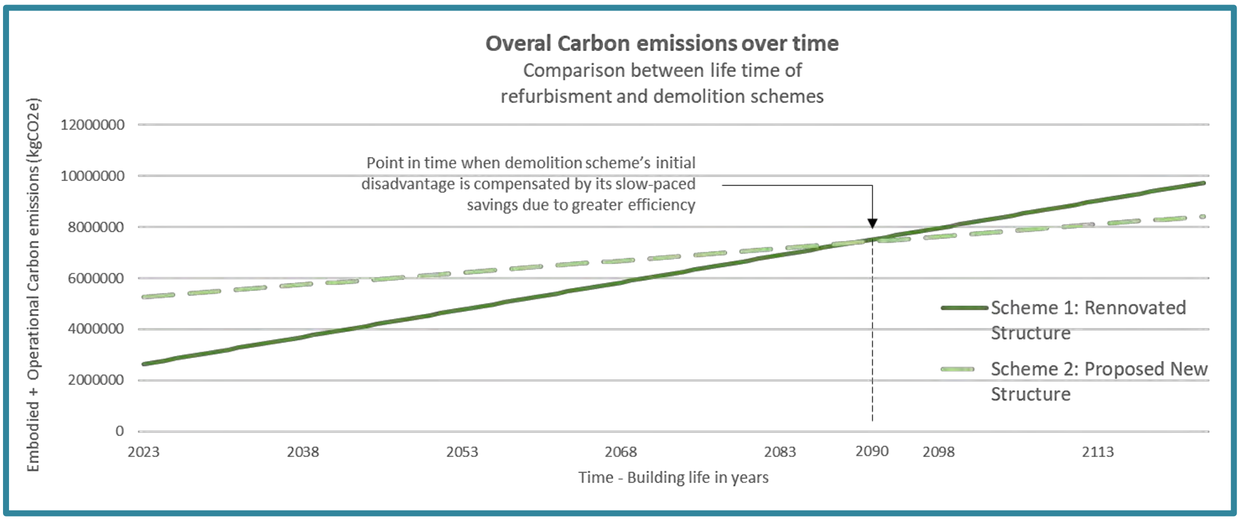


Figure 5 Comparison of combined effect of Embodied and Operational Carbon emissions (in $kgCO_2e$) between the two schemes over the full lifetime of the building post refurbishment of construction completion.

4.1.3 The graph shows a significant initial advantage of the refurbishment scheme. This is attributed to the great savings of retaining existing building fabric compared to the carbon intensive processes of manufacturing, building material production, transportation, and other construction related activities.

4.1.4 The trend lines meet at approximately year 2090, indicating that the energy efficiency of the brand new building would eventually compensate for the heavy use of energy and carbon emissions during its construction phase in the present day. From there onwards the new building continues to generate steadily less carbon emissions.

4.1.5 It is worth noting that although theoretically the new scheme makes up the deficiency, the required time (nearly 70 years) exceeds by far the design life of typical buildings. It would be safe to assume that major renovations would be required ahead of this time negating any assumed, very long-term carbon savings. Also, the benefit of reduced operational carbon emissions over a very prolonged time could be argued to be weak since the UK aims to have net zero energy production by 2050 (which in theory mitigates the impact of energy production and consumption).

4.1.6 In a more realistic scenario and putting the two into perspective, Figure 6 shows the overall carbon emissions for the two schemes 20 years post completion. The 20-year period is chosen as a reasonable point in time that some major renovations might be necessary with either scheme. The saving observed if Scheme 1 (retention and refurbishment) is implemented, lies in the order of 45% less carbon compared to Scheme 2 (demolition and new construction).

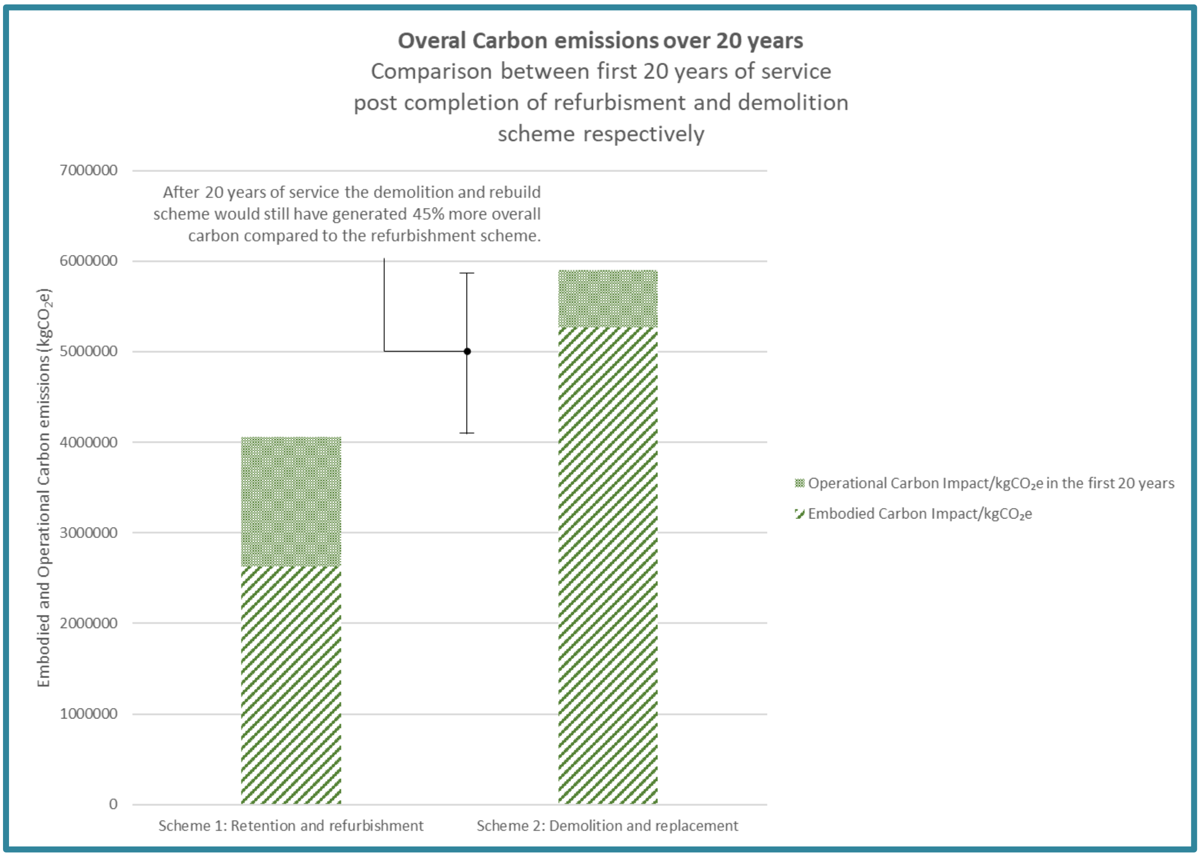


Figure 6 Comparison of combined effect of Embodied and Operational Carbon emissions (in $kgCO_2e$) between the two schemes over the first 20 years of service post construction completion.

5.0 Conclusions and references

5.1 Summary and conclusions

5.1.1 As part of this report, a basic analysis has been undertaken to compare two scheme options for the redevelopment of Ayr Station Hotel from an environmental impact perspective; for Scheme 1 the existing building is largely retained and refurbished to meet modern standards as closely as practically possible, while for Scheme 2 the existing building is demolished and replaced by a typical modern building.

5.1.2 Given the lack of detailed information, a number of assumptions and simplifications had to be made, as listed in previous paragraphs. Those are all based on published literature by universally acknowledged Construction, Engineering, and Architectural bodies along with their Research partners.

5.1.3 The retention percentage assumed for Scheme 1 (retention option) is extremely conservative given that the listed status of the building would require saving a much greater portion of the historic fabric. A more detailed assessment would likely show greater embodied carbon savings for this scheme.

5.1.4 Similarly, the figures used for assessing the operational carbon emissions for Scheme 2 (new building), are based on typical values for very well engineered structures that are fully compliant with best practice, products and detailing in terms of energy saving, insulation, MEP systems etc. Any deviation from such compliance would likely result in more onerous carbon emissions.

5.1.5 Based on the preceding analysis and diagrams, it is concluded that Scheme 2 (demolition and new construction) will emit more total greenhouse gas emissions over its design and serviceable lifetime than the equivalent refurbishment and reuse scheme. Any very long-term savings thanks to modern construction techniques and detailing are potentially offset by required repairs and refurbishment works in the meantime. Also, considering the coordinated effort towards achieving net zero energy production and consumption in the UK, it is likely that such savings will be less relevant in the near future.

5.1.6 The analysis presented within this report, within its limitations and assumptions, only focuses on an objective assessment of the environmental impact of the two schemes. It completely omits from consideration the architectural, historical and aesthetic significance of Ayr Station Hotel, which is of paramount importance towards making a balanced and holistically considered decision about the future of the building.

5.2 References

5.2.1 The following bibliographical references and publications were used for the preparation of this report:

1. IEA 2021a. Adapted from “Tracking Clean energy Progress”. Access at: https://globalabc .org/resources/publications/2021-global-status-report-buildings-and-construction
2. Global Carbon Budget 2017. Access at: https://www.globalcarbonproject.org/carbonbudget/21/ infographics.htm
3. London Energy Transformation Initiative (2020). *LETI Embodied Carbon Primer*. [Online].
4. Historic England. “There’s no place like old homes”. 2019. https://historicengland.org.uk/research /heritage-counts/2019-carbon-in-built-environment/carbon-in-built-historic-environment/
5. Arnold W., Cook M., Gibbons O., and Orr J. (2020) “Setting carbon targets: an introduction to the proposed SCORS rating scheme.”, *The Structural Engineer*, 98(10), pp. 8-12
6. Gibbons O. & Orr, J et al. (2022). “How to calculate embodied carbon.” *IStructE.* Second Edition.
7. Architects’ Journal. “Fine Tuning” Rugby Radio Station Case Study. Vol 249, Issue 02.

Appendix 1 – Existing floor plans

The following plans have been used for the approximate estimation of the floor plan area at each level.

Appendix 2 – Bibliographical reference extracts

The below extracts from bibliographical references were used as part of the high level analysis presented within this report:

TABLE 1: Targets in RIBA 2030 Climate Challenge[4]

	RIBA targets, modules A–C (excl. B6–7), whole building		A1–A5 as % of A–C[6]	Assumed structural carbon as % of whole-building carbon	A1–A5 structures 2030 target (and SCORS rating)
	2020 target	2030 target			
Domestic	600	300	74%	65%	144 (A)
Non-domestic	800	500	52%	60%	156 (B)

NB All figures are given in $kgCO_2e/m^2$ GIA

TABLE 2: Targets in LETI Embodied Carbon Primer (ECP)[5]

	LETI targets, modules A1–A5, whole building		Structural carbon as % of whole-building carbon (per LETI ECP)	A1–A5 structures 2030 target (and SCORS rating)
	2020 target	2030 target		
Residential	500	300	67%	201 (C)
Commercial	600	350	65%	228 (C)
Education	600	350	48%	168 (B)

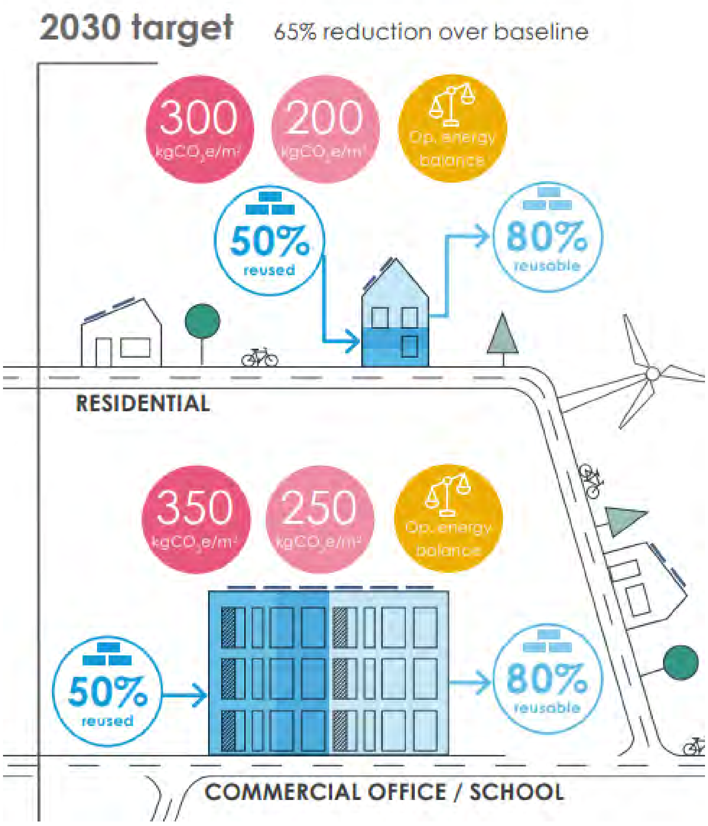
NB All figures are given in $kgCO_2e/m^2$ GIA

on emissions that will have the most impact today.

Benchmarking SCORS against existing projects

The range and gradation of SCORS is informed by a review of embodied carbon estimates from 326 projects shared by Arup, Price & Myers and Thornton Tomasetti.

The data is a mixed set – slightly varying calculation methods, different (though appropriate) carbon factors, and a mixture of building typologies and locations. Data also had to be adjusted to cover lifecycle modules A1–A5, with 15% added to account for modules A4 and A5 where only A1–A3 had been investigated.



Appendix 3 – Case studies of similar renovation projects

4.Zero waste

An introduction to refurbishment.

Part 1: Identifying opportunities at the feasibility stage

Stephen Fernandez discusses ways in which engineers can explore the potential to refurbish existing buildings instead of demolishing and building anew.

↖FIGURE 1: Disused buildings at Coal Drops Yard in rundown area of central London

Introduction

The built environment is a major contributor to the environmental emergency that the world now faces. Structural engineers can, however, play an important role in tackling this problem.

Demolishing existing buildings and replacing them with new ones will continue to stress the finite natural resources on our planet, as highlighted by the Construction Declares[1] initiative. Since May 2019, thousands of practices have acknowledged the extreme seriousness of the situation by making a public commitment towards positive change.

The declaration recognises that, if we are to reduce and eventually reverse the environmental damage, we need to take positive steps today. The measures outlined include to 'upgrade existing buildings for extended use as a more carbon-efficient alternative to demolition and new-build whenever there is a viable choice'[2].

Many who work predominantly on new buildings believe that reusing existing buildings is a compromise. As engineers, we can challenge that perception, as there are countless examples where existing buildings have been transformed into some of the most exciting and dynamic places in the built environment.

This article discusses ways in which engineers can identify potential opportunities for refurbishment at the early feasibility stages. Part 2 will then look at how to maximise the opportunities for refurbishment in the design stage.

Benefits of refurbishment

In the UK, 87% of today's buildings are likely to still be occupied by 2050[3] (with a similar percentage worldwide), and therefore it is essential to improve their performance towards zero carbon. Reusing existing buildings can cut embodied carbon by up to 70% compared with demolishing and reconstructing[4].

In addition to the environmental benefits, reusing existing buildings often delivers greater commercial and social returns than demolishing and reconstructing, with evidence suggesting they can yield 10–75% lower costs and tend to be 15–70% quicker to bring back, depending on the level of intervention[3].

Transforming and reusing existing buildings can also bring social benefits, e.g. reuse of vacant industrial premises can stimulate positive changes in attitudes within communities[5].

Coal Drops Yard in London is a fantastic example where largely derelict heritage buildings (Figure 1) have been transformed into a popular shopping and dining district. It is now the centrepiece of the regeneration of the wider King's Cross area and the transformation of the existing buildings has created a vibrant city quarter with boutiques, restaurants, bars, cafes and public space (Figure 2).

Despite the dramatic architectural statement made, the structural


© JOHN STURROCK

FIGURE 2: Transformation of Coal Drops Yard into thriving destination

embodied carbon footprint of this project was only 240kg/m² (substructure + superstructure) due to the extensive reuse opportunities found in the scheme.

Imagination is needed at early feasibility stages to identify the potential within an existing building, as is it easy to miss opportunities. In a recent design competition, the client's brief was to design a new office building adjacent to an existing one (the brief did not include any works to the existing). However, rather than just designing a new building, Arup's approach was to provide a new extension but also enhance and transform the existing building as part of the development. Arup won the competition and the client explained that the 'outside the box' solution both met its brief but also ingeniously adapted and enhanced the existing building.

So, transforming and reusing existing buildings can offer many advantages over new-build, including being more cost-effective for clients, creating characterful places and preserving heritage value for communities. As structural engineers, we should be aware of these benefits and confidently discuss them with our clients, as it may be possible to justify the case for reuse over new-build.

Maximising opportunities

As engineers, we have a vital role to play in influencing clients and architects to reuse and transform existing buildings. Often, the decision to retain an existing structure will require some input from the engineer. However, it can be easy to simply focus on the risks and problems associated with keeping it, rather than the potential rewards.

Reusing an existing building is not the answer in every case, but carrying out an early informed assessment can reveal exciting opportunities that would otherwise be missed.

If your client wants to know what they can do with their existing building, the first step it to understand what they want. The types of questions worth asking are:

- What are the client's key drivers?
- Are they unhappy with their existing building?
- If aspects of the existing building are inadequate, can they be adapted rather than immediately concluding to rebuild?
- Are there any problems associated with the existing fabric or structure and can they be repaired to fully address the problems?
- Does the building layout work? (Common challenges include inadequate circulation, insufficient natural light or limited floor-to-ceiling heights. Such issues can be addressed through a multitude of interventions.)

Drilling down into the detail of a client's specific issues can often inform a solution that doesn't necessarily involve demolishing and building anew. The works may not be straightforward for the engineer, but it is important that we can articulate and explain the potential options and solutions to our clients. The potential for reuse can be illustrated using examples or case studies clearly demonstrating the transformation, particularly with images and a narrative of 'before' and 'after'.

An important consideration is how the works could be carried out. This doesn't need to be planned in detail but can be a major factor. For example, can the building remain occupied with phased construction? This can offer significant benefits, as temporary accommodation will be limited and temporary relocation potentially avoided.

> **"AS ENGINEERS, WE HAVE A VITAL ROLE TO PLAY IN INFLUENCING CLIENTS AND ARCHITECTS TO REUSE AND TRANSFORM EXISTING BUILDINGS**

Arup won a design competition where one of the client's key drivers was to ensure that the existing facility remained operational while providing them with a state-of-the-art building. The phasing and decant strategy avoided the need for temporary accommodation and was key to winning this commission.

In addition to understanding your client's specific issues, it is also important to discuss the 'bigger picture' with them. For example, if the client owns several buildings in an area, reusing an existing building could unlock future potential for the surrounding area. Reusing an existing building can also help celebrate their existing assets. There are an increasing number of clients today who want to embrace and showcase sustainability. Can reusing the existing building provide them with green credentials to bring them more business?

What do you need to know?

Carrying out a thorough early assessment can reveal exciting opportunities which can add significant value and might have been missed if reuse was not considered. In order to have early conversations with the client or architect, the engineer needs to have technical knowledge, confidence that the approach can work and believe that it is the right thing to do.

Understanding the variety of approaches and interventions is important, but so is appreciating that all existing buildings are unique and must be considered on a case-by-case basis. The starting point should always be to understand the existing building.

FIGURE 3: Review of historical records for Newton Tower at Nottingham Trent University

Structural desk study

Before carrying out any works, a structural desk study is vital to develop a better understanding of the existing building. For example, the date of construction may indicate potential inherent defects, knowing the architect or engineer can inform the detailing, materials or structural systems, and the timeline or history may help understand any load path modifications.

FIGURE 4: 1 Finsbury Avenue, London

Existing information for this desk study may be retrieved from building owner records, local authority records, drawings, calculations and historical mapping (indicating macro changes in plan form or surrounding features); for older buildings, historical papers, articles and photographs can also be useful. The desk study helps to understand a building's history to improve confidence in the structure and its load paths and establish whether it is suitable for reuse.

For example, before works were carried out on the 1960s Newton Building at Nottingham Trent University, an extensive search for historical drawings and records informed the subsequent non-intrusive and intrusive surveys. Construction photographs obtained from the British Library were extremely useful, as they indicated locations of stability bracing and the support for the facade system (Figure 3).

In another example, Arup originally designed the office building at 1 Finsbury Avenue in London in the 1980s. It was subsequently transformed into a flexible workspace, with retail space, restaurants and a boutique cinema (Figure 4). Detailed records were retrieved from archives and, by interrogating the original calculations, columns and foundations with spare capacity were identified, allowing new loads to be introduced with minimal physical intervention. Reviewing the existing information also informed the structural strategy to remove floor areas in the basement to create the necessary double-height space for a cinema, while maintaining the stability of the building.

So, gathering existing data helps to develop a clear understanding of the existing structure and will inform any works to transform and reuse it. However, records should not be relied upon solely. If critical assumptions are being based on elements being constructed as drawn, then some corroborative evidence (e.g. physical confirmation of the construction of the element) will be needed.

> **"BEFORE CARRYING OUT ANY WORKS, A STRUCTURAL DESK STUDY IS VITAL TO DEVELOP A BETTER UNDERSTANDING OF THE EXISTING BUILDING**

Structural form

It is important to identify and document the existing structure and structural elements. This is likely to be informed by the desk study and may require some inspections and local opening-up. However, it can be an iterative process, as the opening-up may reveal aspects not identified in the desk study.

For example, it may be necessary to understand the existing stability system, but if vertical bracing is not found, further local opening-up may be required to confirm that the beam-to-column connections can act as a sway frame.

This process may need to go through several iterations to test initial hypotheses against site observations, with retesting to confirm.

Understanding historical forms of construction is a key skill that engineers need in order to play a decisive role in the refurbishment of existing stock. How could doctors cure patients if they had not studied anatomy?

Condition

It is essential to understand an existing building's condition if it is to be retained. Inspections, opening-up and surveys can help to develop a better understanding of the building, establish the accuracy of the desk study, identify any defects and inform the need for action. With defects, it is important to fully understand the reasons why they occurred to ensure that any rectification is effective.

The engineer needs to be satisfied that the building does not show signs of structural distress and that an identifiable load path and stability system are present. It is not always necessary

FIGURE 5: Grade II* listed Arkwright Building at Nottingham Trent University, with significant historical movement due to settlement

to carry out extensive calculations and back-justification for an existing structure. If it does not show any signs of distress, it is possible that the historical performance can justify its future performance.

An approach often taken for old buildings is the '100-year rule'[8]. This relies on a building being at least 100 years old with no structural distress, an identifiable stability system, and no change of loading.

However, the 100-year rule must also be carefully considered on a case-by-case basis, as there is often a natural process of material change throughout a building's life, which may not be immediately obvious.

Settlement movement against time generally follows a logarithmic curve, so after 100 years, foundation settlement is unlikely to be occurring to any discernible degree. Therefore, any cracking to walls or ceilings that is relatively recent is more likely to be due to another cause, such as subsidence (e.g. trees acting on a clay subsoil or drain leakage) or material degradation (e.g. timber decay or corrosion). Such causes must be identified and eliminated.

The Grade II* listed Arkwright Building at Nottingham Trent University, built in 1877, had suffered significant historical movement due to settlement **(Figure 5)**. Rather than instantly condemning the existing structure or attempting excessive repair works, detailed investigations helped understand why the building had moved, where this had occurred and whether it was continuing.

As evidenced by the cracking and distortions, the building had clearly experienced movements and settlements historically, and further movement would be expected if it was to be subjected to significant alterations to loads on its foundations. Therefore, the design approach was to minimise load changes and, where change was unavoidable, to only locally enhance and strengthen.

Although the building will continue to move, it was not considered cost-effective to try to stop it moving altogether. This would have involved attempting to underpin most of the walls, which would have been very expensive, time-consuming and disruptive, and may not have been successful anyway.

Often, if it is known that a building will continue to move, but not to a degree that will result in anything worse than aesthetic damage, it is possible to incorporate detailing in the finishes that will make the effects of any movement aesthetically palatable, e.g. slip planes and joints in the finishes that eliminate irregular cracking, instead focusing it at locations with straight movement joints.

The engineer also needs to be aware that structures from certain periods are prone to particular forms of degradation or construction problems, such as the presence of asbestos or high-alumina-cement concrete.

During the removal of the internal finishes in the 1960s George Green Library at the University of Nottingham, numerous defects were identified around the perimeter. The building was designed with a combination of *in situ* concrete and precast concrete. The defects encountered were concluded to be a result of poor workmanship and detailing, water penetration at windows and condensation behind finishes, which over time had resulted in the reinforcement corroding and concrete spalling **(Figure 6)**.

The defects were considered to affect the structural strength, robustness and stability of the building and therefore repair was deemed essential. Detailed investigations were carried out to understand the extent of the defects and to develop a repair detail, including visual and delamination surveys, chloride profiling, carbonation, compressive strength and cement content analysis, and cover surveys.

Often, contractors prefer new-build to refurbishment if given a choice, due to the perceived additional risk of the unknown in a refurbishment. De-risking refurbishment by undertaking intrusive investigation at an early stage is therefore important.

Listed status

Listed buildings are considered nationally important and therefore have extra legal protection. The 'listing' of a building in England refers to it being on the statutory list of 'buildings of special architectural or historic interest'. The listing recognises that a building is special in a national context and brings with it controls over alteration, extension and demolition. There are similar protections in place in other countries.

Conservation accreditation systems exist in the UK for members of professional bodies such as the RIBA, RICS, ICE and IStructE which are mandatory for working on some types of projects. Conservation Accredited Engineers[7] have the skills and passion to match the demands of listed buildings, but theoretically any structural engineer can work on buildings protected by heritage legislation. However, it is important to understand the conservation philosophy, different forms of construction, historical materials and to be able to sensitively handle historical fabric[5,8].

FIGURE 6: Major structural defects were uncovered at George Green Library, University of Nottingham

© HUFTON+CROW

FIGURE 7: Minimum interventions at St Pancras Renaissance Hotel, London

A listing can be perceived as a hindrance and some engineers struggle with the 'philosophy of conservation'. Engineering training is often focused on calculating and analysing, and we are expected to deliver a structure that will not fail. Where the philosophy of conservation has not been understood, this has sometimes led to unjustified interventions to the detriment of the historical fabric.

Conservation philosophy involves adopting principles such as minimum intervention, reversibility and honesty[7,8]. Working on historic structures requires the engineer to develop a wide array of skills and knowledge, but the engineer can also play a pivotal role in helping to protect and prolong their lives.

For example, the 19th century Grade I listed St Pancras Renaissance Hotel in London was brought back into use after 20 years of dereliction and is now a five-star hotel with luxury apartments.

However, major works were necessary to meet the requirements for a modern 'luxury' building, particularly for servicing.

The project required a balance between preservation and modification, with a general approach to minimise alterations and to retain as much of the historic fabric as possible **(Figure 7)**. Existing load paths were maintained and remained unaltered, but new slabs were also inserted to support heavier loading from plant, kitchen and cold storage areas, and new staircase and lift cores were introduced to improve circulation and satisfy the fire strategy requirements. These modern insertions were designed to be reversible.

In contrast, the works at the Newton and Arkwright Buildings at Nottingham Trent University involved transforming two separate, and very different, Grade II* listed buildings **(Figure 8)** and joining them together to create a modern academic space and 'heart' to the campus **(Figure 9)**. The brief was to transform outdated and underutilised buildings into modern teaching facilities while conserving the original fabric in an elegant and economical way.

The range of interventions does not compromise the original character but has brought new life to the existing buildings. The transformation secures their long-term future, as well as forming a major entrance into the heart of the campus.

FIGURE 8: Existing buildings at Nottingham Trent University

© NOTTINGHAM TRENT UNIVERSITY

FIGURE 9: Transformation of existing buildings at Nottingham Trent University

Next time...

The second part of this article will describe how the structural engineer can maximise the potential opportunities for refurbishment once in the design stage. This will cover a number of topics that the engineer will need to be familiar with, including specific structural aspects (such as loading, analysis, foundations), holistic multidisciplinary design considerations (such as floor-to-ceiling heights, adapting the internal layout, upgrading for new building services, facade upgrades), and practical considerations (such as phasing, temporary works).

Stephen Fernandez
MEng, CEng, FIStructE, MICE

Stephen is a Conservation Accredited Engineer and Associate Director at Arup in the UK, leading the civil and structural team across Birmingham and Nottingham. He leads multidisciplinary design teams on projects locally and internationally and has extensive experience working on existing buildings of different ages.

HAVE YOUR SAY

tse@istructe.org

@IStructE
#TheStructuralEngineer

REFERENCES

1) ***Construction Declares Climate and Biodiversity Emergency* (2019)** [Online] Available at: www.constructiondeclares.com/ (Accessed: October 2020)

2) ***UK Architects Declare Climate and Biodiversity Emergency* (2019)** [Online] Available at: www.architectsdeclare.com/ *(Accessed: October 2020)*

3) **Addy N. (2014)** 'Making sustainable refurbishment of existing buildings financially viable', In: Burton S. (ed.) *Sustainable retrofitting of commercial buildings: Cool climates*, Abingdon: Routledge

4) **Derwent London (2012)** *Sustainability Report*, p.14 [Online] Available at: www.derwentlondon.com/uploads/downloads/Responsibility/DL_Sustainability_2012_v2_WEB.pdf (Accessed: October 2020)

5) **Ball R.M. (2002)** 'Re use potential and vacant industrial premises: revisiting the regeneration issue in Stoke-on-Trent', *J. Prop. Res.*, 19 (2) pp. 93–110

6) **Fernandez S. (2017)** 'Engineer's approach to conservation', *Proc. ICE – Eng. Hist. Herit.*, 170 (2), pp. 53–66

7) **Avent J. (2015)** 'Conservation compendium. Part 2: Conservation accreditation for the engineer', *The Structural Engineer*, 93 (1), pp. 32–34

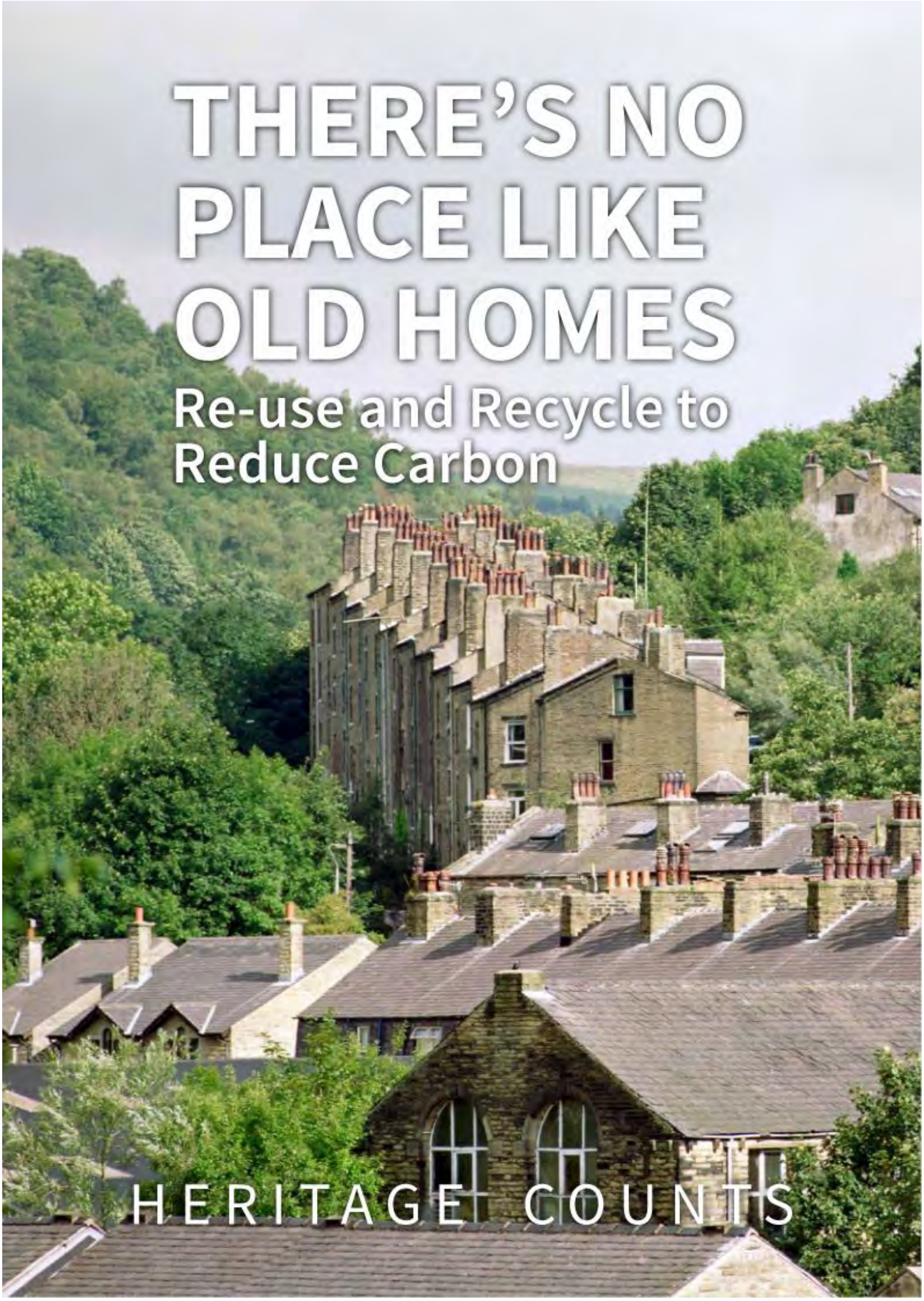
8) **Miller J. (2015)** 'Conservation compendium. Part 1: Why keep it? Engineers and the modern conservation movement', *The Structural Engineer*, 93 (1), pp. 14–17

FURTHER READING

Institution of Structural Engineers (2008) *Guide to surveys and inspections of buildings and associated structures*, London: IStructE Ltd

Institution of Structural Engineers (2010) *Appraisal of existing structures*, London: IStructE Ltd

Appendix 4 - Heritage Counts: Re Use and Recycle to reduce carbon



APPENDIX C

Outline Schedule of Works

Outline Schedule of Works

Note: All works to be undertaken to comply with rail requirements for working adjacent to trackside. We anticipate that scaffold erection to the north range, clock tower etc. will need to be done with track closures.

The schedule relates to the North Range, Clock Tower, Link Range between Clock Tower and South Range, and the South Range. It does not include the buildings to the north of the North Range or the Single Storey building to the SW of the South Range.

The schedule is produced based on limited access internally and from ground level to the north range, with the north range being covered in sheeting so not visible. Assumptions have had to be made due to these limitations.

Note - the following information on approximate dimensions of the buildings are provided below and taken from dimensions from Google Earth:

- South Range 11m wide x 62m long;
- Link 9.5m wide x 7.3m long;
- Clock Tower 8.8 wide x 7.8m long;
- North Range 11m wide x 46m long

Referencing is included on the aerial images in appendix D

1.0 Preliminaries

1.1 Allow to retain existing scaffold to the south range for works. Include for loading bay and materials and plant hoist for works and any adaptations to scaffold to complete the works.

1.2 Allow for full scaffold and temporary roof to north range, clock tower and link between clock tower and south range including loading bay to west side and materials hoist as necessary. The scaffolding will need to take account of the station platform canopies etc.

1.3 Allow for full site set up for welfare, storage, parking etc. Assume car park area available for this.

1.4 Allow for all requirements of the CDM Regulations to be fulfilled, combined with rail requirements.

1.5 At commencement an access strategy for works internally will need to be agreed. The building will be entered sequentially, and each area assessed in turn where safe to allow an access strategy to be developed. This will categorise areas as Green (safe to enter), Amber (can be accessed but defects should be noted), or Red (no access until made safe). This access strategy will be updated during the course of the works as temporary or permanent works are put in place.

1.6 Allow for refurbishment and demolition asbestos survey of the building in line with clause 1.5.

1.7 Allow for preparing and producing measured survey along with recording of structure during works. Note this will need to be sequentially updated as greater access is obtained.

2.0 Roofs – Stripping etc.

2.1 Allow to progressively strip all roofs of finishes, including slates, cast iron weatherings and gutters, lead etc. Clean and set aside materials on loading bays for re-use making assessment for extent of any missing, broken and shortfall materials. This will include removal or any secondary elements such as flues, aerials, fixings etc.

2.2 South Range – R-S01- Short section of Roof between South Gable chimney S01 and Trapezoidal roof to south end.

2.3 South Range – R-S02 - Trapezoidal roof to south end.

2.4 South Range – R-S03 – Short section of Roof between Trapezoidal Roof R-S02 and C-S02.

2.5 South Range – Roof R-S04.

2.6 South Range – Roof R-S05.

2.7 South Range – Roof R-S06.

2.8 South Range – Roof R-S07. Note there is a large added timber dormer built into the west pitch, we suspect for lift over-run. An option may be considered for removing this and reinstating the roof, if this is not required for lift operation.

2.9 South Range – Roof R-S08.

2.10 South Range – Roof R-S09 - Trapezoidal roof to north end.

2.11 South Range – Roof R-S10 - Short section of Roof between Trapezoidal Roof R-S09 and C-S07.

2.12 Link Range Roof – Between Clock Tower and South Range at north end.

2.13 Clock Tower Roof and Associated Parapets at Base

2.14 North Range – Roof R-N01.

2.15 North Range – Roof R-N02.

2.16 North Range – Roof R-N03.

2.17 North Range – Roof R-N04.

2.18 North Range – Roof R-N05.

2.19 North Range – Roof R-N06 – Trapezoidal roof to north end.

3.0 <u>Roofs - Timber Repairs</u>

3.1 Review roof structure as they become exposed to better understand condition and if any temporary support is required.

3.2 Carry out timber repairs to structure. Provisional works set out below but will need to be confirmed when full access available and finishes removed. The philosophy of repairs will be to retain as much historic fabric as possible, where-ever possible partnering timbers to allow retain of historic fabric. New timber to be American or Canadian Douglas Fir. Principal timbers, such as eaves plate will need to be half lapped jointed for replacement sections.

3.3 South Range – R-S01- Short section of Roof between South Gable chimney S01 and Trapezoidal roof to south end.

a) Allow for 30% new sarking boards.
b) No evidence of significant timber decay.
c) See timber repairs below 3.13.

3.4 South Range – R-S02 - Trapezoidal roof to south end.

a) Allow for 100% new sarking boards to flat roof and 30% to sides.
b) Evidence of modest timber decay.
c) See timber repairs below 3.13.

3.5 South Range – R-S03 – Short section of Roof between Trapezoidal Roof R-S02 and C-S02.

a) Allow for 40% new sarking boards.
b) Evidence of significant decay to east side to part requiring replacement of eaves plate between upper and lower mansard over 50% of length, with new 50% of ceiling joists improved with partners timbers, along with mansard rafters below.
c) See timber repairs below 3.13.

3.6 South Range – Roof R-S04.

a) Allow for 30% new sarking boards.
b) Evidence of modest timber decay to east side (see timber repairs below).

3.7 South Range – Roof R-S05 3.13.

a) Allow for 50 % new sarking boards.
b) Evidence of significant decay to east side to part requiring replacement of eaves plate between upper and lower mansard over 50% of length, with 50% of ceiling joists improved with partner timbers. 50% new mansard rafters 50% new wall studs.
c) See timber repairs below 3.13.

3.8 South Range – Roof R-S06.

a) Allow for 30% new sarking boards.
b) Evidence of a reasonable degree of decay to east side to part requiring replacement of eaves plate between upper and lower mansard over 50% of length, with 50% of ceiling joists improved with partners timbers. 50% new mansard rafters.
c) See timber repairs below 3.13.

3.9 South Range – Roof R-S07.

a) Note there is a large added timber dormer built into the west pitch, we suspect for lift over-run. An option may be considered for removing this and reinstating the roof, if this is not required for lift operation.
b) However, for the purpose of pricing the existing dormer will remain with repairs including 100% replacement of sarking boards to roof and 50% replacement of sarking boards/ dormer reveals.
c) Include for modest timber repairs to the gutter above the stone pediment.
d) Allow for 30% new sarking boards.
e) Evidence of modest timber decay to east side.
f) See timber repairs below 3.13.

3.10 South Range – Roof R-S08.

a) Allow for 30% new sarking boards.
b) No evidence of significant timber decay.
c) See timber repairs below 3.13.

3.11 South Range – Roof R-S09 - Trapezoidal roof to north end.

a) Allow for 100% new sarking boards to flat roof and 30% to sides.
b) Evidence of modest timber decay.
c) See timber repairs below 3.13.

3.12 South Range – Roof R-S10 - Short section of Roof between Trapezoidal Roof R-S09 and C-S07.

a) Allow for 100% new sarking boards to flat roof and 30% to sides.
b) Evidence of modest timber decay to east side.
c) See timber repairs below 3.13.

3.13 [Intentionally Blank]

3.14 Link Range Roof – Between Clock Tower and South Range at north end.

a) Allow for 40% new sarking boards.
b) No evidence of significant timber decay.
c) See timber repairs below 3.22.

3.15 Clock Tower Roof and Associated Parapets at Base

a) Allow for 30% new sarking boards.
b) No evidence of significant decay.
c) See timber repairs below 3.22.

3.16 North Range – Roof R-N01 (not visible).

a) Assume 30% new sarking boards.
b) Assume no evidence of significant timber decay as reported as improved condition by Mott MacDonald (MM) Report.
c) See timber repairs below 3.22.

3.17 North Range – Roof R-N02 (not visible).

a) Assume 30% new sarking boards.
b) Assume no evidence of significant timber decay as reported as improved condition by MM.
c) See timber repairs below 3.22.

3.18 North Range – Roof R-N03 (not visible).

a) Assume 30% new sarking boards.
b) Assume no evidence of significant timber decay as reported as improved condition by MM.
c) See timber repairs below 3.22.

3.19 North Range – Roof R-N04 (not visible).

a) Assume 30% new sarking boards.
b) Assume no evidence of significant timber decay as reported as improved condition by MM.
c) See timber repairs below 3.22.

3.20 North Range – Roof R-N05 (not visible).

a) Assume 30% new sarking boards.
b) Assume no evidence of significant timber decay as reported as improved condition by MM.
c) See timber repairs below 3.22.

3.21 North Range – Roof R-N06 – Trapezoidal roof to north end.

a) Assume 100% new sarking boards to flat roof and 30% to sides.
b) Assume no evidence of significant timber decay as reported as improved condition by MM.
d) See timber repairs below 3.22.

4.0 Roofs - Recovering

4.1 Slate roofs to re-use existing with estimate of 30% of new slate to match existing. Existing slates to be used to west elevations. New slate to be from The Natural Slate Co. Ltd Traditional Slate Company Ltd.- Fesco Caledonian Heavy Slate, or from The Traditional Slate Company, subject to samples and in diminishing courses to match existing in size, colour, thickness and texture. Underlay to be used over sarking board. [Note: insulation not included here and will depend on use and agreement of details].

4.2 Allow for flat roofs to be re-covered in lead with falls, drips, lead code and flashing all to the requirements of the Lead Sheet Training Academy. This is to include all flashings, valleys, ridge flashings, weatherings, dressings, including to back of dormers (see photograph 25) etc.

4.3 Allow for cleaning in workshop (SA2.5), painting all cast iron weatherings at the junction between upper roof and lower roof and repainting in marine grade paint for durability such as AkzoNobel Interzone 954 Glass Flake due to the superior useability, greater levels of thickness achieved in 2 coats and overall past performance of this coating on marine structures. Include for using salvaged broken weathering sections to make moulds for missing/failed weatherings assuming 25% required.

4.4 Include for renewing all existing small rooflights to trapezoidal roofs to suit existing openings with Conservation Rooflights. Allow 4 No.

4.5 South Range – R-S01- Short section of Roof between South Gable chimney S01 and Trapezoidal roof to south end.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.6 South Range – R-S02 - Trapezoidal roof to south end.

a) Allow to re-lead flat roof (see photograph 9).
b) Include with cast iron weathering for re-casting 2 No. corner castings where missing, using existing to make mould. Clean and repaint as outline spec 4.3 above.
c) Allow for slate hanging to all sides including corner lead flashings.
d) Include for replicating railing (or re-using) around flat roofs (see below)

4.7 South Range – R-S03 – Short section of Roof between Trapezoidal Roof R-S02 and C-S02.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.8 South Range – Roof R-S04.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.9 South Range – Roof R-S05.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.10 South Range – Roof R-S06.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.11 South Range – Roof R-S07. Note there is a large added timber dormer built into the west pitch, we suspect for lift over-run. An option may be considered for removing this and reinstating the roof, if this is not required for lift operation.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.
b) Include for new lead roof over dormer, including cheeks.
c) Include for new lead flat to west stone pediment.

4.12 South Range – Roof R-S08.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.13 South Range – Roof R-S09 - Trapezoidal roof to north end.

a) Allow to re-lead flat roof (see photograph 9).
b) Include with cast iron weathering for re-casting 2 No. corner castings where missing using existing to make mould. Clean and repaint as outline spec 4.3 above.
c) Allow to slate hanging to all sides including corner lead flashings.
d) Include for replicating railing (or re-using) around flat roofs (as 4.6 d above).

4.14 South Range – Roof R-S10 - Short section of Roof between Trapezoidal Roof R-S09 and C-S07.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.15 Link Range Roof – Between Clock Tower and South Range at north end.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.
b) Include for new leaded flat roof over south dormer, 2 No. conservation rooflight and 6 No. penetrations (vents etc) through roof).

4.16 Clock Tower Roof and Associated Parapets at Base

a) Allow for inspection of decorative lead roof at head of tower. Include for local lead repairs.
b) Include for cleaning and painting of iron finial.
c) Allow for slate hanging to sides of roof including lead flashings to corners and over and around stone roundels to 3 No. faces.
d) Include for renewing the lead parapet gutters around the base.

4.17 North Range – Roof R-N01.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.18 North Range – Roof R-N02.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.19 North Range – Roof R-N03.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.20 North Range – Roof R-N04.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.21 North Range – Roof R-N05.

a) Allow to re-roof upper and lower pitches in slate with flashings, weatherings etc.

4.22 North Range – Roof R-N06 – Trapezoidal roof to north end.

a) Allow to re-lead flat roof (see photograph 9 for likely typical detail).
b) Allow to slate hanging to all sides including corner lead flashings.

4.23 Allow for local sundries, such as weatherings around existing vent pipes through roofs etc. including any additional further rooflights not identified above etc. - Provisional Sum of **£20,000**.

4.24 To flat bay roof to main stair to west elevation of South Range, allow to take up existing finishes and allow for new polymer modified asphalt roof including all flashings to abutments etc.

4.25 Include for full Lightening Protection to current standards.

5.0 Rainwater Goods

5.1 The rainwater goods are generally in poor condition. These will need to be removed throughout. Any sound sections will be retained and re-used, following cleaning and painting.

5.2 Allow for new cast iron gutters at base of mansard roof and all downpipes etc. to match existing profiles. This to include all lead flashings from masonry (see photograph 34) and mansard etc. All to be painted with minimum 2 coats of paint. Inside of gutters to be painted with bitumastic paint. Note: assume overall 30% can be retained for re-use.

6.0 Chimneys

6.1 Allow to provide scaffold to all chimneys and remove pots and set aside for re-use. Remove mortar flaunchings as part of above and then re-set all pots in a 1:3 NHL5 to sand mix. Make up any shortfall. Include for 15 No. new pots where damaged or missing.

6.2 Allow for light cleaning of chimney masonry to remove all algae etc.

6.3 Allow for 30% raking out and re-pointing of stacks above roof line including removal of all vegetation. Include for re-flaunching all top surfaces as part of flaunching.

6.4 Include for gentle defrassing to remove all loose surface masonry and then re-assess stacks to confirm scope of works. Note that where sections have been lost these will only be repaired if required structurally. All new stone to be geological match and for colour and texture.

6.4 Chimney C-S01 – Allow for pinning of 8 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail. Include for removing previous mortar repairs to flat head below arch, and re-setting new mortar repairs to match stone colour. Include for stainless steel light armatures and wire to provide greater durability.

6.5 Chimney C-S02 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.6 Chimney C-S03 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.7 Chimney C-S04 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.8 Chimney C-S05 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.9 Chimney C-S06 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.10 Chimney C-S07 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.11 Chimney CT-C01 – Allow to re-build section of stack removed previously to north elevation but around 4.0m (assumed). Assume all new stone required for stack including lateral support tie back into main clock tower roof and associated weathering.

6.12 Chimney C-N01 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.13 Chimney C-N02 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.14 Chimney C-N03 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.15 Chimney C-N04 – Provisionally allow for pinning of 5 Nr. cracks with 8mm s/s dowels making good face holes with a matching stone dust mortar. Allow to indent repair the stack at 5 No. positions of different sizes and profiles including some curved stones to detail.

6.16 Allow for removal of 20 No. fixings to stack. Allow to indent 5 No. stones where damaged by corrosion jacking. Allow to point 1 No. hole with a matching stone dust mortar.

6.17 At completion of main works and when temporary scaffold and associated roof being removed, use Chimney restraints which include 4 No. fixings into the masonry. Allow to make good the holes with a stone dust mortar to match existing.

6.18 To 1 No. pediment to base of cross wall to west side of South Range, allow to lift pediment stone and replace stone below where previous scaffold fixings has corroded and blown the stonework (see photograph 41).

7.0 <u>Dormers</u>

7.1 Allow for light cleaning of dormer masonry to remove all algae etc.

7.2 Allow for raking out and re-pointing of dormer stacks above roof line including removal of all vegetation.

7.3 Include for gentle defrassing to remove all loose surface masonry and then re-assess stacks to confirm scope of works. Note that where sections have been lost these will only be repaired if required structurally. All new stone to be geological match and for colour and texture.

7.4 These are structurally stable but as part of re-roofing should be tied back into the roof structures for additional restraint.

7.5 Allow to tie back 11 No dormers or pediments to roof to west elevation of south range.

7.6 Allow to tie back 13 No dormers or pediments to roof to east elevation of south range.

7.7 Allow to tie back 2 No dormers to Link Roof.

7.8 Allow to tie back 2 No dormers to Clock Tower.

7.9 Allow to tie back 10 No dormers or pediments to roof to west elevation of north range.

7.10 Allow to tie back 9 No dormers or pediments to roof to east elevation of north range.

7.11 Allow for masonry repairs to 47 No dormers including stone indents, removal of ferrous fixings, occasional replacements etc.

7.12 To east elevation of South Range allow to reinstate 2 No. removed stone brackets pinning back into dormer reveals along with removed cornice between dormers (see photograph 15, 27 and 28).

7.13 To Central curved head dormer to west elevation of South Range allow for removal and replacement of top curved stone where fractured (see photographs 33 and 66) with new to match existing.gbb

7.14 To 1 No. dormer to west side of South Range, allow to drill out previous ferrous fixing with core and remove. Allow to fill core whole with mortar and either make good head with stone cap in resin or with stone dust mortar to match existing.

8.0 <u>South Range Masonry Elevations</u>

8.1 Allow for light cleaning of masonry elevation to remove all algae etc. including west, south, east and north.

8.2 Include for gentle defrassing to remove all loose surface masonry and then re-assess stacks to confirm scope of works. Note that where sections have been lost these will only be repaired if required structurally. All new stone to be geological match and for colour and texture. Note the tooled surface finish to ashlar stones will need to be replicated.

8.4 Allow to rack out pointing, after removal of gutters ad flashings to entire cornice and blocking course below to east and west elevations and re-point.

8.5 Note that for re-pointing works the joints to the west side are generally very narrow in lime putty, whilst those to the west are thicker in lime mortar.

8.6 **West Elevation**

8.6.1 Where cornice badly affected by water damage etc. allow for the following:

a) Cut out and replace individual stones say 4 No. 800mm long. New stones to be bedded in mortar and pinned back to main structure.
b) Allow to indent 3 No. sections of cornice 300mm long x 100mm depth (including mouldings) and 150mm depth. Pin and point in place.
c) Allow to pin 1 No. cracks to cornice with 8mm diameter s/s fixings set at angle and in resin with hole made good with stone dust mortar to match existing.

8.6.2 To west elevation allow to rake out and re-point 50m^2 over different areas noting narrow lime putty joints.

8.6.3 Allow to indent stone surround to west elevation to south of stair window at second floor level (imitating a hopper head – see photograph 45 for example) for 100mm height and 150mm depth and cut to profile, glued and fixed in place with s/s resin dowels.

8.6.4 Where string course between 1st and 2nd floor levels badly affected by water damage, allow to cut out and replace individual stones say 3 No. 1.0m long. New stones to be bedded in mortar and pinned back to main structure.

8.6.5 To west elevation central bay window with curved transoms and masonry to sides, allow to carefully remove steel curved flat plate lintels (see photographs 64 and 65) and insert new stainless-steel lintels. Note the curved stone lintel supported may need to be removed and then reinstated with stainless steel pins. Cracked reveal stones will need to be pinned. Provisionally allow for 2 No. indents to bearings if required.

8.6.6 Allow to indent 4 No. window transoms to underside 600mm long x depth of stone x 75mm high. Pin and glue in place.

8.6.7 To head of ground floor of bay to main Stair to west elevation so South Range, allow a provisional sum for pinning and structural repairs to old cracks (possibly already pinned).

8.6.8 Allow for pinning 12 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

8.6.9 Allow for 15 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing.

8.6.10 Allow for 15 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. This to moulded elements such as cornices, dormers etc.

8.6.11 As scaffold is dismantled allow to remove all fixings used to retain this to masonry. Include for 106 No. holes to be made good with a stone dust mortar to match existing.

8.6.12 Allow for stripping paint off plinth following trials to test results.

8.7 South Elevation

8.7.1 For chimney C-S01 see item 6.4 above.

8.7.2 To south elevation allow to rake out and re-point 20m^2 over different areas noting the wider joints and requirement to use lime mortar. Include for 100% repointing around all cornices, pediments and decorative stonework.

8.7.3 Allow for pinning 12 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

8.7.4 There are 11 No. sections of in-built iron or steelwork such as beams, angles and plates. These have all corroded and caused fracture damage to the surrounding masonry (see photographs 42 and 43). Allow for removal of ferrous elements and damaged stone and then replacement of stone to match existing.

8.7.5 To 3 No. positions, allow to drill out previous ferrous fixing with core and remove. Allow to fill core hole with mortar and either make good head with stone cap in resin or with stone dust mortar to match existing.

8.7.6 Allow for 8 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing.

8.7.7 Allow for 18 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. This to moulded elements such as cornices, string courses, architectural features etc.

8.7.8 As scaffold is dismantled allow to remove all fixings used to retain this to masonry. Include for 16 No. holes to be made good with a stone dust mortar to match existing.

8.8 **East Elevation**

8.8.1 Where cornice badly affected by water damage etc. allow for the following:

a) Cut out and replace individual stones say 4 No. 800mm long. New stones to be bedded in mortar and pinned back to main structure.
b) Allow to indent 6 No. sections of cornice 300mm long x 100mm depth (including mouldings) and 150mm depth. Pin and point in place.
c) Allow to pin 4 No. cracks to cornice with 8mm diameter s/s fixings set at angle and in resin with hole made good with stone dust mortar to match existing.

8.8.2 To west elevation allow to rake out and re-point 75m^2 over different areas noting wider joints and to be in lime mortar.

8.8.3 To 19 No. cracks to lintels allow to stitch pin across cracks with 10mm stainless steel pins set in resin and with the hole made good with a stone dust mortar to match existing. This to be undertaken after removal of causes of some of the cracks such as embedded iron or woody vegetation roots (see photographs 47 and 48).

8.8.4 To 6 No. of the above allow to indent the window reveal below 150 x 150 x 150mm to same profile and finish to improve bearing (see photograph 48).

8.8.5 To 1 No. window flat bar steel lintel has been added and corroded to central window to second floor. Allow to remove lintel and replace with new stainless-steel lintel. At same time replace lintels over which have been previously poorly repaired with mortar.

8.8.6 To string course between 1st and 2nd floor level, allow provisionally to cut out and replace individual stones say 3 No. 1.0m long. New stones to be bedded in mortar and pinned back to main structure.

8.8.7 Allow to indent 4 No. window mullions with new stone to extent to half depth of mullion and be jointed centrally and glued and pinned. Allow 600mm long x depth of stone x half width of mullion.

8.8.8 Allow for pinning 16 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

8.8.9 Allow for 15 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime mortar joints to flat surfaces. Tooled finish to match existing.

8.8.10 Allow for 12 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime mortar joints to flat surfaces. This to moulded elements such as cornices, dormers etc.

8.8.11 To 3 No. positions, allow to drill out previous ferrous fixing with core and remove. Allow to fill core whole with mortar and either make good head with stone cap in resin or with stone dust mortar to match existing.

8.8.12 There are approximately 3 No. sections of in-built iron or steelwork such as beams, angles and plates. These have all corroded and caused fracture damage to the surrounding masonry (see photographs 42 and 43). Allow for removal of ferrous elements and damaged stone and then replacement of stone to match existing.

8.8.13 The movement to the NE corner may be associated with corrosion of the main station canopy beams. Allow to open and around these to investigate to full depth of bearing and to both sides. Allow to clean down all steelwork and treat with paint specification as above (clause 4.3) and then make good stonework around.

8.8.14 As scaffold is dismantled allow to remove all fixings used to retain this to masonry. Include for 103 No. holes to be made good with a stone dust mortar to match existing.

8.9 **North Elevation**

8.9.1 For chimney C-S07 see item 6.10 above.

8.9.2 To south elevation allow to rake out and re-point 30m^2 over different areas noting the wider joints and requirement to use lime mortar. Include for 100% repointing around all cornices, pediments and decorative stonework.

8.9.3 Allow for pinning 3 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

8.9.4 The movement to the NE corner may be associated with corrosion of the main station canopy beams. Allow to open and around these to investigate to full depth of bearing and to both sides. Allow to clean down all steelwork and treat with paint specification as above (clause 4.3) and then make good stonework around.

8.9.5 To 1 No. position, allow to drill out previous ferrous fixing with core and remove. Allow to fill core hole with mortar and either make good head with stone cap in resin or with stone dust mortar to match existing.

8.9.6 To 3 No. cracks to lintels allow to stitch pin across cracks with 10mm stainless steel pins set in resin and with the hole made good with a stone dust mortar to match existing. This to be undertaken after removal of causes of some of the cracks such as embedded iron or woody vegetation roots (see photographs 47 and 48).

8.9.7 Allow for 2 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing.

8.9.8 Allow for 3 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. This to moulded elements such as cornices, string courses, architectural features etc.

8.9.8 As scaffold is dismantled allow to remove all fixings used to retain this to masonry. Include for 10 No. holes to be made good with a stone dust mortar to match existing.

9.0 <u>Link and Clock Tower Masonry Elevations</u>

9.1 Allow for light cleaning of masonry elevation to remove all algae etc.

9.2 Include for gentle defrassing to remove all loose surface masonry and then re-assess stacks to confirm scope of works. Note that where sections have been lost these will only be repaired if required structurally. All new stone to be geological match and for colour and texture. Note the tooled surface finish to ashlar stones will need to be replicated.

9.3 Allow to rake out pointing, after removal of gutters and flashings to entire cornice and blocking course and re-point.

9.4 Note for re-pointing works that the joints to the south side of the link and the Clock Tower are generally very narrow in lime putty, whilst those to the north elevation of the link are thicker in lime mortar.

9.5 To south elevation of the link allow to rake out and re-point 20m^2 over different areas noting narrow lime putty joints. Include for 100% repointing around all cornices, pediments and decorative stonework.

9.6 To the south elevation of the link allow for pinning 3 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

9.7 To the south elevation of the link to 1 No. position, allow to drill out previous ferrous fixing with core and remove. Allow to fill core hole with mortar and either make good head with stone cap in resin or with stone dust mortar to match existing.

9.8 To the south elevation of the link allow for 2 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing.

9.9 To the south elevation of the link allow for 2 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. This to moulded elements such as cornices, string courses, architectural features etc.

9.10 To the south elevation of the link as scaffold is dismantled allow to remove all fixings used to retain this to masonry. Include for 8 No. holes to be made good with a stone dust mortar to match existing.

9.11 To the south elevation of the link include a provisional sum for further stone repairs to west elevation.

9.12 To north elevation of the link allow to rake out and re-point 25m^2 over different areas noting the wider joints and requirement to use lime mortar. Include for 100% repointing around all cornices, pediments and decorative stonework.

9.13 To the north elevation of the link allow for pinning 3 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

9.14 To the north elevation of the link allow for 4 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing.

9.15 To the north elevation of the link allow for 4 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. This to moulded elements such as cornices, string courses, architectural features etc.

9.16 To the south elevation of the link as scaffold is dismantled allow to remove all fixings used to retain this to masonry. Include for 8 No. holes to be made good with a stone dust mortar to match existing.

9.17 To the south elevation of the link include a provisional sum for further stone repairs to west elevation.

9.18 To south elevation of the Clock Tower allow to rake out and re-point 25m^2 over different areas noting narrow lime putty joints. Include for 100% repointing around all cornices, pediments and decorative stonework.

9.19 To south facing dormer of the Clock Tower allow to carefully remove the iron cramp/fixing to the window head (see photograph 84). Cut back pocket and indent 2 No. new sections of stone to match existing, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing and respecting joint pattern.

9.20 To the south elevation of the Clock Tower allow for pinning 5 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

9.21 To the south elevation of the Clock Tower to 3 No. positions, allow to drill out previous ferrous fixing with core and remove. Allow to fill core hole with mortar and either make good head with stone cap in resin or with stone dust mortar to match existing.

9.22 To the south elevation of the Clock Tower allow for 2 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing.

9.23 To the south elevation of the Clock Tower allow for 2 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. This to moulded elements such as cornices, string courses, architectural features etc.

9.24 To the south elevation of the Clock Tower include a provisional sum for further stone repairs to west elevation.

9.25 To west elevation of the Clock Tower allow to rake out and re-point 25m^2 over different areas noting narrow lime putty joints. Include for 100% repointing around all cornices, pediments and decorative stonework.

9.26 To the west elevation of the Clock Tower allow for pinning 5 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

9.27 To the west elevation of the Clock Tower to 3 No. positions, allow to drill out previous ferrous fixing with core and remove. Allow to fill core hole with mortar and either make good head with stone cap in resin or with stone dust mortar to match existing.

9.28 To the west elevation of the Clock Tower allow for 3 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing.

9.29 To the south elevation of the Clock Tower allow for 3 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. This to moulded elements such as cornices, string courses, architectural features etc.

9.30 To the south elevation of the Clock Tower include a provisional sum for further stone repairs to west elevation.

10.0 <u>North South Range Masonry Elevations</u>

10.1 Allow for light cleaning of masonry elevation to remove all algae etc. including west, south, east and north.

10.2 Include for gentle defrassing to remove all loose surface masonry and then re-assess stacks to confirm scope of works. Note that where sections have been lost these will only be repaired if required structurally. All new stone to be geological match and for colour and texture. Note the tooled surface finish to ashlar stones will need to be replicated.

10.3 Allow to rake out pointing, after removal of gutters and flashings to entire cornice and blocking course below to east and west elevations and re-point.

10.4 Note for re-pointing works that the joints to the west side are generally very narrow in lime putty, whilst those to the west are thicker in lime mortar.

10.5 **West Elevation**

10.5.1 To south elevation allow to rake out and re-point 45m^2 over different areas noting the narrow joints in lime putty. Include for 100% repointing around all cornices, pediments and decorative stonework.

10.5.2 Allow for pinning 8 No. further cracked stones on site with 2 No. 8mm stainless steel dowels set in resin and the hole made good in a stone dust mortar.

10.5.3 To 6 No. positions, allow to drill out previous ferrous fixing with core and remove. Allow to fill core whole with mortar and either make good head with stone cap in resin or with stone dust mortar to match existing.

10.5.4 Allow for 5 No. indents say 250mm long x 100mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. Tooled finish to match existing.

10.5.5 Allow for 5 No. indents say 400mm long x 250mm deep x 150mm depth, glued and stainless steel pinned and pointed with lime putty to joints to flat surfaces. This to moulded elements such as cornices, string courses, architectural features etc.

10.5.6 Assume that fire escape stair will be removed. Include for removing all inbuilt steels. Make good the stonework at the steel pocket positions. Include a provisional sum for further repairs around the steels.

10.6 **North Elevation**

10.6.1 MM Report suggests in reasonable condition. Include a provisional sum for further stone repairs to north elevation.

10.7 **East Elevation**

10.7.1 Not visible due to netting. Include the same cost as west elevation

11.0 <u>Windows</u>

11.1 The windows are in variable condition. They are in a poor state of decoration and with failing paint, failing glazing putty, lost or cracked panes, and then some with decay to the frames, mainly the cills.

11.2 Allow to de-glaze and then clean down the frames, sashes, casements etc. in-situ and inspect.

11.3 Allow to remove 20% of windows complete for repair on the bench. These to include new hardwood cills, and then splices to jambs of frames. Allow to re-fit the removed windows.

11.4 Allow to prime, re-glaze and decorate include all filling around the window frames. Include for 25% replacement glazing.

12.0 <u>Roof Access and Maintenance</u>

12.1 Develop design for a suitable maintenance system for the roofs, gutters etc.

13.0 <u>Below Ground Drainage</u>

13.1 Allow for full drainage survey for below ground system.

13.2 Allow for repairs of any defects.

14.0 South Range Internals

14.1 Access was restricted to inspection from where boards were removed from windows.

14.2 Refer to 1.5 to 1.7 in preliminaries for access strategy etc.

14.3 Allow to sequentially work through building to clear all rubbish, carpets, suspended ceilings, modern partitions etc.

14.4 **Third Floor South Range** (Attic Level)

14.4.1 Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 50% of area.

14.4.2 Allow for timber repairs to ceiling and walls and floors due to water ingress (note previous allowances in roof).

14.4.3 Allow to make good missing/removed areas of lath and plaster.

14.5 **Second Floor South Range**

14.5.1 Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 30% of area.

14.5.2 Allow for timber repairs to ceiling and walls and floors due to water ingress.

14.5.3 Allow to make good missing/removed areas of lath and plaster.

14.6 **First Floor South Range**

14.6.1 Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 15% of area.

14.4.2 Allow for repairs to solid ceiling and walls and floors due to water ingress.

14.4.3 Allow to make good missing/removed areas of lath and plaster.

14.4.4 Allow for sundry repairs to panelling etc. in local areas where damaged.

14.7 **Ground Floor North Range**

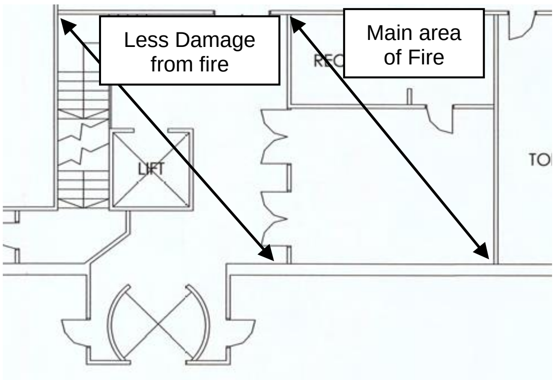
14.7.1 Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 50% of area.

14.7.2 Allow for repairs to solid ceiling and walls and floors due to water ingress.

14.7.3 Allow to make good missing/removed areas of lath and plaster.

14.7.4 Allow for sundry repairs to panelling etc. in local areas where damaged.

14.7.5 To recent fire damaged area to north end to west side to main stair lift and adjoining room to south, allow for complete strip out of finishes to walls and ceilings. Note the floor structure over appears to be of iron beams and jack concrete arches and we assume unaffected. Allow to apply new suspended ceiling to original line and reinstate finishes. Approx area of damage highlighted with photographs overleaf.



Approx Areas affected by fire


Room prior to fire from MM report ref FO02

14.8 <u>Basement - Internals</u>

14.8.1 Include provisional sum for repairs.

15.0 <u>Link and Clock Tower - Internals</u>

15.1 Link - Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 100% of area to north half and 40% to south side to 3rd floor attic level.

15.2 Link - Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 80% of area to north half and 30% to south side to 2nd floor.

15.3 Link - Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 60% of area to north half and 20% to south side to 1st floor.

15.4 Link - Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 40% of area to north half and 20% to south side to Ground floor.

15.5 Link - Allow for timber repairs to ceiling and walls and floors due to water ingress (note previous allowances in roof).

15.6 Link - Allow to make good missing/removed areas of lath and plaster to all floors.

15.7 Clock Tower – Allow to remove 10% of lath and plaster to ceilings and walls at each floor level.

15.8 Clock Tower - Allow for timber repairs to ceiling walls and floors due to water ingress (note previous allowances in roof) to all floor levels.

15.9 Clock Tower - Allow to make good missing/removed areas of lath and plaster.

16.0 South Range Internals

16.1 Access was restricted to the ground floor offices only

16.2 Refer to 1.5 to 1.7 in preliminaries for access strategy etc.

16.3 Allow to sequentially work through building to clear all rubbish, carpets, suspended ceilings, modern partitions etc.

16.4 **Third Floor North Range** (Attic Level)

16.4.1 Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 10% of area.

16.4.2 Allow for timber repairs to ceiling and walls and floors due to water ingress (note previous allowances in roof).

16.4.3 Allow to make good missing/removed areas of lath and plaster.

16.5 **Second Floor North Range**

16.5.1 Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 10% of area.

16.5.2 Allow for timber repairs to ceiling and walls and floors due to water ingress.

16.5.3 Allow to make good missing/removed areas of lath and plaster.

16.6 **First Floor North Range**

16.6.1 Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 10% of area.

16.4.2 Allow for timber repairs to ceiling and walls and floors due to water ingress.

16.4.3 Allow to make good missing/removed areas of lath and plaster.

16.7 **Ground Floor North Range**

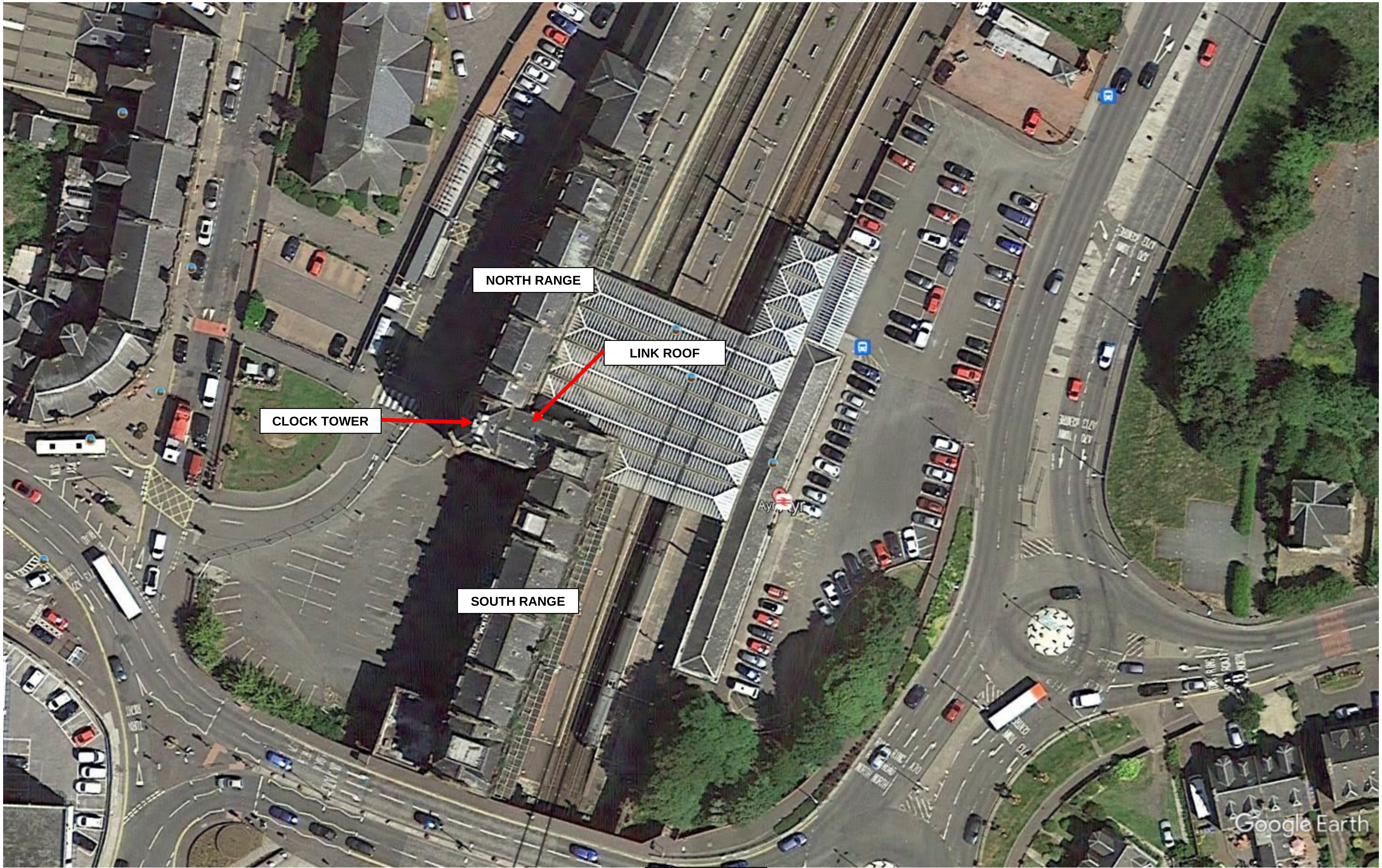
16.7.1 Allow to remove all loose lath and plaster to attic ceiling and walls. Assume 10% of area.

16.7.2 Allow for repairs to ceiling and walls and floors due to water ingress.

16.7.3 Allow to make good missing/removed areas of lath and plaster.

APPENDIX D

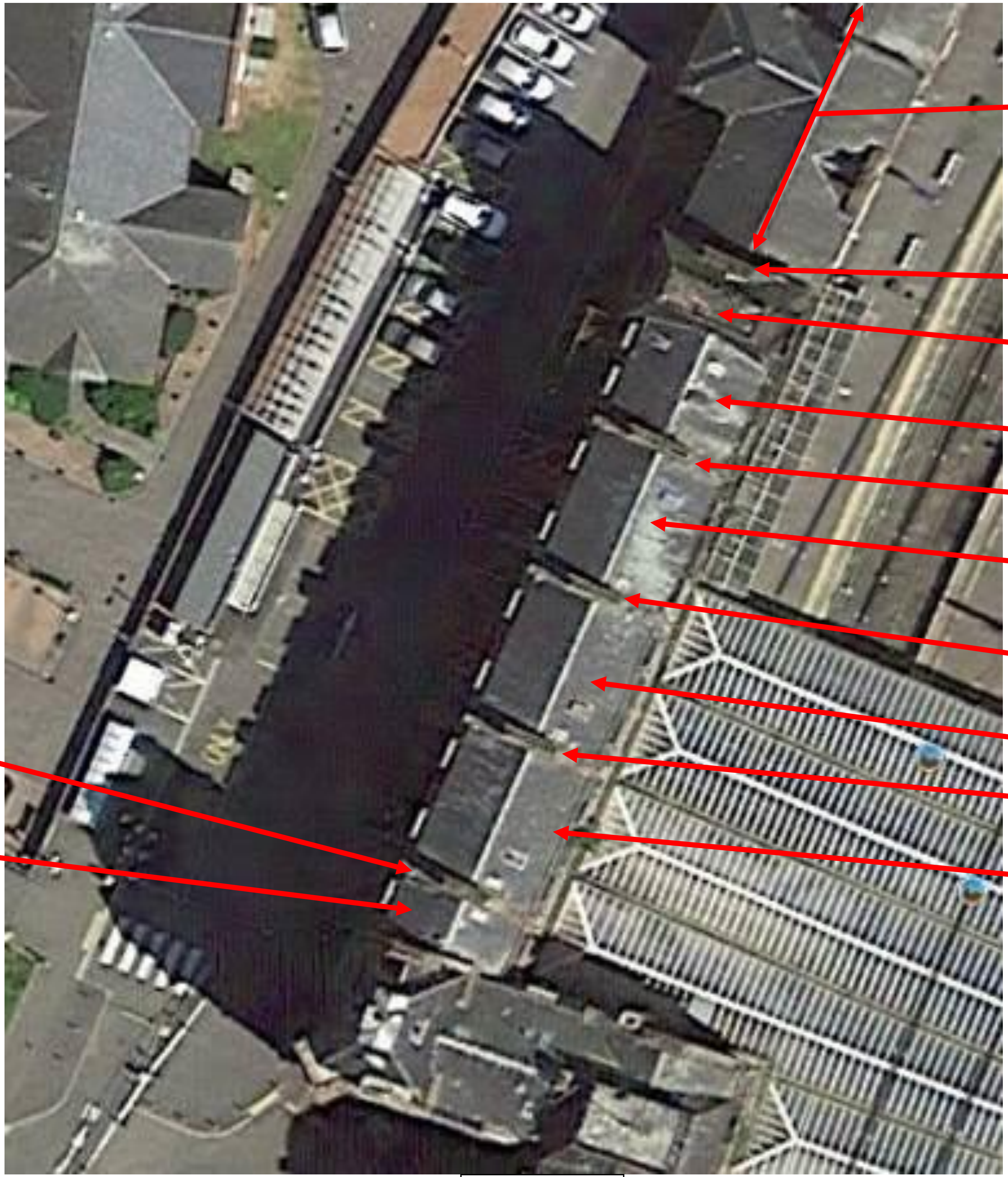
AERIAL VIEWS AND REFERENCING



© Google Earth

SOUTH RANGE, CLOCK TOWER AND LINK ROOF

NORTH RANGE



© Google Earth