Mann Williams Consulting Civil and Structural Engineers
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Ruperra Castle

Structural Condition Survey and Strategic Appraisal Report

for

Hydar Alkhafaji

Project Number:	10247
Date:	August 2024
Rev:	B

Mann Williams Consulting Civil and Structural Engineers
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1.0 Executive Summary

1.1. Ruperra Castle was built in 1626. Since then, the castle has seen several phases of alteration through the removal, infilling and addition of structural openings and wall elements to suit the changes of use for the rooms within the building. The castle has also been without a roof since being gutted by a fire in 1941 which has left the remaining building fabric exposed.

1.2. Ruperra Castle is a Scheduled Monument (Cadw ref: GM379), a Grade II* Listed Building (Cadw Ref: 14069), and is situated within the Ruperra Castle Registered Historic Park & Garden (Cadw ref: PGW(Gm)17(CAE)).

1.3. The building is generally in poor structural condition and is much of it is unsafe to enter due to various areas of vulnerable masonry which are at risk of collapsing, and areas where there is a significant risk of debris falling from height.

1.4. Mann Williams undertook a detailed structural inspection of the castle with the use of a crane and man basket operated by a specialist contractor. The structural inspection was undertaken by a CARE accredited engineer.

1.5. **Condition**

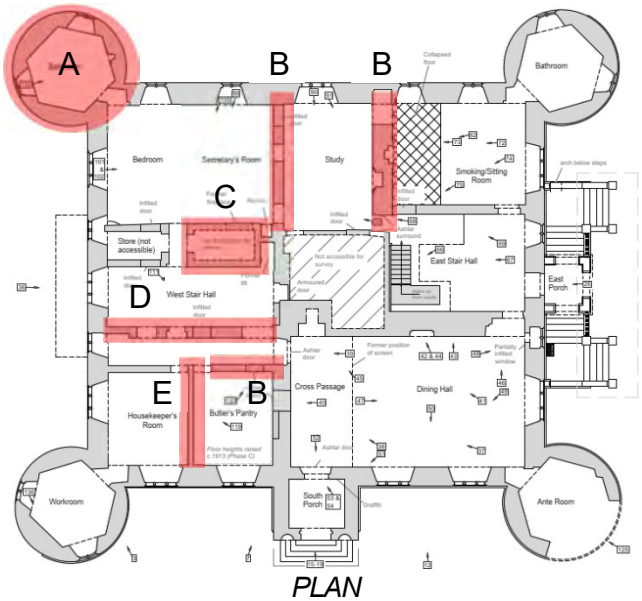
1.5.1. External walls are generally in reasonable condition with some localised areas in poor condition. Internal walls are generally in poor condition with some areas in very poor condition and of significant structural concern. The ground floor and vaulted basement structures are generally in reasonable condition.

1.5.2. Three of the four chimneys are in poor / very poor condition with the most concerning being chimneys C3 & C4. The remaining towers are generally in very poor condition.

1.5.3. The most significant general defects to the castle are ongoing vegetation growth on elevations and at wall heads, poorly built and tied in masonry work where alterations have been historically undertaken, poorly supported masonry at internal door openings where lintels have been lost or have failed.

1.5.4. The most significant specific risks to the monument and the building users are as follows:

A) Cracks in the elevation and significantly deterioration masonry arches in the NW tower with risk of localised / total collapse similar to the SE tower.
B) Significant voids in the facework at floor levels which have significantly reduced capacity and stability of remaining walls. Risk of full height of walls collapsing.
C) Chimney C4 in very poor condition, shattered capping slabs, cracks in the elevations with areas of severely degraded or cracked masonry up the full height. Risk of total collapse of the chimney stack.
D) Large patch of masonry at second floor at significant risk of collapse which poses risk to remaining masonry walls below.
E) Full height masonry wall supported on historic steel beams at risk of collapse.



PLAN

1.5.5. The most significant general risk to building users is loose / vulnerable masonry along wall heads with patches of vegetation growth likely to accelerate degradation and increase risk of falling masonry.

1.5.6. The whole building (including the vaults) is generally accessible through original doors and windows (without frames or glass generally) which increases the likelihood of risk to trespassers or site users.

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1.6. Conclusions

1.6.1. In summary, while the structure of the castle generally remains feasible to save as at the time of inspection, multiple highly vulnerable areas have been identified. In these areas, failure to take action in the immediate or short term will allow further deterioration past the 'point of no return' where it is no longer possible to intervene safely to prevent uncontrolled collapse. It is not possible to put a definitive timeframe on when that point will be reached, but it is clear from the previous collapse of the SE tower and the loss of many smaller sections of masonry that the monument is at high, and over time increasing, risk of catastrophic loss of at least local areas of significant historic fabric.

1.6.2. Due to the condition of the NW Tower, there is a potentially significant risk to passers by and users of the public right of way in the event of an uncontrolled collapse.

1.6.3. To aid in securing the strategic future of the castle, all the 'immediate' actions in the following Recommendations section should be targeted to be undertaken within 12 -18 months, though it would be preferable to shorten this period if logistical, funding and regulatory constraints permitted. 'Short term' works should be targeted to be completed within a further 2 - 3 years.

1.7. Recommendations

1.7.1. Generally, the assessment of the remaining building is that it is saveable and repairable however proposals for repair will require careful consideration and risk assessing. Not undertaking any works at Ruperra Castle will only result in the continued deterioration of the historic fabric.

1.7.2. We recommend undertaking the following Immediate / Urgent Works:

- Secure the castle to mitigate the risk of trespass and vandalism within the monument including the ground / first floor and the vaults.
- Remove asbestos lagging to pipework within the vaults.
- Installation of a crane pad on the north of the site and improved access to the crane pad.
- Localised dismantling and temporary wrapping scaffolding installed onto Chimney C4.
- All Towers - Undertake vegetation clearance to wall heads with localised dismantling to remove significant roots.
- NW Tower – Stabilise the dropped wedge of masonry over W25 at first floor
- NW Tower – Install ratchet strapping to restrain the cracked face of the tower.
- NW Tower – Install temporary roof to mitigate further vegetation growth and water ingress.

1.7.3. We recommend undertaking the following Short-Term Works:

- Undertake a comprehensive clearance / making safe scheme (including vegetation removal) to all wall heads, internal ledges.
- Undertake ground clearance to remove debris, vegetation and uncover the original ground level, this will also provide a stable base onto which scaffolding can be constructed.
- Erect scaffolding and undertake masonry repair works to elevations including infilling of slots, general repointing / patch repairs to facework, consolidation of wall heads, repairs / replacement of door lintels.
- Cell C – install temporary propping / shoring against significantly deteriorated wall.

2.0 Introduction

2.1. Brief and Scope

2.1.1. Mann Williams are appointed by Hydar Alkhafaji the owner of Ruperra Castle, Lower Machen to undertake a detailed structural inspection of the existing building. Ruperra Castle. The castle is presently in a ruined state following a fire in 1941. The client has expressed aspirations to undertake a significant regeneration to the scheduled castle which is envisaged to include a significant scheme of masonry repair works, and reinstatement of a roof / floor structures to bring the building back into a usable state.

2.1.2. Significant concerns have been raised by the client and Cadw with regards to the condition and structural integrity of the currently ruinous building, therefore Mann Williams have been appointed to produce a comprehensive structural form and condition survey report of the Castle which can be used to form the basis of any proposed masonry repair and consolidation works, and any works required to meet the aspirations of the Client to regenerate and reuse the castle.

2.1.3. Pat Ruddock (CARE Accredited Engineer) of Mann Williams undertook a preliminary visual inspection with assistance from a specialist access company with a crane and man basket on the 16th and 20th February 2024 to help inform the requirements and strategies for the detailed inspection. This initial visit also helped identify areas of the castle which could only be inspected safely using the crane and man basket, as these were deemed unsafe or inaccessible from ground level.

2.1.4. Pat Ruddock and Joshua Bird of Mann Williams undertook the detailed condition survey on the 30th & 31st July 2024 with assistance from the same specialist access team who operated the crane.

2.2. Listing Summary

2.2.1. Ruperra Castle is a Scheduled Monument (Cadw ref: GM379), a Grade II* Listed Building (Cadw Ref: 14069), and is situated within the Ruperra Castle Registered Historic Park & Garden (Cadw ref: PGW(Gm)17(CAE)).

2.3. Inspections

2.3.1. During the inspection Mann Williams undertook a visual assessment of each face of the internal masonry walls with assistance from a specialist cranage contractor.

2.3.2. Cell H was generally inaccessible therefore not inspected. Where possible a camera pole, camera zoom or a drone was used to gain a visual into inaccessible spaces (e.g. towers) to provide information on form and condition.

2.3.3. Cells A, B, C, E and the south room of Cell F (west stair hall) were accessible at ground level however it should be noted that these cells had areas of vegetation coverage and significant debris. Cell G was inaccessible at ground level.

2.3.4. Mann Williams were able to undertake a man basket drop into the SW tower to inspect the condition of the interior masonry and undertook inspections of the NW, NE and SE Towers with the use of a drone.

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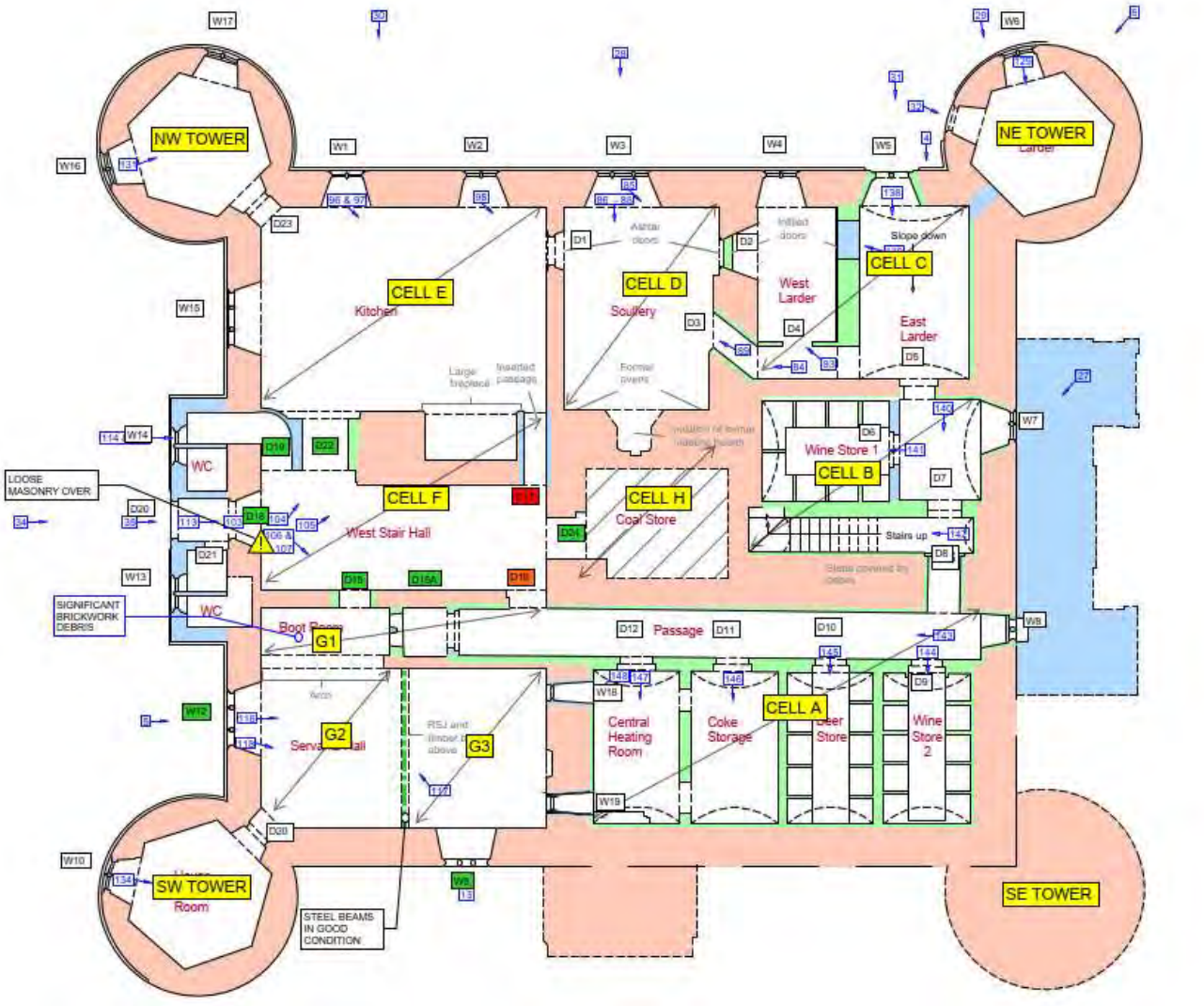
2.4. Referencing

2.4.1. To help locate areas or defects of concern the following referencing system has been used which is based on the cell references outlined in the Cotswold Archaeology's Historic Building Record report and the associated drawings. At each building level, window and door openings have been referenced separately to aid commentary on general or specific items (form and condition) across the castle.



Extract from Mann Williams Vaults / Ground Floor Plan drawing

2.5. Summary record drawings

2.5.1. Refer to Appendix for summary drawings (castle floor plans and tower elevations) recording key aspects of the castle's structural form and condition. These drawings also highlight areas of greatest structural and public safety concern.

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3.0 Structural Form

3.1. External Walls & Towers

3.1.1. The external elevations of the castle comprise approx. 600-1200mm thick, solid masonry walls of brick and coursed rubble stone construction with localised areas of dressed stone detailing at parapets and localised opening jambs.

3.1.2. The east and south elevations feature crenelated parapets which comprise well coursed rubble stone with ashlar stone quoins at edges of merlons, and stone copings. The parapets were added to the castle in the 18th century in place of the original gable walls which supported roof dormers.

3.1.3. There are remains of roof joist / beam pockets which are mostly empty however very locally contain remnants of the original 17th or later 18th Century roof timbers.

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3.1.4. The north and west parapets have mostly been lost historically leaving the masonry shelf at the wall head exposed.

3.1.5. All external elevations feature, stone framed windows with stone mullions and spandrel panels. Window jambs are of brick construction generally and locally features dressed stone quoins (above 3rd floor generally).

3.1.6. Above 3rd floor, window openings in external walls were originally formed with timber (assumed oak) lintels overlaid with stone masonry to eaves level. Below 3rd floor level, window openings are generally formed with width and full thickness brick arches.

3.1.7. External walls are finished with cement render which remains generally insitu.

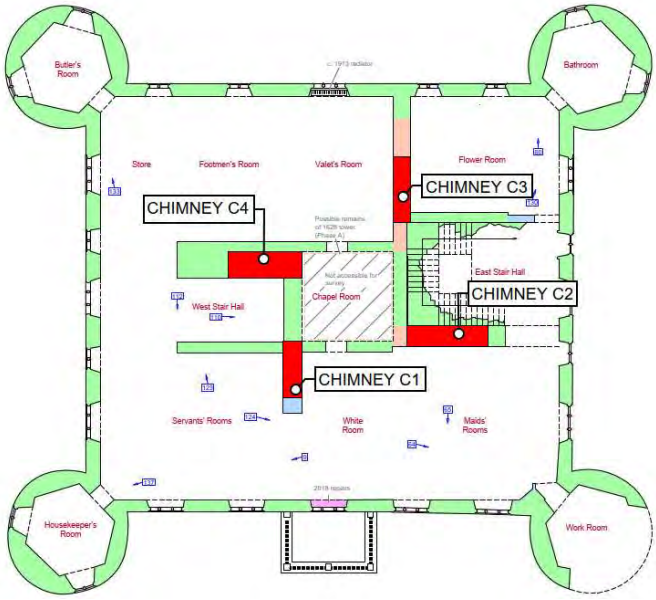
3.2. **Internal Walls**

3.2.1. Internal wall thicknesses vary between 330mm (1.5 x brick) and 1000mm. 330mm thick wall are generally solid red brick masonry. The thicker walls generally comprise external skins of brickwork and /or rubble stone facework with a bound rubble core. There are localised areas of ashlar / dressed stone present in some locations.

3.2.2. The internal walls have seen many phases of alteration during the building's history as detailed further in the Archaeologist's Historic Building Recording report.

3.3. Chimneys

3.3.1. There are 4No. brickwork chimney stacks featured within the castle. The stacks are constructed from brickwork for the majority of their height, with the upper courses constructed from ashlar stone (below the string course). The chimney cap is constructed from stone pillars which support stone capping slabs. Flue cross walls are of brick construction.



3.3.2. Chimneys C1 & C2 have 5No. flues. Chimney C1 has lost all of its stone flue capping and has been more recently reduced in height and braced with scaffolding due to concerns regarding its structural integrity.

3.3.3. Chimney C3 has 6No. flues currently with the 6th flue added more recently as suggested by the obvious construction joint on the north end of the stack where the dressed stone ends.

3.3.4. Chimney C4 has 4No. flues. The majority of the stone capping has been lost historically.

Chimney C1

Chimney C2

Chimney C3

Chimney C4

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3.4. Floors

Note: Interpretation of the suspended floor structures has been assumed based on remains of the structural elements within the building and considering buildings of a similar age and construction.

3.4.1. Suspended Floors

3.4.1.1. The floors of the original castle were of timber construction, comprising timber beams, timber flitch beams (strengthened with iron plates), and timber joists. Beams were generally built into pockets in the masonry walls and onto timber bearers.

3.4.1.2. Floor joists were likely morticed into the sides of the floor beams generally and built onto timber wall plates at room perimeters. Wall plates were generally built into the masonry walls.

3.4.1.3. In Cell A there is the remains of the iron flitch plates of an original floor beam at second floor level.

3.5. Towers

3.5.1. There are 4No. round towers, one in each corner of the castle. The towers are of similar solid masonry construction with brick flat arched openings for window on the exterior sides of the tower (2No. per floor) and vaulted arched openings for doorways internally at each level. Tower walls are topped with castellated parapets supporting stone copings.

3.5.2. Each of the towers supports a series of single chimney flues which connect into fireplaces within the tower or withing the adjacent cells of the castle with flues routed into the tower walls. For comparison, the NW tower has 6No. chimney flues, the NE tower has 4No. chimney flues and the SW tower has 5No. chimney flues.

3.5.3. The wall construction below the windows varies from tower to tower, as a result of historic alterations. For example, in the SW tower, the panel below the windows is approximately 500mm thick at all levels apart from third floor level, where has been reduced to around 200mm thick.

3.5.4. It should be noted that the southeast tower partially collapsed in 1982 whereby the south easterly half was lost.

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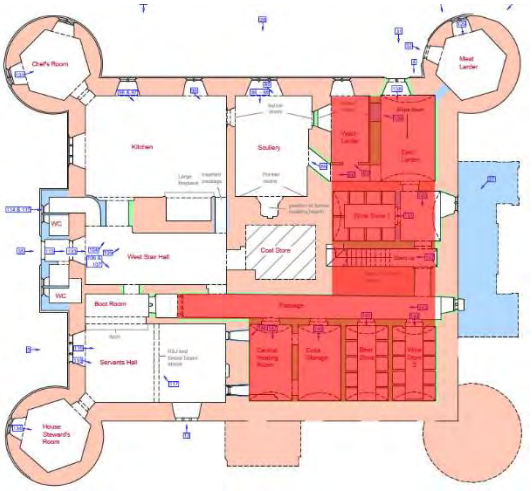
3.6. Vaults & Ground Floor

3.6.1. Vaults at Ruperra Castle comprise a series of cells comprising vaulted brick arched soffits which are built off of solid brickwork walls. The buildup of material over the vaults forming the first floor is unknown.

3.6.2. The vaulted arches generally span the short direction in each of the rooms including the passage, wine / beer stores, coke storage and central heating room.

3.6.3. There are remnants of historic plaster ceilings in most of the cells with Wine Store 1 seemingly retaining the most its original ceiling.



Wine Store 1

Coke Storage

Passage

East Larder

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4.0 Condition

4.1. This section documents the findings of the condition survey undertaken at Ruperra Castle. Due to the scale of the castle and variability in its condition we have grouped defects into the following sections:

1) Localised significant structural defects – Describes localised areas of significant structural concern which occur in one or limited locations e.g. a movement crack in a wall panel, a distorted or leaning merlon, a patch of very deteriorated masonry.
2) Chimney stacks – Provides commentary on each of the chimneys individually.
3) Towers – Provides commentary on each of the towers individually.
4) Structurally Significant General Defects – Defects of more significant concern in their current state which are widespread throughout the building and of a similar type, e.g. failing / missing lintels, patches of missing facework.
5) General Defects – Defects of lesser structural concern in their current state
6) Other specific items of significance – Provides commentary on areas of note or importance from a health and safety or historic standpoint but are not necessarily of structural concern in their current state.

4.2. To help quantify the severity and associated risks of each of the identified defect each one has been each has been assigned 4scores out of 10 for the following:

a) Likelihood of the risk impacting people accessing the monument / listed building
b) Consequence of the risk on people accessing the monument / listed building
c) Likelihood of the risk impacting the fabric of the monument / listed building
d) Consequence of the risk on the fabric of the monument / listed building

4.3. These scores have been combined to give the following:

e) Combined site visitor score = a x b / 10 (out of 10)
f) Combined monument fabric score = c x d / 10 (out of 10)

4.4. The scores have been presented in the format (4 / 5) which represent the combined risk and consequence scores out of 10 for each defect. The first number (4) describes the combined score for risk to site users, the second number (5) describes the combined score for risk to the monument and historic fabric. Defects are listed in order of combined severity.

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4.5. Localised significant structural defects

4.5.1. This section describes individual items of significant structural risk to the historic fabric in addition to being of significant risk to any who may be operating within the castle in the event of a collapse.

4.5.2. Failing arches and masonry panels on face of towers (3.6 / 2.8)

4.5.2.1. On the internal elevations of each of the towers are large pockets which are assumed to be the old pockets for valley beams for the original roof structure. For the SE, SW and NW towers, the surrounding masonry is generally poorly consolidated with several vulnerable stones and signs of movement within the masonry panels.

4.5.2.2. The arches over the doorways to the SE and SW towers at second floor level have generally lost their faces therefore leaving the significantly vulnerable panels of masonry over poorly supported and at risk of collapse. The entrance into the NE and NW towers appears to have lost lintels which replaced original facing arches leaving the facework over vulnerable and poorly supported.

Cell A – Door into SE tower

Cell G2 – Door into SW tower

Cell C – internal elevation of NE tower (Pocket intact)

Cell E - internal elevation of NW tower

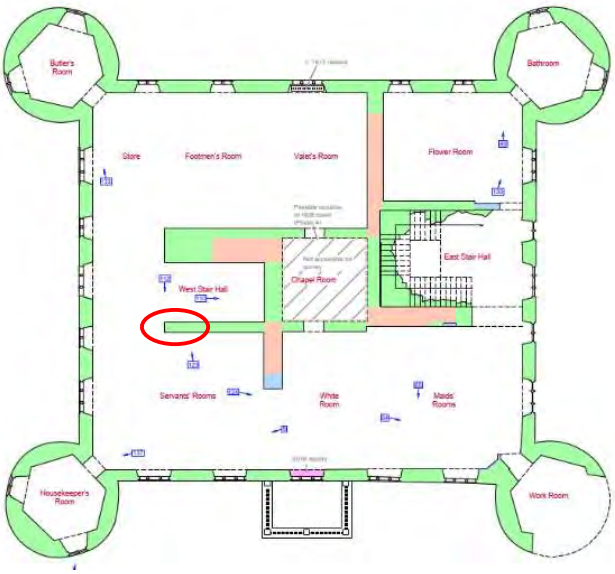
4.5.2.3. The interior of the NE tower has an example of an intact valley beam pocket with the surround masonry in better condition.

4.5.2.4. The current impact of this defect is a general reduction in the robustness of the wall heads with the potential for further loss of historic fabric. This defect is likely to accelerate with ongoing weather and vegetation attack and could result in the loss of larger panels of masonry and could compromise the integrity of the tower walls.

- Risk to site users – Potential to strike building users or operatives working within the building. Likelihood (4) / Consequence (8) / Total (3.2)
- Risk to historic fabric –Potentially significant loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure. Likelihood (4) / Consequence (7) / Total (2.8)

4.5.3. <u>Cell G/F - Overhanging masonry panel (7 / 4.9)</u>

4.5.3.1. At second floor level in Cell G (north elevation), there is a significant patch of masonry (cross hatched in blue below) which is showing varying signs of degradation and is of significant structural concern.



4.5.3.2. As denoted with red lines, there is a significant crack visible on both sides of the wall which appears to suggest that this panel of masonry is separating from the rest of the wall. There is also a hole in the wall with a small badly eroded stack of masonry to the underside of the dressed stone which appears very vulnerable and is at risk of falling out.

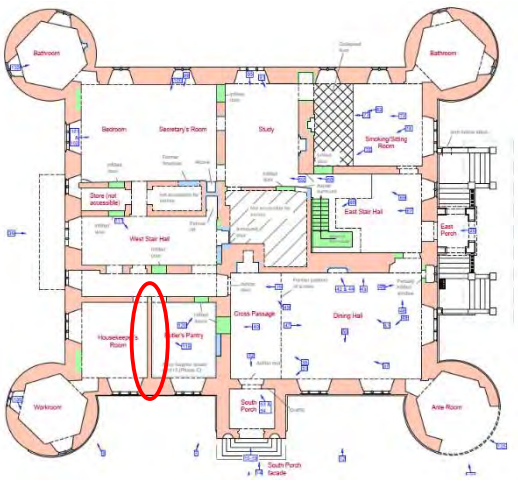
4.5.3.3. Generally, the condition of this panel is very poor and there is a very significant risk of this section collapsing which has the potential to disturb and destabilise the dressed stone wall over and potentially lead to the total collapse of the wall panel.

- Risk to site users – Potential to strike building users or operatives working within the building. Collapses likely to comprise large panels falling from a significant height therefore impacts have the potential to be fatal.
  Likelihood (7) / Consequence (10) / Total (7.0)
- Risk to historic fabric –Potentially significant loss of historic fabric due to loss of original masonry with potentially significant risk to surrounding masonry structure.
  Likelihood (7) / Consequence (7) / Total (4.9)

4.5.4. Cell G – Central cross wall beams and masonry panel (5.0 / 4.5)

4.5.4.1. The central cross wall between cells G1 & G3 is of brickwork construction and is supported on a twin pair of steel / iron beams at first floor clad both sides with timber. The masonry panel has several large voids approximately within 1m above the beam with the surviving brickwork deteriorated and locally loose. The north end of the wall is free standing, and the south end appears to be built into the south elevation of the building.

4.5.4.2. The beams have evidence of severe surface corrosion to both flanges, however, there does not appear to be any significant deformation of these beams, and the bearing appeared generally sound.



- Risk to site users – Potential for whole panel to strike building users or operatives working within the building. Likelihood (5) / Consequence (10) / Total (5.0)
- Risk to historic fabric –Potential for whole panel of masonry to fail in the event that the supporting beams fail, or further masonry is lost around the current voids.
- Likelihood (5) / Consequence (9) / Total (4.5)

4.5.5. <u>Degraded masonry and arches to rooms between cells E & F (2.7 / 4.8)</u>

4.5.5.1. The rooms between Cells E & F were generally not inspectable during the visit as access was limited to the doorways into the respective cells.

4.5.5.2. At second floor level, the vaulted arch over doorway D15 has a large patch of collapsed masonry with the remaining masonry loose and vulnerable to further collapses. The remainder of the vaults have localised loose and degraded bricks and some further loss has occurred on both faces of the arches.

4.5.5.3. Progression is likely to comprise further loss of the masonry with the potential to fail the full arch and compromise the floor over. Collapse is likely to cause significant damage to the surrounding structures and would represent a significant loss of historic fabric.

- Risk to site users – Potential to strike building users or operatives working within the building. Collapses likely to comprise large panels falling from a significant height therefore impacts have the potential to be fatal. Area is generally inaccessible therefore likelihood of injury is lessened.
  Likelihood (3) / Consequence (9) / Total (2.7)
- Risk to historic fabric –Potentially significant loss of historic fabric due to loss of original masonry with moderate risk to surrounding masonry structure.
  Likelihood (6) / Consequence (8) / Total (4.8)

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4.5.6. Degrading and deformed parapets (4.0 / 3.2)

4.5.6.1. Generally where inspected on site, remains of the original parapets are in reasonable condition with some very localised merlons / crenels showing signs of deterioration by means of lost pointing and masonry units.

4.5.6.2. The remains of the parapet to the south of the west elevation is in poorer condition with more widespread areas of lost masonry and degrading bedjoints, in addition to localised areas of vegetation. There are 2No. significant defects which have been identified which are described further below.

4.5.6.3. At third floor / roof level on the east elevation, the Merlon over window W9 has lost a large area of stonework on the external side and is currently leaning into the building. It is unclear whether movement of the merlon is ongoing however further loss of fabric has the potential to destabilise the merlon with the risk of it falling into the building.

Cell B – East elevation merlon over W9

4.5.6.4. At third floor / roof level the merlon over W5 on the north elevation is currently leaning significantly into the building. The bottom courses of the masonry have lost localised stones with remaining stonework being poorly bonded. It is unclear whether movement of the merlon is ongoing however further loss of fabric has the potential to destabilise the merlon with the risk of it falling into the building.

For both of the above items:

- Risk to site users – Potential collapse of the merlons, with risk of large panels of masonry falling from height with the chance to cause fatal injury,
  Likelihood (4) / Consequence (9) / Total (3.6)
- Risk to historic fabric –Potentially significant loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
- Likelihood (4) / Consequence (4) / Total (1.6)

Cell C – North elevation merlon over W5

4.5.7. Cell C – west wall of vaulted slab

4.5.7.1. The masonry wall between the east and west larder in the vaults, has lost a significant amount of its facework on the west larder side. Approximately 50% of the face area is missing with voids of approximately 200mm in depth. The arch springing terminates just above the existing tile level therefore the deteriorated wall is resisting the thrust reactions from the vault. The loss of masonry is significantly reducing the capacity of the structure to resist these thrusts.

4.5.7.2. In the short term,

- Risk to site users – Potential for localised collapses of brickwork from a short height with a minor risk to building users in the shorter term.
  Likelihood (4) / Consequence (3) / Total (1.2)
- Risk to historic fabric – Likely limited in the short term to further loss of brickwork and a reduced integrity to the surviving masonry.
  Likelihood (4) / Consequence (3) / Total (1.2)

4.5.7.3. Without any intervention or installation of propping, the longer-term risks are as follows:

- Risk to site users – Failure of the west wall which could result in failure of the vault putting any users of the vaults at significant risk of harm.
  Likelihood (4) / Consequence (10) / Total (4.0)
- Risk to historic fabric – Significant loss of historic fabric if the vault and wall fail, this would also likely block the current principal access into the vaults.
  Likelihood (4) / Consequence (9) / Total (3.6)

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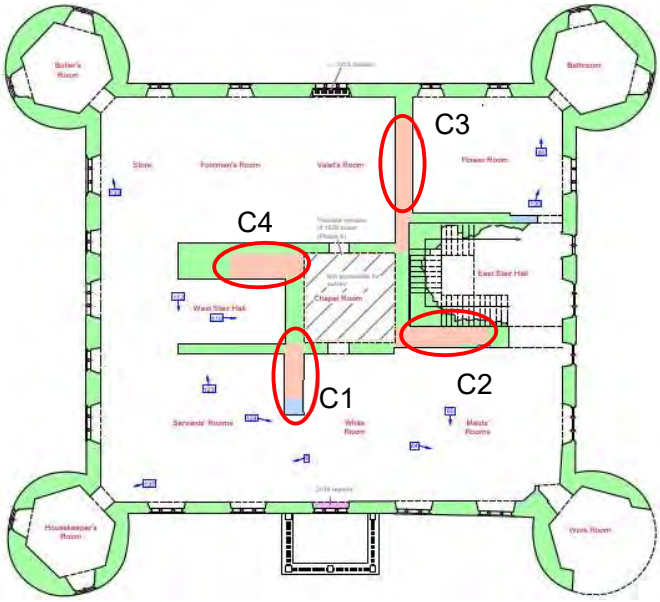
4.6. Chimneys

4.6.1. This section will describe the condition of the 4No. remaining chimneys located around the castle.

4.6.2. In summary the chimneys are in poor condition with the most significant defects found on chimneys C1, C3 and C4. A scheme of temporary protection works has been undertaken on C1 more recently therefore the chimneys of most concern are C3 and C4.



4.6.3. <u>Chimney C1 (2.4 / 1.0)</u>

4.6.3.1. The upper stack of chimney C1 is in very poor condition with significant structural defects putting the historic fabric at risk of collapse. There are several localised patches of masonry missing on the elevations and a significant full height crack on the east elevation of the stack which prompted a more recent phase of temporary stabilisation works. The temporary works comprised wrapping the stack in scaffolding to mitigate movement and potential collapse which would represent a significant loss of historic fabric and significant risk to building users.



- Risk to site users – In its propped state, risk to site users is likely limited to localised loss of masonry from the remaining fabric which falls through the netting falling and striking building users.
  Likelihood (2) / Consequence (8) / Total (1.6)
- Risk to historic fabric – In its propped state the risk to the retained fabric is minimal providing the integrity of the scaffolding remains intact.
  Likelihood (2) / Consequence (5) / Total (1.0)

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4.6.4. Chimney C2 (0.9 / 0.9)

4.6.4.1. Compared to the other chimney stacks, chimney C2 is in reasonable condition with very localised patches of masonry in poor condition. Where in poor condition the masonry is generally missing pointing with localised open joints between masonry units. Chimney caps are generally intact and in reasonable condition.

- Risk to site users – Potential degradation of the existing fabric which may degrade the integrity of the current stack promoting loss of pointing / delaminating of masonry at height which could strike building users.
  Likelihood (2) / Consequence (3) / Total (0.6)
- Risk to historic fabric – Likely limited to loss of historic pointing and delaminating of historic masonry.
  Likelihood (2) / Consequence (3) / Total (0.6)

4.6.5. Chimney C3 (4.2 / 3.0)

4.6.5.1. The stack of chimney 3 is in poor condition with some localised areas in very poor condition. On the east elevation there are large patches of brickwork missing exposing the flues, with remaining masonry in a significantly deteriorated state. The upper stack has a crack on the south end of the chimney which suggests movement within the masonry. The stonework is generally missing pointing. The stone capping to the chimney appears to be generally in reasonable condition.

4.6.5.2. Inspection within the holes into the flues on the east elevation of the stack identified that the masonry cross walls appear to be in reasonable condition generally.

- Risk to site users – Continued degradation of the facework particularly about the significant voids is likely to loosen localised patches of brickwork with the potential of striking building users.
  Likelihood (6) / Consequence (7) / Total (4.2)
- Risk to historic fabric – Continued loss of historic brickwork about the exposed flues which reduces the overall robustness of the masonry panel with the potential to cause further localised collapses.
  Likelihood (6) / Consequence (5) / Total (3.0)

4.6.6. <u>Chimney C4 (7.0 / 5.6)</u>

4.6.6.1. Chimney 4 is in very poor condition with defects of significant structural concern or of concern when considering safety to building users. Capping slabs are generally shattered and surrounded by significant amounts of loose debris. There are several cracks in the facework on all elevations with various areas of severely degraded / cracked masonry up the full height of the stack.

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- Risk to site users – Continued degradation of the brickwork particularly about the areas of significant loss on the north end of the stack which is likely to loosen localised patches of brickwork with the potential of striking building users. There is also a risk of the very loose capping slabs falling from height and inflicting the same. Likelihood (7) / Consequence (10) / Total (7.0)
- Risk to historic fabric – Continued loss of historic brickwork which reduces the overall robustness of chimney stack with the potential to cause further localised collapses. Potential for large corbelling section of chimney stack to break off and fall to ground which could cause significant damage to structures below. Likelihood (7) / Consequence (8) / Total (5.6)

4.7. **Towers**

4.7.1. This section provides commentary on the general condition of each of the towers and describes the most common and significant defects of concern. As required specific defects which are of significance are described further below.

4.7.2. To help summarise the condition of the towers, Mann Williams have produced a series of marked up drawings which utilise the orthographic elevations produced by Cotswold Archaeology therefore this section should be read in conjunction with drawings 10247_SK06 to 10247_SK08 in Appendix.

4.7.3. <u>General</u>

4.7.3.1. The remains of the walls of the towers are generally in poor condition with some localised areas in very poor condition and of significant structural concern. Where in poor condition typical defects comprise degraded and eroded brickwork, which is locally loose or missing, and degraded pointing.

4.7.3.2. Generally, all towers have very degraded wall heads and significant vegetation growth the risks of which have been described further in the 'General Defects' section of this report.

4.7.3.3. The most significant defect observed which is common to all of the remaining towers is the series of vertical cracks between windows on the external face of the towers which are similar to those that we suspect may have contributed to the collapse of the SE tower. Masonry spandrel panels (between the head of one window opening and the cill of the one above) have also been significantly altered in many locations. Where they have been reduced in thickness, cracking is notably worse with daylight visible through some panels.

4.7.3.4. Structural openings are formed with generally brick arches over them, which vary in their condition. Some are in reasonable condition with minor defects (e.g. missing individual bricks, some open joints) and some in poor condition with larger sections of masonry lost or cracking. In the NW tower there are 2No. arches which are in very poor condition and of significant which will be described further below.

4.7.4. <u>Cracking on external elevations of towers</u>

4.7.4.1. Location / Reference - This defect applies to all of the towers which remain generally intact i.e. NE, NE and SW towers.

4.7.4.2. On the elevations of all of the towers, there are vertical cracks between windows which indicates movement within the masonry panels. Crack widths vary generally with some the most significant being up to 40mm wide (estimated). There are locations where the cracks have been observed on the internal elevations and have propagated through window surrounds indicating a significant weakness in the masonry.

4.7.4.3. It is unclear whether the cracks are continuing to open however propagation is likely to comprise continued degradation of the masonry and increased deterioration as a result of water ingress and potential for deep vegetation growth within the cracks.

NE Tower (west facing windows)

NW Tower (east facing window)

SW tower (west facing windows)

4.7.4.4. Cracks appear to be more significant where the spandrel panels between windows have been historically narrowed, reducing the panel thickness from approx. 400-500mm to a single stone skin (150-200mm) with limited structural capacity. Daylight is visible through the crack in the spandrel panels in the SW tower where closer inspection was possible from the man basket. Some of the cracks (in particular on the NW Tower) are showing signs of out of plane movement in addition to lateral movement.

SW tower (2nd floor window)

NE Tower (3rd Floor window)

SE Tower (2nd Floor window)

4.7.4.5. The SW tower has had fewer alterations to the spandrels and as such appears to have less significant cracking than the other towers where alterations were more widespread. These cracks are of major concern as the SE tower partially collapsed with the failure plane passing through the same spandrel panels therefore suggesting there is a risk of similar collapses occurring if left unaddressed.

4.7.5. NW Tower

4.7.5.1. Location / Reference – Arch over opening W25

4.7.5.2. The central section of the arch (approximately 0.4m wide) has displaced significantly with the wedge significantly vulnerable and at risk of falling out which has the potential to cause further unpredictable collapses. The outside edge of the wedge has dropped by approximately 150mm whereas the inside edge has dropped by approximately 20mm.

4.7.5.3. This defect is of significant structural concern, particularly considering the degree of alterations that have occurred to the spandrel panels above and below which further reduce the robustness of this panel of masonry, and limit alternative load paths in the event that the arch collapses.

- Risk to site users – Potential for wedge of masonry and surrounding masonry to fall onto site users with potential to cause fatal injury.
  Likelihood (5) / Consequence (10) / Total (5.0)
- Risk to historic fabric – In the event that no other suitable load path is found by the surrounding masonry, the risk to the historic fabric is significant and there is a risk of significant collapse of the masonry on this elevation.
  Likelihood (5) / Consequence (10) / Total (5.0)

4.7.5.4. The cracks on the west elevation of the NW tower are the most significant of all of the cracking observed on site. The cracks through the spandrel panels are generally 40mm wide from the top of the parapet to second floor level. The wall to the south of the crack is out of plane by approximately 25mm (outwards) at third floor and reduces to approximately 5mm at first floor level. This implies that the masonry panel has moved in both directions.

4.7.6. SE Tower

4.7.6.1. The south-east tower has lost the full height of wall along its southern half. The elevation has failed at the location of the original windows which is considered a natural weak point in the masonry, particularly considering the likely historic narrowing of the spandrel panels to suit changes of use.

4.7.6.2. On the northwest of the tower, there is a full height vertical crack present up the masonry panels between doorways linking the tower to the rest of the castle. This has occurred over the first, second and third floor doorways as shown in the photographs. The crack appears to be approximately 20-30mm wide at its widest and there is evidence of localised masonry loss. It is anticipated that the crack is a cumulative result of the failed lintels / brick arches forming each of the openings.

Above D9 at first floor

4.7.6.3. It is likely that these panels will continue to deteriorate with the potential for significant collapse to the masonry spandrel panels between the openings.

Above D8 at Second Floor

Above D6 at Third Floor Level

- Risk to site users – Localised or small panels of masonry falling onto building users in the event that the spandrel panels fail due to lack of support. Potential to strike building users.
  Likelihood (5) / Consequence (8) / Total (4.0)
- Risk to historic fabric – Potential loss of significant panels of historic masonry which has the potential to impact the surrounding structure and accelerate degradation of the walls either side of the openings. There is a risk that the full slot of masonry could collapse resulting in a significant loss of historic fabric.
  Likelihood (5) / Consequence (7) / Total (3.5)

4.8. **Structurally Significant General Defects**

4.8.1. This section describes the items of significance which appear generally around the castle and are of significant risk to the building fabric or building users operating within the castle.

4.8.2. Loose and vulnerable masonry on wall heads generally (4.5 / 1.0)

4.8.2.1. Location / Reference – This defect applies to all wall heads across the building.

4.8.2.2. Wall heads of the external and internal masonry walls around the castle are fully exposed as the roof structure has historically been lost. As such the upper courses of brickwork / stonework are generally in poor to very poor condition, with several loose areas vulnerable to further weather attack and degradation by ongoing vegetation growth.

4.8.2.3. In some localised areas, bricks / stones are very loose and on the edge of the wall head and at significant risk of falling to ground.

Cell D (head of east wall)

4.8.2.4. The current impact of this defect is a general reduction in the robustness of the wall heads with the potential for further loss of historic fabric. This defect is likely to accelerate with ongoing weather and vegetation attack.

- Risk to site users – Potential to strike building users or operatives working within the building.
  Likelihood (5) / Consequence (9) / Total (4.5)
- Risk to historic fabric – Minor loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
  Likelihood (5) / Consequence (2) / Total (1.0)

4.8.3. Large slots and voids in masonry walls at floor levels (6.0 / 4.8)

4.8.3.1. Location / Reference – This defect applies in most cells of the castle and at each floor level including each of the towers. The most significant areas of slots and voids in the masonry occur in Cells C, D and E.

4.8.3.2. Where inspected, the remaining masonry about the slots were found to be in poor to very poor condition generally with the remaining brickwork poorly bonded or loose and the core work fully exposed to further degradation, in particular where loss has formed a shelf for water to collect. Slots are typically between 300 & 500mm high and approximately 200-400mm deep into the wall thickness, resulting in the masonry over being poorly supported longer term.

Cell C (North Wall)

Cell D (West Wall)

Cell E (North Wall)

4.8.3.3. Generally, the masonry above the slots appears to be corbelling and sound in its current state, however further degradation and loss of masonry units has the potential to cause localised collapses and loss of historic fabric. The shelves formed by the loss of brickwork are generally loose and vulnerable. As demonstrated in very localised locations (summarised in later sections), continued degradation of the slots has the potential to form holes in the full thickness of the internal walls, which could lead to significant structural collapses if enough of the masonry is lost.

4.8.3.4. In some locations (e.g. east wall of cell E), slots are present on both sides of the wall at first and second floor levels, leaving slender sections of masonry to support the self-weight of the walls. Failure of the masonry at these weak points has the potential to cause collapse of the full height of the wall which would represent a significant loss of historic fabric and a significant and likely fatal risk to building users.

4.8.3.5. The current impact of this defect is a general reduction in the integrity of the masonry walls with the potential for significant further loss of historic fabric. This defect is likely to accelerate with ongoing weather, vegetation attack and loss of further masonry.

- Risk to site users – Potential to strike building users or operatives working within the building.
  Likelihood (3) / Consequence (7) / Total (2.1)
- Risk to historic fabric – Minor loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
  Likelihood (3) / Consequence (7) / Total (2.1)

4.8.4. <u>Degrading masonry and lintels at door openings (4.5 / 3.5)</u>

4.8.4.1. Generally, where inspected lintels and door openings were in reasonable condition with some localised areas in poor condition where jambs or heads shows signs of deteriorating masonry. These openings have been highlighted in GREEN on the appended condition summary sketches.

4.8.4.2. Progression is likely limited to long term degradation by means of vegetation or weather attack which has the potential to cause deterioration to the masonry.

4.8.4.3. AMBER defects where doorways are in poor condition are located in the following areas - First Floor (D1, D3, D4, D7, D16, D17), Second Floor (D1, D4A, D4, D5, D6, D7, D8, D9, D10, D12, D14, D15A, D16, D16A), Third Floor (D1, D3, D5).

4.8.4.4. Missing lintels leaving remaining masonry poorly supported and vulnerable to further localised deterioration which has the potential to accelerate fabric loss. Where lintels are missing the masonry panels over appear to have generally collapsed and are currently corbelling (somewhat stable) in their current state.

Cell D West Wall

4.8.4.5. Progressive degradation has the potential to dislodge localised stones and core work with the risk or causing localised areas to breakout and fall from height.

- Risk to site users – Potential to strike building users or operatives working within the building.
  Likelihood (4) / Consequence (5) / Total (2.0)
- Risk to historic fabric – Minor loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
  Likelihood (4) / Consequence (2) / Total (0.8)

4.8.4.6. Degraded or poorly constructed brickwork jambs separating from older masonry and at risk of localised collapse of whole sections of masonry.

- Risk to site users – Potential to strike building users or operatives working within the building.
  Likelihood (4) / Consequence (5) / Total (2.0)
- Risk to historic fabric – Minor loss of historic fabric if newer panels fall onto historic masonry and cause damage. Likelihood (4) / Consequence (2) / Total (0.8)

Cell A – Opening D9

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4.8.4.7. The most significant (RED) defects where lintels have failed or where masonry is of significant structural concern are the following – First floor (D6, D8, D19), Second Floor (D2, D3, D14B, D15), Third floor (D2, D6).

4.8.4.8. Failing timber lintels resulting in cracking to panels of masonry over which are vulnerable to further deterioration. Loss of the lintels has the potential to result in the collapse of the panel of masonry over the lintels which could pose a significant risk to building users, and a moderate risk to the building fabric.

4.8.4.9. Where lintels have failed, this is a risk of localised collapse of the masonry which would represent a moderate loss of historic fabric and a potentially significant risk to building users in the event of a collapse.

- Risk to site users – Potential for lintels and panels of masonry falling onto building users. Likelihood (5) / Consequence (9) / Total (4.5)
- Risk to historic fabric – Moderate loss of historic fabric if lintels fail with the potential for localised collapses. Likelihood (5) / Consequence (7) / Total (3.5)

First Floor Opening D6

First Floor Opening D19

4.8.5. <u>Degrading masonry and lintels at third floor window openings (4.5 / 1.0)</u>

4.8.5.1. Location / Reference – All windows at 3rd Floor except for W16 and W13. The most significant defects of concern occur at windows W12, W17, W8.

4.8.5.2. Generally, all lintels have been lost from the head of the windows on all elevations at third floor level, and the masonry panel which would have sat on lintels have been lost. The remaining masonry on the shelves formed by the historic collapses is loose and vulnerable.

4.8.5.3. At opening W12, the existing iron lintels are significantly corroded and is at risk of failing and causing the panel of masonry over to collapse similar to what has occurred elsewhere.

Opening W12

4.8.5.4. At W17 and W8, the lintels have already failed and are loose in their current locations therefore at risk of falling to ground.

Opening W17

Opening W8

4.8.5.5. The current impact of this defect is a general reduction in the robustness of the wall heads with the potential for further loss of historic fabric. This defect is likely to accelerate with ongoing weather and vegetation attack.

- Risk to site users – Potential to strike building users or operatives working within the building.
  Likelihood (5) / Consequence (9) / Total (4.5)
- Risk to historic fabric – Minor loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
  Likelihood (5) / Consequence (2) / Total (1.0)

4.8.6. <u>Straight joints in masonry walls and at interfaces with external walls (5.4 / 4.2)</u>

4.8.6.1. Location / Reference – Generally, applies to all areas of new masonry where original openings have been infilled, and at the end of most of the major cross walls at junction with the external elevations. The most significant joints observed were between the east and west walls of Cell D (connection to the north elevation), the walls forming the rooms between Cell E & F (connection to west elevation).

4.8.6.2. There are significant straight joints between the cross walls and the external elevations which appear to suggest the walls are not sufficiently tied in or buttressing the external elevations.

4.8.6.3. Water ingress and vegetation growth within these joints has the potential to cause further localised loss of masonry with the potential for further loss of historic fabric.

- Risk to site users – Potential for whole panels of masonry to collapse due to lack of suitable support at the ends particularly when combined with other significant defects.
  Likelihood (6) / Consequence (9) / Total (5.4)
- Risk to historic fabric – Minor loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
  Likelihood (6) / Consequence (7) / Total (4.2)

4.8.6.4. This defect is explored further in the discussions to describe our interpretation of the global impact of the lack of tie between the cross walls and the external walls.

Cell E – Connection to west elevation

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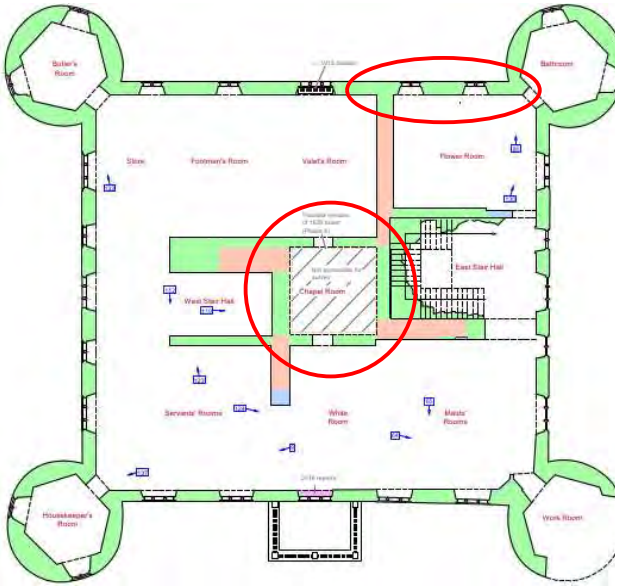
4.9. General Defects

4.9.1. This section describes the most significant common defects observed across the building.

4.9.2. Vegetation growth on wall heads and elevations (2.4 / 2.0)

4.9.2.1. Location / Reference – This defect applies to all wall heads across the building. The south wall of Cell E has a large panel of ivy growth covering the east of the elevation. Significant tree growth on the north wall of Cell C. Large tree growth in Cell H making it inaccessible and not inspectable. Ivy and tree growths to heads of all towers apart from the SE Tower.



4.9.2.2. Vegetation is causing degradation of the masonry fabric in serval areas around the building. Where present, Ivy and other plant species including buddleia have rooted between and behind masonry units degrading the joints and thereby loosening localised or clusters of bricks / stonework.

4.9.2.3. At ground level, there is significant vegetation coverage limiting general accessibility through the cells and minimising space for any future access or construction works.

Cell A - South Elevation

Cell H - 3rd Floor Level

NW Tower – Top of tower

Cell A - Ground Floor Level

4.9.2.4. The current impact of this defect is a general reduction in the robustness of the masonry (in particular wall heads) with the potential for further loss of historic fabric. Vegetation is likely to continue without intervention which is likely to accelerate degradation and loss of historic masonry.

- Risk to site users – Potential to dislodge localised bricks / clusters of masonry which could fall onto building users or operatives working within the building.
  Likelihood (3) / Consequence (8) / Total (2.4)
- Risk to historic fabric – Potentially significant loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
  Likelihood (5) / Consequence (4) / Total (2.0)

4.9.3. <u>Deterioration to brick arches at window openings (0.8 / 1.4)</u>

4.9.3.1. Location / Reference – Defect applies to most of the arched openings at ground, first and second floor levels on external walls in all cells.

4.9.3.2. Generally, brick arches over window openings are in reasonable condition and very locally in poor condition. Where in poor condition the arches are missing very localised bricks, have degraded / weathered bed joints between brick courses however appear to be performing adequately in their slightly deteriorated state.

4.9.3.3. The current impact of this defect is a general reduction in the robustness of the brick arches with the potential for further loss of historic fabric.

- Risk to site users – Potential to dislodge localised bricks / clusters of masonry which could fall onto building users or operatives working within the building.
  Likelihood (1) / Consequence (8) / Total (0.8)
- Risk to historic fabric – Potentially significant loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
  Likelihood (2) / Consequence (7) / Total (1.4)

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4.9.4. Deterioration of stone windows (1.4 / 1.5)

Note: Stone windows are a non-structural item therefore will require a detailed inspection and review by a specialist conservation architect however has been raised as a general defect across the castle.

4.9.4.1. Location / Reference – Generally for all windows

4.9.4.2. Window mullions are showing varying signs of degradation and erosion. Generally, mullions of the majority of the windows are significantly eroded with varying levels of section loss putting the remainder of the window surrounds at risk of failing resulting in a loss of historic fabric.

4.9.4.3. The current impact of this defect is a general reduction in the robustness of the brick arches with the potential for further loss of historic fabric.

- Risk to site users – Continued deterioration of the mullions and spandrel panels puts the windows at risk of losing large sections of historic fabric which have the potential to fall onto persons using the building.
  Likelihood (2) / Consequence (7) / Total (1.4)
- Risk to historic fabric – Potential loss of window mullions and spandrel panels if degradation continues. However, there are several windows of this type across the building therefore is likely a minor impact on overall historic fabric.
  Likelihood (5) / Consequence (3) / Total (1.5)

4.9.5. Loose and defective historic plaster at height (1.5 / 0.9)

Note: deteriorating plaster work is a non-structural item therefore will require a detailed inspection by a specialist conservation officer, however, has been raised a potential risk to building users.

4.9.5.1. Location / Reference – Generally in small, localised areas in all cells with the most significantly loose areas being observed in cells B, D and E.

4.9.5.2. Remaining lath and plaster finishes across the castle (where inspected) are in variable condition. In cells E&F the plasterwork where present was noticeably in reasonable condition considering the exposed environment. Where in poor condition the plaster is loose and at risk of falling from height in small to large pieces. At one location, as shown in the photograph, the historic plaster on the underside of opening W9 at second floor in cell B has separated from the arch and appears very loose.

4.9.5.3. The current risk is a loss of potentially significant historic plasterwork and potential risk to building users as a result of falling debris.

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- Risk to site users – Continued deterioration of the plaster at risk of causing large sections of historic fabric to fall with the potential to fall onto persons using the building.
  Likelihood (3) / Consequence (5) / Total (1.5)
- Risk to historic fabric – Loss of historic plasterwork through continued degradation however is likely a minor impact on overall historic fabric.
  Likelihood (3) / Consequence (3) / Total (0.9)

4.10. **Other specific items of significance**

4.10.1. Cell A - Surviving flitch plates of floor beam (1.8 / 4.0)

4.10.1.1. The surviving flitch plates of the original floor beam are heavily deformed (due to historic fire damage) and showing evidence of corrosion generally due to the exposed environment. The iron plates appear stable in their current state and are of historic significance.

4.10.1.2. Progression is likely to comprise continued corrosion and delamination to the ironwork with the potential to lose small sections in the future. Excessive deterioration has the potential to dislodge the beams and may present a risk to building users and a significant loss of historic interpretation.

- Risk to site users – If the flitch plates were to fall to ground there would be a moderate risk of injury to site users.
  Likelihood (3) / Consequence (6) / Total (1.8)
- Risk to historic fabric – Continued degradation of the plates and potential loss of these flitch plates from their current location would represent a significant loss in historic fabric as the only surviving beam in its original position.
  Likelihood (5) / Consequence (8) / Total (4.0)

4.10.2. Cell B – Original stone staircase (1.8 / 0.9)

4.10.2.1. The remains of the cantilever stone staircase in Cell B generally appear to be in stable in its current state with some very localised areas of cracking observed to individual treads observed.

4.10.2.2. The majority of the staircase has been lost historically presumably as a result of excessive weathering.

4.10.2.3. Landings at floor levels were briefly inspected and were found to be locally fractured and friable therefore there is a risk of pieces of masonry falling from height and onto building users.

4.10.2.4. Progression is likely to comprise continued weathering of the stone treads with the potential for further loss of sections of the treads where already cracked.

- Risk to site users – Potential to strike building users or operatives working within the building.
  Likelihood (3) / Consequence (6) / Total (1.8)
- Risk to historic fabric – Minor loss of historic fabric due to loss of original masonry with minor risk to surrounding masonry structure.
  Likelihood (3) / Consequence (3) / Total (0.9)

4.10.3. Vaults / Ground Floor (0.4 / 0.4)

4.10.3.1. Generally, the vaulted brick arches in the vaults are in reasonable condition with no significant structural defects observed other than the deteriorating wall in Cell C noted previously. The brickwork is generally sound, with pointing in reasonable condition. There was some localised evidence of water ingress onto the basement floor which is assumed to be a result of the heavily vegetated buildup over.

- Risk to site users – Minimal and likely reduced to materials (pointing) dislodging if deterioration worsens in the vaults.
  Likelihood (2) / Consequence (2) / Total (0.4)
- Risk to historic fabric – Potential for vandalism in the vaults due to a lack of secure access
  Likelihood (4) / Consequence (1) / Total (0.4)

4.10.4. Asbestos pipe lagging in the vaults (4.8 / NA)

4.10.4.1. The remaining pipe lagging in the vaults is anticipated to contain asbestos which if disturbed has the potential to cause a significant health hazard to building users.

- Risk to site users – Potential hazard to building users / site operatives if disturbed during any works.
  Likelihood (6) / Consequence (8) / Total (4.8)
- Risk to historic fabric – No risk anticipated

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4.11. Overview

4.11.1. An overview of the defects and the associated risk scores is provided below. Each defect has been listed below and ordered with respect to their average risk scores. :

Clause Ref:	Description	H&S Risk Score	Risk to Monument Score	Average Risk Score
	Localised significant structural defects			
4.6.6	Chimney C4	7.0	5.6	6.3
4.5.3	Cell G/F - Overhanging masonry panel	7.0	4.9	5.95
4.7.5	NW Tower – Central section of arch dropped and at risk	5.0	5.0	5.0
4.5.4	Cell G – Central cross wall beams and masonry panel	5.0	4.5	4.75
4.5.7	Cell C – west wall of vaulted slab	4.0	3.6	3.8
4.5.5	Degraded masonry and arches to rooms between cells E & F	2.7	4.8	3.75
4.7.6	SE Tower – Full height crack in NW elevation.	4	3.5	3.75
4.5.6	Degrading and deformed parapets	4.0	3.2	3.6
4.6.5	Chimney C3	4.2	3.0	3.6
4.5.2	Failing arches and masonry panels on face of towers	3.6	2.8	3.2
4.6.3	Chimney C1	2.4	1.0	1.7
4.6.4	Chimney C2	0.9	0.9	0.9
	Structurally Significant General Defects			
4.8.3	Large slots and voids in masonry walls at floor levels	6.0	4.8	5.4
4.8.6	Straight joints in masonry walls and at interfaces with external walls	5.4	4.2	4.8
4.8.4	Degrading masonry and lintels at door openings	4.5	3.5	4.0
4.8.2	Loose and vulnerable masonry on wall heads generally	4.5	1.0	2.75
4.8.5	Degrading masonry and lintels at third floor window openings	4.5	1.0	2.75
	General Defects			
4.9.2	Vegetation growth on wall heads and elevations	2.4	2.0	2.2
4.9.4	Deterioration of stone windows	1.4	1.5	1.45
4.9.5	Loose and defective historic plaster at height	1.5	0.9	1.2
4.9.3	Deterioration to brick arches at window openings	0.8	1.4	1.1
	Other specific items of significance			
4.10.1	Cell A - Surviving flitch plates of floor beam	1.8	4.0	2.9
4.10.4	Asbestos pipe lagging in the vaults	4.8	NA	2.4
4.10.2	Cell B – Original stone staircase	1.8	0.9	1.35
4.10.3	Vaults / Ground Floor	0.4	0.4	0.4

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5.0 Discussions

5.1. **General commentary on the building in its current state**

5.1.1. While the plan form of the castle – a square structure with corner turrets and substantial cross walls – appears inherently robust, there are several significant and widespread defects which have deteriorated its overall form and condition which in combination have resulted in the castle's poor state of repair. The following sections explore each of the significant items / defects which have impacted the remaining structure either in isolation or in combination with other defects.

5.2. **Historic alterations**

5.2.1. As demonstrated further in the Archaeological Building report, Ruperra Castle has seen several phases of alteration over the years through the removal, infilling and addition of structural openings and wall elements to suit the changes of use for the rooms within the building. Generally, where new wall elements or infills to openings have been added these appear to be generally poorly built or tied into the original masonry walls and as such are showing signs of deterioration and delamination from the original building fabric.

5.2.2. The castle has also been without a roof since the fire in 1941 leaving the building fabric exposed to weather attack and vegetation growth which is the predominant cause of defects across the castle.

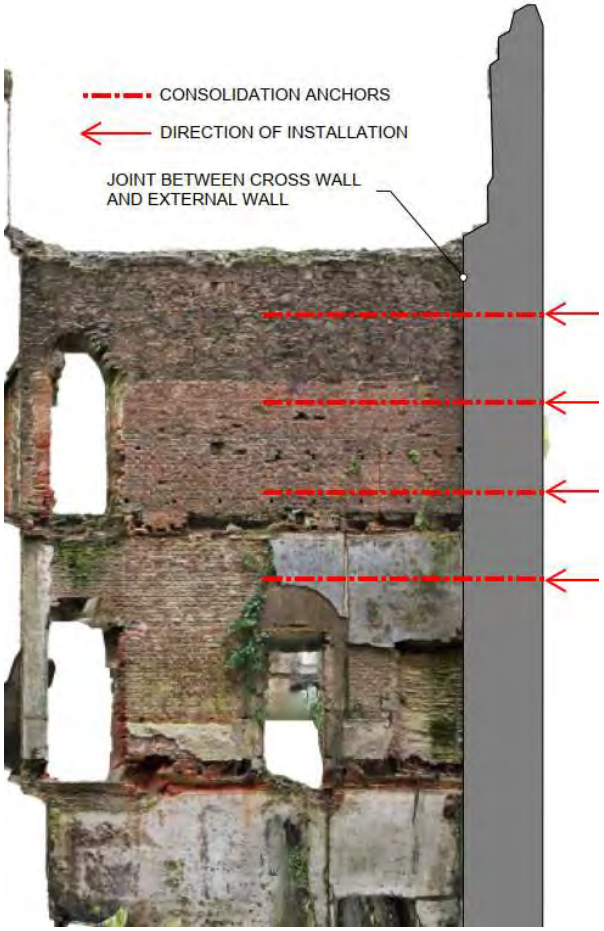
5.2.3. One of the most significant alterations is the reduction in thickness of the spandrel panels within the towers which is discussed further below.

5.3. **Tie between cross walls and external walls**

5.3.1. As outlined previously, the existing cross walls generally appear to butt up against the external walls with limited to no evidence of being built in or tied to the external elevations. This could suggest that the cross walls are not, and perhaps were not, intended to buttress the external elevations of the building potential as they were considered sufficiently robust due to their significant thickness and self-weight (approx. 1.2m). By inspection, the external walls appear sufficiently robust withstand lateral wind loading without the cross walls.

5.3.2. Globally the main concern is the stability of the cross walls under lateral loading, in particular where the walls are already significantly degraded and reduced in thickness as a result of significant masonry loss at floor levels. Since the floors and roof structures have been lost historically, the wall panels (mainly full height) are generally supported on two sides (along the bottom and on one side to internal walls) which dramatically reduces the stability and capacity of the masonry walls irrespective of their current condition.

5.3.3. One option which could be considered to improve the stability of some of the cross walls would be to tie them into the external walls by installing a series of consolidation anchors (cintec or similar) at regular centres which are designed to resist the lateral loads applied to the wall panels.



5.3.4. The anchors will enhance the capacity of the wall and its ability to resist lateral wind loading, and help mitigate the risks of whole wall panels falling into building which would be a considerable health and safety risk and a significant risk to the monument. They should also reduce requirements for temporary works to restrain the internal elevations during the works and permit the use of a more traditional access scaffold to undertake repair works to the joints and to the wall panels generally.

5.3.5. Anchors can be installed generally from outside the building which would be favourable from a general health and safety and risk to operatives' perspective.

5.3.6. The adjacent sketch shows an initial proposal for the west wall of Cell D with anchors installed from outside to inside.

5.3.7. This consolidation method is feasible where walls are of sufficient thickness (>400mm). However, there are areas (e.g. walls between Cell G2 & G3 and between Cell G1 & G3) where the existing masonry is 200-300mm thick which would not be suitable for this type of repair.

5.4. **Interpretation of impacts of significant slots in the masonry panels**

5.4.1. One of the most significant, and site wide defects around the castle is the large slots and voids in the masonry walls at floor levels. As the floor structures progressively collapsed due to the fire damage and continued weathering, the originally embedded floor beams and wall plates are assumed to have pulled the surrounding areas of masonry out, leaving the core work and remaining masonry vulnerable to weather and vegetation attack. The loss of brickwork represents a significant reduction in the robustness of the masonry panels in particular where the slots have occurred at all levels. One example is the cross wall between Cells E & D the masonry has approximately 250mm depth of masonry missing on both sides, which is 500mm of the original 800mm thick (over 60%) that has been lost with some localised holes though the full thickness of the wall at assumed beam pocket.

5.4.2. Considering loading on the walls in their current states, it could be the case that there is sufficient masonry remaining to support the vertical self-weight of the walls, however the lateral load (wind, impact) capacity of the stacks is dramatically reduced as a result of the weaknesses caused by the slots. Combined with the finding that the walls are not suitably tied in at the ends implies that there is a significant instability issue with regards to the remaining wall which needs to be considered as part of the proposed works.

5.4.3. Providing safe access is achievable (as noted in the previous section), there are options which could be considered to repair the slots in the masonry to reinstate integrity to the walls which are summarised as follows:

5.4.4. Option 1 – Rebuild on a like for like basis in masonry with new brickwork. Bricks could either be handmade to match existing or could be modern red brick depending on cost / conservation requirements. This would likely be the most suitable approach from a conservation perspective, however is likely to be slow and would need to be undertaken with great care as removal of brickwork will locally reduce the capacity of the masonry. The sequence of demolition and rebuilding would need to be carefully considered. Infilled brickwork could be installed with stainless steel bed joint reinforcement for improved robustness and to help bond new and old masonry.

PROS
- ✓ In keeping with aesthetic of the castle
- ✓ Additional bed reinforcement will improve robustness.
- ✓ Flexible installation, options to reinstate beam / joist pockets.

CONS
- × Slower sequence of works
- × Potential for further loss of historic masonry to suit coursing of new brickwork
- × If modern brickwork, bricks are unlikely to course with existing

5.4.5. Option 2 – Infill voids with lime concrete and tie into surrounding masonry. This would require shuttering to be installed on one or both sides of the wall (propped off scaffolding). Once shuttered slots would be flooded with concrete.

PROS
- ✓ Quicker method of construction.
- ✓ Encapsulated brickwork in its current form therefore minimising historic fabric loss.
- ✓ Flexible installation, options to reinstate beam / joist pockets.

CONS
- × Alien material, which is aesthetically different,
- × Repaired slots / voids may look ugly / messy once complete.
- × Potential difficulties of getting concrete to the areas required.

5.5. **Towers**

5.5.1. Structural overview of towers

5.5.1.1. At first sight, the towers appear inherently robust based on their circular, geometrically stable shape and thick wall construction with rigid connections back to the remainder of the castle. Loading around window openings would have been resisted by a combination of the brick arches and the thick spandrel walls which would have transferred loading back into the main bodies of masonry either side of the stone windows and down to the foundations. The floors and roof structure would have acted as rigid diaphragms to help transfer lateral loads to the perimeter walls however considering the significant self-weight and thickness of the masonry it is likely the walls would have been able to stand without them (as they are currently).

5.5.1.2. The previous partial collapse of the SE tower is the most visible indicator that this characterisation of the towers as inherently robust is no longer accurate. While the exact failure mechanism of the SE tower is unknown, it is notable that the failure plane runs through the spandrel panels between the window openings, and there are indications that some at least of those spandrels had been reduced in thickness.

5.5.2. Impact of alterations

5.5.2.1. The most significant structural alterations which have impacted the towers is the loss of the roof structure and the reduction in spandrel panel thickness.

5.5.2.2. Losing the roof structure has left the wall heads and interior of the tower exposed to the weather which has caused progressive degradation of the upper courses of stonework creating large pockets into which vegetation has been able to grow and in turn cause even further distress to the fabric, including significant deterioration to the arches over the uppermost window openings in the tower. As the upper arches have deteriorated it is assumed that water has continued to propagate down through the building which has then caused defects with the lower arches.

5.5.2.3. As noted above the spandrels are a key part of the main walls of the tower in combination with the brick arches over the window openings. During the building's history the spandrel panels have been significantly reduced thereby reducing the overall robustness of the masonry and removing scope for secondary paths.

5.5.2.4. In a comparative review of each of the towers, the NW tower has only one bay where the spandrel panel has been retaining at its full thickness, and even here it is only half the height of the original spandrel panel. The SW tower retains most of its original spandrel panels, and the NE tower has two out of six of its spandrel panels retained at full thickness.

5.5.2.5. A further alteration which has impacted the towers' structural integrity is the addition of flues serving fireplaces inserted within the main body of the castle adjacent to the towers. This will have reduced the thickness of the tower wall close to its connection to the main castle wall. In the case of the NW tower, inserted fireplaces are noted at three levels in the adjacent main west elevation, all of whose flues run up through the tower wall.

5.5.3. Impact of defects and deterioration

5.5.3.1. The most significant structural defects of concern to the towers are the degrading and distressed brick arches over the openings, and the significant cracking in the elevations. It should be noted that the towers exhibit evidence of other general defects such as slots in the masonry where floors were originally present, and some localised missing pointing or brickwork however these are considered of less significance.

5.5.3.2. As noted previously, the ongoing growth of vegetation and water ingress through the wall heads has caused significant degradation to the brick arches whereby localised patches of masonry have been lost, reducing the capacity of the remaining arches and the tie between the full masonry panels.

5.5.3.3. In all towers there is evidence of deterioration in some form to the arches with the most significant being the arch over opening W25 in the NW tower where the central wedge has dropped and is at risk of falling out. The consequences of losing the masonry wedge in the NW tower are unknown however have the potential to be significant and there is concern that such an event could lead to a localised / total collapse.

5.5.4. Cracks in the elevations

5.5.4.1. The cracks in the elevations are assumed to have resulted from a combination of the reduction in their thickness, and the progressive deterioration of the brick arches over. As the arches started to lose capacity, the spandrel panels were mobilised to resist more of the loading around the openings. Where the spandrel panels are reduced in thickness it is assumed these did not have sufficient capacity to resist the associated loadings which therefore resulted in the cracks in the masonry. It is notable that generally where spandrel panels have been retained at full thickness, the cracking is less significant, and at the NW tower where all spandrels have been reduced the cracking is most severe.

5.5.4.2. In summary, it appears that the combined effects of multiple ill-considered alterations and significant deterioration following loss of the roof has left the NW tower in particular in a very poor condition. Consideration should be given to temporary measures which could help improve the robustness of the structure until such time as permanent repairs can be implemented.

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5.6. Phasing of future proposed works

5.6.1. In its current state, Ruperra Castle remains generally inaccessible due to a combination of the dangerous nature of the structure and the associated risks, and general limitations such as significant vegetation growth or debris buildups at ground /. First floor levels. Undertaking any future works to the building will need be carefully considered and likely phased to permit safe working practices within the building. It is likely the works would be undertaken on a cell-by-cell basis in the interim to establish a safe working methodology which can be applied for the proposed repair works to the structure. One approach to the phasing has been outlined below:

5.6.2. PHASE 1 – MAKING SAFE - To include a comprehensive making safe exercise to all the areas of high level of masonry around the castle including all parapets and ledges along the perimeter walls and the wall heads and chimney stacks internally. Where possible clearance of any upper landings or floor areas would be undertaken during this phase to permit future access into these spaces in the following phases of work. It may be the case in some very localised areas that controlled demolition would be the most appropriate method of making safe the areas as it may be impractical or cost prohibitive to try to dismantle some of the existing masonry. Considerations for this will be discussed separately below.

5.6.3. It is anticipated that this exercise would be undertaken using a crane and man basket to permit shorter range access to the masonry at which point any loose stones can be probed and safely removed (dropped to ground) / stored on site. This will require input from Cadw and Archaeologists with regards to formalising an archaeological watching brief and advise on recording methodologies for any removed masonry or other materials from the wall heads / chimneys.

5.6.4. PHASE 2 – GROUND LEVEL CLEARANCE – As the ground level debris constitutes an archaeological deposit, it will need to be excavated and sorted by an archaeologist in situ. Collaboration could be arranged with a building contractor to assist with simultaneous vegetation clearance, and the practicalities of removing the sorted debris (either via skips craned out, or conveyors used to remove material through window openings.) Following the general clearance, the intention would be to form localised bases for scaffolding from which any significant structural repairs / consolidation works could be undertaken.

5.6.5. During this phase, one option could be to lift in prefabricated crash boxes which would comprise hot rolled steel frames which would be erected outside the building then crane lifted into the cells. The crash boxes would be designed to provide a safe retreat point for any operatives within the castle and provide a safe space to work from during the ground level clearances. The crash boxes can be left insitu for as long as deemed necessary by the contractor or until such a point that the cell is deemed safe to access as suitable repair or stabilisation works have been undertaken. This methodology has been previously successfully employed on a similarly degraded castle in Northern Ireland.

5.6.6. PHASE 3 – TEMPORARY SCAFFOLDING & STABILIZATION – This would involve the erection of an access scaffold within the cell which would permit close-up access to the elevations. The scaffolding could be designed with an upper-level crash deck to provide protection to operatives working below and also be designed to provide lateral restraint to the walls to be worked on, in particular where significant slots are present, to mitigate the risk of the panels falling into the work zones.

5.7. Considerations for Controlled Demolition

5.7.1. As detailed previously, there are several areas of the castle which are in very poor and potentially dangerous condition in their current state with a moderate likelihood of localised collapses which put other areas of the monument at risk. As such options for controlled demolition of very specific elements could be explored in particular where practicalities of safely repairing or stabilising the existing masonry walls are challenging or financially unviable.

5.7.2. Controlled demolition would comprise the use of a crane and man backet from which operatives would dismantle the existing masonry walls (from top down) by prying out stonework & brickwork and dropping it into the empty cells below. Once dismantled, the expectation would be that the cell would be considered safe to access at which time archaeologists could undertake similar clearance works to those described in para 5.6.4 above.

5.7.3. It is recognised that any controlled demolition work would likely require prior re-recording (particularly of areas where previous recording was poor due to access constraints.) There would also be an expectation that dismantled/demolished areas would be rebuilt like for like in due course

5.8. **Access & Security**

5.8.1. The castle is located on private land, but a public right of way passes close by. Caerphilly County Borough Council has taken steps to temporarily close this right of way for safety reasons. They were right to do so since users of the right of way would be at risk from falling debris, particularly given the condition of the NW tower. From the exterior, with the exception of the SE tower, the building appears superficially intact, potentially attracting passersby to consider exploring internally. Currently the existing castle is readily accessible from all sides via the existing doorways and windows (missing glass) with no significant security or barriers in place to discourage casual access by members of the public who may consider trespassing. The doorway into the vaults is poorly covered with a mesh fence placed loose against the doorway however there have been reports of trespassers accessing both the vaults and the main body of the building.

5.8.2. Considering the condition of the building structure and the widespread areas of highly unstable masonry, there is a not insignificant risk that a trespasser or passersby using the public right of way could be struck with loose debris with the potential for severe or fatal injury. With regards to the monument, there is a risk of damage as a result of vandalism to potentially historically significant areas of the building. Consideration should be given to appropriate warnings being posted around the exterior of the castle and access restrictions put in place to deter potential trespassers and restrict casual access into the castle.

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6.0 Conclusions

6.1. At first glance, the ruin of Ruperra Castle, despite lacking a roof or floors, appears to be a generally robust and well-built structure with thick solid masonry walls arranged in a structurally favourable configuration. However, extensive closer inspection and analysis has identified several significant areas where historic interventions, including addition and removal of walls, creation of new openings, combined with the general lack of repair since the fire in 1941 have generally reduced the overall robustness and integrity of the surviving building.

6.2. For all areas of the building, the longer the structure is left without intervention, the greater the risk to both the building itself from an impact on historic fabric standpoint, and in terms of health and safety of people entering or passing close to the structure. Defects which have been classified as minor or moderate in the current assessment have the potential to become of more significant risk as the building continues to deteriorate and as currently high-risk areas are lost. Whilst it is not possible, due to the unpredictable nature of deterioration of masonry ruins particularly after such long periods of exposure to the elements, to put a timeframe on the 'point of no return', it is clear that the proportion of the building which cannot be saved is increasing with time.

6.3. External Walls

6.3.1. The external walls of the building (excluding the towers), though having localised areas in poorer condition, are generally in reasonable and repairable condition. The main risks associated with the external walls are limited to loose masonry or materials on wall heads, vegetation growth accelerating degradation of the historic fabric, and some localised parapet merlons which are at risk of falling into the castle. Slots on the internal elevation of the external walls are of structural concern as they are currently leaving large panels of masonry unsupported, however the risks are likely limited to localised loss of masonry rather than the collapses of entire walls as the exterior walls are generously constructed. Works to the external walls in the immediate case. are likely be limited to general making safe works (removal of debris from leges etc). The risk of global collapse of a wall affecting the public right of way or the Bothy, is assessed as being very low.

6.4. Internal Walls

6.4.1. Internal walls are in worse condition generally, with several defects which are of significant structural concern. The most significant general defect is considered to be the voids and slots in the masonry walls in particular where they occur both sides of the cross walls between cells. If left to degrade further there is a risk of losing whole wall panels which would be a considerable loss of historic fabric and major safety risk to building users.

6.4.2. The internal walls are generally likely repairable however will require more immediate intervention which is likely to include elements of making safe, temporary stabilisation, or controlled dismantling (in particular in Cell G) which are likely to be phased as denoted in the discussions.

6.5. Chimneys

6.5.1. Chimney C3 and C4 are of significant concern considering their very poor condition with C4 being the more concerning of the two. Chimney C2 is generally in reasonable condition.

6.5.2. The temporary scaffolding installed around chimney C1 appears to have secured this at risk structure and should remain in place until permanent repair works can be undertaken.

6.5.3. At Chimney C3, though the significant holes in the facework are of concern, the cross walls in the flues appear robust If left to degrade further there is a risk of rapid escalation in loss of masonry. Chimney C3 is likely repairable though partial dismantling may be required.

6.5.4. At C4 there is a significant risk of local and possibly more general collapse without some form of intervention in the immediate/ short term. Partial dismantling/controlled demolition should be considered.

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6.6. Towers

6.6.1. Generally, the towers are in poor condition with the NW tower being of significant structural concern considering the several serious defects identified and the significant cracking in the elevation in comparison to the rest of the towers. The general reduction in robustness due to the excessive deterioration and alterations to the existing spandrel panels outlines that the defects are likely to continue to develop as more masonry is degraded and/or lost.

6.6.2. The towers are likely saveable / repairable in their current condition however the NW tower in particular will require more immediate scheme of repair or temporary stabilization / protection works to mitigate further deterioration and a potentially significant collapse. The risk of a significant partial collapse of the northwest tower potentially affecting the public right of way is assessed as moderate. Such a collapse would be very unlikely to affect the Bothy.

6.7. Ground Floor / Vaults

6.7.1. The vaults were generally found to be in reasonable and repairable condition with no significant areas other than the wall in Cell C identified as an area of concern. Providing works are undertaken to address the wall in Cell C, restoration works to the vaults should be able to be undertaken without significant issue.

6.7.2. The presence of what may be asbestos pipe lagging in the vaults is a significant risk to anyone accessing these areas. It should be investigated urgently by a specialist surveyor and appropriate action taken depending on the findings of the inspection.

6.8. Overall

6.8.1. In summary, while the structure of the castle generally remains feasible to save as at the time of inspection, multiple highly vulnerable areas have been identified. In these areas, failure to take action in the immediate or short term will allow further deterioration past the ‘point of no return’ where it is no longer possible to intervene safely to prevent uncontrolled collapse. It is not possible to put a definitive timeframe on when that point will be reached, but it is clear from the previous collapse of the SE tower and the loss of many smaller sections of masonry that the monument is at high, and over time increasing, risk of catastrophic loss of at least local areas of significant historic fabric.

6.8.2. To aid in securing the strategic future of the castle, all the ‘immediate’ actions in the following Recommendations section should be targeted to be undertaken within 12 -18 months, though it would be preferable to shorten this period if logistical, funding and regulatory constraints permitted. ‘Short term’ works should be targeted to be completed within a further 2 - 3 years.

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7.0 Recommendations

7.1. Introduction

7.1.1. The conclusions of this report identify progressive defects which will continue to degrade the condition of the monument. A series of risks to users accessing the castle have also been presented. The following recommendations are intended to provide guidance on how these issues could be mitigated with prioritization.

7.1.2. Based on the conclusions of this report we recommend a schedule of works is developed based on the recommendations below. These works are likely to involve a combination of consolidation and repair works to protect the monument and works to exclude the public. This full schedule of works will require further design input and potentially further survey work.

7.1.3. The recommendations have been split into two categories of urgency as follows:

- Immediate / Urgent Works – Works to be undertaken immediately to resolve issues which may cause instability or collapse in the short term and are making the structure unsafe.
- Short Term Works – Works to be undertaken, in the short term, to resolve issues which are currently causing progressive degradation and or damage to the structure.

7.1.4. Medium and long term consolidation and repair works will also be required, to secure the structure on a permanent basis, and form the basis for any future re-use of the building. These works will be extensive and scheduling them falls outside the scope of this report. Similarly, upon completion of structural repairs, ongoing maintenance will be required to manage risks of future deterioration of the monument.

7.1.5. All of the works proposed below are our best estimate of the required works based on the survey work completed to date. All of these works will be subject to Scheduled Monument Consent and will require justification. This will not only be to justify the requirement to undertake an intervention or repair but also for the proposed materials, repair details and methodology.

7.2. Immediate / Urgent Works

7.2.1. To mitigate the risk of trespass and vandalism within the monument, we recommend installing suitable fencing and signage to deter any members of the public accessing the site. Installed fencing if specified should be fitted with a lockable gate to provide access for the client or to permitted professionals undertaking works to the castle.

7.2.2. The potentially asbestos pipe lagging in the vaults should be tested by an asbestos specialist and appropriate action taken depending on the findings. Access to the vaults should be prevented until such testing has been undertaken.

7.2.3. Access to the north side of the castle should be improved including providing a suitable crane pad (or similar) to facilitate the use of a crane as part of any proposed works. The crane utilised during the investigation was at the maximum of its reach when located on the south side of the site therefore having a suitable setup point on the north of the castle will provide access to the most critical areas e.g. the NW tower and Chimney C4.

7.2.4. For Chimney C4, we recommend installing a wrapping scaffolding similar to that installed on Chimney 1 and that a making safe exercise is undertaken to remove any significant vegetation and loose masonry or cap stones which are currently at risk of falling to ground.

7.2.5. <u>All Towers</u>

7.2.5.1. The towers, particularly the NW tower, are significant risk items which if left unaddressed have the potential to result in significant losses of historic fabric and potential considerable risk to site users. Therefore, as a minimum we would recommend the following works are undertaken in the immediate case to help mitigate further degradation and stabilise the existing masonry.

7.2.5.2. Undertake comprehensive vegetation clearance along the head of the towers, allowing for localised dismantling of header courses to permit the removal of penetrating roots. Any significantly loose masonry to be dropped into the tower and/or stored on site in an agreed location for later reinstatement. Works to be undertaken using a crane and man basket as the towers are deemed unsafe and unsuitable for scaffold or roped access.

7.2.6. NW Tower

7.2.6.1. Stabilising the dropped wedge of brickwork in the NW tower to reduce the risk of potential collapse of the arch over window W25. One option could be installing a single / pair of vertical ratchet straps which would be threaded through the window below and up to the floor above such that the wedge would be held in place by the arch over which is in better condition. Timber packers would be installed to the underside of the wedge to provide sufficient contact between the strap and the masonry.

7.2.6.2. Tying across the cracks and restraining the tower masonry as a whole back to the rest of the castle by installing a series of ratchet straps along the spandrel panels to hold the surviving masonry in place until permanent works can be undertaken. This could comprise installing a series of anchor points into the return walls of the castle onto which the ratchet straps would be installed and subsequently tensioned.

7.2.6.3. Install a temporary roof onto the NW tower to mitigate further vegetation growth and water ingress which is currently causing significant deterioration to the wall heads and the masonry below.

7.3. **Short Term Works**

7.3.1. Similar to the phased approach communicated in the discussions, undertake a first phase comprehensive scheme of making safe works to clear the internal ledges / wall heads of all loose debris to make the overall site safer to access at ground level. As part of this work, remove all high level vegetation particularly at wall heads, including poisoning tree stumps where roots cannot be removed from walls.

7.3.2. Once the making safe works described in 7.3.1 are complete, undertake a preliminary archaeological ground clearance in all safe to access rooms to permit the installation of scaffolding adjacent to vulnerable cross walls. During this phase it may be prudent to consider implementing the crash box system (In the Discussions) whereby prefabricated crash boxes are brought into the building to permit safe clearance of the ground floor spaces.

7.3.3. Install scaffolding / similar approved system to either side of vulnerable masonry walls, in particular the cross walls between cells E & D, D & C and between E & F which are significantly voided and of structural concern.

7.3.4. For the walls in cell G which are significantly degraded and unsafe to access currently, we recommend considering their controlled demolition. This would include the wall between Cells G2 & G3 and the wall between Cell G & Cell F where there is a significant area of overhanging masonry.

7.3.5. In Cell C, at ground level, we recommend installing a system of temporary propping or temporary shoring against the central wall which is significantly deteriorated to mitigate the risk of the wall and adjacent vault failing as a result of continued degradation and loss of masonry. Options could include lifting tonne bags of sand / gravel and positioning them against the wall in the temporary case.

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8.0 Appendix - Drawings

List of Drawings

10247_SK01_P1 - STRATEGIC STRUCTURAL INSPECTION – GENERAL NOTES
10247_SK02_P2 - STRATEGIC STRUCTURAL INSPECTION – VAULTS / GROUND FLOOR PLAN
10247_SK03_P2 - STRATEGIC STRUCTURAL INSPECTION – FIRST FLOOR PLAN
10247_SK04_P2 - STRATEGIC STRUCTURAL INSPECTION – SECOND FLOOR PLAN
10247_SK05_P2 - STRATEGIC STRUCTURAL INSPECTION – THIRD FLOOR PLAN
10247_SK06_P1 - STRATEGIC STRUCTURAL INSPECTION – NE TOWER
10247_SK07_P1 - STRATEGIC STRUCTURAL INSPECTION – NW TOWER
10247_SK08_P1 - STRATEGIC STRUCTURAL INSPECTION – SW TOWER

EXECUTIVE SUMMARY OF FORM AND CONDITION

FLOORS

STRUCTURAL FORM

GENERALLY, ALL SUSPENDED FLOORS WITH THE EXCEPTION OF THE VAULTED MASONRY GROUND FLOORS HAVE BEEN LOST HISTORICALLY. FLOORS ORIGINALLY COMPRISED LONG SPANNING TIMBER (ASSUMED OAK) BEAMS WHICH SUPPORTED TIMBER JOISTS AND A BOARDED FLOOR BUILDUP IN KEEPING WITH THE PERIOD OF CONSTRUCTION.

CONDITION

THE REMAINING VAULTED FLOORS ARE IN REASONABLE CONDITION WITH NO STRUCTURALLY SIGNIFICANT DEFECTS OF CONCERN.

ROOF

STRUCTURAL FORM

GENERALLY ALL ROOF STRUCTURES HAVE BEEN LOST FROM THE BUILDING. THE ROOF HAS SEEN SEVERAL PHASES OF CONSTRUCTION THE LATEST BEING HIPPED ROOFS CONSTRUCTED ONTO EACH CELL OF THE BUILDING. THERE ARE SOME LOCALISED PIECES OF THE ORIGINAL ROOF STRUCTURE WHICH REMAIN EMBEDDED WITHIN THE STRUCTURE.

CONDITION

N/A

WALLS

STRUCTURAL FORM

THE CASTLE COMPRISES 4NO. EXTERNAL ELEVATIONS OF 900mm THK MASONRY WITH CASTELLATED PARAPETS ON THE SOUTH AND EAST ELEVATIONS AND NO PARAPETS ON THE NORTH AND WEST ELEVATIONS. THE CASTLE CONTAINS AN ARRAY OF INTERNAL MASONRY WALLS OF VARYING THICKNESS. THE WALL CONSTRUTIONS TYPICALLY COMPRISES A COMBINATION OF BRICKWORK AND SOLID STONE CONSTRUCTION INSTALLED OVER SEVERAL PHASES OF CONSTRUCTION DURING THE BUILDING'S HISTORY.

THE MAJORITY OF THE CASTLE IS OF C17 STONE AND BRICKWORK CONSTRUCTION, WITH ELEMENTS OF ASHLAR STONEWORK RETAINED PARTICULARLY ON THE PARAPETS AND THE CENTRALISED "STRONG ROOM". IT IS EVIDENT FROM THE ARCHAEOLOGICAL REPORT THAT THE CASTLE HAS SEEN MANY PHASES OF ALTERATION, THE MOST SIGNIFICANT BEING IN THE LATE C18 AND LATE C19 / EARLY C20.

CONDITION

THE CONDITION OF THE SURVIVING MASONRY STRUCTURE VARIES CONSIDERABLY FROM ELEMENTS IN REASONABLY SOUND CONDITION WITH NO STRUCTURALLY SIGNIFICANT DEFECTS, TO AREAS IN VERY POOR CONDITION WITH LARGE SECTIONS OF MASONRY LOSS AND/OR SIGNIFICANT STRUCTURAL DEFECTS WITH THE POTENTIAL TO CAUSE MODERATE TO SIGNIFICANT LOSS OF BUILDING FABRIC AND HIGH RISK TO ANYONE ENTERING THE BUILDING IF DEGREDATION IS LEFT UNADDRESSED.

FORM & CONDITION OF EXISTING CHIMNEY STACKS

STRUCTURAL FORM

THE CHIMNEY STACKS ARE OF BRICKWORK CONSTRUCTION GENERALLY WITH THE UPPER COURSES OF MASONRY COMPRISING ASHLAR STONE CONSTRUCTION TOPPED WITH A STONE CHIMNEY CAP ARRANGEMENT.

CHIMNEY C1 - THE UPPER STACK OF CHIMNEY C1 IS IN VERY POOR CONDITION WITH SIGNIFICANT STRUCTURAL DEFECTS PUTTING THE HISTORIC FABRIC AT RISK OF COLLAPSE. CHIMNEY POTS HAVE BEEN LOST, THERE ARE SEVERAL LOCALISED PATCHES OF MASONRY MISSING ON THE ELEVATIONS AND A SIGNIFICANT FULL HEIGHT CRACK ON THE EAST ELEVATION OF THE STACK WHICH PROMPTED A MORE RECENT PHASE OF TEMPORARY STABILISATION WORKS. THE TEMPORARY WORKS COMPRISED WRAPPING THE STACK IN SCAFFOLDING TO MITIGATE MOVEMENT AND POTENTIAL COLLAPSE WHICH WOULD REPRESENT A SIGNIFICANT LOSS OF HISTORIC FABRIC AND SIGNIFICANT RISK TO BUILDING USERS.

CHIMNEY C2 - COMPARED TO THE OTHER CHIMNEY STACKS, CHIMNEY C2 IS IN REASONABLE CONDITION WITH VERY LOCALISED PATCHES OF MASONRY IN POOR CONDITION. THE CONCRETE CHIMNEY POTS COMPRISE WHERE IN POOR CONDITION THE MASONRY IS GENERALLY MISSING POINTING. CHIMNEY CAPS ARE GENERALLY INTACT AND IN REASONABLE CONDITION. DEFECTS OBSERVED DO NOT APPEAR TO BE OF SIGNIFICANT STRUCTURAL CONCERN OR OF SIGNIFICANT CONCERN FROM A HEALTH AND SAFETY STANDPOINT.

CHIMNEY C3 - THE STACK OF CHIMNEY 3 IS IN POOR CONDITION WITH SOME LOCALISED AREAS IN VERY POOR CONDITION. ON THE EAST ELEVATION THERE ARE LARGE PATCHES OF MASONRY MISSING EXPOSING THE FLUES, WITH REMAINING MASONRY IN A SIGNIFICANTLY DETERIORATED STATE. THE UPPER STACK HAS A CRACK ON THE SOUTH END OF THE CHIMNEY WHICH SUGGESTS MOVEMENT WITHIN THE MASONRY. THE STONEWORK IS GENERALLY MISSING POINTING. THE STONE CAPPING TO THE CHIMNEY APPEARS TO BE GENERALLY IN REASONABLE CONDITION. CONTINUED DETERIORATION OF THE FACEWORK HAS THE POTENTIAL TO CAUSE SIGNIFICANT LOSS OF HISTORIC FABRIC AND RISKS LARGE PANELS OF MASONRY FALLING TO GROUND PUTTING BUILDING UERS AT RISK.

CHIMNEY C4 - CHIMNEY 4 IS IN VERY POOR CONDITION WITH DEFECTS OF SIGNIFICANT STRUCTURAL CONCERN OR OF CONCERN WHEN CONSIDERING SAFETY TO BUILDING USERS. CAPPING SLABS ARE GENERALLY SHATTERED AND SURROUNDED BY SIGNIFICANT AMOUNTS OF LOOSE DEBRIS. THERE ARE SEVERAL CRACKS IN THE FACEWORK ON ALL ELEVATIONS WITH VARIOUS AREAS OF SEVERELY DEGRADED / CRACKED MASONRY UP THE FULL HEIGHT OF THE STACK.

KEY

AREA OF CONCERN CONSIDERING POTENTIAL RISK TO VISITORS / WORKERS WITHIN THE BUILDING

AREA OF SIGNIFICANT STRUCTURAL CONCERN WHICH MAY IMPACT THE HISTORIC FABRIC.

CONDITION / DEFECT CLASSIFICATIONS

W# & D# STRUCTURAL OPENING IN APPARENTLY REASONABLE CONDITION, AND SOUND IN ITS CURRENT STATE / CONFIGURATION. LINTELS MAY BE MISSING BUT MASONRY CORBELLED AND STABLE.

W# & D# STRUCTURAL OPENING WITH DEFECTS WHICH POSE A RISK TO THE STRUCTURAL FABRIC, OR USERS OF THE BUILDING.

TYPICAL DEFECT TYPES - LOOSE & MISSING MASONRY / LINTELS AT HEIGHT, OVERHANGING MASONRY WHERE LINTELS HAVE BEEN LOST, DETERIORATING BRICK ARCHES, VEGETATION GROWTH.

W# & D# **W# & D#** - STRUCTURAL OPENING WITH SEVERE DEFECTS WHICH POSE A SIGNIFICANT RISK TO THE STRUCTURAL FABRIC, OR USERS OF THE BUILDING.

TYPICAL DEFECT TYPES - VERY LOOSE / VULNERABLE MASONRY AT HEIGHT. FAILED OR AT RISK LINTELS WITH THE POTENTIAL TO CAUSE LOCALISED COLLAPSES OF MASONRY.

W# & D# NOT INSPECTED

PARAPETS - AS THE SECTION ABOVE THE CONDITION OF PARAPETS HAS BEEN SUMMARISED USING THE RED, AMBER, GREEN CLASSIFICATIONS.

WALL HEADS - AS THE SECTION ABOVE THE CONDITION OF WALL HEADS HAS BEEN SUMMARISED USING THE RED, AMBER, GREEN CLASSIFICATIONS.

LARGE SLOTS / POCKETS OF MASONRY MISSING AT FLOOR LEVELS (GROUND, FIRST AND SECOND FLOOR) WHERE FLOOR JOISTS / BEAM POCKETS HAVE BEEN LOST HISTORICALLY. MASONRY OVER AND UNDER IS GENERALLY POORLY SUPPORTED, LOOSE AND VULNERABLE.

STRAIGHT JOINTS IN MASONRY INDICATING MASONRY NOT TIED IN / BUTTRESSING WALLS.

ORIGINAL RAINWATER OUTLETS

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REV	DESCRIPTION	BY	DATE
P1	FOR INFORMATION	JB	13/11/24

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT

RUPERRA CASTLE

TITLE

STRATEGIC STRUCTURAL INSPECTION - GENERAL NOTES

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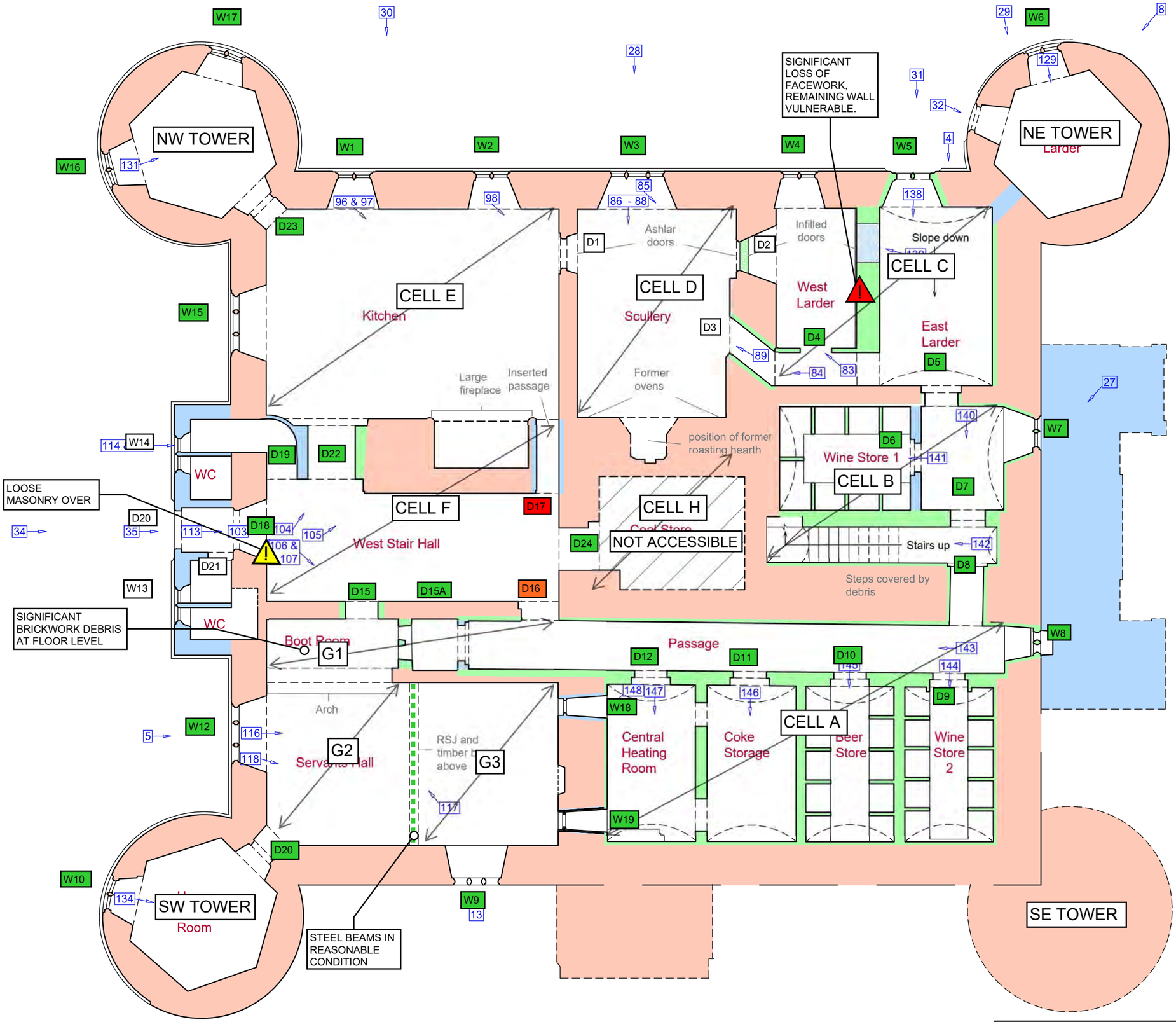
DRAWN	CHKD	SIZE	SCALE	DATE
JB	PR	A3	NTS	08/08/24

STATUS

FOR INFORMATION

PROJECT	DRAWING	REV
10247	SK-01	P1



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REV	DESCRIPTION	BY	DATE
P1	FOR INFORMATION	JB	30/08/24
P2	TOWER & VAULTS CONDITION UPDATED	JB	13/11/24

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT

RUPERRA CASTLE

TITLE

STRATEGIC STRUCTURAL INSPECTION - VAULTS / GROUND FLOOR PLAN

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DRAWN	CHKD	SIZE	SCALE	DATE
JB	PR	A3	1:125	08/08/24

STATUS

FOR INFORMATION

PROJECT	DRAWING	REV
10247	SK-02	P1

NOTE: THESE DRAWINGS HAVE BEEN PRODUCED USING ARCHAEOLOGICAL BUILDING PLANS PROVIDED BY COTSWOLD ARCHAEOLOGY.

GENERAL HAZARDS

LOOSE /VULNERABLE MASONRY ALONG EDGES OF ROOMS WHERE SLOTS OF UNDERCUT MASONRY ARE LOCATED.

LOOSE / VULNERABLE MASONRY ALONG WALL HEADS WITH PATCHES OF VEGETATION GROWTH LIKELY TO ACCELERATE DEGREDATION AND INCREASE RISK OF FALLING MASONRY.

CENTRE OF EXISTING ARCH HAS FAILED AND IS AT RISK OF FALLING AND CAUSING SIGNIFICANT COLLAPSE.

NW TOWER

NE TOWER

SW TOWER

SE TOWER

FAILING LINTELS WITH CRACKED MASONRY OVER

HOLE THROUGH WALL, SLOT OF MISSING MASONRY BOTH SIDES. WALL NOT SUITABLY TIED IN AT NORTH END.

Bedroom

CELL E

CELL D

Study

CELL C

Smoking/Sitting Room

Infilled door

Former fireplace

Alcove

Store (not accessible)

not accessible for survey

FAILED LINTEL AND VULNERABLE BRICKWORK OVER.

FAILING LINTELS WITH EXPOSED COREWORK

Ashlar surround

CELL B

Hall

CELL F

CELL H

NOT ACCESSIBLE

stairs up from vaults

Porch

FAILED PLASTER OVER door

FAILED LINTEL WITH CRACKED MASONRY OVER

arch below steps

POORLY BONDED AND VULNERABLE MASONRY

Former position of screen

Partially infilled window

Ashlar door

Cross Passage

Dining Hall

CELL A

Infilled doors

Butler's Pantry

House Steward's Room

Floor heights raised c.1913 (Phase C)

NO WALL HERE

LOOSE JOISTS & MASONRY AT RISK OF FALLING.

South Porch

Graffiti

South Porch facade

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REV	DESCRIPTION	BY	DATE
P1	FOR INFORMATION	JB	30/08/24
P2	TOWER CONDITION UPDATED	JB	13/11/24

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT

RUPERRA CASTLE

TITLE

STRATEGIC STRUCTURAL INSPECTION - FIRST FLOOR PLAN

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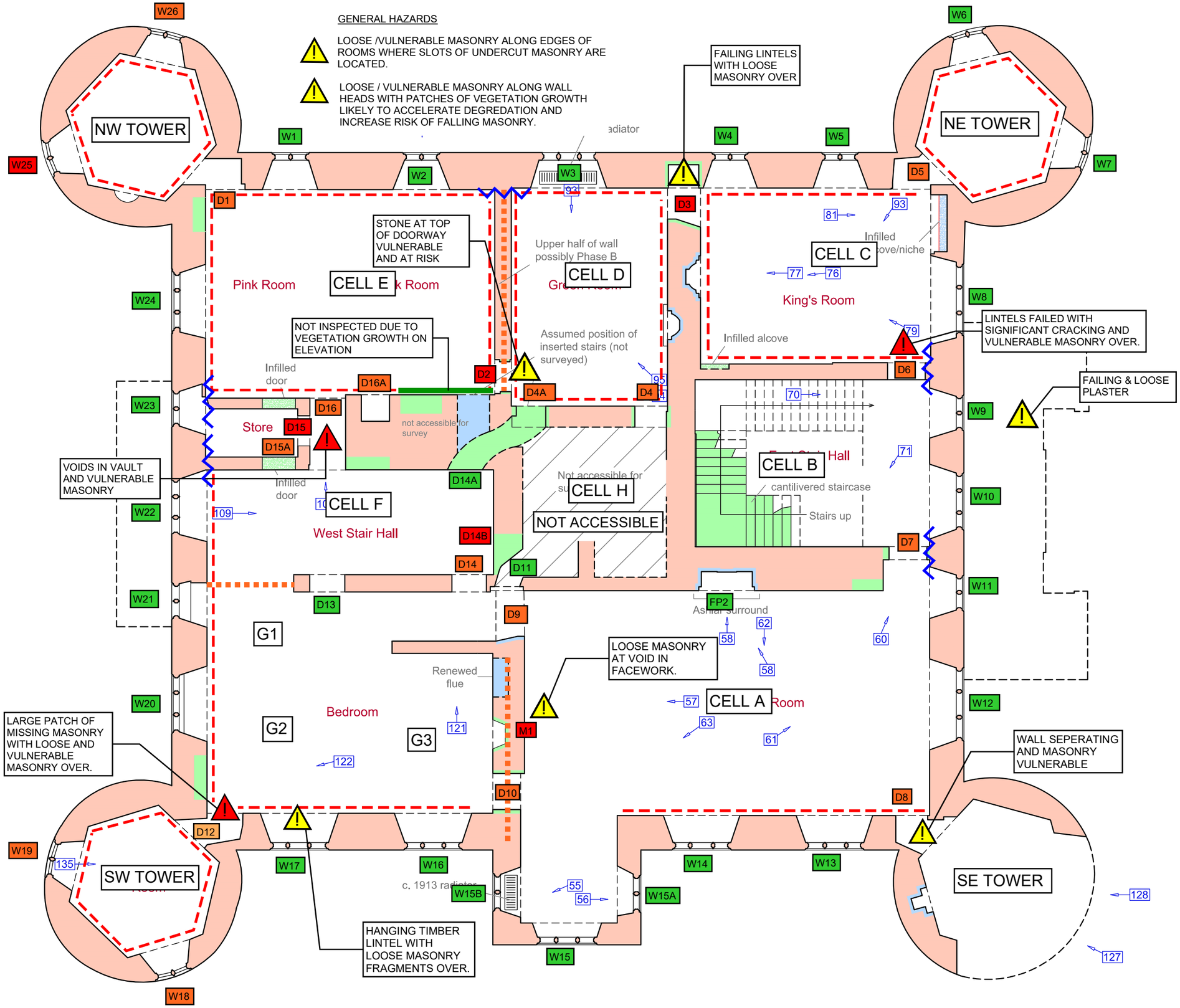
DRAWN	CHKD	SIZE	SCALE	DATE
JB	PR	A3	1:125	08/08/24

STATUS

FOR INFORMATION

PROJECT	DRAWING	REV
10247	SK-03	P2



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REV	DESCRIPTION	BY	DATE
P1	FOR INFORMATION	JB	30/08/24
P2	TOWER CONDITION UPDATED	JB	13/11/24

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
RUPERRA CASTLE

TITLE
STRATEGIC STRUCTURAL INSPECTION - SECOND FLOOR PLAN

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DRAWN	CHKD	SIZE	SCALE	DATE
JB	PR	A3	1:125	08/08/24

STATUS
FOR INFORMATION

PROJECT	DRAWING	REV
10247	SK-04	P2

GENERAL HAZARDS

LOOSE / VULNERABLE MASONRY ALONG WALL HEADS WITH PATCHES OF VEGETATION GROWTH LIKELY TO ACCELERATE DEGREDATION AND INCREASE RISK OF FALLING MASONRY.

NW TOWER

NE TOWER

SW TOWER

SE TOWER

U.N.O. GENERALLY THIS ELEVATION HAS NO PARAPET.

TREE GROWING ON LEDGE

MERLON SIGNIFICANTLY LEANING & VULNERABLE

c.1973 radiator

PATCH OF DRESSED STONE AT JAMB SEPERATING AND AT RISK OF FALLING.

REMAINING LINTEL AND STONE AT RISK OF FALLING

LARGE VOIDS IN FACEWORK AND LOOSE MASONRY LEAVING FLUES SIGNIFICANTLY VULNERABLE.

ASHLAR STONE LOOSE AND AT RISK

Possible remains of 1626 tower (Phase A)

MERLON LEANING INTO BUILDING & VULNERABLE

FAILING & LOOSE PLASTER ON JAMBS

SHATTERED LANDING SLAB

LARGE VOID AT END OF WALL WITH SIGNIFICANT UNSUPPORTED MASONRY. 2 NO. HOLES THROUGH WALL. LARGE PANEL OF VULNERABLE, CORBELLING MASONRY OVER.

FULL HEIGHT CRACK

SIGNIFICANTLY CORRODED LINTEL

TREE GROWING ON LEDGE

MASONRY ARCH FAILING, MASONRY OVER AT RISK

MASONRY ARCH FAILING, MASONRY OVER AT RISK

2018 repairs

FAILED LINTEL BALANCED IN PLACE. LOOSE MASONRY OVER

MASONRY ON TOP OF WALL LOOSE, LEANING IN AND AT RISK OF FALLING FROM HEIGHT

LARGE PANEL OF PLASTER SPLIT AND AT RISK OF FALLING.

NOT INSPECTED DUE TO LARGE TREE GROWING IN CELL.

NOTE: THESE DRAWINGS HAVE BEEN PRODUCED USING ARCHAEOLOGICAL BUILDING PLANS PROVIDED BY COTSWOLD ARCHAEOLOGY.

CELL A — Maids' Rooms
CELL B — st Stair Hall
CELL C — Flower Room
CELL D — Valet's Room
CELL E — en's Room
CELL F — West Stair Hall
CELL H — Chapel Room
G1
G2 — Servants' Rooms
G3 — White Room
Store

W1 W2 W3 W4 W5 W6 W7 W8 W9 W10 W11 W12 W13 W14 W15 W16 W17 W18 W19 W20 W21 W22 W23 W24 W25 W26
D1 D2 D3 D5 D6 D7 D8
C1 C2 C3 C4
FP1
80 130 133 110 123 124 64 9 137

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REV	DESCRIPTION	BY	DATE
P1	FOR INFORMATION	JB	30/08/24
P2	TOWER CONDITION UPDATED	JB	13/11/24

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
RUPERRA CASTLE

TITLE
STRATEGIC STRUCTURAL INSPECTION - THIRD FLOOR PLAN

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DRAWN	CHKD	SIZE	SCALE	DATE
JB	PR	A3	1:125	08/08/24

STATUS
FOR INFORMATION

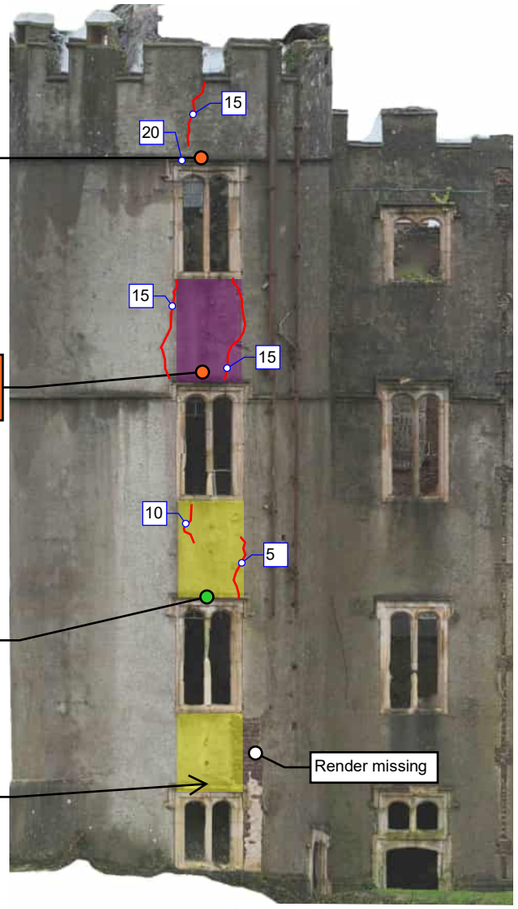
PROJECT	DRAWING	REV
10247	SK-05	P2

Photo 1

Photo 2

Photo 3

NORTH ELEVATION



Arch in poor condition, bottom course seperating from arch. some missing bricks.

Photo 1

Arch in poor condition, bricks missing at springing (internally) on inside face. Bricks missing at centre of arch.

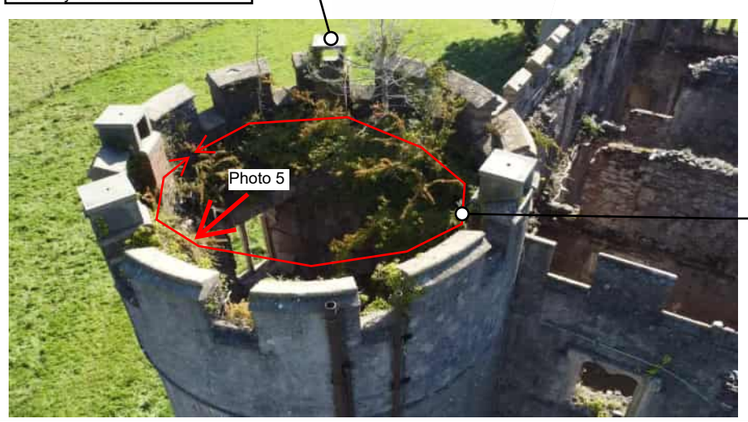
Photo 2

Arch in reasonable condition, hairline crack at centre of arch.

Arch in reasonable condition

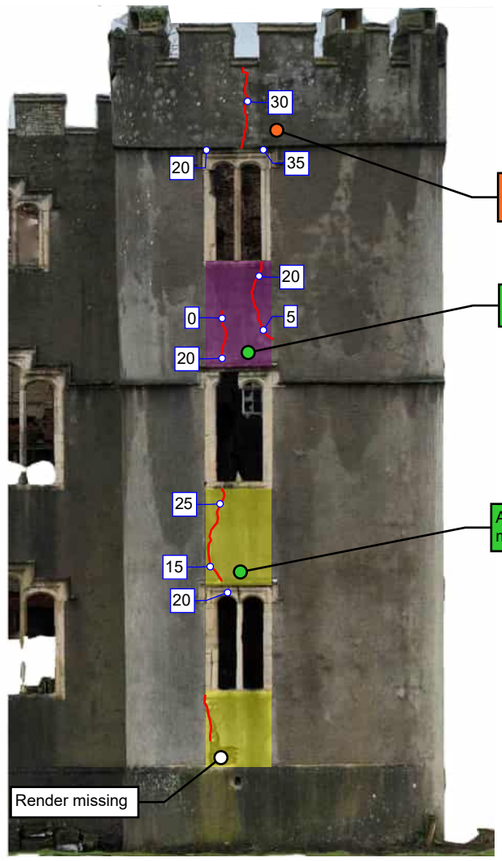
Render missing

The tower has 4No. visible chimney stacks on the roof with flues that continue through the masonry walls below.



Significant vegetation along head of full perimeter of tower. Significant shrub on south side. Masonry at wall head significantly deteriorated by ongoing vegetation growth and weather attack.

EAST ELEVATION



Arch in reasonable condition, central section locally loose

Photo 3

Arch in reasonable condition, small crack at centre.

Arch in reasonable condition, bricks missing at springing (internally)

Render missing

Photo 5

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KEY

- Spandrel panel historically reduced to thickness of stone windows (100-150mm thick)
- Thicker Spandral panel (approx. 400mm)
- Crack locations (shown indicatively)
- # Estimated crack width (mm) or estimated out of plane movement. E.g +10 denotes 10mm of movement away from the building. -10 denoted 10mm of movement into the building.

Note: Crack widths and out of plane movement distances provided were estimated from ground level and were not specifically measured on site.

REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	JB	18.10.24

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT

RUPERRA CASTLE

TITLE

STRATEGIC STRUCTURAL INSPECTION - NE TOWER

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DRAWN	CHKD	SIZE	SCALE	DATE
JB	PR	A3	NTS	08/08/24

STATUS

PRELIMINARY

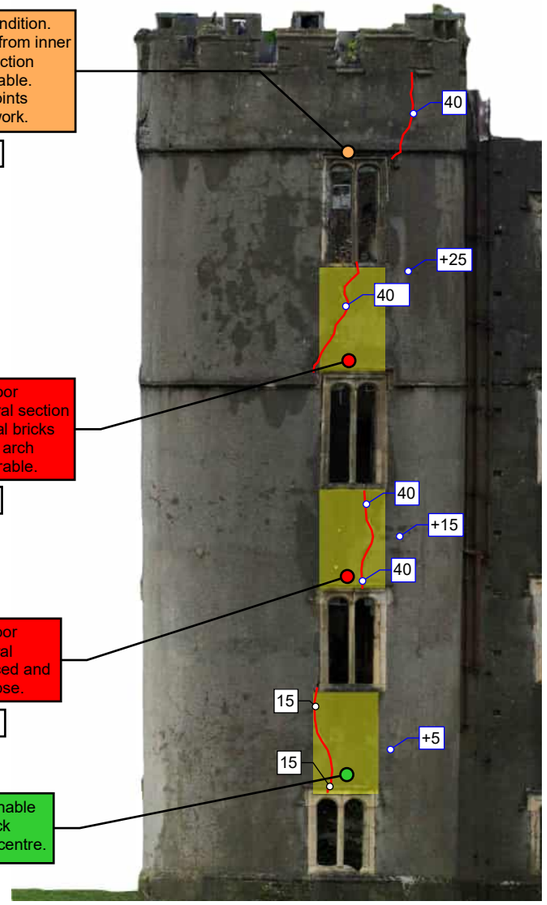
PROJECT	DRAWING	REV
10247	SK06	P1

Photo 1

Photo 2

Photo 3

WEST ELEVATION



Arch in poor condition. Bricks missing from inner face, central section appears vulnerable. Several open joints between brickwork.

Photo 1

Arch in very poor condition central section has lost several bricks and remaining arch appears vulnerable.

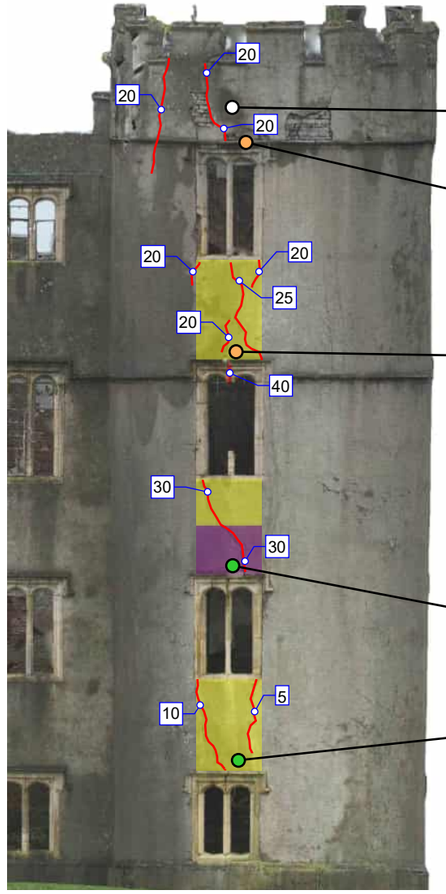
Photo 2

Arch in very poor condition central section displaced and at risk of collapse.

Photo 3

Arch in reasonable condition. Brick missing from centre.

NORTH ELEVATION



Render significantly deteriorated and missing permitting water ingress through masonry.

Arch in poor condition, missing central bricks and bricks at springing (internally).

Photo 4 (C)

Arch in poor condition, missing central bricks, central row missing across full soffit of arch. Bottom course appears to be seperating. Note large gap (20-30mm) between frames. Mullion missing.

Photo 4 (B)

Arch in reasonable condition, very localised central bricks inner face. Crack in soffit of the arch.

Photo 4 (A)

Arch in reasonable condition. bricks missing locally from springing.

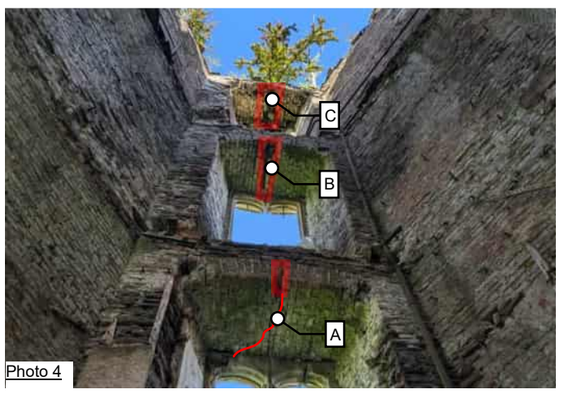


Photo 4

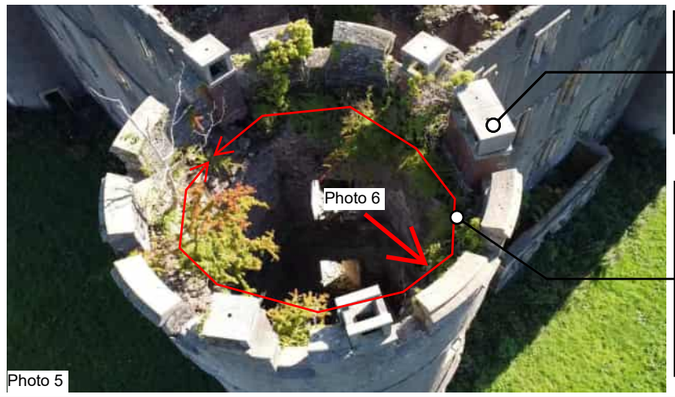


Photo 5

The NW Tower has 6 No. visible chimney stacks on the roof with flues that continue through the masonry walls below.

Significant Vegetation along head of full perimeter of tower. Significant shrub on north side. Masonry at wall head significantly deteriorated by ongoing vegetation growth and weather attack.

Photo 6

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	JB	18.10.24

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT

RUPERRA CASTLE

TITLE

STRATEGIC STRUCTURAL INSPECTION - NW TOWER

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DRAWN	CHKD	SIZE	SCALE	DATE
JB	PR	A3	1:125	08/08/24

STATUS

PRELIMINARY

PROJECT	DRAWING	REV
10247	SK07	P1


Photo 1

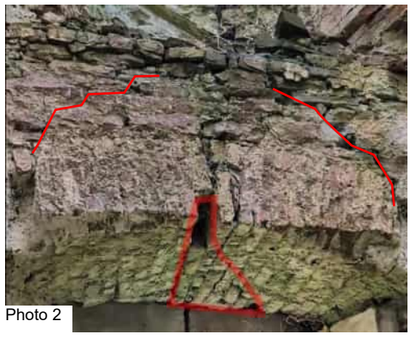
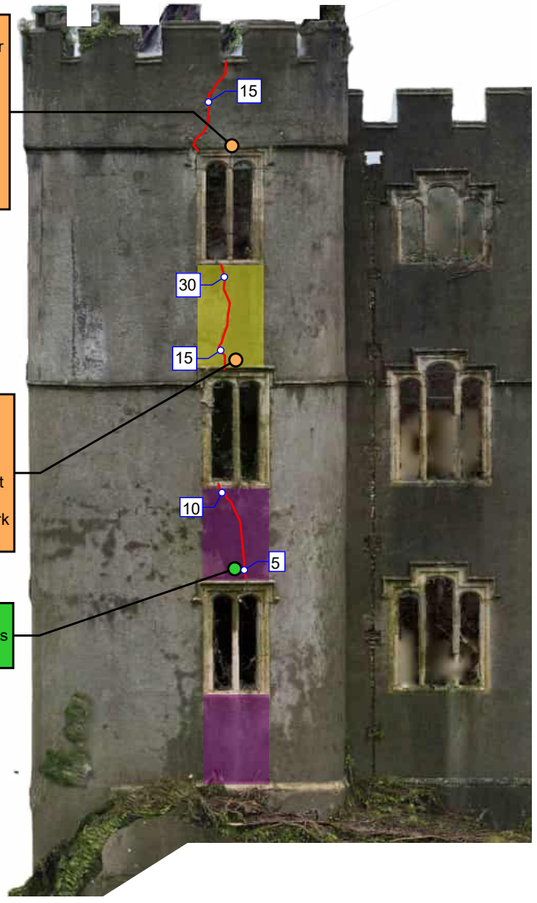


Photo 2


Photo 3


Photo 4

SOUTH ELEVATION



Arch in poor condition. Bricks missing from inner face, central section appears vulnerable. Several open joints between brickwork. Masonry over has historically been lost leaving head of arch exposed to weathering.

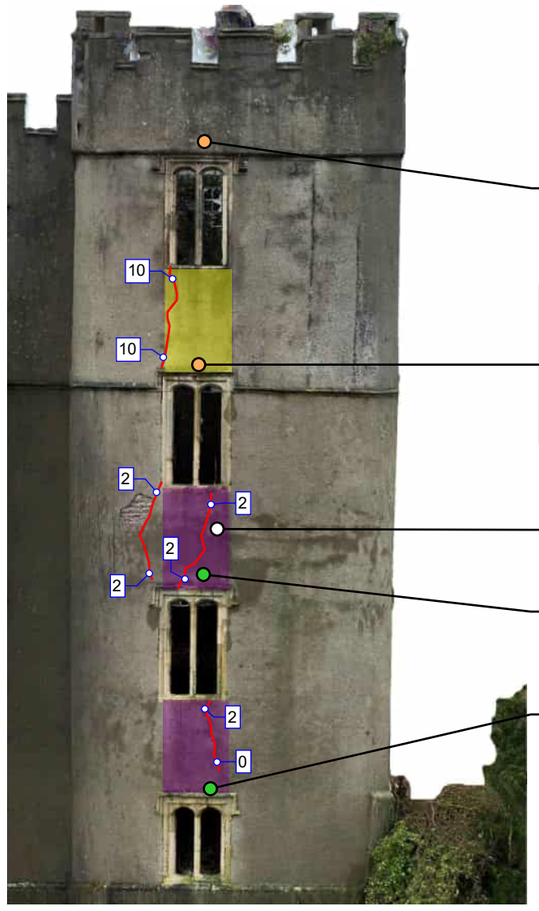
Photo 1

Arch in poor condition, some open joints on soffit at centre of arch. 1No. missing brick on inside face of arch. Bulge in soffit on outside face. Diagonal cracks on internal facework over arch.

Photo 2

Arch in reasonable condition, some open joints on soffit.

WEST ELEVATION



Arch in poor condition, missing localised bricks, open joints on soffit. North springing poorly supported.

Photo 4

Arch in poor condition, some open joints on soffit at centre of arch. 1No. missing brick on inside face of arch. Bulge in soffit on outside face. Diagonal cracks on internal facework over arch.

Photo 3

Crack continues through full spandral panel.

Arch in reasonable condition, missing localised bricks.

Arch in reasonable condition

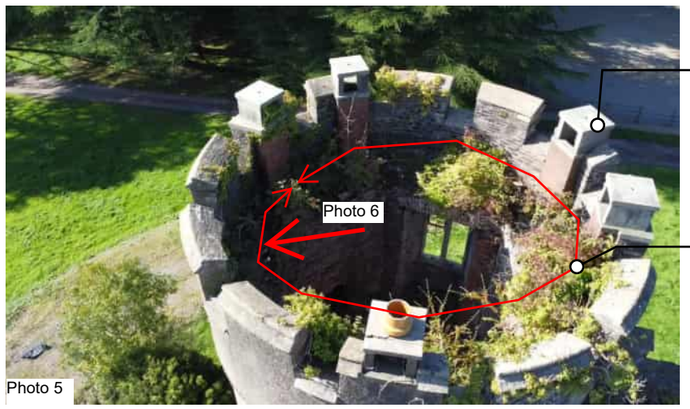


Photo 5

The tower has 5No. visible chimney stacks on the roof with flues that continue through the masonry walls below.

Significant Vegetation along head of full perimeter of tower. Significant shrub on north side. Masonry at wall head significantly deteriorated by ongoing vegetation growth and weather attack.


Photo 6

NOTES

1. This drawing is copyright and may not be reproduced without the permission of Mann Williams.
2. All drawings are to be read in conjunction with the project specification with all works carried out in accordance with the latest British Standards and codes of practice.
3. Any ambiguities or discrepancies between this drawing and any other information given elsewhere must be reported to Mann Williams for clarification before work proceeds.
4. All dimensions to be checked on site and any discrepancies reported to the engineer before work commences.
5. Only figured or calculated dimensions should be used and no drawing , in any format should be scaled.

KEY

- Spandrel panel historically reduced to thickness of stone windows (100-150mm thick)
- Thicker Spandral panel (approx. 400mm)
- Crack locations (shown indicatively)
- # Estimated crack width (mm) or estimated out of plane movement. E.g +10 denotes 10mm of movement away from the building. -10 denoted 10mm of movement into the building.

Note: Crack widths and out of plane movement distances provided were estimated from ground level and were not specifically measured on site.

REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	JB	18.10.24

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT

RUPERRA CASTLE

TITLE

STRATEGIC STRUCTURAL INSPECTION - SW TOWER

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DRAWN	CHKD	SIZE	SCALE	DATE
JB	PR	A3	NTS	08/08/24

STATUS

PRELIMINARY

PROJECT	DRAWING	REV
10247	SK08	P1