

Pennard Castle, Gower

Photogrammetric 3D Building Survey



Prepared
For

City and County of Swansea

By



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Crynodeb/Summary

Comisiynwyd Archaeoleg Mynydd Du Cyf gan Ddinas a Sir Abertawe i gynnal arolwg ffotogrammetrig o Gastell Pennard, Gŵyr. Nod yr arolwg yw i gynhyrchu ‘efell ddigidol’ ffotogrammetrig 3D manwl gywir o’r castell. Prif ffocws yr arolwg oedd Mur Llen y Gogledd, sydd wedi dioddef rhywfaint o gwaethygiad yn y blynyddoedd diwethaf. Mae adolygiad o fapiau a delweddau hanesyddol wedi’i gynnal i roi gwybod i ba raddau y mae’r castell wedi dirywio.

Mae’r adroddiad presennol yn nodi canlyniadau’r arolwg ffotogrammetrig 3D yn unol â Safon Sefydliad Siartredig yr Archeolegwyr ac yn rhoi arweiniad ar ymchwilio a chofnodi archeolegol o adeiladau neu strwythurau sy’n sefyll (cyhoeddwyd 2014, 2020); a Chanllawiau Arfer Da Ffotogrammetrig Ceisiadau Treftadaeth Ddiwylliannol a Lloegr Hanesyddol (cyhoeddwyd 2017). Cynhaliwyd arolwg o’r awyr (drôn) yn unol â’r rheolau a’r rheoliadau sydd wedi’u cynnwys yng Ngorchymyn Mordwyo Awyr 2016 a’i ddiwygiadau yn 2018 a 2019.

Black Mountains Archaeology Ltd were commissioned by City and County of Swansea to undertake a photogrammetric survey of Pennard Castle, Gower. The aim of the survey to produce accurate, measured 3D photogrammetric ‘digital twin’ of the castle. The main focus of the survey was the North Curtain Wall, which has suffered some deterioration in recent years. A review of historic maps and images has been undertaken to inform on the extent of the deterioration of the castle.

The present report sets out the results of the 3D photogrammetric survey in accordance with the Chartered Institute for Archaeologists Standard and guidance the archaeological investigation and recording of standing buildings or structures (published 2014, 2020); and Historic England’s Photogrammetric Applications for Cultural Heritage Guidance for Good Practice (published 2017). Aerial (drone) survey was undertaken in accordance with the rules and regulations contained within Air Navigation Order 2016 and its 2018 and 2019 amendments.

Acknowledgements and Copyright

The project was managed by Richard Lewis BA MCIfA. The photogrammetric 3D survey was undertaken by Richard Lewis and Libby Langlands BA MA. The report was prepared by Richard Lewis and Libby Langlands; the 3D modelling and illustrations by Richard Lewis. The Welsh translation of the summary was provided by Dr Rhys Morgan. The copyright of this report is held by Black Mountains Archaeology Ltd, who have granted an exclusive licence to the City and County of Swansea enabling them to use and reproduce the material it contains. Llyfrgell Genedlaethol Cymru/National Library of Wales provided permission to use Plates 1-7 and 12-15. The West Glamorgan Archives were very helpful and provided permission to use Plates 9-11 and 16. The RCAHMW kindly provided permission to reproduce the Figures 215-6, 218 and 219 from the Early Castles Inventory (1991) and Plates 18-21 and 23. Amgueddfa Cymru/National Museum Wales kindly gave permission to use Plate 8. Finally, the Gower Society kindly provided permission to reproduce images from Bernard Morris’s article on the castle (Plate 22). Ordnance Survey maps where published are reproduced under licence 100058761. Black Mountains Archaeology Ltd retain copyright of any annotations.

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Reference

Lewis, R, and Langlands, L, 2022, *Pennard Castle, Gower, Photogrammetric 3D Building Survey*. Black Mountains Archaeology Ltd Report No.256.

Photogrammetric 3D Building Survey

1 Introduction

- 1.1.1 Black Mountains Archaeology Ltd/*Archaeoleg Mynydd Du Cyf* were commissioned by City and County of Swansea to undertake a photogrammetric survey of Pennard Castle, Gower (Figure 1). The aim of the survey to produce accurate, measured 3D photogrammetric modelling of the castle utilising aerial (drone) and terrestrial digital cameras. The outcome a detailed 'digital twin' of the castle. The main focus of the survey was the North Curtain Wall, which has suffered some deterioration in recent years. A review of historic maps and images has been undertaken to inform on the extent of the deterioration of the castle and key dates where elements of the castle have been stabilised with conservation work. Any descriptions of the deterioration of the castle, particularly the north curtain wall, are from a visual archaeological perspective as opposed to structural, as we are not qualified to comment on the structural stability, weakness or otherwise of any part of the castle's standing masonry.
- 1.1.2 The programme of 3D photogrammetric survey was implemented according to the standards set out in *Historic England's Photogrammetric Applications for Cultural Heritage Guidance for Good Practice* (Published 2017). Aerial (drone) survey was undertaken in accordance with the rules and regulations contained within *Air Navigation Order 2016* and its 2018 and 2019 amendments.

2 Background

- 2.1.1 A comprehensive archaeological description has already been produced for Pennard Castle, see RCAHMW (1991, 288-296), Morris (1987, 6-15 and 2013, 107-115), Morris *et al* (2005, 12-13), and Newman (2001, 505-507). Bernard Morris' rather good account of the recent developments at the castle (1987, 6-15) were reprinted in his memorial book in 2013, a collection of his papers titled 'The Pleasure of Unravelling Secrets'. Whittle's (1992, 123-4) short description appears to be summarised from the RCAHMW (1991) Early Castles of Glamorgan Inventory. It is not the intention to repeat these detailed descriptions here. However, a brief note on the castle's development is provided to place the current works into context and key dates are noted in the results section on the castle's development and consequent decline.
- 2.1.2 Pennard Castle (SMGm044) is located on a promontory overlooking Pennard Pill; a be-sanded estuary on the south coast of Gower. It is associated with a contemporary deserted medieval church and village now situated within dunes immediately to the east. Meanwhile the medieval castle ringwork of Penmaen Burrows (SMGm129) is situated nearby on the western escarpment of the estuary.
- 2.1.3 Pennard was a demesne manor of the lords of Gower when it was acquired by Henry de Beaumont on his conquest of Gower between 1107-1119. Soon afterwards Pennard Church was included in an endowment to an ecclesiastical cell that he established at Llangennydd, Gower. Whilst there is no contemporary record of the castle itself, it is believed to have been established by this date in the form of an earthwork and palisade enclosure.
- 2.1.4 This early phase of the castle took advantage of the steep topography to the north and west, with a ring bank and ditch to the south and east together forming an oval enclosure measuring 34m x 28m in plan. Excavations in 1961 revealed evidence of a

palisade along the cliff to the west, which probably continued to the south along the same line of the later extant curtain wall. The stone footings of a rectangular hall were also uncovered to the west of the enclosure which predated the masonry defences and appeared to overlie an earlier timber hall. A section of wall found to the south of the enclosure indicates the presence of further internal structures.

- 2.1.5 The castle was fortified in stone in the very late 13th/early 14th century with light walling of modest strength that respected the earlier enclosure. The most well-preserved elevation is that of the north curtain, together with the northern half of the west wall, which survives to the height of the wall walk circa 5m above ground level. A 1741 engraving of the castle indicates that this curtain wall once featured crenelations, although very little physical evidence of this survives today. The fortifications also feature the substantial 'Edwardian' gatehouse at its eastern front and the square Western Tower, the latter being a later addition.
- 2.1.6 Sand encroachment on Pennard Pill had already begun by the 14th century. In 1317 William De Braose granted hunting rights at Pennard to his huntsmen but excluded his rabbit warren located 'in the sand dunes'. Much like at Penmaen and Kenfig, as well as the Gower village of Rhossili, the be-sanding necessitated the building of a new church further inland and the gradual abandonment of the old village and castle, which was described as 'ruinous' in 1650 (RCAHMW 1991).

3 Location, Topography, Geography and Airspace

- 3.1.1 The photogrammetric survey area is located at Pennard Castle (SMGm044) on the south coast of Gower at NGR SS 254423.218,188500.759.
- 3.1.2 Pennard Castle is located within uncontrolled Class G airspace (<FL195). The photogrammetric (aerial) survey area is positioned within the restricted airspace of Swansea Airport's Runway Protection Zone (RPZ: SFC to 2000FT). Permission was sought from Swansea ATC who confirmed the survey can be undertaken in the RPZ provided the UAV pilot has the correct permissions from the CAA.
- 3.1.3 The geology of the survey area is the Gully Oolite Formation, Ooidal Limestone, these are sedimentary bedrock formed approximately 345 to 347 million years ago in the Carboniferous Period (BGS 2022). Superficial deposits include windblown sand dating to the Quaternary Period (3million years ago), with an acceleration of deposits from the medieval period.

4 Objectives

- 4.1.1 The main objectives of the photogrammetric (terrestrial and aerial) survey was to produce metrically accurate rendered photorealistic 3D modelling of the survey area, buildings and general scenes georeferenced with high accuracy. The outcome a detailed 'digital twin' of the castle. Modelling utilised Structure from Motion (SfM) photogrammetric techniques obtained through camera capable SUA (drone) and DSLR camera to produce measurable 3D models of the photographed scene. The term photogrammetry was first coined by a Prussian architect Albrecht Meydenbauer in an 1867 article called 'Die Photometrographie' and Dominique Arago, a French surveyor, was using photographs to create topographic maps as early as 1840. Modern photogrammetric methods used flat lensed cameras to create photogrammetric montages of buildings or other methods such as stereoscopy using multiple aerial images to create the illusion of depth (3D) from 2D images. Present day

photogrammetry uses sophisticated algorithms and workflows to digitally stitch each pixel together to create real world measured 3D representations of the photographed scene with outputs including dense point clouds (LAS), triangular meshes (OBJ) and orthophotography (plans and elevations – georeferenced TIFF). The accuracy or more appropriately the margin of error is calculated using the ground sampling distance (GSD), which is the distance between two adjacent pixel centres normalised to real world dimensions. Centimetre accuracy of photogrammetric outputs is reached by using Real Time Kinematic (RTK) GPS (satellite navigation systems) survey methods of control points within the surveyed area.

- 4.1.2 The *definition* of an archaeological **Building Investigation and Recording** as set out by the *Chartered Institute for Archaeologists* (CIfA) is a programme of work intended to establish the character, history, dating, form and archaeological development of a specified building, structures, heritage assets or complexes and its setting, including buried components, on land, inter-tidal zone or underwater.
- 4.1.3 The *purpose* of an archaeological Building Investigation and Recording is to examine a specified building, structures, heritage assets or complexes, and its setting, in order to inform:
- the formulation of a strategy for the conservation, alteration, demolition, repair or management of a building, or structure, or complex and its setting.
 - or
 - to seek a better understanding, compile a lasting record, analyse the findings/record, and then disseminate the result.
- 4.1.4 (Chartered Institute for Archaeologists Standard and guidance for the archaeological investigation and recording of standing buildings or structures. Published 2014, 2020)

5 Legislative Framework

- 5.1.1 The rules and regulations for the use of UAS (Unmanned Aircraft Systems or drones) in UK airspace is set out in the *Air Navigation Order 2016* and its *2018* and *2019* amendments. The CAA publishes the ANO within CAP393 (Civil Aviation Publication). CAP382 details the safety occurrence reporting scheme for aircraft. CAP722 Unmanned Aircraft System Operations in UK Airspace – Guidance and Policy, is compiled by the Civil Aviation Authority's Unmanned Aircraft Systems Unit (UAS Unit). CAP722 is intended to assist those who are involved with the development, manufacture or operation of UAS to identify the route to follow in order that the appropriate operational authorisation(s) may be obtained and to ensure that the required standards and practices are met. Its content is primarily intended for non-recreational UAS operators and guides all commercial UAS activity, resulting in UAS pilots/operators needing to obtain an Operational Authorisation (OA), formerly the Permission for Commercial Operations (PfCO). All UAS flights were operated within the limitations and conditions of the company Operational Authorisation (OA), Operations Manual and the applicable articles of the ANO.
- 5.1.2 Any works affecting an ancient monument and its setting are protected through implementation of the *Ancient Monument and Archaeological Areas Act 1979*. In Wales the 1979 Act has been strengthened by *The Historic Environment (Wales) Act 2016*. The 2016 Act makes important improvements for the protection and management of the Welsh historic environment. It also stands at the centre of an

integrated package of secondary legislation (Annexes 1-6), new and updated planning policy and advice, and best-practice guidance on a wide range of topics (*TAN 24 Historic Environment*). Taken together, these support and promote the careful management of change in the historic environment in accordance with current conservation philosophy and practice.

- 5.1.3 The *Ancient Monument and Archaeological Areas Act 1979* and *The Historic Environment (Wales) Act 2016* sets out a presumption in favour of preservation *in-situ* concerning sites and monuments of national importance (scheduled/listed), and there exists in the current *Planning Policy Wales (Chapter 6)* a presumption in favour of preservation *in-situ* of all types of heritage assets.

6 Methodology

- 6.1.1 The investigations consisted of an archaeological survey to produce accurate, measured 3D photogrammetric modelling of the castle utilising aerial (drone) and terrestrial digital cameras. The outcome a detailed 'digital twin' of the castle. The main focus of the survey was the North Curtain Wall, which has suffered some deterioration in recent years. Any descriptions of the deterioration of the castle, particularly the north curtain wall, are from a visual archaeological perspective as opposed to structural, as we are not qualified to comment on the structural stability, weakness or otherwise of any part of the castle's standing masonry.
- 6.1.2 The survey was carried out by multiple UAVs (drones), each equipped with a Hasselblad 35mm equivalent 20mp, 1" sensor, 4k UHD camera; a 35mm equivalent 20mp, 1" sensor, fitted with a mechanical shutter and 4k UHD camera; a 35mm equivalent (24mm) camera with a 12mp 1/2.3" CMOS sensor and a terrestrial Canon EOS 2000D DSLR camera with a 24.7mp, 22.3mm x 14.9mm CMOS sensor. The terrestrial and aerial survey was tied into the Ordnance Survey National Grid and Datum using a GNSS/Glonass (GPS) RTK Receiver and data logger with a <20mm tolerance.
- 6.1.3 All 3D models were produced using proprietary photogrammetry software and aligned using known ground control points (GCPs). Dimensional control was then applied to the 3D model and then reprocessed using the new parameters to create dense point clouds (LAS) and high face count meshes exported to OBJ format. All high-resolution orthographic renders (orthoplanes and orthomosaics) were exported and scaled in raster (JPEG) format.
- 6.1.4 The survey was undertaken over two days on the 14th January 2022 and 24th January 2022. The weather was clear and fine on the 14th January 2022, with strong but low winter sunlight that cast shadows over the survey area during the course of the day. The weather was overcast on the 24th January 2022 but with good light conditions for the survey.
- 6.1.5 The capture, processing and output of 3D models conformed to professional industry standards and best practice guidelines set out by Historic England's *Photogrammetric Applications for Cultural Heritage Guidance for Good Practice* (2017). A digital copy of the report and archive will be supplied to Pennard Golf Club, Swansea Council, CADW, the regional HER and the Royal Commission on the Ancient and Historical Monuments of Wales.

7 Results

7.1.1 The investigations consisted of an archaeological survey to produce accurate, measured 3D photogrammetric modelling of the castle utilising aerial (drone) and terrestrial digital cameras. The outcome a detailed 'digital twin' of the castle. The main focus of the survey was the North Curtain Wall, which has suffered some deterioration in recent years. To place the present condition of Pennard Castle into context, detailed research was undertaken to try and establish, as far as reasonably possible, a visual or documentary history of the castle and the key moments when the monument experienced physical change. Any descriptions of the deterioration of the castle, particularly the north curtain wall, are from a visual archaeological perspective as opposed to structural, as we are not qualified to comment on the structural stability, weakness or otherwise of any part of the castle's standing masonry.

7.2 Photogrammetric 3D Survey

7.2.1 The survey of the castle to create a 3D photogrammetric digital twin was undertaken using three UAV (drone) aircraft types and a handheld DSLR camera. The monument was photographed from all angles, including internal spaces (square tower, half-round mural tower, garderobe and gatehouse towers). The resultant high-resolution photographs were then processed in proprietary photogrammetry software and aligned using five ground control points (GCPs), which were surveyed with a GNSS/Glonass (GPS) RTK Receiver with a sub-20mm error margin to OSGB36 (National Grid). The Ground Sampling Distance (GSD) achieved was an excellent 0.46cm/pixel. Dimensional control was then be applied to the model and then reprocessed using the new parameters to create a dense point cloud of over 187 million points and high face count meshes, exported to OBJ format, with a mean RMS error of 0.07cm. All high-resolution orthographic renders (orthoplanes and orthomosaics) were exported and scaled in raster (JPEG) format from the detailed 3D model for the production of elevation and plan drawings (Figures 1-8).

7.2.2 The full high resolution photogrammetric 3D model (digital twin) and orthomosaic plan for Pennard Castle forms the primary record and has been supplied as individual OBJ files over 3.4GB in size. The 3D model was then decimated (reduced in size) by 70% to enable uploading to an online interrogable 3D viewer, which has a 1GB size limit, here <https://cloud.pix4d.com/dataset/1174971/model?shareToken=b0d5b379-e040-4583-b3af-eee08bc48e00>. A lower resolution 3D model was also animated as a visual interpretative aid. The 3D animation can be found here https://youtu.be/IICwdLk_wcg.

7.3 Documentary Evidence and Castle Description

7.3.1 The following descriptions are not meant to be an exhaustive account of the documentary/pictorial history of Pennard Castle but rather a note on some of the available documentary evidence that provides insights into the development and deterioration of the castle, particularly the north curtain wall.

7.3.2 *12th century (Figure 1)*

7.3.3 Primary ringwork constructed in the 12th century (Figure 1) together with primary timber hall, probably after 1119 when Pennard Church was included in an endowment by Henry de Beaumont, Earl of Warwick, to an ecclesiastical cell that he established at Llangennydd, Gower. This early phase of the castle took advantage of the steep

topography to the north and west, with a ring bank and ditch to the south and east together forming an oval enclosure measuring 34m x 28m in plan. Excavations in 1961 (Alcock 1961, 81) revealed evidence of a palisade along the cliff to the west, which probably continued to the south along the same line of the later extant curtain wall. The stone footings of a rectangular hall were also uncovered to the west of the enclosure which predated the masonry defences (and appeared to overlie the earlier timber hall). A section of wall found to the south of the enclosure indicates the presence of further primary internal structures.

7.3.4 Windblown sand inundation is first referenced in 1317 when William de Braose granted hunting rights to his huntsman, excluding the rabbit warren in the sand dunes (RCAHMW 1991, 289). Although Toft (1988, 30) notes that the excavation of a medieval house to the north of the castle found windblown sand in deposits predating the 14th century. Hugh Despenser, Lord of Glamorgan, was permitted under Royal licence in 1322 to obtain Pennard Castle from the possession of the widow of John de Burgo (RCAHMW 1991, 289).

7.3.5 *Late 13th/early 14th century*

7.3.6 The castle was fortified in stone in the very late 13th/early 14th century with light walling of modest strength that respected the earlier enclosure (Figure 1). Exceptionally hard lime mortar has to some degree helped with the preservation of the masonry. The castle consists of an Edwardian Gatehouse of flanking round (drum) towers, oval curtain walls with a half-round mural tower on its northwest angle complete with garderobe, a second projecting garderobe immediately to the east and a large square tower abutting the western curtain defences. Both the western square tower and half-round mural tower are almost certainly residential as opposed to defensive. There is no evidence of any internal stone stairs. The curtain wall measures around 1.1m to 1.3m in width and follows the course of the defensive rampart of the primary ring ditch castle. The ditch on the south-western side was visible in the present survey despite significant besandment. The curtain wall is distinctive in that two sources of stone were used in its construction. The lower half is of red sandstone and upper half a lighter colour limestone. This is most evident in the short section or stub of surviving curtain wall on the southwest defences, which retained its crenelations as late as 1952. Several theories have been put forward on the provenance of the lower red sandstone, with the RCAHMW suggesting Cefn Bryn as a possible source, Bernard Morris's more sensible suggestion is an outcrop a little over 100m to the southwest and Leslie Alcock suggests that stone from the primary hall was used after demolition (RCAHMW 1991, 293). The wall walk survives relatively intact along the north curtain wall and while covered in ivy growth there may be the remnants of merlons surviving. However, the crenelations on the north curtain have largely been lost, with the most recent collapse identified in the 20th century (see Figures 2-5).

7.3.7 *16th and 17th centuries*

7.3.8 Further evidence of besandment and abandonment at Pennard Castle and Church can be gleaned from a letter sent to the King's Commissioners in 1535 by the incumbent of Pennard Church (adjacent to Pennard Castle), Henry Hopkins noted how his church, house and glebe land were affected by the drift of sands of the sea. He also noted that tenements had been abandoned resulting in a loss of income for the church (Toft

1988, 30-32). It is probable that by this point Pennard Church and any surviving elements of the village were abandoned due to besandment. Although how long the medieval village survived is not known but it is likely that the village moved higher up the valley.

7.3.9 Baker and Francis (1870), quoting Oliver Cromwell's Survey of Gower in 1650, note on several occasions the besandment of the castle, its ruinous state and loss of agricultural land to common grazing.

- *"The Castle of Penard was anciently the scite thereof but now there remains but but parte of the ruines, and by old surveys the demeazne lands are affirmed to lye between the old Church and the said Castle, and thence extendinge to Penards Bridge and to the cliffes but now the said lands are wholly besanded by meanes of the enarnesse thereof vnto the sea and rendered altogether vunprofitable, lyeinge open coñon"* (ibid 1870, 69).
- *"...there is also another coñon called Penard's Burrows, wherin the inhabitants have coñon as aforesaid, but the same is now for the most parte overspread with sand"* (ibid 1870, 80).

7.3.10 The castle was finally recorded as,

- *"...there remayneth Scittuaçon of the Castle of Pennard, Desolate and ruinous, and soe long time vnrepayred that scarcely there remayneth one whole wall. It standeth vppon a Rocke neare adjoyneing to the sea, and now compassed with much sand. And for Demanes thereof we find in auncient paper which is in the nature of a Survey that the Demayns thereof is betweene the ould Church besanded to the said Castle and from thence to Pennards Bridge, and from thence to the three Cleeves"* (ibid 1870, 315).

7.3.11 Although, this last description is at odds with the Buck Brothers engraving (Plate 1), which shows the north curtain walls relatively intact in a little under a hundred years later.

7.3.12 *18th century*

7.3.13 The engraving by Samuel and Nathaniel Buck dated to 1741 (Plate 1) is titled Pennarth or Penkerth Castle and is the earliest depiction of the castle. Samuel Buck (1696-1779) and his brother Nathaniel (died between 1759-1774) were arguably the finest topographers and artists of historic places in the mid-18th century. The brothers created over 400 engravings of historic buildings (castles, monasteries, mansions etc) and over 80 views of towns and cities from 1726 to around 1759. The combined works known as Buck's Antiquities were often sold in sets by county or subscribers, such as the Society of Antiquaries and members of the nobility. They toured England and Wales visiting predominantly the landed gentry and their estates, who became benefactors/subscribers, creating numerous sketches from which finished drawings were developed and engraved.

7.3.14 The Buck brothers engraving (Plate 1) depicts Pennard Castle in fairly good condition but with the usual vegetation on wall tops suggestive of a ruinous state of the monument. The engraving places the castle into landscape context, with Oxwich Castle (SMGm043) and the Church of St Illtyd's (LB11536) at Oxwich shown (probably a little stylised) in the distance. Five tall ships are anchored in Oxwich Bay and a

beached boat on Three Cliffs Bay. The view takes in the north curtain wall of Pennard Castle and the gatehouse.

- 7.3.15 The castle is shown perched upon a small craggy cliff with the land steeply sloping northwards to Pennard Pill. Today, this craggy cliff has all but disappeared under windblown sand, with blackthorn and other scrubby species now taken hold over where the cliff tops once stood. The gatehouse towers are shown at full height complete with several merlons and one crenel visible on the south drum tower, but with what appears to be some masonry loss to the northeast curtain wall where it connects to the north drum tower. The northeast curtain wall (Figure 3) appears fairly intact with several merlons and one crenel visible together with two arrow loops. One arrow loop is in the merlon; a similar arrow loop positioned in a merlon was also noted on the west curtain wall above the square tower (Plate 15). The lower arrow loop matches the approximate location of the surviving arrow loop. The corner of the north curtain wall, where the north-eastern and north walls marry, is shown as a sharp corner. Historic photographs and the existing remains all show that this corner of the curtain wall is curved. Therefore, the depiction of the corner of the curtain wall is again shown with some artistic licence.
- 7.3.16 The north curtain wall (Figure 2) is shown in good detail with the half-round mural tower on its northwest angle and the collapsed garderobe void in the masonry at the base. The second projecting garderobe immediately to the east is shown intact with no void as it is today. The large square tower is shown abutting the western curtain defences as it is today with no crenelations. There is no evidence shown of the masonry loss to the base of the north curtain wall, which is visible today on the eastern and central areas of the wall (Figures 2 and 8; Plates 23, 26-27). The crenelations on the north curtain wall and the half-round mural tower are shown intact.
- 7.3.17 The square tower shown behind the north curtain wall is not a tower and must be the truncated remains of the south curtain wall, which today survive as a small upright section. An arrow loop, merlon and crenel are depicted, which marry well with early images (Plates 4, 12, 13, 18, 20-21 and 22) of this surviving element of the south curtain wall. The remaining masonry shown behind the north curtain wall is the internal remains of the north drum tower.
- 7.3.18 Pennard Castle is depicted again at the end of the 18th century in several water colours by John Warwick Smith, a famed landscape artist from Cumbria who visited Wales numerous times (Plates 2 and 3). Smith illustrated a view to the southwest of Pennard Castle in 1795 (Plate 2). Here the absence of windblown sand against the cliffs below the north curtain wall is shown again together with four people working in the fields. The north curtain wall is shown relatively intact but now with a void in the lower part of the projecting garderobe, matching the void in the masonry immediately to the west in the half-round mural tower. The putlog holes are shown as a feature of the north curtain wall, the half-round mural tower and the square tower. It is tempting to consider the harder black lines visible at the base of the north curtain wall as showing the masonry deterioration we see today (Figure 2 and 8) but the depiction of the castle is in the distance of the painting and thus it is more likely shading.
- 7.3.19 The second view of the castle by John Warwick Smith is to the east from Three Cliffs Bay (Plate 3), again in 1795. The south curtain wall is not visible, except a small squarish piece of masonry to the south (right) of the castle, which probably represents

the surviving stub of the south curtain wall. The square tower together with the mural tower are shown, the latter perhaps a little stylised. What is quite interesting is the vast swathe of windblown sand below the castle, which to some extent mirrors the view today, albeit with less vegetation present.

7.3.20 19th century

- 7.3.21 Views of the castle in the 19th century include romantic engravings and early photographs and provide a very good visual record. Henry Gastineau (1791–1876) was an English engraver and prolific painter. He published an engraving of a view towards the west of Pen Arth (Pennard) Castle in 1823 (Plate 4). The image shows the gatehouse and the south curtain wall stub in a little detail, including crenelations, and a short surviving section of the south curtain wall connected to the south drum tower. The latter shows several crenels surviving but no merlons. Half of the drum tower and the southeast curtain wall section have since collapsed. The southeast curtain wall section appears to show a deteriorating arrow loop. The gatehouse generally and the north drum tower mirrors the survival of masonry depicted by the Buck brothers (Plate 1).
- 7.3.22 John Henry Robinson (1796–1871) produced an engraving of Penarth (Pennard) Castle in 1830 (Plate 5). The image shows the castle in the distance outlined by the sky and the north curtain wall free of vegetation. The image of the castle is too distant to be of any further help, although it does paint a romantic view of the castle and surrounding landscape.
- 7.3.23 Newman & Co. (London) published an engraving of Pennard Castle and Oxwich Bay in 1850 (Plate 6). The image shows the castle in the middle ground, with small boats in Oxwich Bay and a steamship out in the Bristol Channel. A person with a horse and covered cart on a road in the valley is also visible but this looks peculiar given Pennard Pill should also be in this location. The engraving shows the castle in a state of disrepair. The north drum tower and northeast curtain wall with some significant deterioration of masonry, a large void in the northeast curtain wall in particular. This is odd given later depictions of the northeast curtain do not show this hole until the middle of the 20th century. Putlog holes are again a feature of the north curtain wall and voids in the projected garderobe and mural tower. What is perhaps interesting is an area demarked by shadow on the corner of the northeast and north curtain wall that may show fallen stonework in the location of the masonry deterioration we see today in this position (Figure 2 and 8).
- 7.3.24 A lithograph print of Pennard Castle dated around 1860 (Plate 7) shows just the gatehouse of the castle. No curtain walls, indeed, no other walls or associated features belonging to the castle are shown. Both drum towers are shown, the south with one arrow loop high up on the tower; the north with two arrow loops, one high up and the other partway down the tower. No crenelations are visible and the segmented arch of the window above the gateway has some stones missing. Pennard Pill to the right of the picture appears high and a lot wider than in reality.
- 7.3.25 A print created in 1934 from Francis Lockey's calotype negative (Plate 8) shows one of the earliest photographic images of the castle in 1855-60. Here we find the first detailed view of the interior of the gatehouse and its state of preservation. The interior of the south drum tower has collapsed, probably when the south curtain wall came down in the later medieval period, although this is purely speculative. A stub of the

south curtain wall can be seen standing at around a metre in height extending outwards from the south drum tower for a few metres. At least three merlons are visible surmounting the south drum tower and the southeast facing wall is still intact, half of which later collapsed sometime shortly before 1911. The image shows a good depiction of the gatehouse interior pre-concrete repairs (1923-4), but the two surviving merlons and single crenel have been altered, with the latter appearing to have risen in height slightly in the current survey. The interior and south wall of the north drum tower is higher than today and shows around six courses of masonry above current levels, which are now lost. Also visible is a substantial height of masonry belonging to the northeast curtain wall (Figures 3, 4, 5 and 6) on the interface with the north tower. This masonry, now lost, is also shown on the Buck brother's engraving (Plate 1) and also Henry Gastineau (Plate 4), and later images including Dillwyn Llewelyn 1870s photographs and P.B.Abery's late 19th century photographs. This higher part of the north gatehouse tower and northeast curtain wall must have collapsed possibly after 1911 (Plate 16) and certainly by the Second World War (Plate 19). Also visible is a small section of the northeast curtain wall, with an internal putlog hole above the wall walk, which has since collapsed. It is difficult to gauge how much of the wall has come down but comparisons with later images (Figure 5; Plates 10, 16 and 19) show that part of this wall and putlog hole appeared to have survived well into the 20th century, collapsing sometime after 1991 (Plate 23).

- 7.3.26 A collection of photographs from the Dillwyn Llewelyn archives shows a family outing to the castle in 1874 (Plates 9-11). The photographs are located around the gatehouse and then several from Pennard Pill looking up to the castle's north curtain wall. Plate 9 shows the gatehouse in detail with a large crack down the centre of the south drum tower, where the collapse of half of this tower occurs only a few decades later. The pre-concrete repairs (1923-4) stonework can be seen at the base of each tower and inside the gatehouse, as can the eroded entrance to the half-round tower on the north curtain wall, the wall walk and a crenel. Of particular note are the two characters standing in the gatehouse entrance. An elderly couple in formal 19th century clothing. It is possible that this is a photograph of John Dillwyn Llewelyn and his wife Emma Thomasina, nee Talbot. They would have been in their mid-60s in 1874 and the gentleman in the photograph has the long 'mutton chops' facial hair for which he was famous. John Dillwyn Llewelyn was founder member of the Royal Photographic Society and a pioneer of early photography. John's daughter Thereza was also a noted photographer and scientist, and it is possible that she took this photograph of her parents (Plate 9).
- 7.3.27 Plate 10 shows a very early image of the interior of the north curtain wall from the corner with the northeast section of curtain wall west almost to the projecting garderobe. The image clearly shows the deterioration of the lower courses of the curtain wall and while there has been significant loss of stonework, particularly facing stones, in this area since this photograph was taken the extent is not as great as was first assumed. The general profile of the collapsed masonry today can be loosely aligned with the historic collapse shown in Plate 10 and while in places four or five courses have been lost, these tend to be localised. The greatest loss though is along the wall walk and the crenelations. This is where the parallels between Plate 10 and the present survey divorce. The wall walk has collapsed in several places in the centre of the curtain wall and masonry has been lost along the wall tops, presumably what

was left of the merlons and crenels have now disappeared. The final Dillwyn Llewelyn photograph from 1874 (Plate 11) is very useful despite the extreme distance of the castle. The profile of the north curtain wall can be seen clearly together with the possible remains of one merlon to the east and then nearly full crenelated defences surviving sweeping around from the half-round mural tower to the western curtain wall above the square tower. Today only one eroded crenel survives on the half-round tower and the crenelations on the curtain wall above the square tower have all but disappeared (a hint of two surviving crenels can be seen in the present survey).

- 7.3.28 Plate 12 is an undated inkwash drawing of Pennard Castle. While broadly 19th century in date it has been included as the image shows an almost full height section of surviving south curtain wall attached to the south tower of the gatehouse. The section of curtain wall has one upper arrow loop, and the width of wall loosely matches the small area or stub of south curtain wall noted in Francis Lockey's calotype negative (Plate 8). Henry Gastineau's engraving (1823) shows this wall section in a much-dilapidated state with a large hole in the wall, presumably the eroding arrow loop. Therefore, this drawing (Plate 12) could predate Henry Gastineau's engraving of 1823. The image also shows missing stonework from the base of the drum towers but otherwise the north curtain wall looks intact, complete with eroding crenelations. This image also truthfully shows the corner of the north curtain wall curving.
- 7.3.29 A collection of photographs (Plates 13-15) by P.B. Aberly taken at the turn of the 20th century (c1900) shows the castle a few short years before the significant collapse of the gatehouse's south tower (before 1911). P.B. Aberly lived Builth Wells in 1898 and came from Folkestone in Kent. He became a noted and popular local photographer. He owned a photography studio in the town and was the official photographer for the Birmingham Water Works at the Elan Valley. His photograph of the gatehouse (Plate 13) shows the south drum tower still intact (east facing elevation) with dilapidated crenelations. The gatehouse entrance arches are intact as is the northeast curtain wall as it curves around to the north curtain wall (complete with putlog holes and arrow loops). The base of the drum towers show the deterioration of stonework visible in earlier images, with the south drum tower losing more stonework when comparing the photograph with the Dillwyn Llewelyn photographs (Plate 9) of only a few decades before. There has been some loss of masonry to the gatehouse above the window with around eight courses having been lost with the remainder stabilised with concrete capping, probably during the 'concrete' conservation works of 1923-4. The south curtain wall is now a stub of masonry a metre or so off the ground. Further west the other surviving stub of south curtain wall is visible in detail complete with putlog holes and crenelations standing to what must have been near full height of the original curtain wall. An arrow loop is visible in one of the merlons. Both the arrow loop and half of this surviving wall collapsed in 1959. Some evidence of repair is visible to the surviving south curtain wall, with repairs in masonry, presumably in 1963 during conservation work.
- 7.3.30 Plate 14 shows Aberly's view of the gatehouse again but this time including a much dilapidated west curtain wall where it meets the square tower. The presumed original doorway into the square tower probably acting as a catalyst to the destabilisation of the stonework above. Plate 15 offers a good view of the interior of the north and west curtain walls. Crenelations are visible along the west curtain wall, including an arrow loop in one merlon. These are all now missing except the base of two of the crenels.

The half-round tower's crenel appears together with a surviving merlon on the north curtain wall, the latter now also gone with a significant loss of masonry here. The wall walk along the west curtain wall and the visible section on the north curtain appears to survive relatively well today. The doorways into the half-round tower and project garderobe have survived well since this photograph was taken, however, the latter is now missing much of its eastern jamb and springer. Of interest and shown in the south drum tower is an enfilading arrow loop, which was destroyed when half of this tower (east facing elevation) collapsed before 1911 only a few years after this photograph was taken.

- 7.3.31 The first pictorial evidence for what is arguably one of the most serious structural failures dates to 1911, a souvenir guide to Swansea and district, commemorating the coronation of King George V (Plate 16). This image shows for the first time the collapse of the east facing elevation of the gatehouse's south drum tower along the fault line and arrow loop seen in earlier images. The gatehouse archway is shown in a pretty perilous state with only a few stones holding the arch together. The northeast curtain wall is shown still reasonably intact, although this has now been lost. It is tempting to consider that the gentleman in the photograph in the bowler hat and overcoat may have been surveying the remains for the then Office of Works. A photograph from around this time was used to produce postcards, one with a postal date of 1934 (Plate 17). The photograph must have been taken between 1911 and 1924 when the south drum tower partially collapsed but before the 'concrete' conservation works of 1923-4. The image also shows the northeast curtain relatively intact but the north curtain is in shadow so little can be seen. The west curtain wall's crenels can just be made out.
- 7.3.32 Plates 18-21 (Figures 4 and 5) are images held by the RCAHMW and date to 1941. These images show the 'concrete' conservation works carried out a little under twenty years before. Bernard Morris (1987; 2013, 111-13) helpfully fills in the blanks regarding the conservation work carried out in concrete. The Council of the Royal Institution of South Wales minute books (1923 and 1924) records an agreement with Pennard Golf Club and the Cambrian Archaeological Association to repair the castle "...to organise a scheme whereby the decay of Pennard Castle maybe arrested and the ruins preserved..." (Morris 1987; 2013, 112). The repairs in concrete included stabilising the south tower of the gatehouse after the collapse nearly fifteen years previous, the gatehouse archway and gatehouse wall tops. The perilous collapsing door through the west curtain wall into the square tower was also repaired and a faux doorway left inserted. In addition to the repairs, Plate 18 also shows the arrow loop in the north eastern curtain wall had started to deteriorate with a sizable hole in the wall. But even at this late-stage Plates 20-21 show significant masonry surviving on the north curtain wall, not recognisable as crenelations at this point anymore but still a significant loss of the parapet towards the half-round tower compared with the present survey. Of the two crenels visible on the surviving stub of the south curtain wall in Plate 21, only the eastern eroded crenel now survives. The arrow loop and merlon to the west has not survived. Half of this surviving stub of the south curtain wall collapsed outwards in early 1960 (Morris 2013, 113).
- 7.3.33 Bernard Morris (*ibid*) describes the collapse of around half of the surviving south curtain wall in 1960 (Plate 22). The Gower Society recorded both the view of the south curtain wall in 1952 before collapse and then in 1960 after around half of the wall fell down. Morris then describes the campaign to raise funds to save the remaining

masonry and further conserve the castle. The South Wales Evening Post ran an article on 26th April 1963 to help raise awareness and funds for the campaign. On the 1st November 1963 the Evening Post reported that the repairs were expected to start on the 11th November that year. The repairs were carried out in stone and attempted to blend in with the original stonework. The south curtain wall was stabilised, and the repairs can be seen in lighter colour stone. It would appear that the hole on the northeast curtain wall arrow loop was also repaired at this time. When the RCAHMW surveyed the castle in the 1980s (published 1991), they recorded the hole in the northeast curtain as a void on their elevation drawing (Figure 3), however, Plate 23 shows the void repaired indicating that the repair work may not have been carried out in 1963. Plate 23 also shows the northeast curtain with a large area of masonry collapse but with one putlog hole surviving adjacent to the repaired arrow loop. By the time Toby Driver (RCAHMW) took the aerial photograph below in 2005 the putlog hole and surrounding wall had disappeared

- 7.3.34 (<https://rcahmw.ibase.media/en/view-item?i=56767&WINID=1655221972637>)
- 7.3.35 Further repairs appear to have been made to the northeast curtain wall after 2010, in particular the arrow loop. Another of Toby Driver's aerial photographs (below) of that date show the arrow loop in the same condition as Plate 23 in 1991 and 2005. However, later RCAHMW aerial images and the present survey record the arrow loop fully restored.
- 7.3.36 <https://rcahmw.ibase.media/en/view-item?i=27793&WINID=1655221972637>
- 7.3.37 On the 14th June 2021 Wales Online (<https://www.walesonline.co.uk/news/wales-news/three-cliffs-bay-castle-swansea-20809134>) ran with a story about people scaling the walls (north curtain wall) and lighting fires. These activities contributing to the further deterioration of the castle's masonry, particularly the north curtain wall and wall walk. The news article also alluded to funding being made available for the conservation, repair and interpretation of the castle.
- 7.3.38 The present photogrammetric 3D survey of Pennard Castle and the research into the documentary evidence for the castle's deterioration and repair has been carried out in response to these recent activities.
- 7.3.39 *Timeline*
- 7.3.40 **12th century:** primary ringwork constructed together with timber hall, probably after 1119.
- 7.3.41 **1317:** windblown sand first mentioned when William de Braose granted hunting rights to his huntsman.
- 7.3.42 **1322:** Hugh Despenser, Lord of Glamorgan, was permitted under Royal licence to obtain Pennard Castle from the possession of the widow of John de Burgo.
- 7.3.43 **Late 13th/early 14th century:** castle was fortified in stone with light walling of modest strength that respected the earlier enclosure. Distinctive curtain wall of two sources of stone were used in its construction.
- 7.3.44 **1535:** a letter sent to the King's Commissioners by Henry Hopkins noted how his church, house and glebe land were affected by the drift of sands of the sea and tenements abandoned.

- 7.3.45 **1650**: Oliver Cromwell's Survey of Gower in 1650 notes on several occasions the besandment of the castle, its ruinous state and loss of agricultural land to common grazing.
- 7.3.46 **1741**: Buck brothers engraving (Plate 1) is the earliest depiction of the castle. South curtain wall ruinous.
- 7.3.47 **1795**: John Warwick Smith paints several water colours of the castle (Plates 2 and 3). Absence of windblown sand against the cliffs below the north curtain wall, which is shown relatively intact but now with a void in the lower part of the projecting garderobe. Vast swathe of windblown sand below the castle.
- 7.3.48 **Pre-1823**: undated inkwash drawing (Plate 12) of Pennard Castle showing an almost full height section of surviving south curtain wall attached to the south tower of the gatehouse.
- 7.3.49 **1823**: Henry Gastineau engraving (Plate 4) showing gatehouse and the south curtain wall stub, including crenelations, and a short but dilapidated surviving section of the south curtain wall connected to the south drum tower.
- 7.3.50 **1830**: John Henry Robinson engraving (Plate 5) showing the castle in the distance outlined by the sky and the north curtain wall free of vegetation. The image of the castle is too distant.
- 7.3.51 **1850**: Newman & Co. (London) engraving (Plate 6) showing the castle in a state of disrepair. The north drum tower and northeast curtain wall with some significant deterioration of masonry, a large void in the northeast curtain wall, which doesn't appear in later images, artistic licence?
- 7.3.52 **1860**: lithograph print (Plate 7) showing just the gatehouse of the castle. No curtain walls, indeed, no other walls or associated features belonging to the castle are shown
- 7.3.53 **1855-60**: Francis Lockey's calotype negative (Plate 8) showing one of the earliest photographic images of the castle and gatehouse interior before collapse of south tower before 1911. A stub of the south curtain wall standing by the south drum tower. Gatehouse interior pre-concrete repairs (1923-4) shown. Loss of around six courses of masonry on the north drum tower. Northeast curtain wall largely intact.
- 7.3.54 **1874**: Dillwyn Llewelyn family outing to the castle in 1874 (Plates 9-11). Gatehouse shown in detail with a large crack down the centre of the south drum tower. Deterioration of the lower courses of the north curtain wall. Wall walk has collapsed in several places in the centre of the curtain wall and masonry has been lost along the wall tops. North curtain wall now devoid of crenelations but crenelated defences surviving sweeping around from the half-round mural tower to the western curtain wall above the square tower.
- 7.3.55 **c1900**: B. Aberly photographs (Plates 13-15) shows the south drum tower and northeast curtain wall still intact a few short years before the significant collapse of the gatehouse's south tower (before 1911). Base of the drum towers show the deterioration of stonework. South curtain wall against drum tower now a low stub of masonry. South curtain wall stub sanding with putlog holes and crenelations. Crenelations along the west curtain wall and half-round tower survive.
- 7.3.56 **1911**: first pictorial evidence for loss of gatehouse south drum tower in a souvenir guide to Swansea and district, commemorating the coronation of King George V (Plate 16). Collapse of the east facing elevation of the gatehouse's south drum tower along

the fault line and arrow loop seen in earlier images. The gatehouse archway is shown in a pretty perilous state with only a few stones holding the arch together.

- 7.3.57 **1923-4:** Repairs in concrete. Institution of South Wales, Pennard Golf Club and the Cambrian Archaeological Association agree to repair the castle "...to organise a scheme whereby the decay of Pennard Castle maybe arrested and the ruins preserved...". The repairs in concrete included stabilising the south tower of the gatehouse after the collapse nearly fifteen years previous, the gatehouse archway and gatehouse wall tops. The perilous collapsing door through the west curtain wall into the square tower was also repaired in concrete and a faux doorway left inserted.
- 7.3.58 **1941:** images held by the RCAHMW (Plates 18-21; Figures 4-5) show the 'concrete' conservation works carried out in 1923-4 in detail. Arrow loop in the northeast curtain wall deteriorated with a sizable hole in the wall. Significant masonry still surviving on the north curtain wall but not recognisable as crenelations.
- 7.3.59 **1960:** Bernard Morris describes the collapse of around half of the surviving south curtain wall (Plate 22). Gower Society recorded both the view of the south curtain wall in 1952 before collapse and then in 1960 after around half of the wall collapsed.
- 7.3.60 **1963:** Repairs in stone. Campaign to raise funds to save the remaining masonry and further conserve the castle. South Wales Evening Post article on 26th April 1963 to help raise awareness and funds for the campaign. On the 1st November 1963 the Evening Post reported repairs to start on 11th November 1963. Repairs carried out in stone to blend in with the original stonework. The south curtain wall was stabilised and hole on the northeast curtain wall arrow loop was also repaired.
- 7.3.61 **1980s:** RCAHMW surveyed the castle in the 1980s (published 1991), recorded the hole in the northeast curtain as a void on their elevation drawing (Figure 3), however, Plate 23 shows the void repaired indicating that the repair work may not have been carried out in 1963.
- 7.3.62 **1991:** Publication of RCAHMW survey. Plate 23 shows the northeast curtain with a large area of masonry collapse but with one putlog hole surviving adjacent to the repaired arrow loop. By the time RCAHMW took an aerial photograph in 2005 the putlog hole and surrounding wall had collapsed.
- 7.3.63 **2010:** Further repairs appear to have been made to the northeast curtain wall and arrow loop after this date. Numerous aerial photographs made by RCAHMW after 2010.
- 7.3.64 **14th June 2021:** Wales Online ran with a story about people scaling the walls (north curtain wall) and lighting fires. These activities contributing to the further deterioration of the castle's masonry, particularly the north curtain wall and wall walk.
- 7.3.65 **14th January 2022 and 24th January 2022:** The present photogrammetric 3D survey of Pennard Castle and the research into the documentary evidence for the castle's deterioration and repair was carried out.

8 Conclusions

- 8.1.1 The investigations consisted of an archaeological survey to produce accurate, measured 3D photogrammetric modelling of the castle utilising aerial (drone) and terrestrial digital cameras. The outcome a detailed 'digital twin' of the castle to which future surveys can be compared in detail. The main focus of the survey was the North Curtain Wall, which has suffered some deterioration in recent years. To place the present condition of Pennard Castle into context, detailed research was undertaken to try and establish, as far as reasonably possible, a visual or documentary history of the castle and the key moments when the monument experienced physical change.
- 8.1.2 Section 7.2 above details the outcome of the photogrammetric survey, which includes details on the level of error that is used to determine the overall accuracy and quality of the survey. The Root, Mean, Square (RMS) error corresponds to the difference between the initial and computed positions of the GCPs surveyed by GNSS Glonass (GPS) RTK receiver, which was 7mm (RMS) across the 3D model with a Ground Sampling Distance (GSD – the distance between two adjacent pixel centres normalised to real world dimensions) of 4.6mm/pixel. An excellent outcome resulting in a high-quality georeferenced 3D photogrammetric model that will provide a detailed 'Digital Twin' against which future surveys and critically castle deterioration can be compared.
- 8.1.3 Section 7.3 details the castle's development and decline as far as documentary evidence, particularly pictorial, can demonstrate. The early development of the castle in the 12th and 13th centuries is noted, as is the incremental advancement of windblown sand from 1317 to 1650. The Buck brothers engraving (Plate 1) offers for the first time a visual record of the castle. Which shows the castle relatively intact, apart from the south curtain wall, which has likely partially collapsed by this time. Subsequent images show the gradual decline of the castle culminating with the substantial loss to the gatehouse's south drum tower before 1911. The first substantial repairs are carried out in 1923-4 primarily in concrete, which has saved the gatehouse and west curtain wall from further collapse. However, the concrete repairs will likely need replacing in the coming years as water ingress behind the repairs over the past hundred years will almost certainly be creating 'hidden' damage to the medieval masonry, particularly lime mortars, undermining the strength of the structures. Half of the surviving south curtain wall collapsed in 1960 and this instigated the second significant programme of repairs, this time in stone to mimic the medieval masonry. The south curtain wall was stabilised and hole on the northeast curtain wall arrow loop was also repaired. Small scale ad hoc repairs have been carried out over the past 20yrs, including the repairs to the northeast curtain wall's arrow loop.
- 8.1.4 The north curtain wall, including the northeast section, has suffered significant decline since the Buck brother's depiction in 1741 (Plate 1). The parapet is largely reduced to the wall walk on the north curtain wall, with crenelations now largely lost. The external face of the curtain has two significant areas of masonry collapse, on the eastern corner and in the centre where facing stones have fallen out revealing the core of the medieval wall. The rate of decay here appears slow as the photograph taken by the RCAHMS in 1991 (Plate 23) shows approximately the same scarring in the walls, although if this area is not repaired then further collapse is likely. Indeed, a vertical crack in the masonry (Figure 3) from floor to a now lost putlog hole in the northeast curtain wall may be symptomatic of this process. The crack from the now lost putlog

hole can be traced in Plate 13 up through the masonry to the wall top and now represents the edge of the collapsed hole in northeast curtain wall. However, the recent repairs here on the arrow loop have saved the adjacent small section of curtain wall from further collapse.

- 8.1.5 It is a similar story with the interior of the north curtain wall. The decline in the parapet and crenelated defences is perhaps more apparent on the interior. While the exterior of the wall is shown in several 18th century images, it is Francis Lockey's calotype negative that gives us our first 19th century view of the castle and northeast curtain wall. The crenelated defences are largely missing from the small section visible in the image and this is corroborated in the Dillwyn Llewelyn family visit images in 1874. Plate 10 offers the first good image of the interior of the north curtain wall. It is clear that since this image was taken significant masonry loss has occurred to the parapet, indeed reducing the masonry here to almost the level of the wall walk. The scaring visible in the wall all along the lower portion of the curtain is not too far removed from the scaring recorded in the present survey. The only difference that rather than whole scale loss along the scar in the facing stones, several discrete areas of stone have dropped out causing small 'pyramid' shaped masonry collapses along the length of the scar. There is also less windblown sand in these images compared to today. Later images (Plates 15, 16, 19 and 20; Figures 4-5) show the continued but gradual decline of the north curtain wall with significant losses in masonry to the parapet adjacent to the half-round tower and the large hole in the northeast curtain wall. The wall walk has suffered considerable deterioration with only small patches now surviving indicating its original height. The voussoir and part of the eastern door jamb has been lost from the door through to the projecting garderobe and the loss of facing stones in the curtain wall here extends up to the segmented archway. This is an area under threat from further collapse. The exterior entrances to the projecting garderobe and half-round tower appear stable but these are popular thoroughfares for the public and therefore further damage from footfall is likely. The ivy covering the curtain wall is a serious threat to the monument, particularly the eastern corner where earlier images show small cracks in the masonry. The ivy is both damaging the masonry all along the length of the curtain wall but also masking any potential defects in the wall from view.
- 8.1.6 While not the focus of the present survey it is also worth noting the loss of facing stones to the west and south facing external elevations of the square tower. The small tree on the northwest side will be undermining the foundations on this corner of the tower.

9 Bibliography

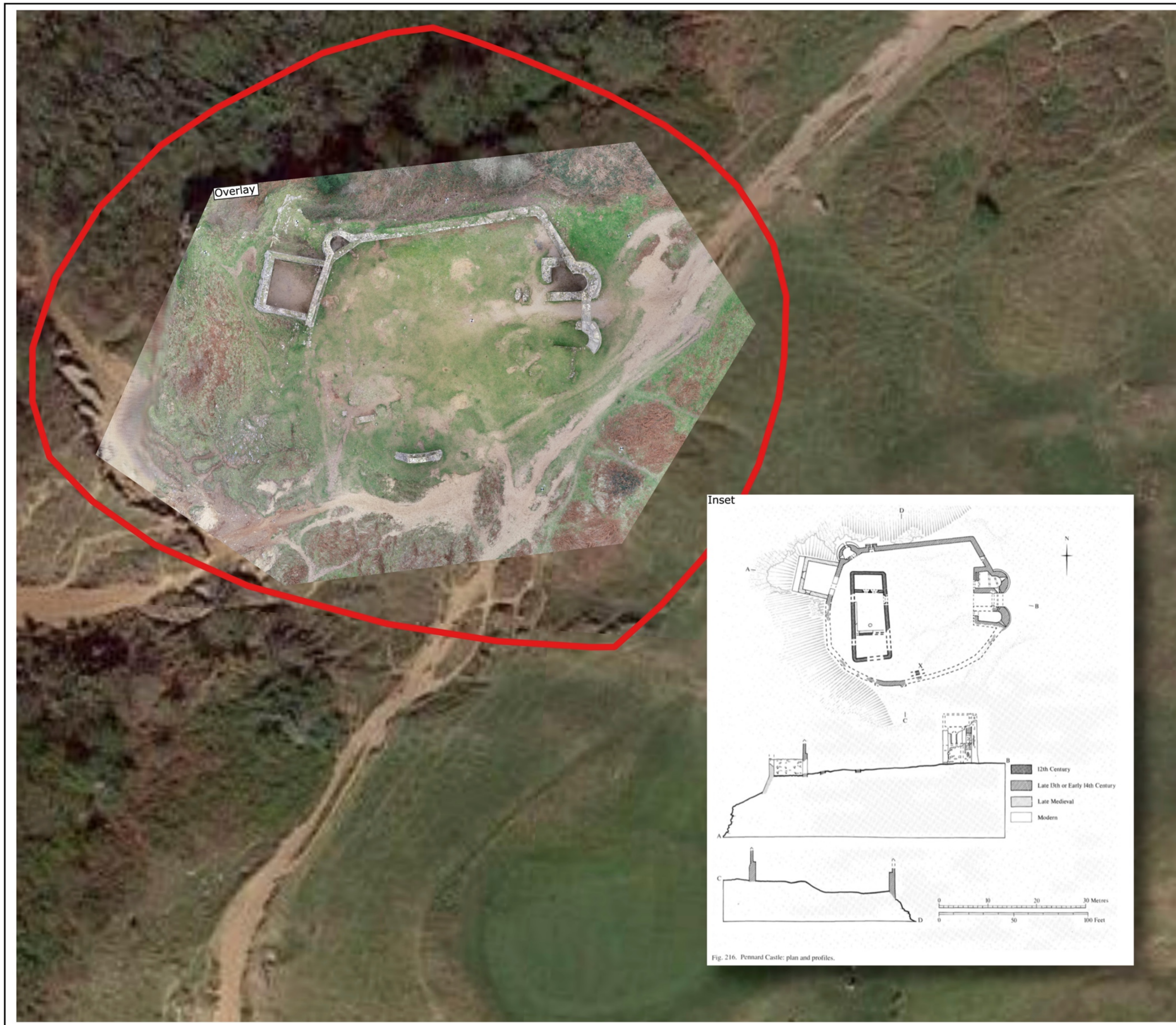
- Alcock, L, 1961, Excavations at Three Glamorgan Castles in *Morgannwg V*, 79-82.
- Baker, C, and Francis, G, 1870, Oliver Cromwell's Survey of Gower A.D. 1650. Edited for the Cambrian Archaeological Association.
- CADW, 2011, *Conservation Principles for the sustainable management of the historic environment in Wales*. Cardiff.
- Morris, B, 2013, Pennard Castle. The Last Two Hundred Years (1987) in *The Pleasure of Unravelling Secrets Contributions to Swansea & Gower History*, 107-115. The Gower Society.
- Morris, B, 1987, Pennard Castle. The Last Two Hundred Years in *Gower* **38**, 6-15. The Gower Society Journal.
- Morris, B, Ridge, M, and Ridge, R, 2005, *The Castles of Gower*. The Gower Society.
- Newman, J, 2001, *The Buildings of Wales, Glamorgan*. Yale Press.
- Toft, L, 1988, A study of the coastal village abandonment in the Swansea Bay region, 1270-1540 in *Morgannwg XXXII*, 21-37.
- Whittle, E, 1992, *A Guide to Ancient and Historic Wales, Glamorgan and Gwent*. HMSO London.

Other Sources

BGS <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

10 Appendix I – Figures

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- BLACK MOUNTAINS ARCHAEOLOGY -
- ARCHAEOLEG MYNYDD DU -

PROJECT

Pennard Castle Photogrammetric Building Survey

Photogrammetric orthomosaic plan

DRAWING NUMBER

1102/31/05/22/1

DRAWN BY


Richard Lewis

SCALE

0 5 10 15 20 25 m



LEGEND

 Cadw Scheduled Monument Area

Overlay: Pennard Castle Photogrammetric Orthomosaic

Inset: Fig 216 Pennard Castle plan and profiles
(RCAHMW 1991,p291) © Crown Copyright: Royal
Commission on the Ancient and Historical Monuments
of Wales

Base map (c) Google Earth

Ordnance Survey base map reproduced under
licence 100058761.

Figure 1. Pennard Castle, Gower (SMGm044), Photogrammetric Orthomosaic Plan. Inset: Fig.216 Pennard Castle plan and profiles © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.

North Facing Curtain Wall

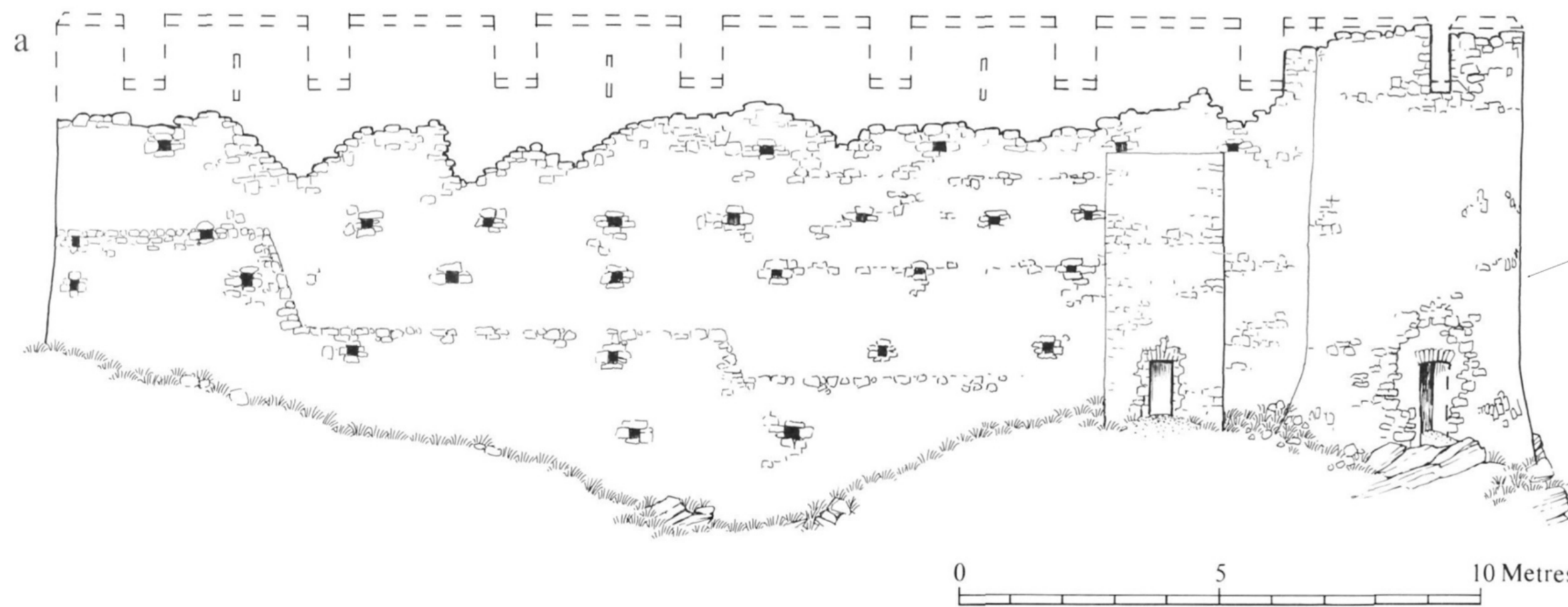
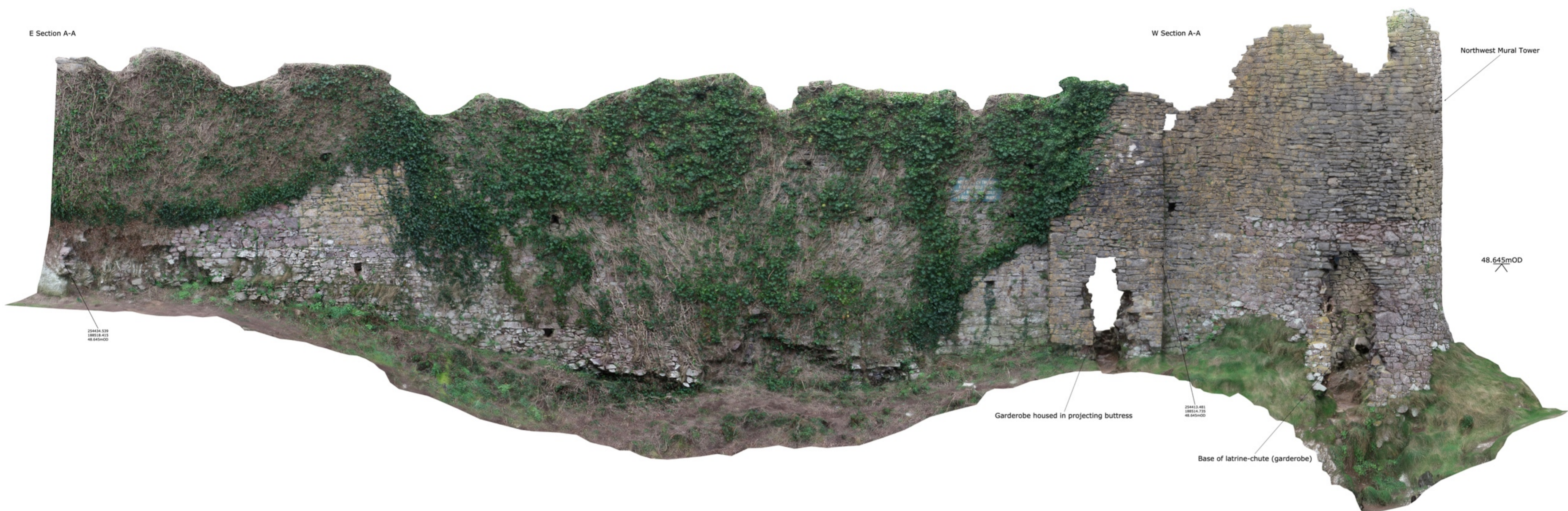


Fig. 218. Pennard Castle: (a) external north front. The crenellation restored in broken lines is based on early photographs, the Buck print, and slight surviving vestiges (RCAHMW 1991, p293).



Project No: 1102
Drawing No: 1102/19/05/22/1
Surveyed by: Richard Lewis & Libby Langlands
3D Photogrammetric Modelling by: Richard Lewis
Drawn by: Richard Lewis

Pennard Castle (SMGm044) Orthographic Photogrammetric Elevation of the north facing Curtain Wall

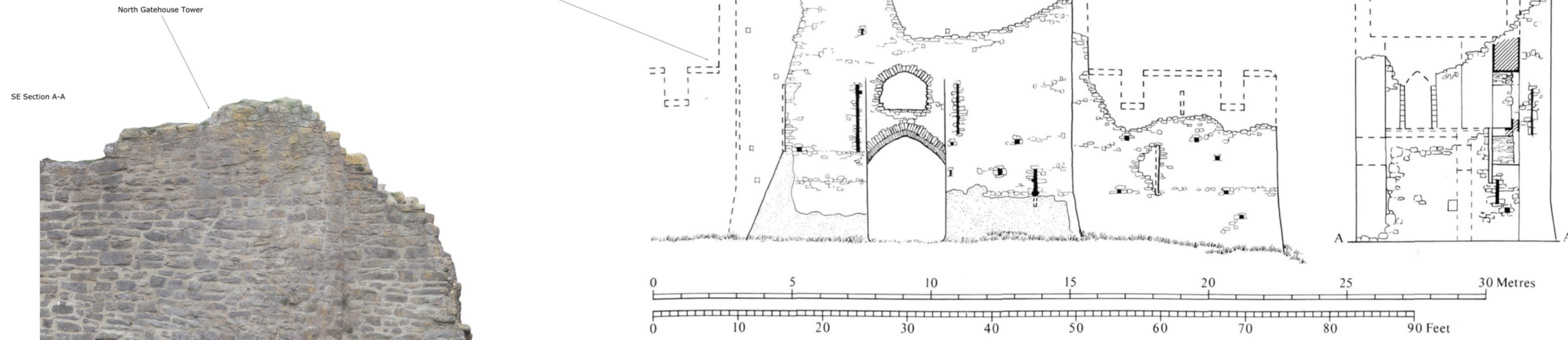
Scale (at A2)
0m 2m

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Figure 2. Orthographic Photogrammetric Elevation of the north facing Curtain Wall. Inset: Fig.218 Pennard Castle External North Front © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.

Northeast Facing Curtain Wall

Fig. 219. Pennard Castle: (a) external east front; (b) cross-section of gatehouse, looking north (RCAHMW 1991, p293).



Project No: 1102
Drawing No: 1102/19/05/22/2
Surveyed by: Richard Lewis & Libby Langlands
3D Photogrammetric Modelling by: Richard Lewis
Drawn by: Richard Lewis

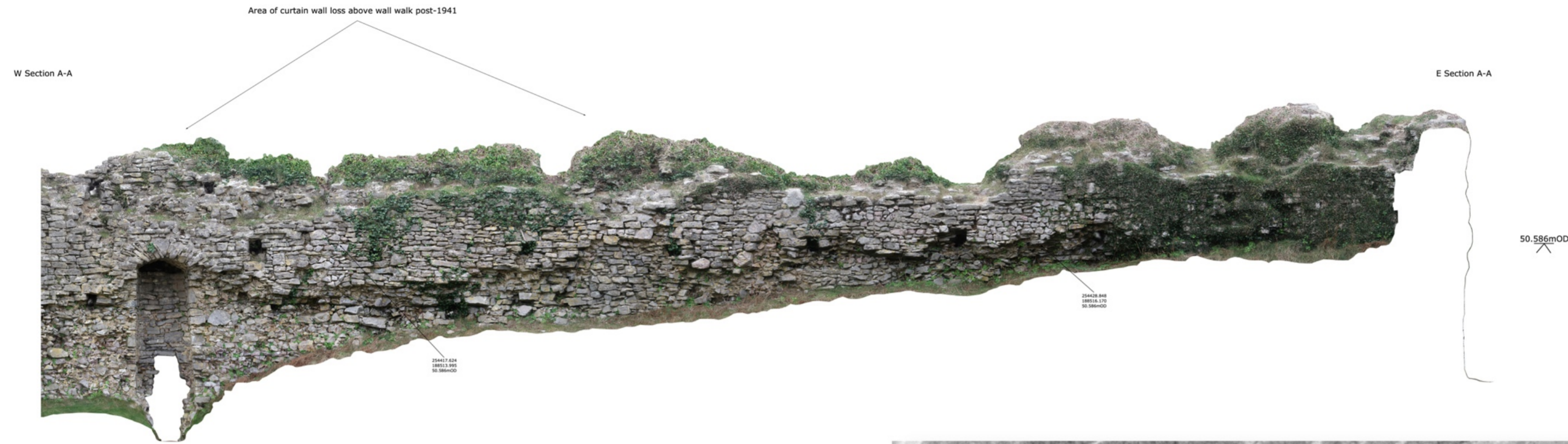
Pennard Castle (SMGm044) Orthographic Photogrammetric Elevation of the northeast facing Curtain Wall

Scale (at A2)
0m 2m

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Figure 3. Orthographic Photogrammetric Elevation of the northeast facing Curtain Wall. Inset: Fig.219 Pennard Castle External East Front © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.

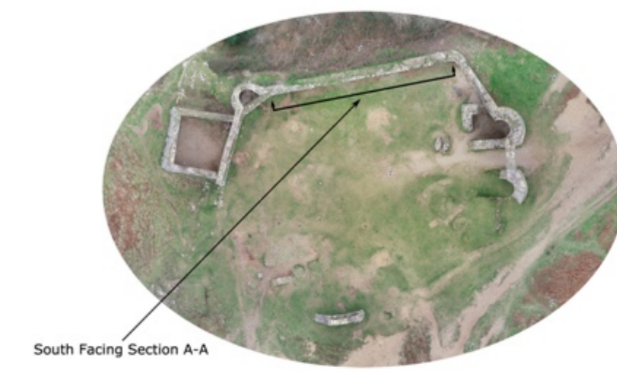
South Facing North Curtain Wall



View of the south facing North Curtain wall and interior of Pennard Castle. June 1941
Archive No. 6351169 (c) RCAHMW



View north of Pennard Castle post-1941
Archive No. 6413367 (c) RCAHMW



South Facing Section A-A

Project No: 1102
Drawing No: 1102/19/05/22/4
Surveyed by: Richard Lewis & Libby Langlands
3D Photogrammetric Modelling by: Richard Lewis
Drawn by: Richard Lewis

Pennard Castle (SMGm044) Orthographic Photogrammetric Elevation of the south facing North Curtain Wall

Scale (at A2)
0m 2m

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Figure 4. Orthographic Photogrammetric Elevation of the south facing internal North Curtain Wall. Inset Photographs: 'North Curtain Wall June 1941' (Archive No.6351169) and 'View North post-1941' (Archive No.6413367) © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.

Southwest Facing Internal North Curtain Wall



View of the gatehouse at Pennard Castle June 1941. Archive No. 6351162 (c) RCAHMW.

Significant area of curtain wall masonry collapse post-1952.



Put-log hole collapse: Left post-1952. Right post-1991.

Arrow loop repaired after 2010.

Northern Curtain Wall

NW Section A-A



Significant area of curtain wall masonry collapse post-1952. Put-log hole collapse after 1991. Arrow loop repaired after 2010.

20404 803
20401 16 800
51.218mOD

20407 716
20412 110
51.21600

51.218mOD

North Gatehouse Tower

SE Section A-A



Southwest Facing Section A-A

Project No: 1102
Drawing No: 1102/19/05/22/3
Surveyed by: Richard Lewis & Libby Langlands
3D Photogrammetric Modelling by: Richard Lewis
Drawn by: Richard Lewis

Pennard Castle (SMGm044) Orthographic Photogrammetric Elevation of the southwest facing internal North Curtain Wall

Scale (at A2)
0m 2m


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Figure 5. Orthographic Photogrammetric Elevation of the southwest facing internal North Curtain Wall. Inset Photograph: 'View of Gatehouse June 1941' (Archive No.6351162) © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.



Project No: 1102
Drawing No: 1102/19/05/22/6
Surveyed by: Richard Lewis & Libby Langlands
3D Photogrammetric Modelling by: Richard Lewis
Drawn by: Richard Lewis

Pennard Castle (SMGm044) 3D Photogrammetric Model
View to the west



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Figure 6. Pennard Castle Photogrammetric 3D Model, high mesh count and texture, view to the west.



Figure 7. Pennard Castle Photogrammetric 3D Model, high mesh count and texture, view to the northwest.



Figure 8. Pennard Castle Photogrammetric 3D Model, high mesh count and texture, view to the southwest.

11 Appendix II – Plates



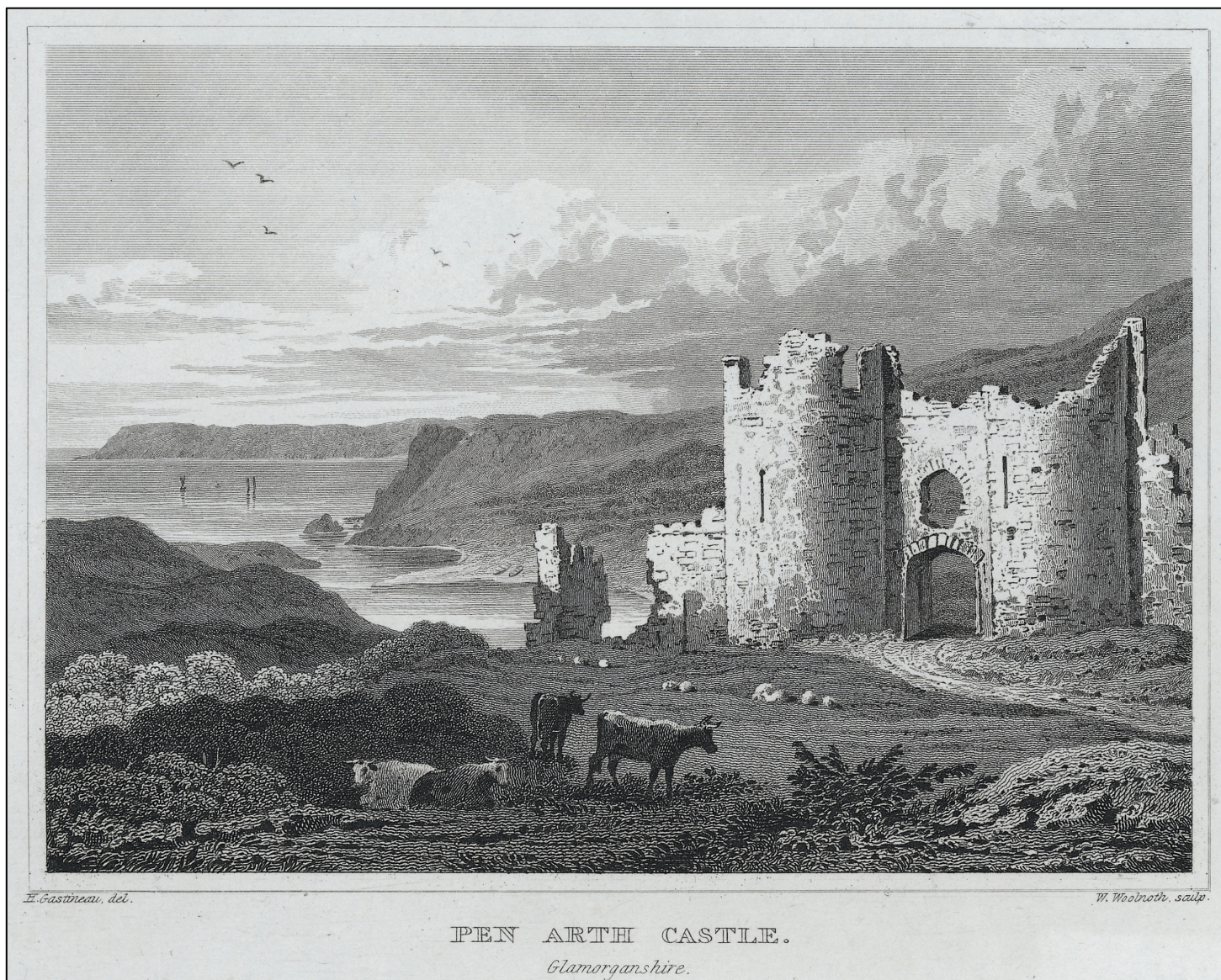
Plate 1 – 1741 Pennarth (Pennard) Castle, Samuel & Nathaniel Buck. ©National Library of Wales.



Plate 2 – 1795 Ruins of Pennard Castle (to southwest) John Warwick Smith 1749-1831. ©National Library of Wales.



Plate 3 – 1795 Ruins of Pennard Castle (to east) John Warwick Smith 1749-1831. ©National Library of Wales.



PEN ARTH CASTLE.

Glamorganshire.

Plate 4 – 1823 Pen arth Castle Henry Gastineau. ©National Library of Wales.



Plate 5 – 1830 Penarth (Pennard) Castle John Henry Robinson. ©National Library of Wales.



Plate 6 – 1850 J Newman & Co Engraving of 'Pennard castle, & Oxwich bay, Gower'. ©National Library of Wales.



Plate 7 – c1860 Pennarth (Pennard) Castle. ©National Library of Wales.



Plate 8 – 1855-1860 Pennard Castle from interior of court. Print created in 1934 from Francis Lockey's calotype negative. Accession number- 03_Lockey_NMWA24629.

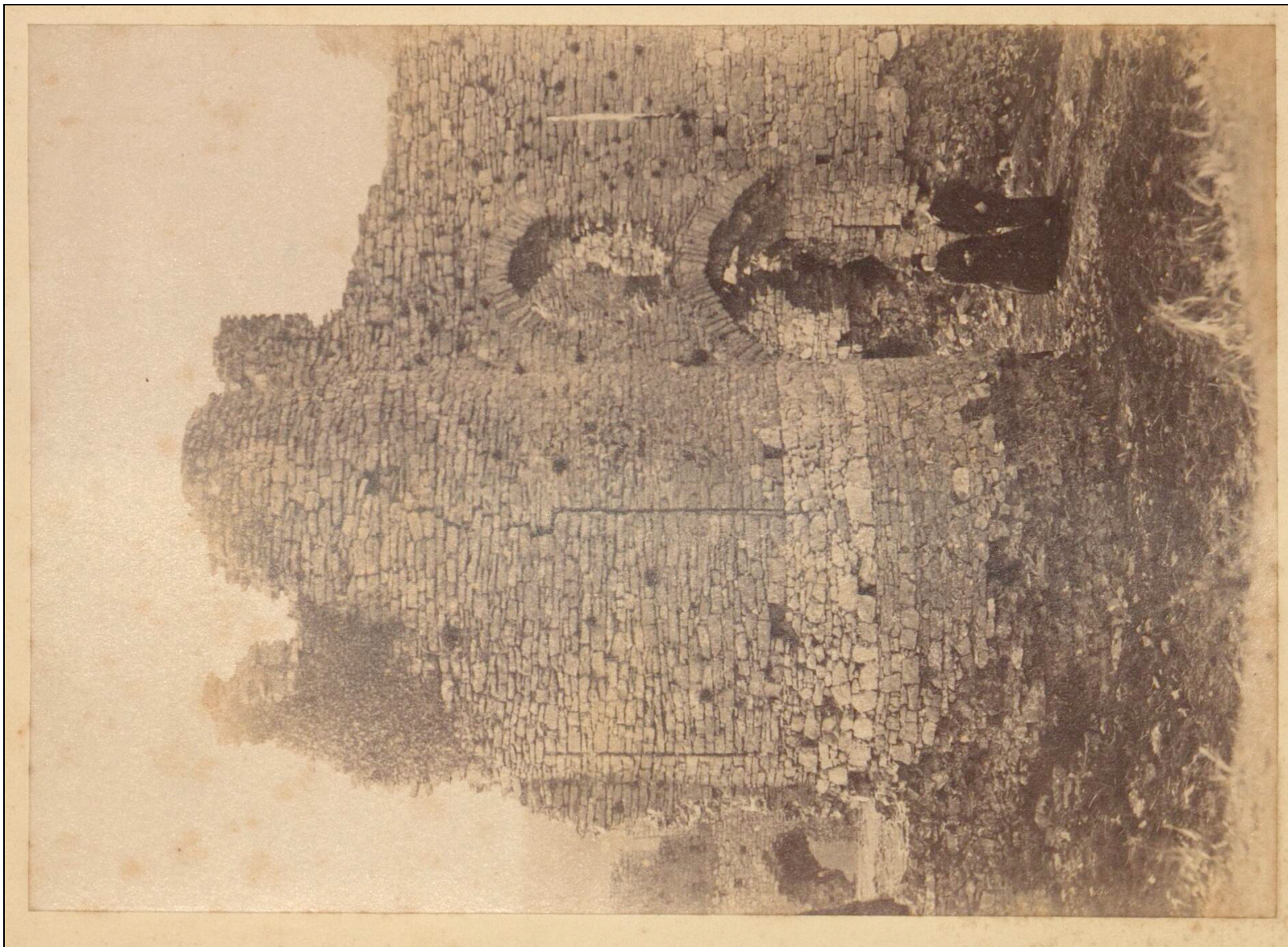


Plate 9 – 1874 Dillwyn Llewelyn family x8 photos during an outing DD Z 368 14 2. © West Glamorgan Archives.



Plate 10 – 1874 Dillwyn Llewelyn family x8 photos during an outing DD Z 368 14 8. © West Glamorgan Archives.



Plate 11 – 1874 Dillwyn Llewelyn family x8 photos during an outing DD Z 368 14 5. © West Glamorgan Archives.



Plate 12 – 19th century, possibly pre-1823, Pennard or Pennarth Castle. Ink wash. ©National Library of Wales.



Plate 13 – 1900-1911 Abery, P. B. (Percy Benzie)1877-1948. ©National Library of Wales.



Plate 14 – 1900-1911 Aberly, P. B. (Percy Benzie)1877-1948. ©National Library of Wales.



Plate 15 – 1900-1911 Aberly, P. B. (Percy Benzie)1877-1948. ©National Library of Wales.

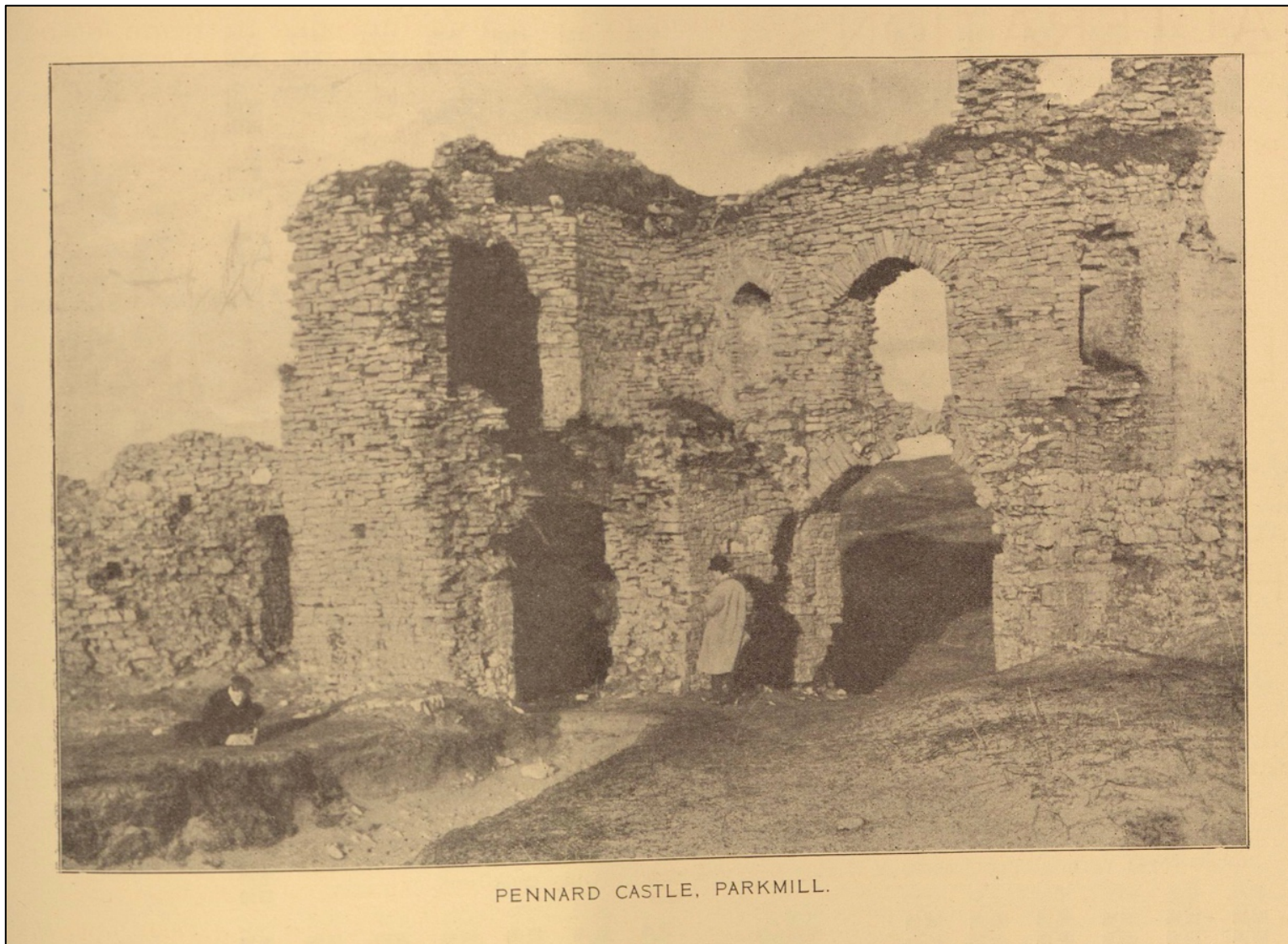


Plate 16 – 1911 Souvenir guide to Swansea and surrounding district, issued to commemorate the Coronation of King George V. DD JVH 184. © West Glamorgan Archives.



Plate 17 – Postcard of Pennard Castle with postal date of 6th June 1934. Photograph must be dated between 1911-1924 when the south tower had partially collapsed but before the concrete repairs of 1923-1924.



Plate 18 – View of the Gatehouse June 1941 (Archive No. 6351166) with 1923-4 concrete repairs. © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.



Plate 19 – View of the Gatehouse interior June 1941 (Archive No. 6351162) with 1923-4 concrete repairs. © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.



Plate 20 – View of the Pennard Castle, south and north curtain walls and gatehouse June 1941 (Archive No. 6351169) with 1923-4 concrete repairs. © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.



Plate 21 – View of the Pennard Castle, south and north curtain walls, square tower and gatehouse interior June 1941 (Archive No. 6351170) with 1923-4 concrete repairs. © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.

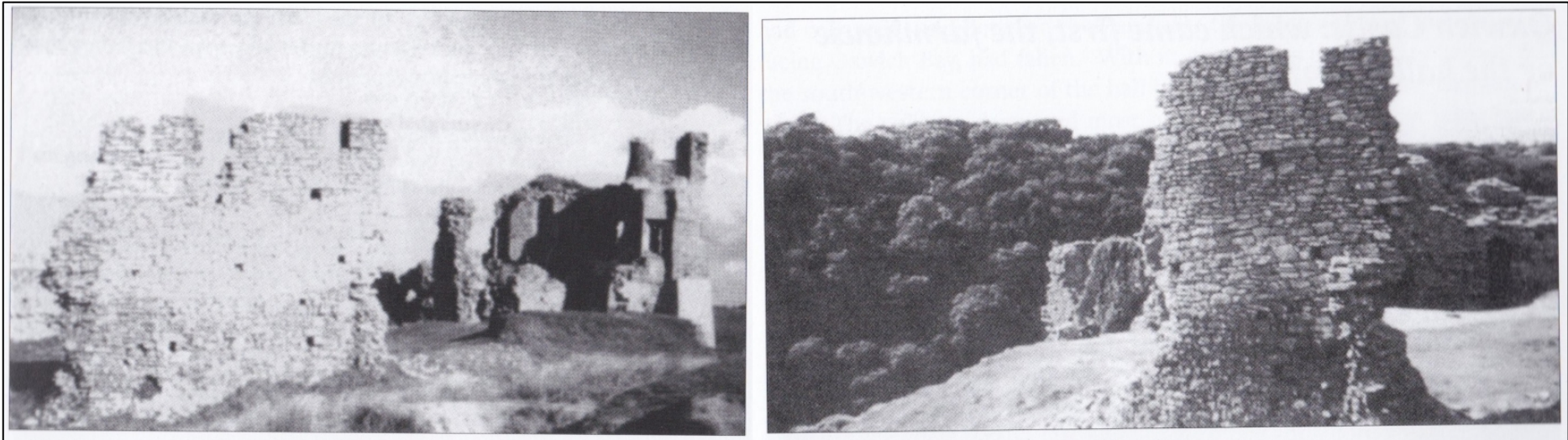


Plate 22 – View of the south curtain wall before (Left: 1952) and after partial collapse (Right: 1960) after Morris 1987, 13-14. © Gower Society.



Plate 23 – View of the Gatehouse and North Curtain Wall 1991, after RCAHMW 1991, Fig 215, 290. © Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Wales.



Plate 24 – View to the west of Pennard Castle 14th January 2022.



Plate 25 – View to the west of Pennard Castle 24th January 2022.



Plate 26 – View to the southwest of Pennard Castle 24th January 2022.



Plate 27 – View to the south of Pennard Castle 24th January 2022.



Plate 28 – View to the north of Pennard Castle 24th January 2022.



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