Whitford Point Lighthouse

NPRN 34289

Report on RCAHMW Survey Work, 2023-2024

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May 2025

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Royal Commission on the Ancient
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Contents

List of Figures

List of Tables

Ackowledgements

The RCAHMW would like to thank Bella Romain for re-engaging the RCAHMW with Whitford Point lighthouse from a maritime archaeological perspective. We would also like to thank Hamish Fenton for kindly sharing his 2018 photogrammetry record of the lighthouse, which has provided an important reference point for this report.

1. Introduction

Whitford Point Lighthouse (Figure 1.1 and 1.2) is the only wave-swept cast-iron lighthouse surviving in the UK, and one of only two worldwide. The significance of the lighthouse is recognised in its status as both a Scheduled Monument (Cadw, 1979) and a Grade II* Listed Building (Cadw, 2000). The latter designation noting that it is "a rare survival of a wave-swept cast-iron lighthouse in British coastal waters, and an important work of 19th century lighthouse design and construction".

The structural integrity of the lighthouse is a cause for concern, because of observable degradation to its structural ironwork, coupled with ongoing and significant erosion to the stone plinth around its base. The latter of these is the main focus of this report, which sets out to establish a timeline for the development of erosion damage, including loss of material and formation of significant scour pools, to the stone apron surrounding the base of the lighthouse. A key piece of work in achieving this objective is the photogrammetric survey of the lighthouse by the RCAHMW in August 2023. This sought to establish a 3D digital baseline against which prior and subsequent change in the overall structure could be assessed. A further survey visit was undertaken in October 2024 to begin the process of gathering subsequent comparative data.

This report starts with a general description (Section 2) of the lighthouse to provide context to the following sections. The on-site survey methodology is then summarised (Section 3) along with an overview of the available historical imagery of the lighthouse. The results of the 2023 and 2024 surveys are presented in Section 4, followed by a review of the currently available historical imagery to establish the overall chronology of change to the site. The results of the 2023 and 2024 survey are presented first, because they allow a known state to be established, which can then be worked back from, using the historical photographs. Conclusions and recommendations for future work are provided in Section 5.

Figure 1.1: Whitford Point Lighthouse, looking north-west, on 17/08/2023 (© Crown Copyright: RCAHMW).

Figure 1.2: Location of Whitford Point Lighthouse (© Crown Copyright: RCAHMW).

2. General Description

The observations of this summary description are based on the photogrammetry surveys undertaken in August 2023 and October 2024, cross-referenced with Hague's account of the lighthouse (1994: 85-6). In several cases, the existing, published measurements, such as heights, diameters, etc. within Hague's work, and the Cadw Listing and Scheduling statements are incorrect, presumably due to difficulties in accessing parts of the structure, with the survey methods available at the time.

The surviving lighthouse was built in 1865 to mark the shoal ground around Whitford Point, on the north-east corner of the Gower and on the southern side of the western entrance to the Lougher estuary (Figure 1.2). It was constructed by the Llanelli Harbour and Burry Navigation Commissioners to replace an earlier piled wooden structure built in 1854. It remained in formal use until 1921, after which it was lit on an irregular seasonal basis (Hague, 1994: 86).

Whitford Point Lighthouse is 19.2m in height, from the base of the lowest cast-iron band to the top of the surviving finial. It is 7.1m in diameter around the lowest part of the cast-iron work, and occupies a footprint some 27.5m in diameter inclusive of the base collar and stone apron. The lighthouse is formed of a main tower section, in turn topped by a living-room, lantern, and domed roof with finial (Figure 2.1).

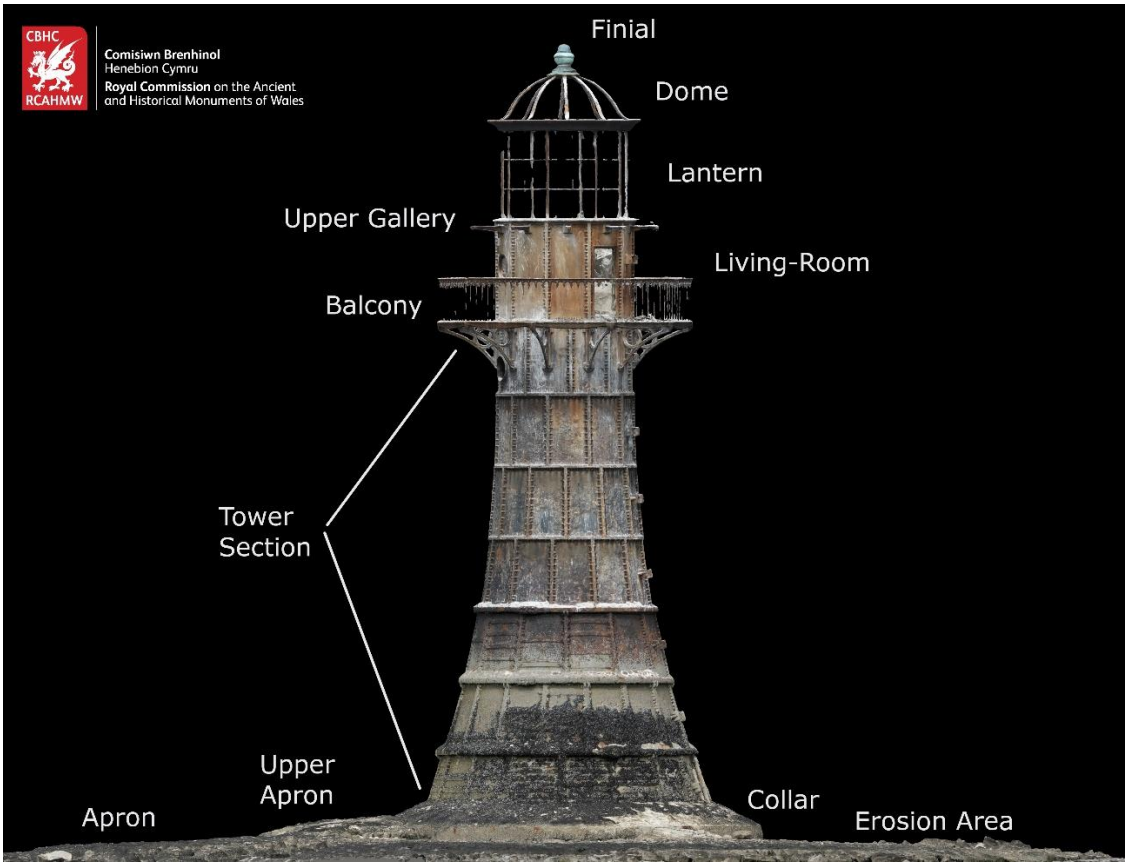

Figure 2.1. Annotated Orthomosaic of the southern elevation of Whitford Point Lighthouse, derived from RCAHMW survey on 17/08/2023 (© Crown Copyright: RCAHMW).

The tower section of the lighthouse has a height of 12.1m and consists of seven rings of heavy cast-iron plates that are bolted together by external flanges (Figure 2.2). Hague (1994: 85) notes that this is in contrast to other cast-iron lighthouses which usually utilised internal flanges, but considers the external method would better facilitate erection of the tower during the limited low water working

windows at the site. These taper from a diameter of 7.1m at the bottom of the lowest ring, to 3.52m at the top of the seventh ring. The lower levels of the lighthouse tower are reported to be partly filled with stone ballast (Hague, 1994: 85).

The living-room is formed by an eighth ring of cast-iron plates, 2.6m high, above which is the glazed lantern itself (Figure 2.3). The glazing comprises eight main sections, with six square panes within each section. An increasing number of the secondary glazing bars are now being lost. One section is likely to have been a glazed doorway to allow access to the upper external gallery. The lighthouse roof is domed, the original copper is missing, leaving only ten roof frames visible, the roof is topped with a ball finial (now partially incomplete). The junction between the top of the tower section and the living-room is distinguished by a ten-sided balcony (originally with a wooden floor) and balustrade, supported by ten ornate cast-iron brackets with roundel-decorated spandrels (Hague, 1994: 85). A further, smaller, balcony is arranged around the lantern to facilitate its cleaning. The railings of this are now lost, but the ten support brackets remain in place. When viewed from overhead (Figure 2.4), these are arranged so that they are between the brackets of the main balcony, and in-line with the dome frames.

Figure 2.2: The lower cast-iron sections, collar and surrounding apron of Whitford Point Lighthouse on 17/08/2023 (© Crown Copyright: RCAHMW).

Figure 2.3: The upper sections of Whitford Point Lighthouse on 17/08/2024, including the living-room, lantern, dome and balustrades (© Crown Copyright: RCAHMW).

Figure 2.4: Overhead view of Whitford Point Lighthouse on 17/10/2024, north is to the top (© Crown Copyright: RCAHMW).

The lowest cast-iron ring of the tower section is partially encased in a concrete collar, 9.8m in diameter (Figure 2.5). This is subject to erosive undercutting on its eastern side, which reveals its original vertical thickness to be c. 1.6m. The collar slopes gently downwards from the base of the cast-iron tower for 1.3m, with a fall of 0.6m, its outer extent is formed by a vertical face c. 0.8m in height. The outer vertical face of the collar is in turn protected by a pitched stone apron. The main part of the apron is c. 27.5m in total diameter and is formed from 'ribs' of stonework radiating outwards from the collar, infilled with well-laid closely packed smaller stones. A further set of larger header stones around the outside of these was intended to ensure the integrity of the outer edge of the apron. The junction between the collar and the apron is covered with a further layer of stonework and mortar. This upper apron extends outwards for 2.5-3m from the edge of the collar, but now only survives in two small areas on the western side of the lighthouse (Figure 2.6). It is unclear from historic photos of the lighthouse if the upper apron originally extended all the way around the collar, or was only placed along the western side.

The lighthouse is reached via a tidal causeway across the foreshore and surrounding mussel beds to the south-eastern side of the stone apron. A ladder mounted on the eastern side originally provided access to the top of the tower section, entering through the main balcony floor. A doorway into the living-room, through the eighth cast-iron ring, gave entry to the interior, with a further ladder leading downwards to the store-room beneath the living-room. Both rooms were lit with a pair of lunette windows set above each other on the western and northern side of the lighthouse. The glazed area of the lantern must have been reached by an internal stairway or ladder from the living-room beneath. The floor of the lantern is now collapsed onto the living-room below (Figure 2.7). The interior wall of the living-room is lined with bricks, which extend to the window framing of the lantern.

Figure 2.5: The collar surrounding the base of the lowest cast-iron ring of Whitford Point Lighthouse, photographed on the 17/08/2023 (© Crown Copyright: RCAHMW).

Figure 2.6: Surviving sections of the upper apron on the western side of Whitford Point Lighthouse, photographed on 17/10/2024 (© Crown Copyright: RCAHMW).

Figure 2.7: Oblique view of the upper elements of Whitford Point Lighthouse on 17/08/2023, including the visible interior of the lantern and living-room (© Crown Copyright: RCAHMW).

3. Methodology

Assessment of the extent of erosion damage around the base of the lighthouse took two forms. The first of these entailed undertaking a photogrammetry survey of the entire lighthouse structure to create a 3D digital record of the site. It was intended that this would serve as a baseline against which subsequent change could be objectively assessed, and against which prior change could be documented.

The second, related element, undertaken for this report was based on a review of existing archival photos within the National Monuments Record, of the lighthouse, dating from the 1970s onwards. These include both ground-level and plane-based aerial images. It was hoped that they would provide an overall impression of the development of erosion damage around the base of the lighthouse prior to the point of the 3D Digital survey.

3.1 Photogrammetry Survey

The initial photogrammetry survey was carried out on 17th August 2023 (Figure 3.1 and 3.2). The aim of this work was to create a detailed point cloud and 3D Model of the lighthouse and surrounding apron, from which an orthomosaic and digital surface model (DSM) could be derived to inform both the condition at the time of survey, and to act as a point of comparison in the future. The survey utilised a sub-250g UAV (Uncrewed Aerial Vehicle) to gain sufficient photographic coverage around and above the lighthouse structure. This was supported by an RTK GNSS (Real Time Kinematic Global Navigation Satellite System) instrument to allow the survey to be georeferenced through a series of temporary ground control points.

The resulting photogrammetry dataset comprised 540 UAV images and related ground control data for georeferencing. This was processed using *Reality Capture* to create the associated point cloud, 3D-Model, ortho mosaic and DSM.[1] On site conditions on the day of survey were challenging, with gusty easterly winds preventing photography of the upper parts of the lighthouse in as much detail as was originally planned. Despite this, the resulting outputs provide a good baseline record of the overall structure, and a highly detailed record of the lower part of the tower, collar, and stone apron. A 3D Model of the final survey was uploaded to the RCAHMW page of the Sketchfab portal to facilitate public access to the results. [2]

A further survey was undertaken on 17th October 2024 during wider RCAHMW fieldwork in the Whitford Point area, using the same methodology. Due to time available on site, this only focused on the lowest cast-iron ring of the tower section, the collar, and the stone apron. Georeferencing was undertaken through the same RTK GNSS process. The resulting photogrammetry dataset of 151 images was lower than intended due to gusty winds, but as in 2023 provided a highly detailed comparative record of the lower parts of the tower, collar and stone apron.

One limitation of photogrammetry as a survey technique is that it cannot reliably measure features through water. An impression of the archaeological material below the surface of the scour-pools can be achieved within the 3D Model, Orthomosaic, etc., but it is not possible to accurately measure depth, for example in a DSM. This limitation would also apply to a terrestrial laser-scan survey.

[1] Survey archived within the NMRW, PGS2023_018: https://coflein.gov.uk/en/archive/2023-09-20_2206/
[2] Survey viewable here: https://skfb.ly/oUE8R

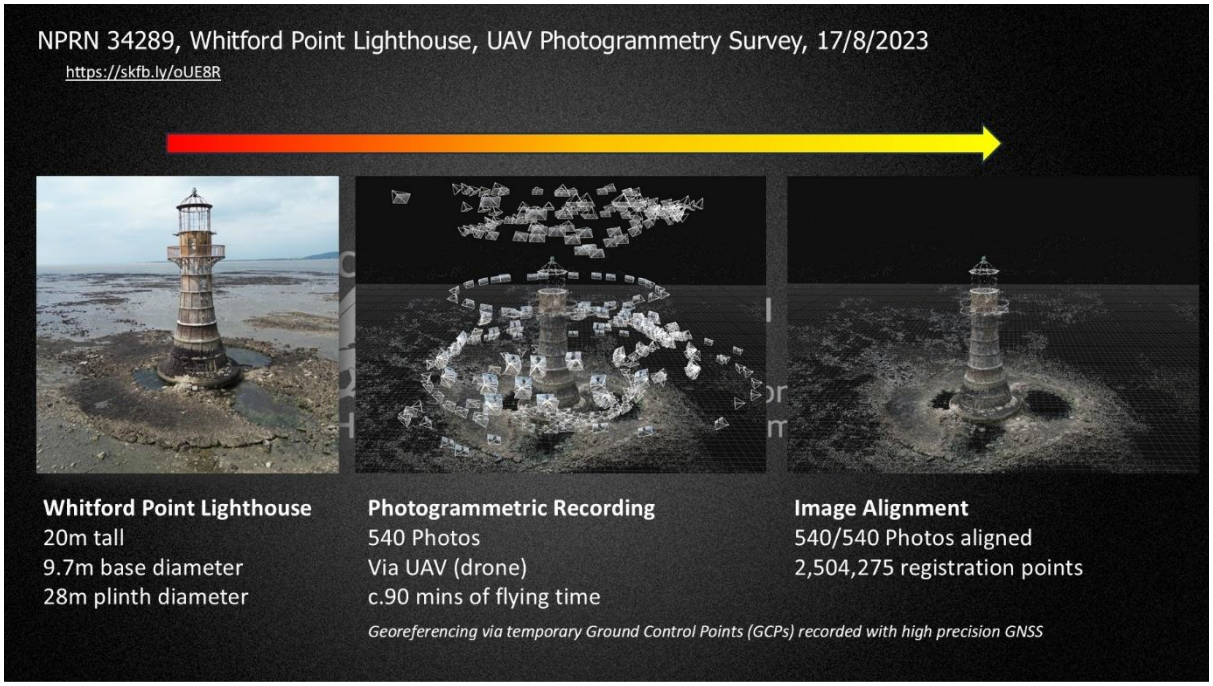

Figure 3.1: Photogrammetry survey of Whitford Point Lighthouse, 17/08/2023. Data collection and image alignment (© Crown Copyright: RCAHMW).

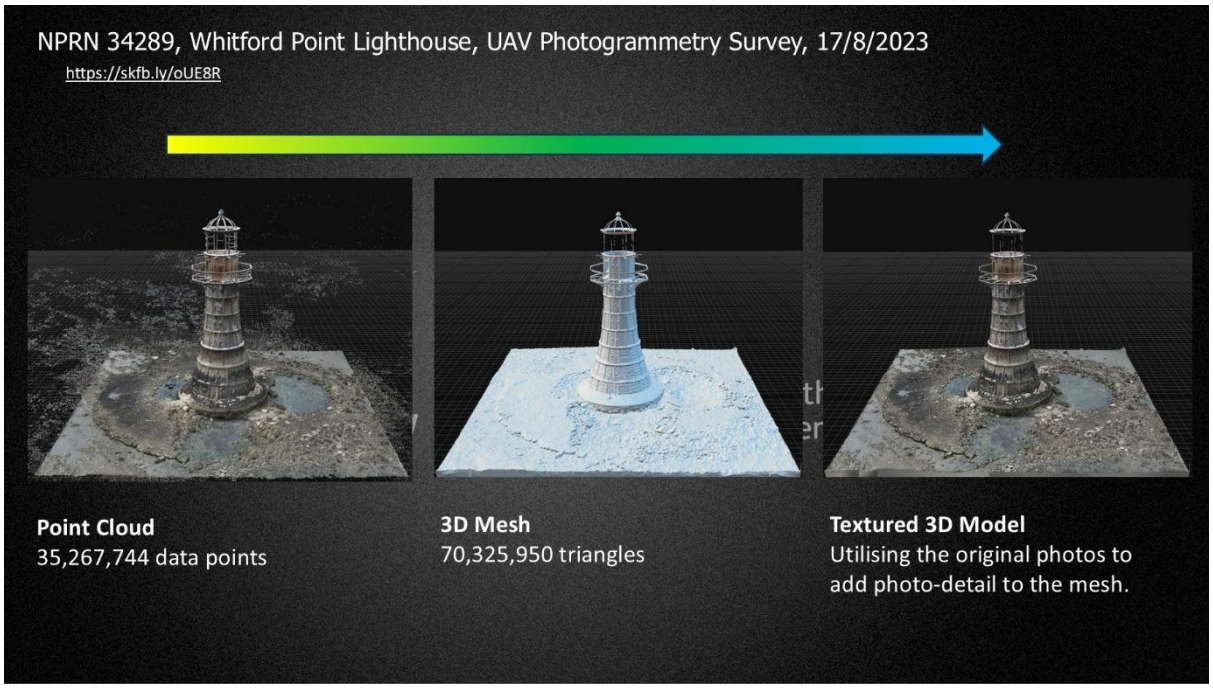

Figure 3.2: Photogrammetry survey of Whitford Point Lighthouse, 17/08/2023. Point cloud, mesh and texture (© Crown Copyright: RCAHMW).

3.2 Historical Imagery Review

The photogrammetry survey of August 2023, summarised above, served to provide a baseline for comparison against subsequent monitoring surveys, such as that conducted in October 2024. It also provided a baseline against which sources of data preceding the August 2023 condition could be compared. Historical images of the lighthouse held within the NMRW archive had clear potential to be able to identify overall trends to the pattern of erosion around the base of the lighthouse. Such

images comprised both ground-level and aerial photos, and while they were not georeferenced or scaled, they could be interpreted to gain an overall understanding of the trajectory of erosion.

The overall types of images, and date range, are summarised in Table 3.1. The earliest are ground-level photos of the lighthouse in 1971, moving through a range of aerial images, and other ground-based images in the 1990s, 2000s, and 2010s. In addition, when making publicly available the results of the August 2023 photogrammetry survey on the Sketchfab Portal, the RCAHMW was notified by Hamish Fenton of a photogrammetry survey of the lighthouse that they had completed in 2018. This survey provided a further comparative point of reference and extended the 3D Digital coverage of the site.

Table 3.1: Historical images of Whitford Point Lighthouse consulted.

Photo Type	**Date**	**Description**	**Origin**
Ground-level	1971	General view, from the southeast.	D. Roberts/RCAHMW
Ground-level	1972	General view, from the southeast.	D. Hague/RCAHMW
Aerial	1991	Oblique view at high tide.	C. Musson/RCAHMW
Aerial	1994	Oblique views from the southeast and north	C. Musson/RCAHMW
Aerial	1997	Oblique views at high tide.	T. Driver/RCAHMW
Aerial	2002-3	Oblique views at high tide.	T. Driver/RCAHMW
Ground-level	2006	General view, from the south.	D. Leighton/RCAHMW
Aerial	2008	Oblique view, from the southeast.	T. Driver/RCAHMW
Aerial	2010	Oblique view, from the southeast.	T. Driver/RCAHMW
Photogrammetry	2018	Kite-based photogrammetry survey	H. Fenton

4. Results and Interpretation

4.1 RCAHMW Photogrammetry Survey

The photogrammetry survey of the lighthouse undertaken in August 2023 provided several outputs to allow an assessment of the extent of erosion damage to the base of the lighthouse to be made. In particular, the georeferenced orthomosaic (Figure 4.1) and DSM (Figure 4.2) allowed the features around the base of the lighthouse to be mapped in detail within *ArcGIS.* The combination of an orthomosaic image, and a DSM meant that this could be done on a visual basis, and considering changes in the surface height of the stone apron picked up within the DSM. The extent of the scour pools, and surrounding erosion areas was mapped (Figure 4.3), and a percentage impact figure calculated (Table 4.1). The same process was then repeated for the October 2024 survey (Figures 4.4 – 4.6) to assess any change over the relatively short period of time between the two surveys.

The results of the survey presented below are instructive. Water-filled scour pools, indicating the deepest areas of erosion impact, account for 23% of the total area of the stone apron. Large scour pools have formed on the northern and eastern sides, with a smaller pool on the southern side of the lighthouse. The visible extent of the scour pools is the same for 2023 and 2024. Meanwhile, areas of damage to the structural integrity of the stone apron affect just over 49% of the total area. These are primarily around the edges of the main scour pools where the stonework is undergoing a process of dislocation and displacement. Further, more localised areas exist on the southwest and northwest edges of the apron This figure increased by 0.5% between August 2023 and October 2024, reflecting very localised changes. The upper apron has been subject to much greater loss, and now only survives in one area on the western side of the lighthouse, representing only 10% of its original area, assuming that it once occupied the entire circumference of the collar.

Table 4.1. Percentage area loss of stone apron and upper stone apron in 2023 and 2024.

Component	**Area ($m^{2)}$**	**% loss (of original)**
Stone Apron	*537 m^2*	*N/A*
2023 Scour Pools	125 m^2	23.2%
2023 Damage	265 m^2	49.3%
2024 Damage	267 m^2	49.7%
Upper Stone Apron	*113 m^2*	*N/A*
2023 Surviving Extent	14 m^2	87.6%
2024 Surviving Extent	11 m^2	90.3%

As noted, the scour pools and erosion are most extensive on the eastern and northern sides of the lighthouse (Figures 4.1 – 4.6). The eastern scour area is visibly undercutting the collar, potentially by as much as 0.5m from the vertical outer edge of the collar. The same process is evidence on the northern side of the collar where a 0.5m deep undercut is observable. The scour pool on the southern side of the collar has not yet started to undercut the collar, based on the observations in August 2023.

The erosion of the apron and associated scouring just described have caused a reduction in the height of material around much of the base of the lighthouse. By contrast, in one area, on the northeast edge of the apron, there is a build-up of loose stones and rubble that have raised the height of the recorded surface in that area, relative to the surrounding undamaged apron. This probably represents material that has been pulled out of the erosion/scour areas and deposited on the northeast edge of the apron.

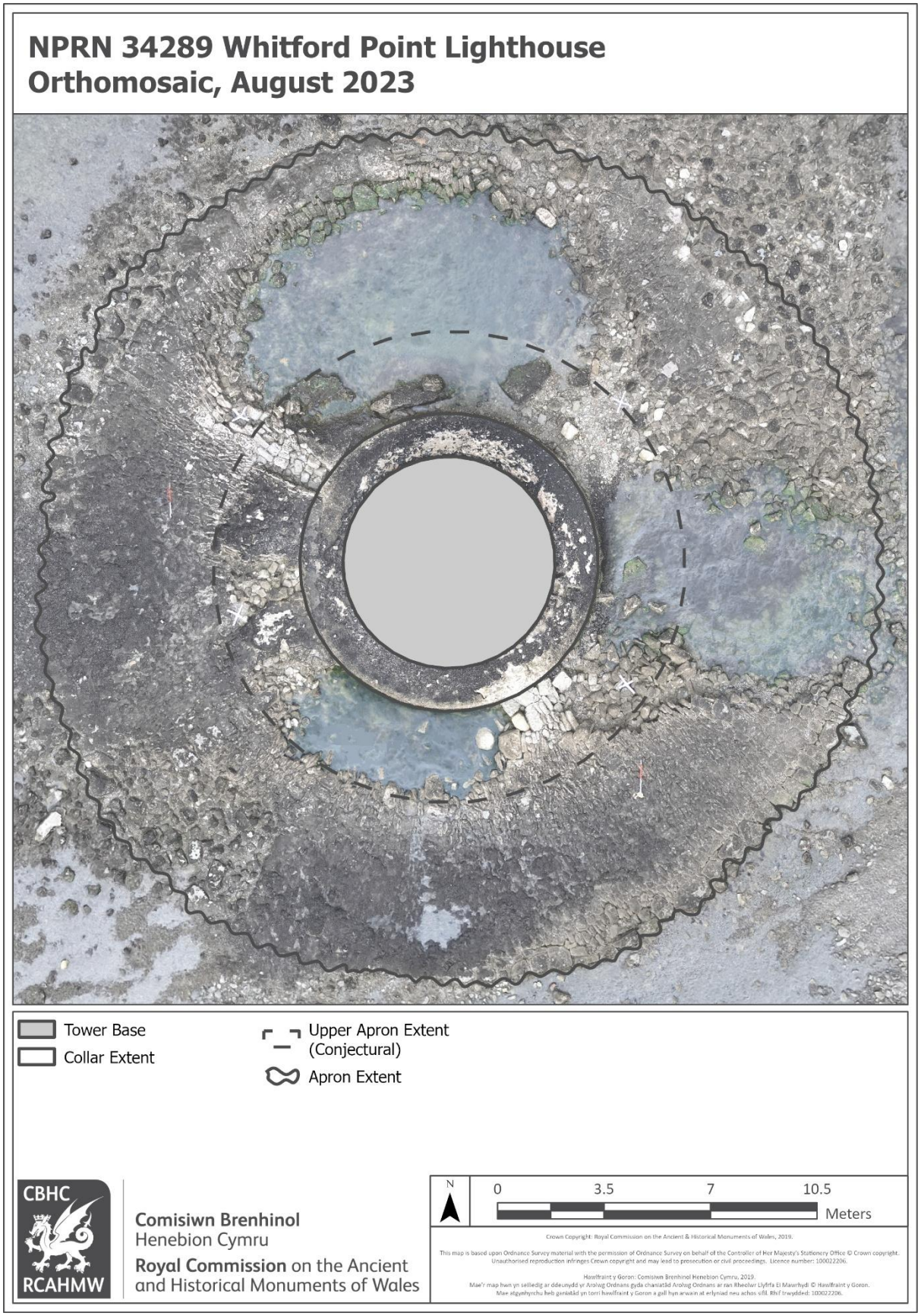

Figure 4.1: Annotated Orthomosaic of Whitford Point Lighthouse derived from a photogrammetry survey on 17/08/2023 (© Crown Copyright: RCAHMW).

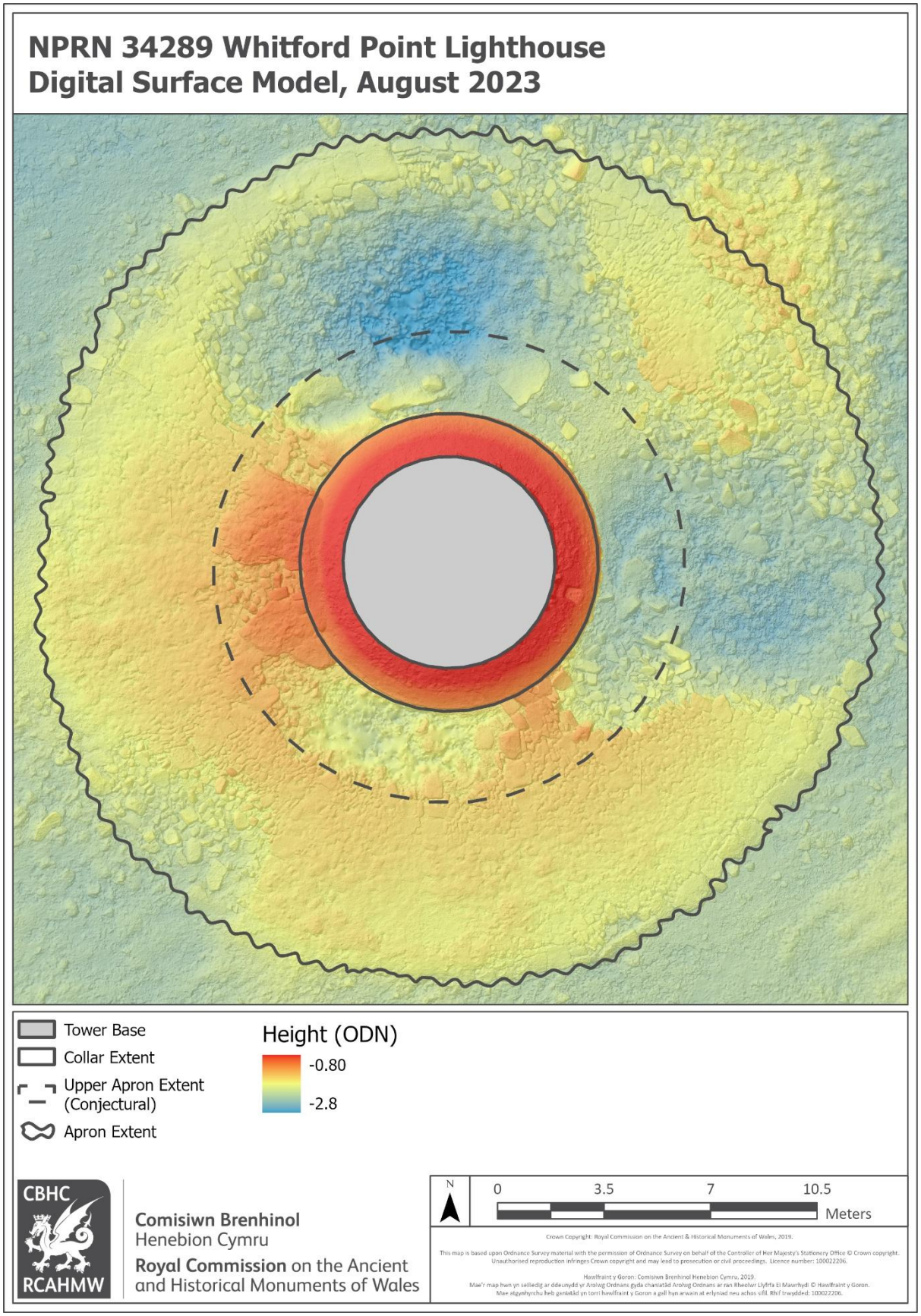

Figure 4.2: Annotated DSM of Whitford Point Lighthouse derived from a photogrammetry survey on 17/08/2023 (© Crown Copyright: RCAHMW).

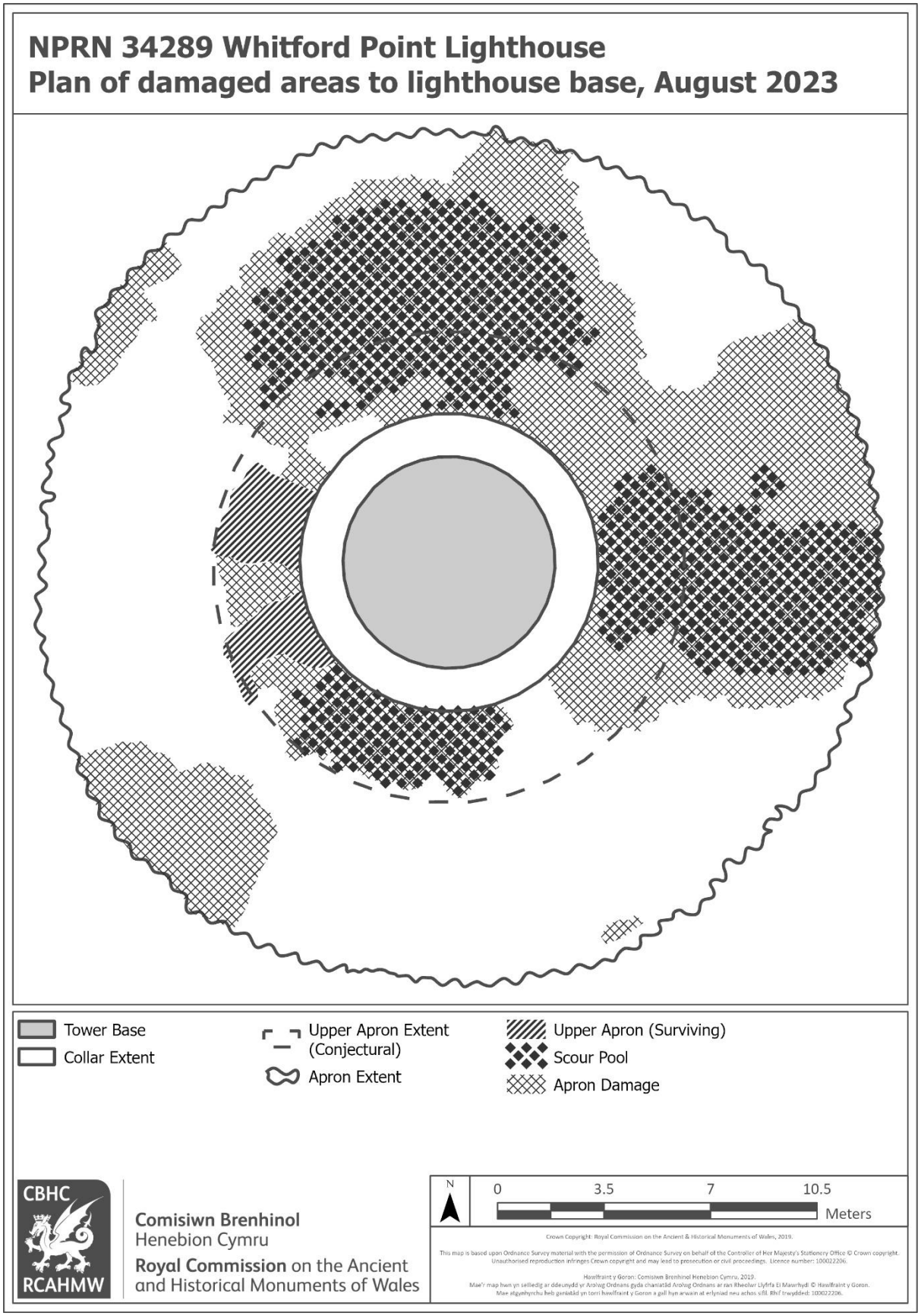

Figure 4.3: Interpretation of Orthomosaic and DSM of Whitford Point Lighthouse, derived from a photogrammetry survey on 17/08/2023 (© Crown Copyright: RCAHMW).

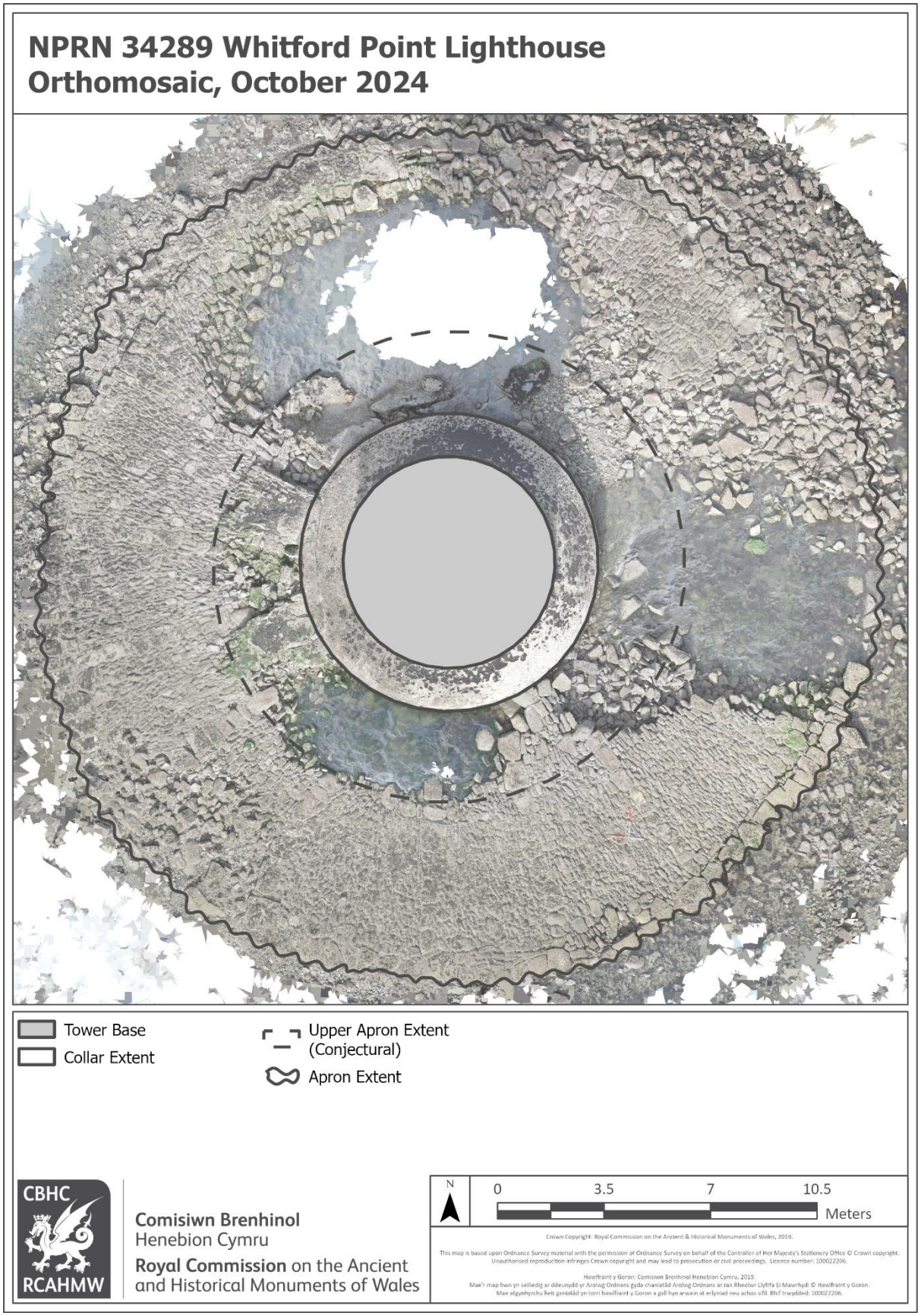

Figure 4.4: Annotated Orthomosaic of Whitford Point Lighthouse derived from a photogrammetry survey on 17/10/2024 (© Crown Copyright: RCAHMW).

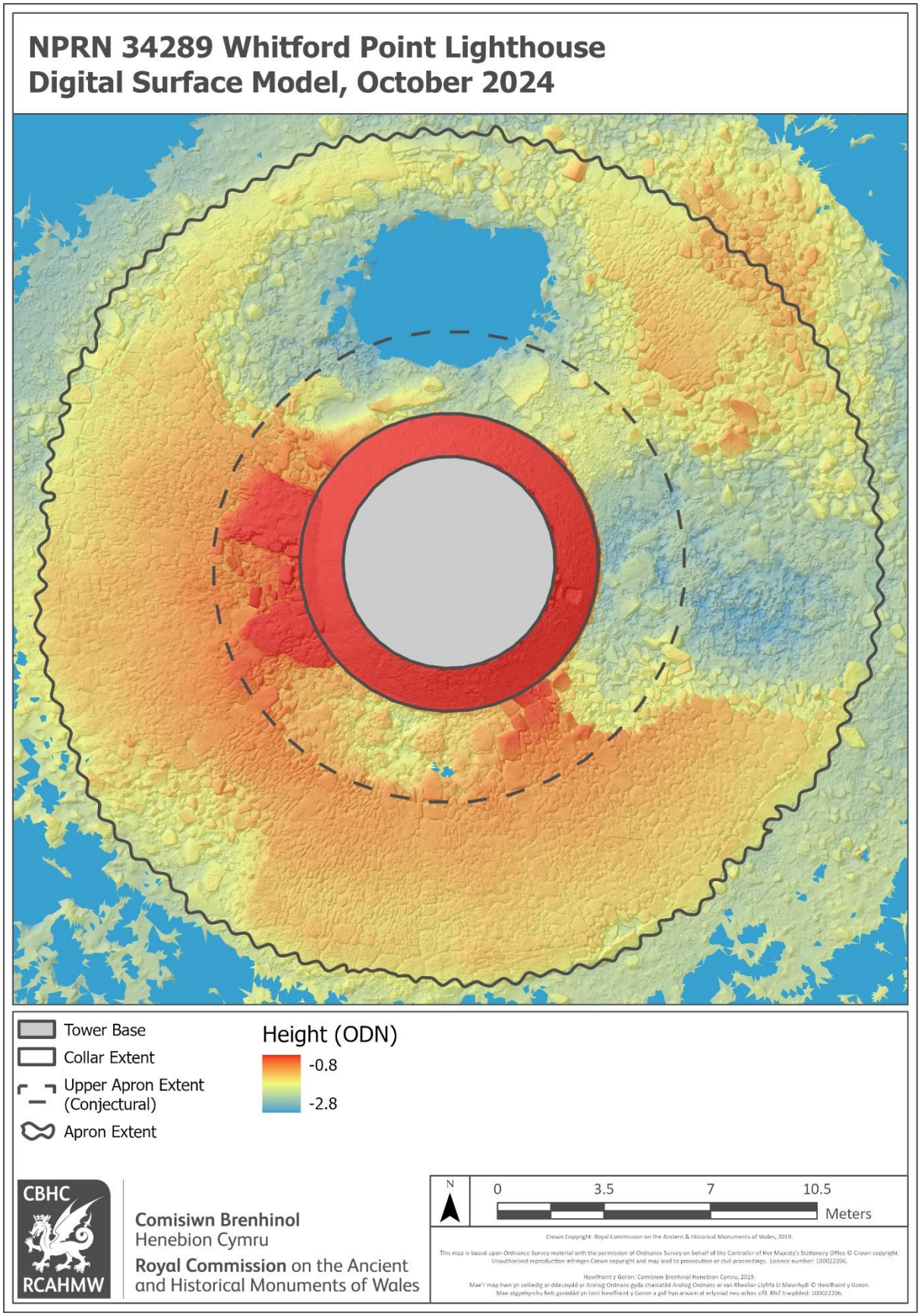

Figure 4.5: Annotated DSM of Whitford Point Lighthouse derived from a photogrammetry survey on 17/10/2024 (© Crown Copyright: RCAHMW).

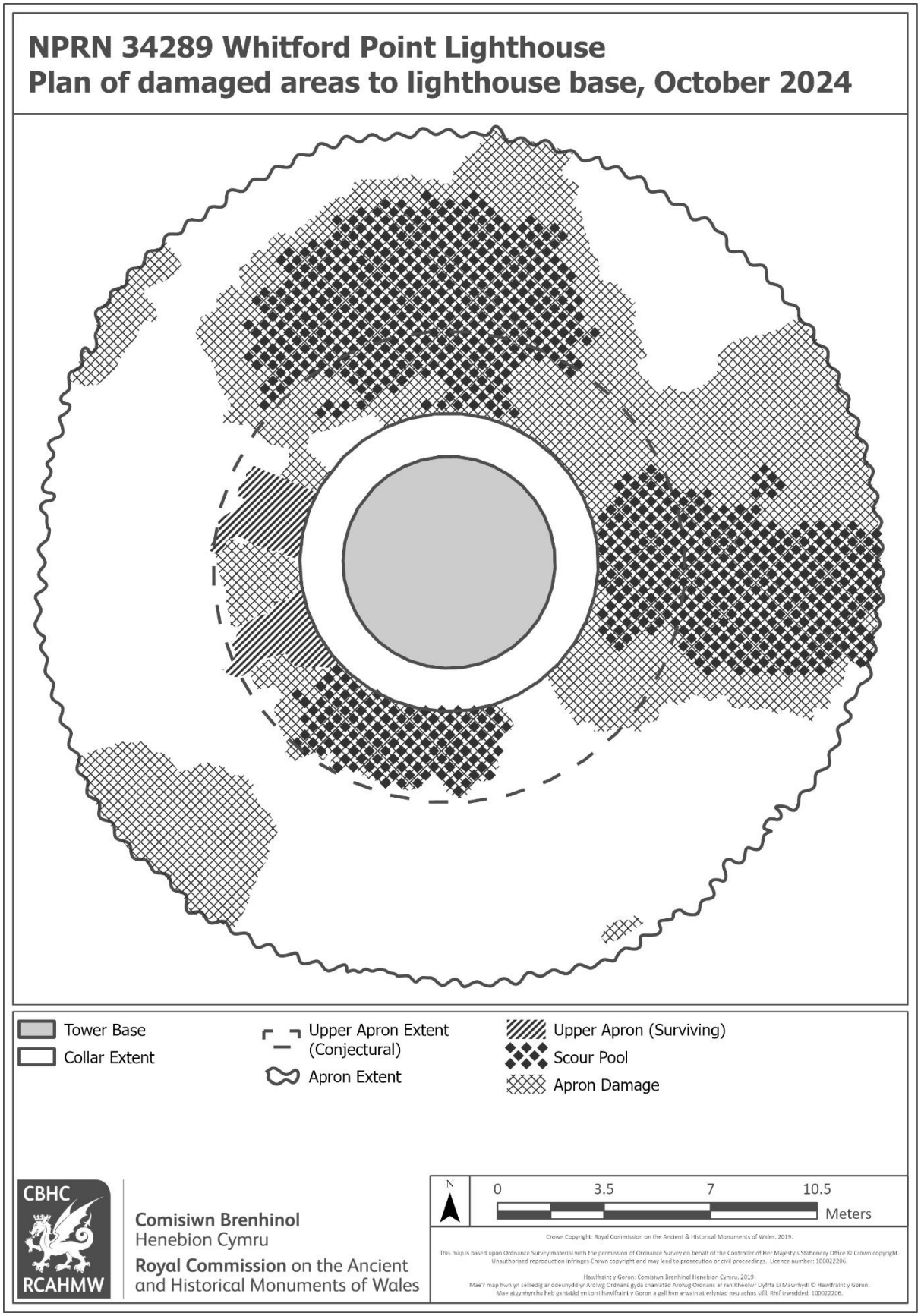

Figure 4.6: Interpretation of Orthomosaic and DSM of Whitford Point Lighthouse, derived from a photogrammetry survey on 17/10/2024 (© Crown Copyright: RCAHMW).

The 2024 survey served to demonstrate that the overall methodology adopted in 2023 was repeatable within the available tidal window, and effective in being able to identify even relatively small areas of localised change that had taken place between the two surveys. It was also instructive to compare the visibility of stonework between an August and October survey. The latter had a much lower level of weed cover across the stone apron, which in turn allowed for better interpretation of the results.

An obvious challenge is in establishing the timeframe between monitoring surveys. The 14 month period between the baseline survey in August 2023 and the monitoring survey in October 2024 witnessed relatively little overall change. Implementing another 14- or 15-month gap would timetable the next survey for early spring 2026, when weed coverage of the apron is likely to be reduced relative to the summer months. If that survey is not possible due to poor weather or other factors, then a survey in the autumn of 2026 would provide a benchmark two years after the October 2026 survey. Either of these options seem appropriate in attempting to gauge the frequency required for future monitoring.

4.2 Historical Imagery

By contrast to the photogrammetry dataset, the available historical imagery does not provide a measurable record of the erosion to the lighthouse base over time. To some extent this is academic, as the erosion has happened, but has been recorded in its current form, as detailed in Section 4.1. The available historical imagery has been used in the context of this report to gain an overview of the progress of erosion to the lighthouse base over the last 50 year for which the images span. This is made easier with the presence of aerial photographs from the 1990s onwards. The following account is therefore necessarily a chronological narrative by decade with the coverage dictated by the availability of images. Footnote hyperlinks to the image entry within the NMRW archive are provided with each image to allow viewing at a more convenient size than within this report.

1970s

1970s imagery is restricted to ground-level photographs taken in 1971 (Figure 4.7 left) and 1972 (Figure 4.7 right), from the southern side of the lighthouse. It is impossible to assess the extent of any erosion to the apron as only a small part on the southern side is visible. The whole area of the apron does appear to be covered in mussels, consistent with the surrounding intertidal area. These are absent from later images of the apron, so it is possible to surmise that the extent of erosion in the 1970s was very small to non-existent, based on the coverage of mussels over the apron, which decreases, as erosion increases in later years.

1980s

The only image[3] identified from the 1980s shows the lighthouse at high tide, which while interesting, does not help assess the chronology of damage to the lighthouse base.

[3] https://coflein.gov.uk/en/archive/6438988/

Figure 4.7: Ground-level photographs of Whitford Point Lighthouse, viewed from the south (© Crown Copyright: RCAHMW). Left: 1971, by Dylan Roberts, archive No. 6171738.[4] Right: 1972, by Douglas Hague archive No.6498731 (© Crown Copyright: RCAHMW).[5]

1990s

A set of aerial photographs from the RCAHMW flying programme provide the first overhead images of the lighthouse. These comprise a single image from 1991, and further images from 1994 and 1997. The 1991 and 1997 images show the lighthouse at high tide and are of no use for gauging the erosion to the apron. Critically, the available 1994 images provide aerial coverage from both the northern and southern sides of the lighthouse (Figure 4.8 and 4.9) and are therefore highly informative regarding the condition of the stone apron at that point in time.

Figure 4.8: Aerial photo of Whitford Point Lighthouse, viewed from the southeast, taken by C. R. Musson on 29/03/1994, archive No. 6144854 (© Crown Copyright: RCAHMW).[6]

[4] https://coflein.gov.uk/en/archive/6171738/
[5] https://coflein.gov.uk/en/archive/6498731/
[6] https://coflein.gov.uk/en/archive/6144854/

Figure 4.9: Aerial photo of Whitford Point Lighthouse, viewed from the north, taken by C. R. Musson on 29/03/1994, archive No. 6144846 (© Crown Copyright: RCAHMW).[7]

Figure 4.8 and 4.9 make it clear that the large scour pools within the foreshore to the east of the lighthouse are well formed by the mid-1990s. Moreover, the western edges of the scour pools are starting to erode the eastern edge of the stone apron. Reference to Figure 4.8 illustrates that the stone apron appears largely free of erosion damage on its southern and western sides in the areas that would become badly impacted in subsequent decades. There is a suggestion of some dislocation of stones from the outer southwestern edge of the apron, associated with a small scour pool within the adjacent foreshore. By contrast, Figure 4.9 offers a view of the lighthouse from the north. This shows that the process of erosion to the stone apron is underway on the northern side of the lighthouse, characterised by the loss of stonework from the area where the collar and apron meet.

2000s

Aerial images from 2002 and 2003 show the lighthouse at high tide. Ground-level photography from 2006, and aerial photography from 2008 therefore form the main record for this decade. The ground-level photography was undertaken by Dave Leighton in 2006 during a site visit to the lighthouse (Figure 4.10) and includes a general image, and a detail of the apron. Both these images are taken from the south side of the lighthouse. The only visible damage is to an area of disturbed stonework on the southwestern outer edge at a point that corresponds with a larger area of damage in the 2023 survey. The detail of the apron stonework is also instructive, in charting the decrease in mussel coverage on the one hand, and because the photo gives coverage of an area that was subject to the southern scour pool by 2023, but which appears undamaged in 2006.

The aerial images from 2008 taken by Toby Driver are especially useful (Figure 4.11). Shot from the southeastern side of the lighthouse, they clearly show that the northern scour pool and area of erosion, beginning to be visible in 1994 was extensive and well-formed by this point. An area of damage to the edge of the apron is also visible on the southeastern side, which would have been out

[7] https://coflein.gov.uk/en/archive/6144846/

of shot in the 2006 images. On the southwestern edge of the apron, the damage thought visible in the 2006 ground-level photograph is clearly observable, while a possible area of damage, which became more pronounced in subsequent years, is hinted at along the junction of the collar and upper apron.

Figure 4.10: Ground-level photos of Whitford Point Lighthouse, viewed from the south, in 2006 (© Crown Copyright: RCAHMW). Left: General view, archive No. 6309802.[8] Right: Detail of stone apron, archive No. 6309852 (© Crown Copyright: RCAHMW).[9]

Figure 4.11: Aerial photo of Whitford Point Lighthouse, viewed from the southeast, taken by Toby Driver on 20/06/2008, archive No. 6458875 (© Crown Copyright: RCAHMW).[10]

[8] https://coflein.gov.uk/en/archive/6309802/
[9] https://coflein.gov.uk/en/archive/6309852/
[10] https://coflein.gov.uk/en/archive/6458875/

2010s

A clear, oblique, aerial image of the lighthouse was taken by Toby Driver in 2010 as part of the RCAHMW flying programme (Figure 4.12). This shows the well-established northern scour-pool and associated erosion. Clear, developing damage to the eastern side of the apron edge is also visible. This appears related to the substantial, deep scour pool, to the east of the lighthouse apron, noted as present in the 1990s (above), which is impacting on the eastern edge of the apron. The patch of damage on the southwestern edge of the apron is visible, along with a scour pool to the southwest of the apron itself. The small area of damage at the upper apron/collar junction on the southwestern side of the lighthouse, possibly visible in the 2008 image, is confirmed as present in this 2010 photograph.

Figure 4.12: Aerial photo of Whitford Point Lighthouse, viewed from the southeast, taken by Toby Driver on 02/03/2010, archive No. 6462393 (© Crown Copyright: RCAHMW).[11]

The first 3D digital survey of the lighthouse was undertaken in April 2018 by Hamish Fenton using a kite-based system.[12] This was work was not completed as part of a recording scheme, but nevertheless provides an excellent record of the structure and apron at that point in time. It provides a helpful bridge between the aerial images from 2010, and the RCAHMW survey of August 2023. Fenton's survey (Figure 4.13) illustrates that all the main areas of erosion and scour visible in 2023 were established by 2018. In particular, the eastern area has developed rapidly from the situation in 2010 to comprise a large area, filled with water, and with associated loss of the apron edge around its eastern side. The apron between the eastern and northern erosion areas has suffered loss, especially adjacent to the collar, it is better preserved further away from the collar. The northern erosion area itself appears relatively stable. On the southern side of the lighthouse, erosion damage is developing in the area adjacent to the collar that was first confirmed in the 2010 aerial images. Damage to the southwestern edge of the collar has increased, compared to 2010. Finally, reference

[11] https://coflein.gov.uk/en/archive/6462393/
[12] https://skfb.ly/6XOKq

to Fenton's 2018 survey indicates the undercutting of the collar associated with the northern and eastern erosion areas.

Figure 4.13: Orthomosaic of Whitford Point Lighthouse, derived from a photogrammetry survey by Hamish Fenton on 18th April 2018 (Image courtesy of Hamish Fenton).[13]

4.3 Overall Observations

Combining the two sets of data outlined in Sections 4.1 and 4.2 allows a set of overall observations regarding the development and progression of erosion damage to the base of Whitford Point Lighthouse (Figure 4.14). These overall observations are based on using the August 2023 RCAHMW survey as a known baseline against which the information contained within the available historical images can be compared. Three main areas of damage to the base of the lighthouse can be demarcated based on the August 2023 survey; on the northern, eastern and southwestern sides, and it is simplest to address each of these in turn (below).

First, it is worth highlighting the value of incorporation of the 2018 survey data kindly shared by Hamish Fenton. This allows Table 4.1 to be updated to include figures derived from 2018, presented in Table 4.2 and greatly increases the period for which the erosion to the base of the lighthouse is covered by 3D digital datasets.

Table 4.2. Percentage area loss of stone apron and upper stone apron 2018-2024.

Component	**Area ($m^{2)}$**	**% loss (of original)**
Stone Apron	*537 m^2*	*N/A*
2018 Scour Pools	103 m^2	19.2%
2023 Scour Pools	125 m^2	23.2%
2018 Damage	229 m^2	42.6%
2023 Damage	265 m^2	49.3%
2024 Damage	267 m^2	49.7%
Upper Stone Apron	*113 m^2*	*N/A*
2018 Surviving Extent	15 m^2	86.7%
2023 Surviving Extent	14 m^2	87.6%
2024 Surviving Extent	11 m^2	90.3%

[13] Hamish Fenton's record of the lighthouse from 2018 can be viewed here: https://skfb.ly/6XOKq

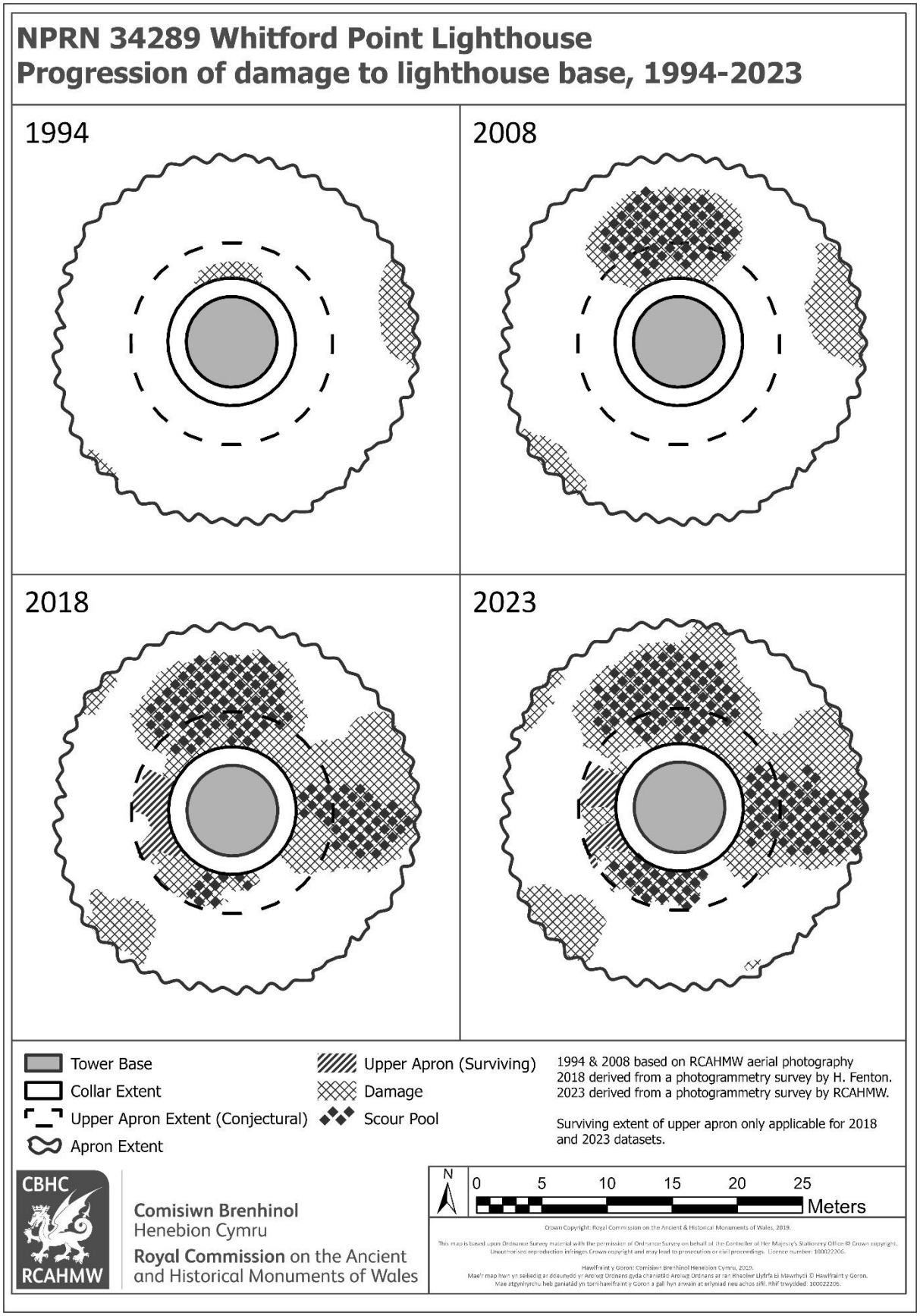

Figure 4.14. Overall progression of erosion damage to the stone apron of Whitford Point Lighthouse between 1994 and 2023 (© Crown Copyright: RCAHMW).

Northern erosion area

This area is not visible in the 1970s ground-level images, but the overall impression from those photographs is that the entire apron is intact and covered in mussel growth, there is no mention of erosion in any written records from this time.

RCAHMW aerial images from the mid-1990s make it clear that the area of erosion on the northern side of the lighthouse has started to form by 1994, characterised by an area of missing stonework from the apron. By 2008 the erosion is well-established with clear and significant loss of material from the apron. By contrast, increase between 2008 and 2023 appears to be relatively small. Reference to the 2018 photogrammetry survey illustrates undercutting of the apron in this area, which it is suggested was already happening by 2008.

An area of developing damage to the northwestern edge of the apron is present in the 2023 survey, which can be identified as being tentatively present in 2018.

Eastern erosion area

The eastern erosion area within the apron appears to have developed since the 2008/2010 aerial images. There is no suggestion of it in the 1994 aerial images or the 2006 ground-level photographs, although damage to outer-apron edge may have been out of shot. In 1994, 2008 and 2010 damage is restricted to the edge of the apron. But, by 2018 the eastern erosion area is well-developed with a significant associated scour pool and undercutting of the collar. This trajectory continues through to the 2023 and 2024 surveys with observable increase to this erosion area. There is also loss of material from between the northern and eastern areas in the period between 2018 and 2023. The eastern erosion area illustrates the speed with which significant loss of material can occur, in this case in the eight years between the 2010 aerial photographs and the dataset captured by Hamish Fenton in 2018.

Intriguingly, the 2023/2024 surveys identified an area of the northeastern apron edge with a pile of loose stones on it, assumed to have been deposited there following scouring from the northern or eastern areas. Reference to the 2018 data shows that this pile of stones was greater in extent in 2018 than in 2023/2024. It may therefore have been created during the scouring of the eastern erosion area between 2010 and 2018, before now reducing in coverage.

Southern erosion area

In 1994, damage in this area is restricted to the possible dislocation of stonework from the outer-edge of the apron on its southwestern side. The same area exhibits a development of the same damage in 2008. By 2010 there is some suggestion of loss of material where the apron and collar meet, and this is clearly the case by 2018 when a large area of erosion damage is visible from the apron/collar area on the southern side of the lighthouse. The depth of this is illustrated by the formation of a scour-pool within it. The extent of material missing from the southwestern edge of the apron has also increased by 2018. This process continues to the 2023 and 2024 surveys, with an increase to the erosion damage and scour-pool, as well as the apron edge. As with the eastern area, this demonstrates the rapidity with which significant loss can occur, in this case between 2010 and 2018, with continuation through to 2023 and 2024.

Foreshore hinterland

The area of foreshore surrounding the lighthouse apron has also been subject to change during the period covered in this report. Or rather, there are large areas of scour that have developed to the

east of the lighthouse that are clearly visible in aerial photos from the mid-1990s onwards. These have formed two discreet areas that to some extent match the orientation of the northern and eastern erosion areas within the apron itself. Similarly, the developing erosion to the southwestern edge of the apron, and the southern erosion area, seemingly have an alignment with an area of foreshore scour to the southwest of the apron.

Taken together, these three areas align along an axis of c. 230° if the southwestern scour is assumed to be in a position 'upstream' of the lighthouse, with the large, deeper areas to the north and east lying 'downstream'. It is potentially telling that the predominant wave direction in the area, as reported by the closest set of data held by the Welsh Coastal Monitoring Centre comes from between 230° (WCMW Survey Unit 8c13.1) and 236° (WCMC Survey Unit 8c12.13).

It is outside of the archaeological focus, or indeed expertise, of this paper to pass further comment on these scour areas. But, development of an informed understanding of the processes that are causing them – wave action, tide action, or a combination of the two – coupled with analysis of the extent to which they are impacting on the apron itself is critical for furthering our understanding of the erosion processes on the lighthouse. Such understanding may include being able to move from the hindcasting undertaken in this report, to a situation of forecasting the future acceleration, stabilisation, or reduction in the rate of erosion is possible.

5. Conclusions & Recommendations

Rather than repeat the overall observations set out above, the main conclusions from this review of the available data are briefly summarised via a series of key points relating to the chronological development of erosion and damage to the stone apron, recommendations for ongoing monitoring, and areas for future, mainly non-archaeological, work.

5.1 Erosion and Damage Chronology

- The northern erosion area is established, albeit on a small scale by 1994, with dramatic increase between 1994 and 2008. It now appears relatively stable in extent, but the rate of collar undercutting is not well-established.
- Loss of material to northwestern edge of apron can be identified since c.2018. This seems likely to continue, at a currently unknown rate.
- The eastern erosion area has developed since c. 2008, and increased rapidly to 2018. There has been a slow increase in the 2018-2024 covered by photogrammetry data.
- Loss of material between the northern and eastern erosion areas is ongoing.
- The southern erosion area has developed since c. 2010, and increased rapidly to 2018. The rate of increase has seemingly slowed, but is ongoing. Loss of material to the southwestern edge of the apron is likely to have been happening, albeit slowly, from c. 1994 onwards.

5.2 Ongoing Monitoring

On the basis of the development of erosion and damage to the lighthouse apron, a series of recommendations for the ongoing monitoring of the erosion to the apron and collar can be made:

- Repeat surveys undertaken at an initial frequency of c.24 months, ideally in spring/autumn, with next scheduled survey in Autumn 2026.
- GNSS recording of scour-pool depths on next monitoring visit, and thereafter to gauge development of areas beneath the surface which cannot be reliably measured from photogrammetry/laser-scaning surveys.

5.3 Future Work

Finally, further non-archaeological work would greatly enhance understanding of the current stability of the lighthouse, and of the wider geomorphological processes taking place in the area which are undoubtably impacting on the erosion processes that the lighthouse is subject to:

- Engineering inspection of lighthouse structure to assess the extent to which the cast-iron structure retains physical integrity, allowing an assessment of the ongoing stability of the entire structure.
- Sedimentological/geomorphological analysis of the foreshore hinterland of the lighthouse to provide a better understanding of the context within which the structure sits, specifically the impact of the scour within the foreshore to the east and west of the lighthouse.

6. Sources

Cadw, 1979. *Scheduled Monument Description, GM407. Iron Lighthouse at Whitford Point*. https://cadwpublic-api.azurewebsites.net/reports/sam/FullReport?lang=en&id=3628

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Welsh Coastal Monitoring Centre, Hydrodynamic Data, https://www.wcmc.wales/data

Supplementary Sources (held within the NMRW archive)

CAM001-01-3435-00 - Cadw Registered Files Collection, https://coflein.gov.uk/en/archive/6518126/

Drawings and elevations of the lighthouse (non-RCAHMW)
https://coflein.gov.uk/en/archive/6018629/