Beacon Island
Interim report on the Department of Maritime Archaeology–University of Western Australia 2014 expedition

Jeremy Green (ed.)
with contributions by
David Lumley, Jeff Shragge and Paul Bourke

The Beacon Island February 2014 expedition members: Tom Hoskin, Nader Issa, Paul Bourke, Jeff Shragge, David Lumley, Nic Bigourdan, Maddy McAllister, Susan Green, Jeremy Green and Leigh O'Brien standing next to the beacon

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BEACON ISLAND FIELDWORK FEBRUARY 2014

SUMMARY

Jeremy Green

Figure 1. Aerial photograph of Beacon Island showing hut numbers used in the WA Museum survey.

As the remaining part of the Your Community Heritage—*Batavia* National Heritage Listing Grant an expedition was planned by the Department of Maritime Archaeology of the Western Australian Museum to Beacon Island, the island where the majority of the survivors of the *Batavia* shipwreck were located and where many of them died or were killed in the ensuing massacres that took place there (see Drake-Brockman, 1963; Green, 1989; Ariese, 2011). During the 2013 expedition to Beacon Island (Green, forthcoming) a human tooth was found lying on the ground, indicating a nearby burial (see below). Therefore the 2014 project planned to conduct a remote sensing survey of part of Beacon Island, together with the finalisation of the survey of the interior of some of the buildings on the island that were unavailable in 2013. David Lumley and a team from the UWA Geophysics Department, agreed to assist with the remote sensing work and a small team was organised to undertake a short expedition to Beacon

Island to complete the work. The WA Department of Fisheries assisted with transportation to and from the island and the project started on 31 January and finished on 6 February. This report describes the work undertaken.

THE PROJECTS

The work planned for the expedition consisted of remote sensing, undertaken by UWA Geophysics and Maritime Archaeology Department; photographic visualisation of the interiors of buildings and external textures of island vegetation and buildings by Paul Bourke, UWA iVEC; recording dimensions of interiors of remaining un-surveyed buildings on the island by Maritime Archaeology Department.

REMOTE SENSING

Figure 2. The tooth found in 2013.

The initiative for the remote sensing survey came as a result of the discovery of a human tooth on the last day of the 2013 expedition (Fig. 2). The tooth, lying on the surface of the ground, indicated that there was a possible burial in the vicinity. The area was a nesting ground for the wedge-tailed shearwater (*Puffinus pacificus*) which burrow into the ground to nest. As part of the burrowing process, the birds tend to extract small objects from the burrows and it was thought that the tooth, possibly loose from the jaw, was thrown up in the burrowing process. The area where the tooth was found has relatively low vegetation, so it was ideal for a remote sensing survey. An area was selected from the Landgate aerial photographs of the island covering a rectangle of 1152 m^2 in area (Fig. 3). Some trimming of the vegetation was required to help the surveying process. Six systems were used to survey the area: ground penetrating radar (GPR) using high, medium and low frequency systems; conductivity, magnetometer and metal detector.

Metal Detector Survey

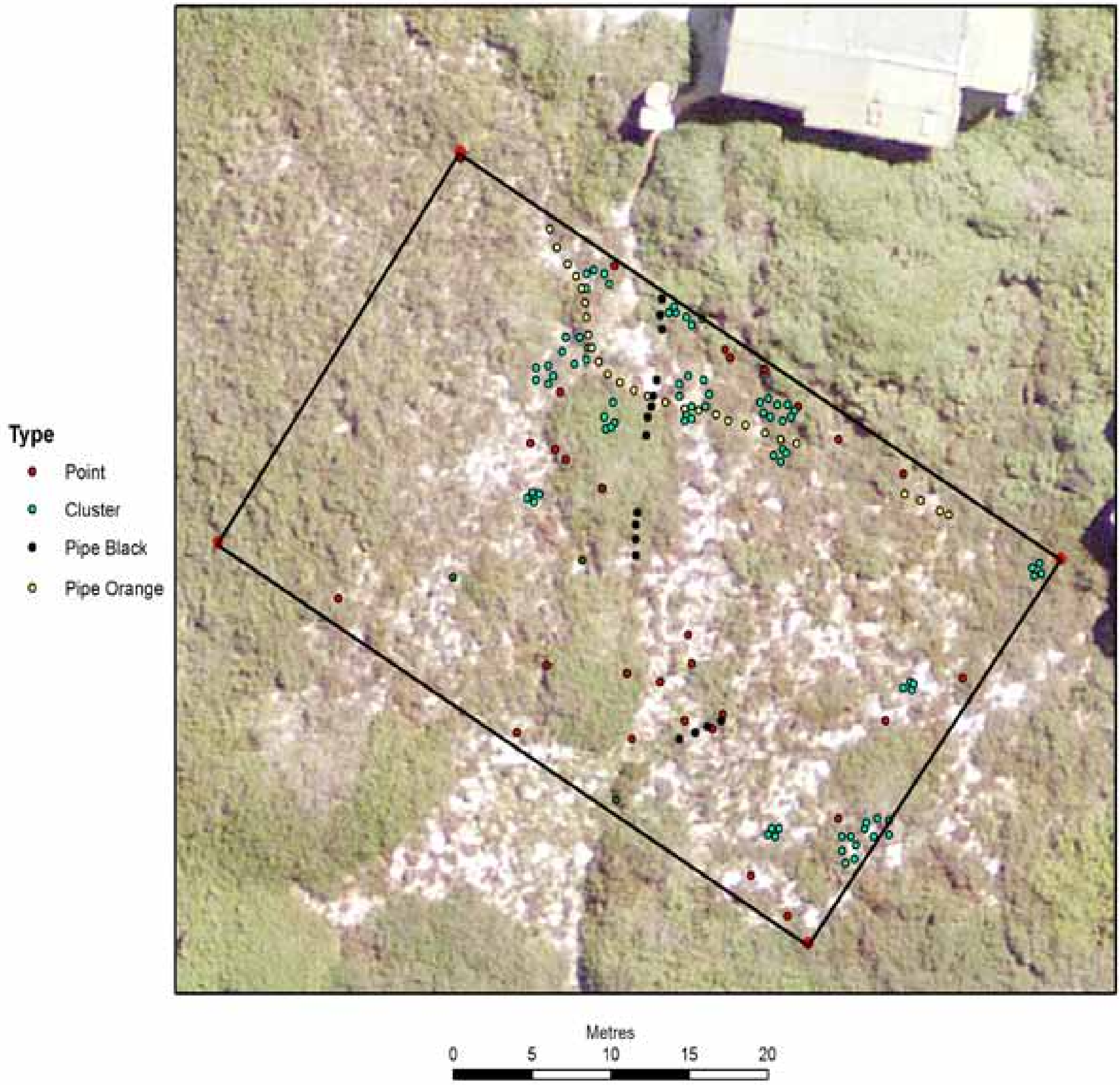

Figure 3. Aerial photograph of survey area on Beacon Island together with the metal detector targets (the orange pipe was an electricity conduit, the black pipe was a water pipe).

The Department of Maritime Archaeology brought a MineLab SD2200 metal detector to carry out the metal detector survey; however, this failed to work in the field. Fortunately, an ELSEC 5000 underwater metal detector had been brought for use in the shallow water. This instrument, while not ideal, did provide an opportunity to survey the area and it was quite useful since its relatively low sensitivity tended to ignore a lot of the small metal objects on the surface. Targets were recorded using a GNSS (Global Navigation Satellite System), either as single point targets or as an area of high reading where the perimeter was recorded. Results were plotted on the island Geographical Information System (GIS) (Fig. 1). The GIS uses information gathered over the years to produces layers of spatial information. All the surveying work for 2014 was placed on the GIS and is the basis of the images of the surveys carried out on the island.

Figure 4. Metal detecting, Nic Bigourdan operating the ELSEC metal detector and Maddy McAllister operating the differential GPS system.

Figure 5. Maddy McAllister recording the GPS position of the metal detector target.

UWA GEOPHYSICS SURVEYING

David Lumley and Jeff Shragge

The following geophysics surveys were conducted by the UWA Geophysics team on Beacon Island, February 2014: 1. Ground penetrating radar (GPR), 2. Conductivity, 3. Magnetometer, and 4. Differential GPS (DGPS). The UWA Geophysics team consisted of David Lumley, Jeffrey Shragge, Nader Issa and Tom Hoskin. All surveys were conducted in a rectangular grid of 40 m x 25 m (1000 m^2), located immediately SW of the old Johnson's accommodation building No. 9 which is an area of high archaeological interest (see Fig. 1). The exact coordinates of the survey grid are given in the GPS section below. To facilitate the surveys, some clearing of brush was required, which was rehabilitated after the surveys were completed. Near surface conditions were not optimal, especially for radar data, due to the dense brush, hummocky nature of the terrain, and the shallow tunnels of shearwater birds just below the ground surface. Nevertheless, we were able to record some excellent data sets that seem to show interesting features in the raw unprocessed data, which should be enhanced after geophysical image processing.

Ground Penetrating Radar

Figure 6. Jeff Shragge operating the 250 MHz GPR.

We tested 3 separate shielded GPR radar sources: 100 MHz, 250 MHz and 500 MHz. In general, the higher the radar frequency, the higher the image resolution, but the shallower the depth of penetration. From a quick field analysis of diffraction hyperbolas in the GPR data, we estimated the average radar wave velocities to be ~200 m/microsec in the top 0.5 m or so, and ~100 m/microsec deeper than 0.5 m or so.

Figure 7. Jeff Shragge (left) recording and David Lumley pulling the 500 MHz GPR.

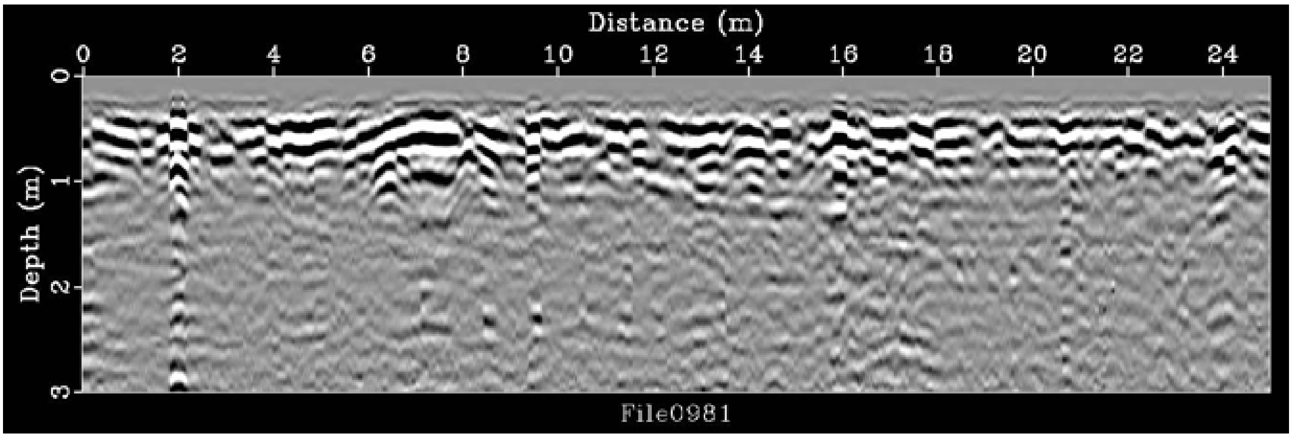

Figure 8. 500 MHz GPR cross-section taken along line 9N. An anomaly of possible archaeological interest is visible between 6.5–8.5 m along the line at depths between 0.5–1.0 m.

This means that the 100, 250 and 500 MHz radar sources have a one quarter wavelength resolution of approximately 25–50 cm, 10–20 cm and 5–10 cm respectively at the site (i.e. objects this size or larger can likely be resolved in migrated radar images). We did not observe any strong reflections deeper than ~2 m depth, probably due to a saltwater contact at this depth, which would be highly conductive and thus attenuative to radar energy. Based on our field test results, we collected two 3D GPR surveys at 500 MHz in orthogonal directions, and one 3D GPR survey at 250 MHz. Each 3D survey has an inline spacing of 4 cm and a crossline spacing of 50 cm. The 500 MHz GPR data exhibits excellent quality and shows features in the raw data which may be of both geological and archeological interest (Fig. 8). The 250 MHz GPR data is rather noisy and low resolution. Our field tests showed that the 100 MHz data was too noisy and too low resolution to be useful at this site and so a 3D survey was not acquired at this frequency. In the near future, we plan to apply further data processing and 3D wave-equation imaging to the raw 500 MHz and 250 MHz data sets in order to obtain the best 3D radar images at the site.

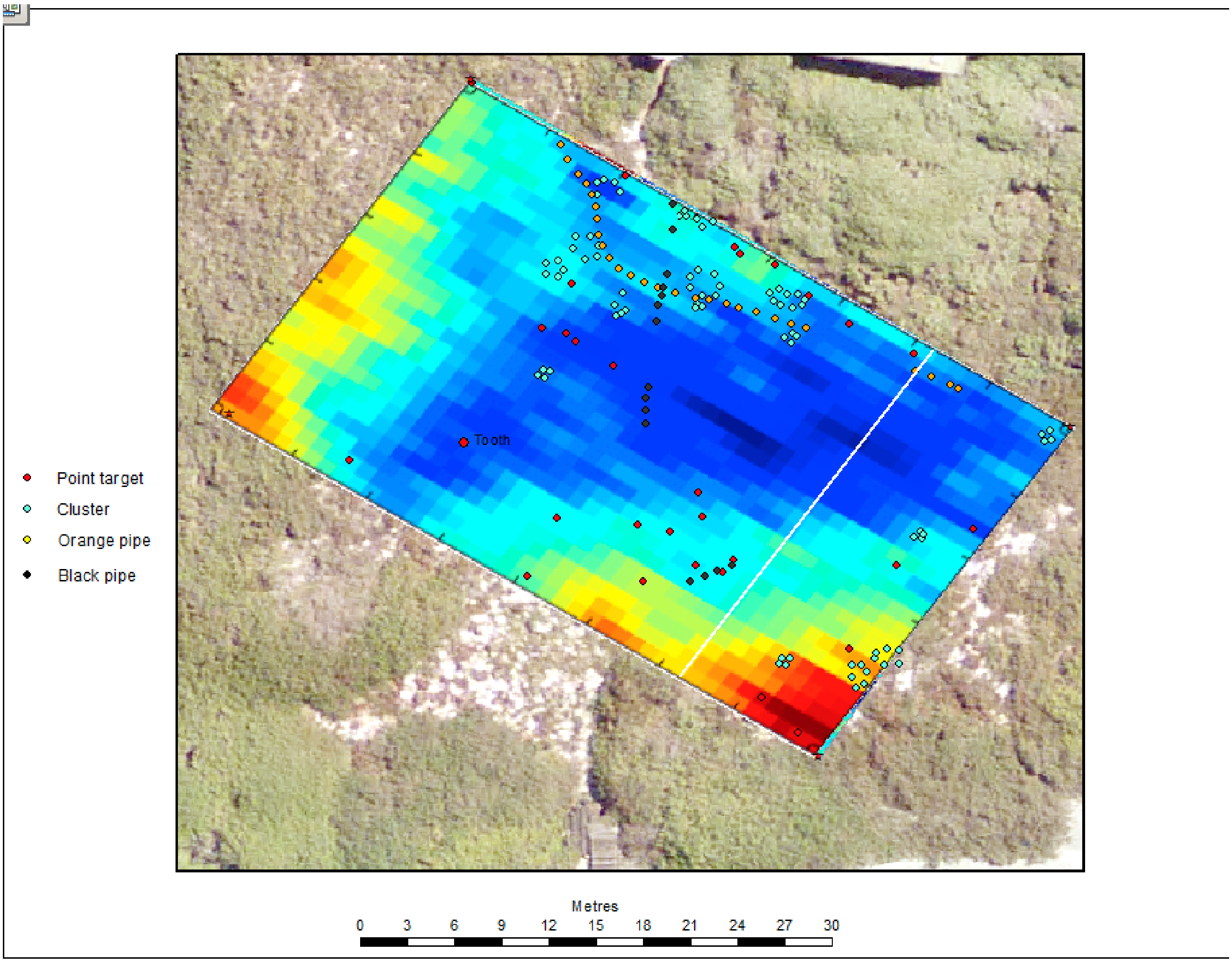

Figure 9. GIS image of the conductivity survey overlaid with metal detector survey. The white line corresponds to the feature in Fig. 6 of possible archaeological interest between 6.5–8.5 m along the line at depths between 0.5–1.0 m.

Conductivity

Conductivity measurements were recorded on the 40 m x 25 m survey grid area at 1 m inline and 1m crossline sampling. Conductivity data were acquired for three separate frequencies of 5, 10 and 15 kHz. In general, like radar, the higher the frequency, the higher the resolution but the lower the depth of penetration. Unprocessed raw results from the conductivity data (Fig. 9) show that subsurface conductivity increases towards the southern beach (salt water is highly conductive), and that there are some low conductivity (resistive) anomalies in the centre of the survey and towards Johnson's house that could be features of interest. Further processing to enhance the conductivity data will be performed.

Figure 10. Nader Issa operating the conductivity survey.

Magnetometer

Figure 11. Tom Hoskin operating the magnetometer.

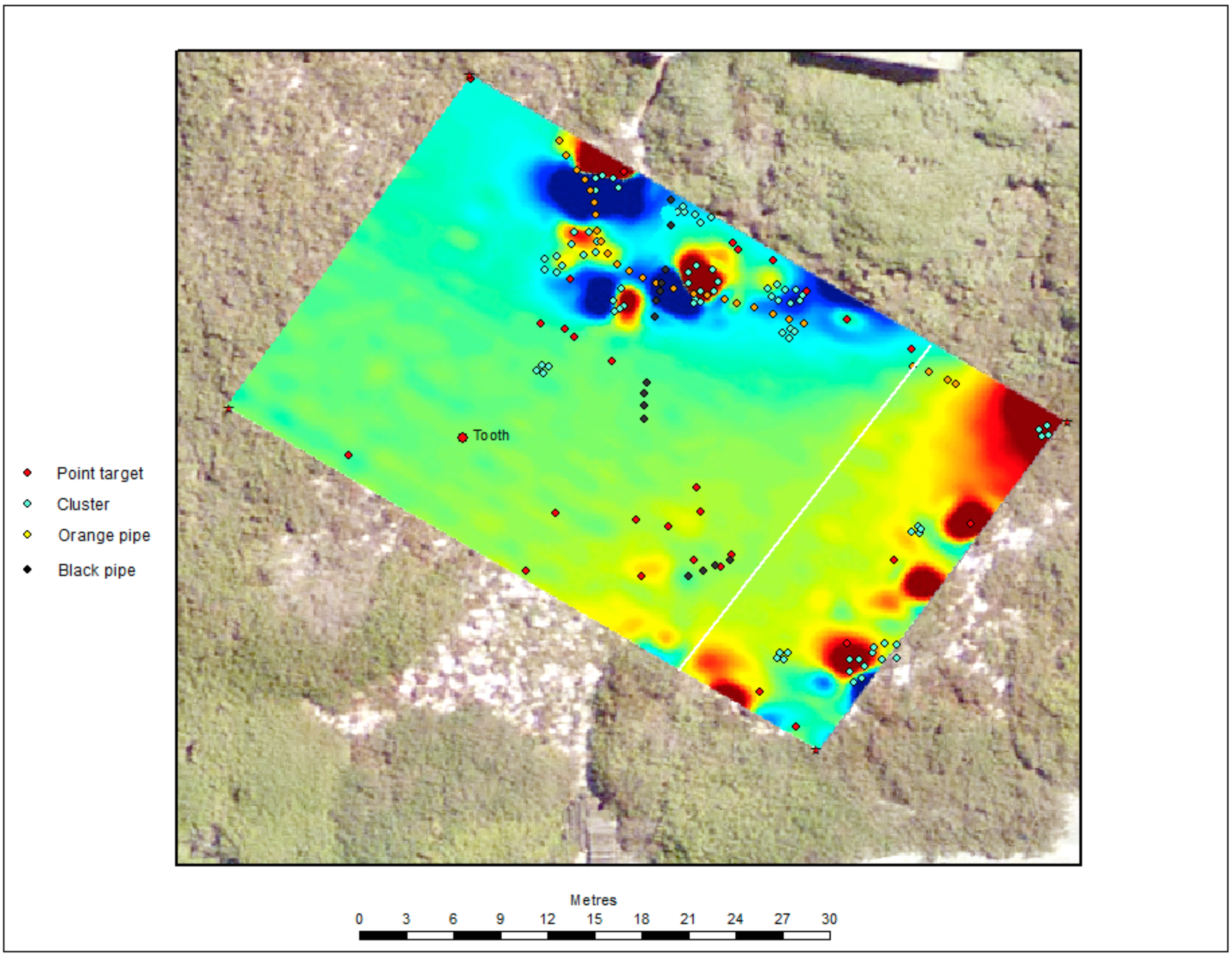

Figure 12. Magnetometer survey overlaid with metal detector survey. Note the large magnetic targets in upper and left hand side of survey, probably associated with rubbish pits or modern debris from fishing industry.

Magnetometer measurements were recorded on the 40 m x 25 m survey grid area at 1 m inline and 1 m crossline sampling. Magnetic data were acquired in vertical mode for two separate sensors at 0.5 m and 1.0 m height above the ground surface, including the vertical field gradient. We also set up a baseline magnetometer station to record background diurnal variations in the earth's magnetic field so that these could later be subtracted from the magnetometer rover data (similar to subtracting tidal effects from groundwater measurements). Unprocessed raw results from the magnetometer data (Fig. 12) show that the magnetic field strength increases gently towards the beach, and that there are some very large magnetic anomalies near Johnson's house and at the SE edge of the survey that may be related to old fishing camp buried junk pits. Weaker magnetic anomalies may be revealed and enhanced after data processing that could be of archaeological interest.

GPS Surveying

Figure 13. Maddy McAllister and Nic Bigourdan with the DGPS rover (pole) and the GPS base station (yellow tripod) in background.

A GNSS (Global Navigation Satellite System) antenna base-station was deployed over a previously established survey peg near the south-eastern tip of Beacon island (point name: CP04). The coordinates of this peg, measured in 2013, were (N 6846845.293, E 772926.369, AHD 1.051 m), which was used to specify the base location. All coordinates are given here in MGA94, Zone 49.

With the base station in place, a number of measurements were made using a rover antenna and differential satellite positioning (Fig. 12):

1. The four corners of the rectangular survey area were measured:

N 6846926.62	E 772768.948	AHD 1.17 m
N 6846947.19	E 772783.558	AHD 1.49 m
N 6846970.05	E 772750.447	AHD 1.51 m
N 6846949.20	E 772736.413	AHD 1.52 m

Upon completion of geophysical survey work, these corners were marked with metal pegs and fluorescent flagging tape.

2. Previously established survey pegs, BE01 and CP06 (within the survey area), were re-measured to confirm the relative positioning accuracy was within 0.5 m laterally and 0.1 m vertically.

3. The DGPS positions of numerous anomalies, found during a metal detector sweep within the survey area, were recorded.

Finally, 10 hours of GPS readings were logged at the base and this data was uploaded to AUSPOS for an absolute position determination. The resulting coordinate measurement (see AUSPOS report) was (N 6846844.864, E 772926.326, AHD 1.383 m), which is within 0.5 m of the 2013 position.

BUILDING INTERIOR RECORDING

Jeremy Green

During the 2013 expedition we were unable to access three buildings, Nos 12–14. These buildings were surveyed and photographed during the 2014 expedition using the same methodology as the 2013 survey. This completes the building survey of the island. In addition a plan was made of the foundations of Building 37, said to be the first building on Beacon Island.

Figure 14. WA Museum, Building No. 12.

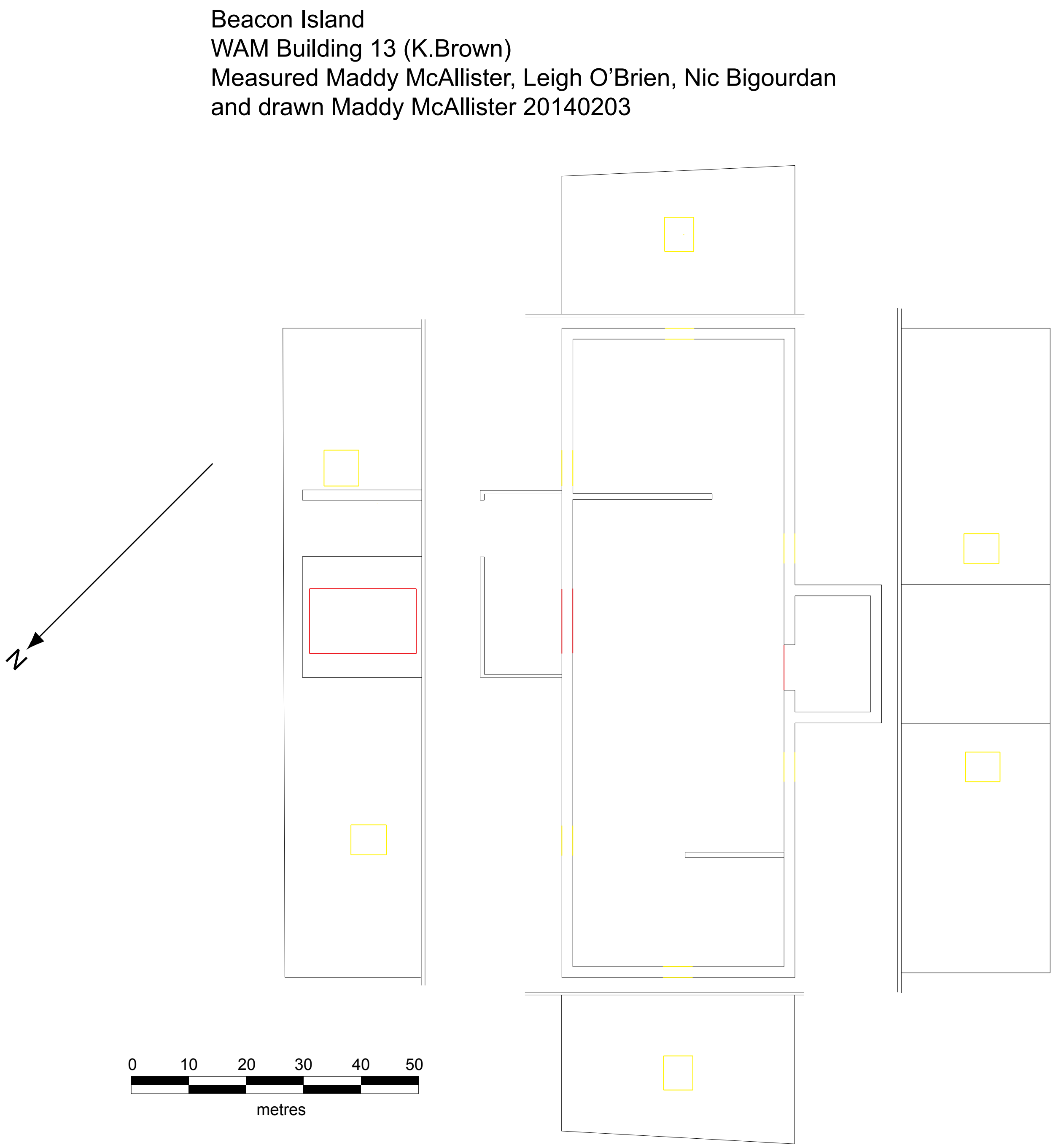

Figure 15. WA Museum, Building No. 13.

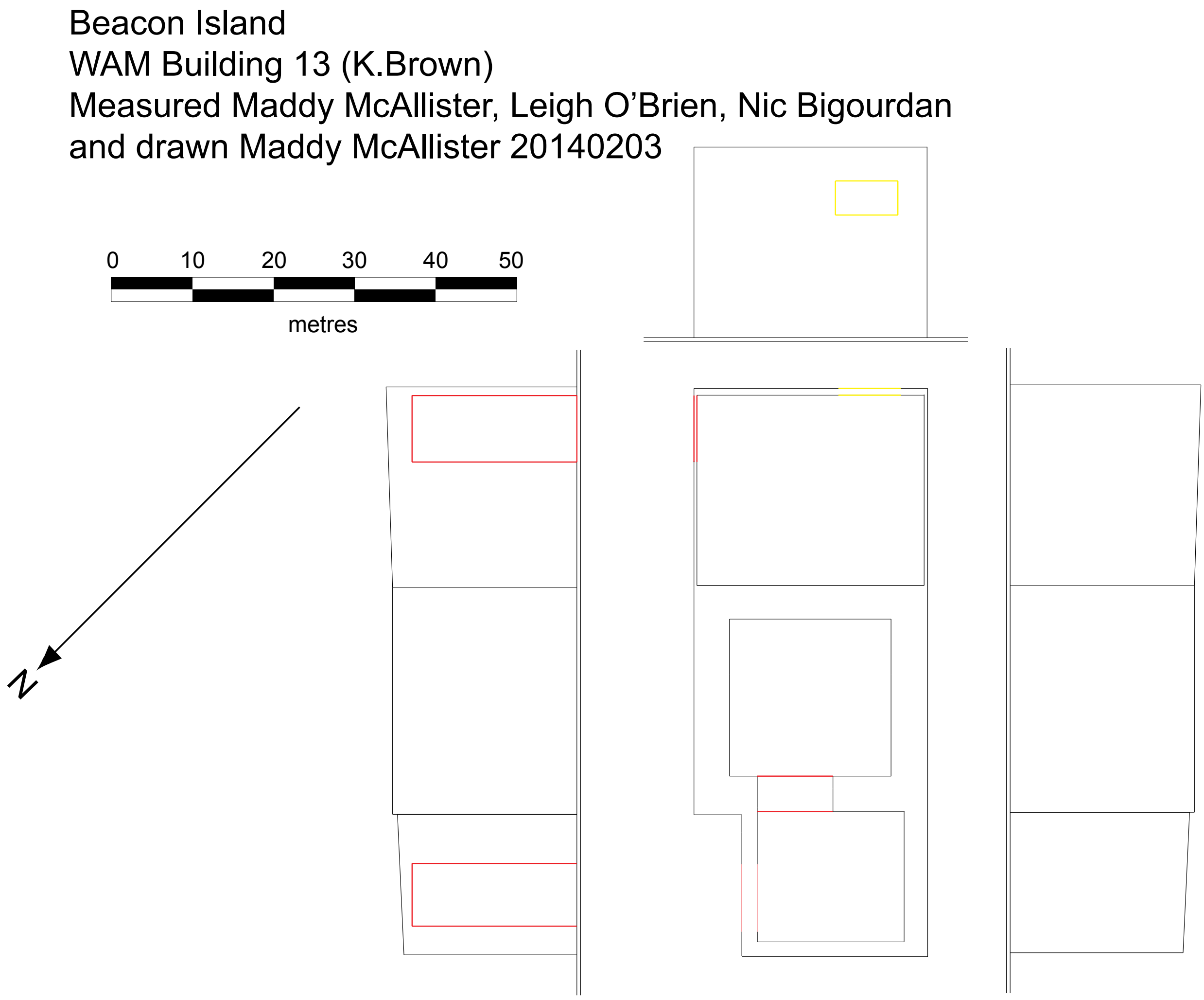

Figure 16. WA Museum, Building No. 13.

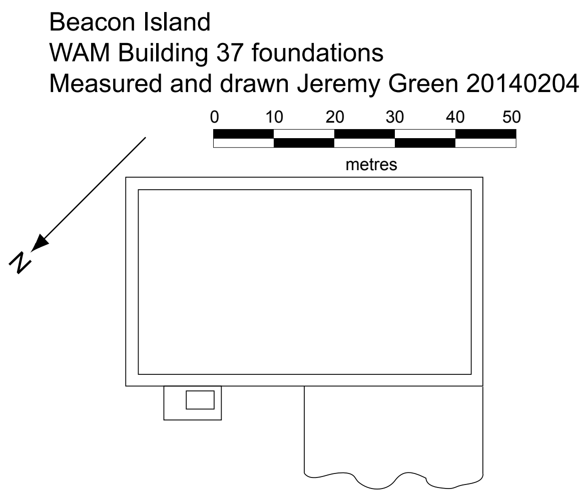

Figure 17. WA Museum, Building No. 37.

DIGITAL RECORDING

Paul Bourke

During my 2013 and 2014 visits to Beacon Island four general digital asset categories were acquired, they were: high resolution panoramic images (also known as gigapixel images); 360 x 180 degree bubbles (also known as equirectangular spherical projections); photographs intended for use as building textures as well as general textures (coral, sand, flora, etc); photographs for 3D model reconstruction purposes. These assets, while serving also as a general record of the site were mainly intended to enable the creation of a virtual environment, that is, ways of experiencing/exploring the island digitally.

High resolution photographs

The resolution of a single SLR camera sensor is limited, that is, one cannot buy an arbitrary high resolution sensor. The solution to generating very high resolution images is to take a number of overlapping images and using image processing techniques find matching points and eventually align, stitch and blend the images together. This is a relatively widely used technique employed in a wide range of applications from microscopy to the Hubble Space Telescope. The resolution of the final image depends on the number of photographs taken, the field of view of the lens, and the camera sensor size. The resulting images can form a valuable digital record since it captures both the detail, and if one zooms out, the context of the site. The principles and techniques employed are not that different to those used in Google Earth.

A number of high resolution wide angle panoramic images were acquired, in particular, from the end of each jetty and from locations on the beach near the main jetty. The image in Figure 18 gives an example of the angular range of the images captured and the detail. Generally such images are taken using a motorised or robotic unit in order to automate what might be a large number of images taken across a regular grid. In the case here the images were taken manually although using a precise angle graduated scale on the tripod.

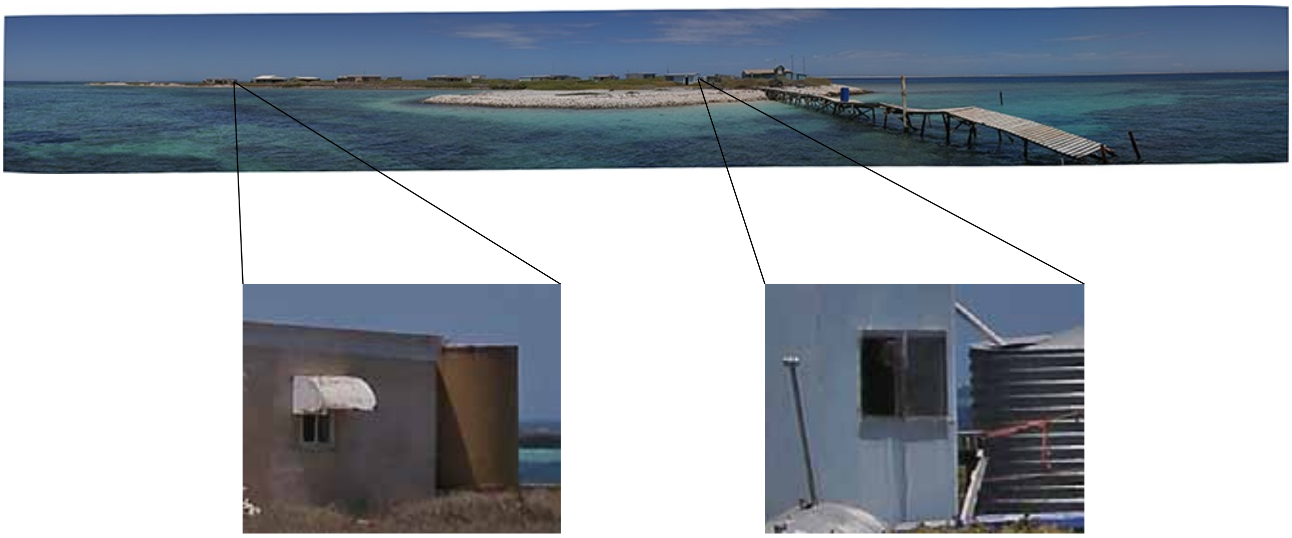

Figure 18. High resolution image from the main jetty, 45,000 x 7,000 pixels (2014).

Figure 19. High resolution images from the other two jetties on the opposite side of the island (2013).

Bubbles

'Bubbles' is the term given to 360 degree by 180 degree panorama images captured from a single position. These can be captured like the high resolution images above, but the term as used here refers to moderate resolution images (around 8 000 pixels across). The distinction is that these can be captured very quickly, within minutes, using a SLR camera and 180 degree fisheye lens (Canon 5D Mark III and 8–15 mm fisheye zoom lens). In 2013 bubbles were captured from regular points across the island on the outside of the buildings. Additionally bubbles were from a position, sometimes two or more, within every room on the island. The positions chosen were generally central positions except where that might be obstructed or in some cases a mirror would reveal the camera and photographer. The 2014 survey completed this for the three building for which access was not previously available. The 2013 survey also saw points captured on Long and Seal Island.

While the above images look distorted that is just a result of the mapping of a sphere onto the plane, similar to the distortions that arise from Earth maps where the north and south poles appear distorted. When viewed in the correct way there is no distortion. Such images are a common way of populating a so called 'virtual tour' where one jumps from position to position and at each discrete position is able to freely look around and zoom.

In total there are now 40 external bubbles and over 100 bubbles from the rooms in the buildings.

Figure 20. Centre of room 2 on building 3. Every room in every building was photographed in this way.

Figure 21. Example of an external bubble.

Figure 22. Bubbles from the main jetty after the mid section was damaged between the 2013 and 2014 trips (2014).

Textures

In order to create a believable 3D virtual environment of the island it is necessary to capture images that can be used as textures. The geometric detail of a virtual space may be limited but apparent detail can be presented through careful placement of textures. The textures captured are applied to the building structures derived from the measured floor plans. In addition textures can be captured that will allow believable models of the island landscape and as a means of creating models of the flora. The building facades captured by the maritime museum can be used for the building textures but there are benefits in having additional high quality, orthographically captured images of individual features such as windows and doors. An attempt was made to photograph every door and window of every buildings, noting that in some cases this was not possible due to access constraints.

Figure 23. Example of orthographic capture of building features.

Figure 24. Photography of plant material in order to create believable virtual plants.

Figure 25. Images of coral and sands in order to create landscape textures.

3D reconstruction

The automatic reconstruction of digital models entirely from photographs is an exciting new capability that is being actively explored and researched by the author. While not new, the quality of the algorithms has increased rapidly over the last few years. As a result and with knowledge of how to capture the images optimally means that the resulting models are becoming increasingly detailed and accurate. This is emerging as a powerful method of recording 3D structures that might otherwise be hard or time consuming to model manually.

The two structures on the island that were targeted for this reconstruction were the coral 'building' and the cairn. Both would be very difficult to create manually and if they were manually created would be only representative of the structure rather than accurate. As an indication of the progress in the software in this area and the new experience in how to optimally take photographs and a new calibrated prime lens, the results in Figures 26–27 from the 2014 trip were significantly better than a similar attempt in 2013.

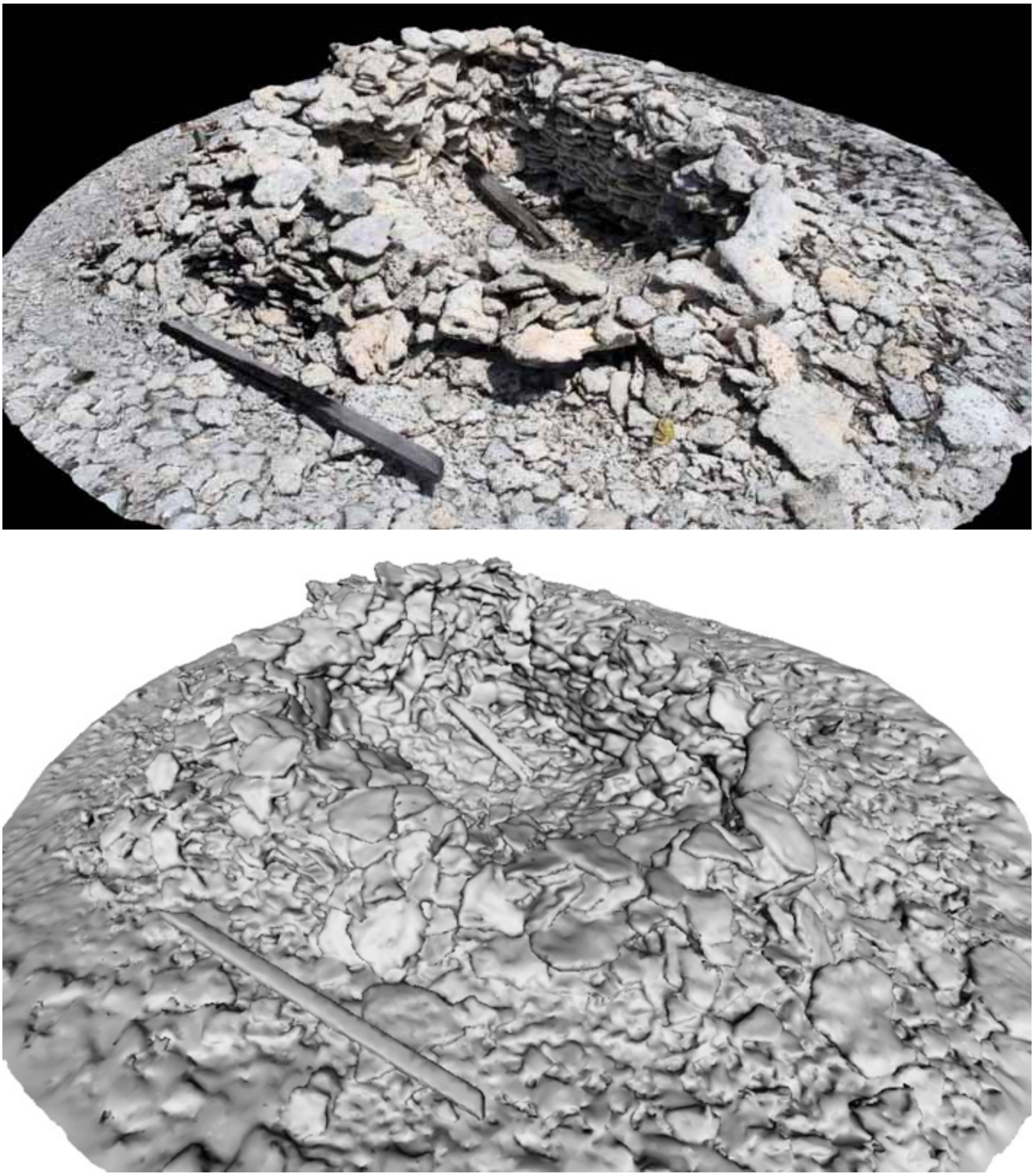

Figure 26. Computer rendering of the textured mesh (top), the underlying geometry (below).

Figure 27. Reconstruction examples of the cairn, mesh on the left, textured mesh on the right.

ACKNOWLEDGEMENTS

The 2014 expedition members would like to than the WA Department of Fisheries Regional Manager Ron Sheperd for his help and assistance in getting our equipment and supplies to and from Beacon Island. Greg Finlay and his crew of the Fisheries PV *Chalmers* were of great help in loading and unloading the gear, particularly on an the extremely rickety Beacon Island jetty. The WA Museum is grateful for the Your Community Heritage—*Batavia* National heritage Listing grant which funded this work. This report finalises the grant and will be incorporated in a final publication later in 2014. We would also like to thank Susan Green who volunteered her services to look after the camp, organise the supplies and arrange the cooking. Leigh O'Brien, from the WA Museum—Geraldton assisted with logistics. It is rather sad that this project is probably the last time anybody will live in the buildings on Beacon Island which are scheduled to be demolished later this year. However, the long term advantages of bringing the island back to its natural state and having an extremely detailed record of what was on the island at the beginning of 2014 has advantages for the wider public.

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