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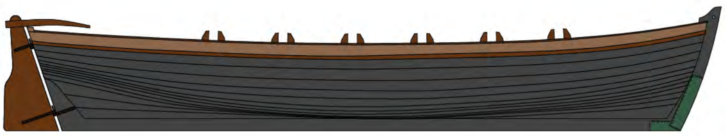
Sydney Metro Project
Barangaroo Station
UDHB1
'Barangaroo Boat'



Excavation Report
VOLUME 2

UDHB1
Barangaroo Metro
Darling Harbour, Sydney
NSW

July 2022

Sydney Metro Project: Barangaroo Station
UDHB1 'Barangaroo Boat'
Excavation Report

Volume 2

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Acknowledgements

On a project of this kind there are many people who make it a success, especially those who worked directly on the recording and recovery of the wreck. These dedicated and talented people are acknowledged in Section 2.2 of this report. Acknowledgement must also be given to those who supported the team when hard decisions had to be made under pressing circumstances. Sydney Metro was, and still is, invested in the project and wanted the archaeological work required to be done to the highest standards, with the best people that were available in Australia. The support provided by John Holland CPB Ghella JV, particularly Robert Muir (Project Environmental Engineer) and Construction Manager Steven Kotevich, cannot be underestimated, whether it be the supply of materials or the labour of the site carpenters. Like Sydney Metro, John Holland CPB Ghella JV wanted the best possible job done, albeit quickly.

Apart from the Casey and Lowe and AMBS staff who were on site, there was critical support provided by the 'indoors' team who ran around Sydney sourcing specialised tools. Nikki Kirkman worked fast and skilfully in organising the required paperwork to get our interstate visitors onto site at extremely short notice. Kylie Seretis performed herculean feats pulling together the documentation required for approvals, giving the field team more time on site.

A special thank you to Mary Casey, the Excavation Director. On a time-critical project of this kind, where almost all the team were engaged in an archaeological conundrum they had never encountered before – raising an articulated timber wreck on a construction site – there was a cacophony of opinions on what should, and shouldn't, be done. Mary ferociously backed her team at all times and you can't ask for much more from a boss.

The role of the Australian National Maritime Museum, in particular Keiran Hosty, Curator of Technology and Archaeology, should also be acknowledged. Early on, the Museum recognised the significance of the boat and indicated that it would like to put it on display. Having a final destination for the boat gave a clearer sense of direction on how the wreck was to recorded and recovered.

The Australian National Maritime Museum and the Silentworld Foundation provided gratis to the project its staff to work on the site, and this is gratefully acknowledged.

We'd also like to thank those who provided advice before and during the recovery of the wreck – Greg Jackson, Nigel Erskine, Mark Dowsing, Peter Cowie and Peter Gosell.

This report is Volume 2 of an 8 Volume series on the archaeological excavations at Barangaroo Station. The Volumes contain the following:

Volume 1 – Main Report

Volume 2 - Boat Report (this volume)

Volume 3 - Subsidiary Reports

Volume 4 - Site Plans and Harris Matrix

Volume 5 – Appendices (Main Report)

Volume 6 – Appendices (Boat Report)

Volume 7 – Artefact Catalogue

Volume 8 – Digital Archives

Cover Image: Top right – **Oblique view of wreck from stern to bow, after ceiling planking removed.** *(Source: B. Wharton)*, Top left – **'Millers Point from gasworks' showing the vicinity of the Langford boatyard.** *(Samuel Elyard ca. 1854. State Library of New South Wales)*, Bottom left – **Team working on wreck prior to disassembly**. *(Source: Daily Telegraph)*, Bottom Right – **Profile view of a drawing reconstruction of UDHB1 by Benjamin Wharton**.

Summary

Introduction

The purpose of this summary is to provide a concise overview of the discovery, excavation, conservation and interpretation so far, of a significant piece of colonial Australian heritage. It also aims to highlight the importance and benefits of collaborative projects within the cultural heritage industry.

In 2018, a group of archaeologists led by Dr Mary Casey, of Casey & Lowe, were excavating a section of waterfront land in Darling Harbour. The area was to become the new Barangaroo Station, which would form part of the Sydney Metro network. The excavation in this particular area was drawing to a close when an unexpected assemblage of timber planking was uncovered. It soon became clear that this was a significant discovery. The timbers belonged to the wreck of an early Australian-built vessel, which at the time, was a rare, if not unique find in Australia.

By early October 2018, it could be stated that the wreck, which was named Unidentified Darling Harbour Barangaroo No. 1 (UDHB1), was the remains of a 28 to 30-ft clinker boat, built from local timbers. It was likely constructed in the early 1800s and abandoned as early as the 1830s. If this initial assessment was supported by further investigation, UDHB1 would be the earliest Australian-built vessel found at the time in Australia.

The significance of the boat lies in what it can tell us about its form, materials and method of construction. It offers a multitude of research opportunities for analysing the early Australian economy and what was then the frontier industry of Australian shipbuilding.

Figure 1: Darling Harbour, Sydney. Excavation site circled in red. Source: Google Maps.

The Project: Barangaroo Metro Station

UDHB1 was discovered at the construction site of the new Barangaroo Station, on the eastern shore of Sydney's Darling Harbour. Sydney Metro is a NSW Government public transport project, constructing new rail lines and stations across the Sydney region. The Barangaroo Station was one of a number of new stations being constructed on the Chatswood to Sydenham component of the metro rail line.

Boatyards and Wharves: Barangaroo's Rich History

The archaeological excavations that led to the discovery of the UDHB1 took place within, and to the west of Hickson Road, Barangaroo in Sydney's Darling Harbour. An excavation was warranted at the site, as archaeological remains were likely to be present, originating from the bustling wharves which flourished along the shores of Darling Harbour in the 19th and early 20th centuries. Through such finds, researchers could learn more about environmental change, landscape modification, maritime infrastructure and engineering, as well as changing technologies, working conditions and life at the wharves and shipyards.

One of the establishments within the excavation area was that of William Langford, who constructed a boatyard around 1833, adjacent to where UDHB1 was found. Langford built a house on the property in the early 1830s, as well as successive wharves.[1] The wreck was found at the foot of the historical location of Clyde Street in a former intertidal zone, between Langford's boatyard to the east and the open water to the west.

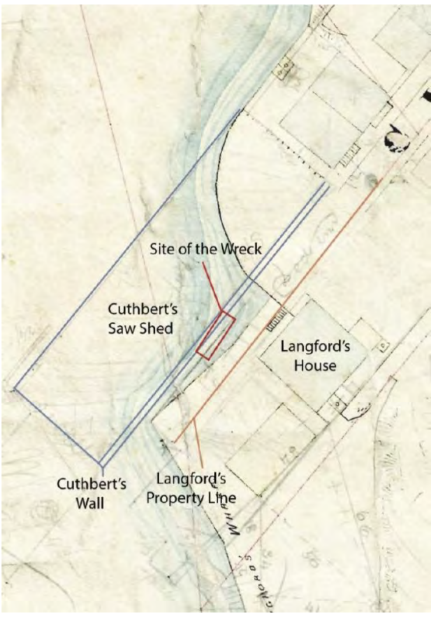

Figure 2: Site of wreck relative to Langford's house and Cuthbert's sawshed. Source: Historical Atlas of Sydney, City of Sydney Archives.

Figure 3: Langford's house highlighted in orange. Source: Robert Russell, 1835. State Library of Victoria. Image H38124.

A Fascinating Find: UDHB1

When the team of archaeologists discovered timber planking, a maritime archaeology specialist was called in to provide further analysis of the site and determine if it was, in fact, a wreck. Labelled UDHB1, the remains were indeed from a small, timber, clinker-built vessel that would soon be affectionately known as the Barangaroo Boat.

[1] ***Casey & Lowe, December 2017: pg 69, 79.***

Figure 4: Timber planking that would eventually be identified as UDHB1. Source: Cosmos Archaeology.

Orientated with its bow northwards towards the land, it was situated in the intertidal zone at what would have once been a small shelving sandy cove between rising sandstone outcrops. The boat's stern was positioned less than a metre east of the western edge of a wharf wall on Langford's property, and the wreck was angled slightly away from the wharf towards to the north west. On its port side, the footings of the eastern wall for Cuthbert's sawshed cut through the port bow of the wreck. This wall was constructed in the 1860s.

The vessel was resting on its starboard side with a cut sandstone block underneath its portside keel. This block, with oyster shells on its underside, had been deliberately moved into position under the vessel to keep it in place. This indicates that the vessel did not sink at its moorings adjacent to Langford's western wharf wall or drift into the small cove and beach itself. It is likely to have been deliberately brought to this location and beached.

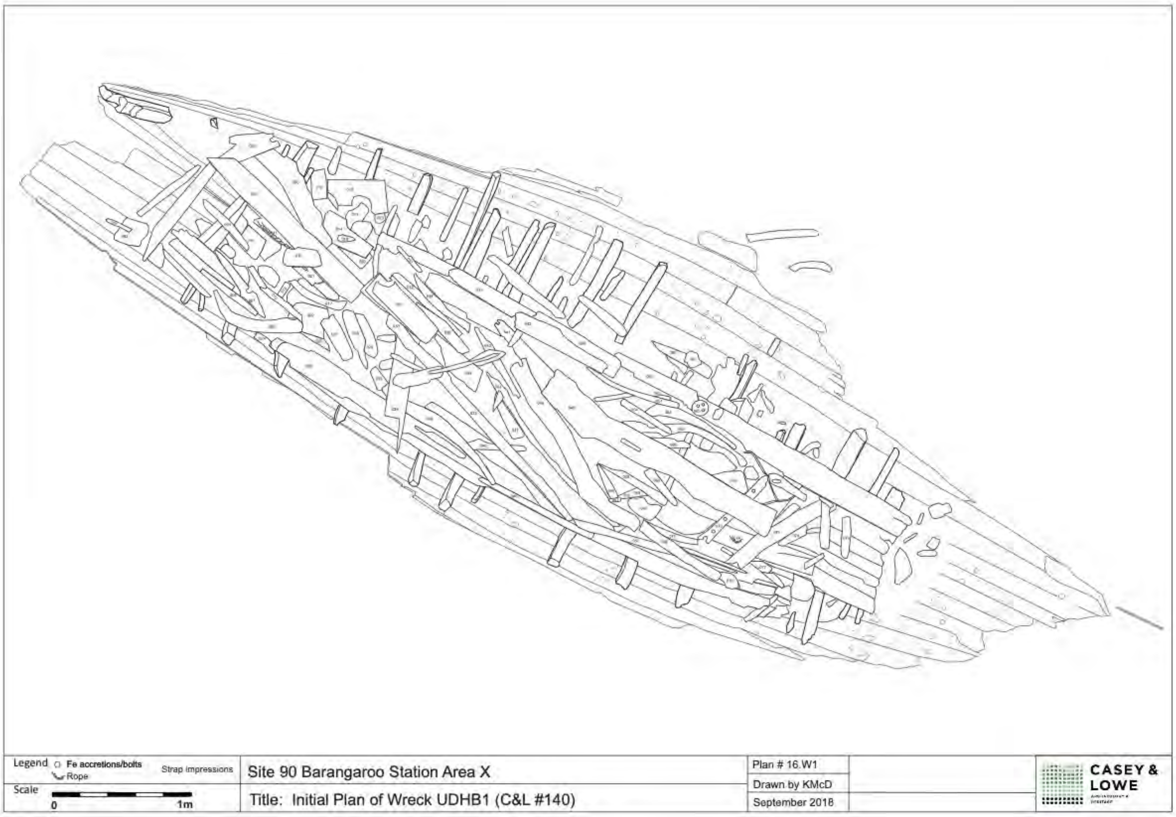

Figure 5: UDHB1 prior to removal of loose timbers. Source: Casey & Lowe.

Figure 6: Recording the wreck site for photogrammetry purposes. Source: Cosmos Archaeology.

Figure 7: Loose timbers can be seen deposited in the hull. Scale in 500 mm increments. Source: Cosmos Archaeology.

There were timbers, fibre rope and leather objects within the hull, some of which appeared to be associated with the vessel while others may have been deposited into the boat after it had been dragged into its position. The wreck appeared to have been used in part as a skip bin by the adjacent boatyard.

Upon confirmation that a wreck had been found, the most immediate task was to assess its cultural heritage significance. This would determine how the wreck would be recorded and removed. The wreck was located close to the top of a large area that was to be bulk excavated to a depth of more than 20 m to accommodate the station box. Leaving the wreck *in situ* was not a viable option.

It was clear that a robust research design was urgently needed to provide direction and a framework for the boat's analysis and conservation. This was developed based around what was known at the time regarding the boat's significant features.

Recovering a Crucial Piece of History

Following discussions with the Australian National Maritime Museum, it was decided that the wreck would be excavated and then eventually put on permanent display for the public. This decision was an important development, as it dictated how the mammoth recording and recovery process would be undertaken. After discussing a number of options, it was decided that the wreck would be disassembled at the site, conserved and then reassembled.

The successful recording and removal of UDHB1 necessitated the use of a variety of skill sets, which brought together heritage professionals who had not previously worked together as a team in such an environment. Although the subject of the investigation was a shipwreck, it was located in a terrestrial environment. The maritime archaeologists on the team could readily identify the individual components of the wreck, while the historical archaeologists provided the expertise to excavate and recover the timbers. The conservators brought innovative techniques, care and attention to the handling and packaging of the timbers. The coordination and understanding of the roles and responsibilities of each of these groups was critical for ensuring an exceptional result.

Recording and Packing

The recording of the wreck at the pre-disassembly stage was not dissimilar to what would occur on a terrestrial site. Firstly, the sediments were excavated so that the wreck and its contents could be recorded *in situ*. The methods included measured drawings, surveying and photogrammetry, the latter producing a 3D model of the wreck. The contents of the wreck were then removed and recorded according to their stratigraphical contexts. The wreck contents were a collection of loose timbers which were mostly worked, and the majority of which were not part of the structure of the wreck. The ceiling planking was then removed so that the sediments which had accumulated in the bilge (the space between the ceiling planking and the hull) could be excavated using the same methods. Throughout each stage, photography and photogrammetry were continually employed, to capture every element of the assemblage.

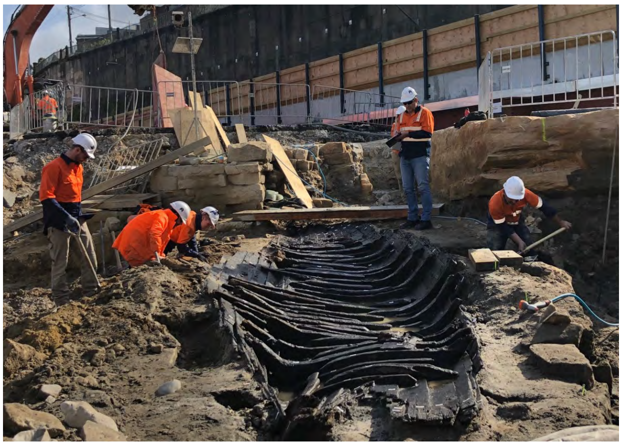

Figure 8: Recording elements of the wreck. Source: Cosmos Archaeology.

Figure 9: Timber walkways used to assist with the recording process. Source: Cosmos Archaeology.

The unique site presented a number of challenges for accessing the wreck during the recording and excavation process. Once the baulks were removed, timber walkways were erected spanning the wreck so that the archaeologists could lie horizontally to work.

Once photographed, the loose timbers were recorded then wrapped in geotextile material which had been cut to size. The bundle was then soaked in fresh water before being wrapped in plastic. The bundle was cable-tied in a manner so as to retain the water for as long as possible. This was because it was imperative to keep the timbers as wet as possible until they were placed under conservation. The timbers were then placed in custom-made timber crates and stored on site in refrigerated containers.

Figure 10: Ceiling planking being wrapped and placed into a custom-made crate. Source: Cosmos Archaeology.

Figure 11: Team members gently lifting a plank into position inside its crate. Source: Casey and Lowe.

Work came to a halt in late October, as the team started to prepare the methodologies for the final step of removing the wreck. During this time, *in situ* protection was put in place to keep the wreck moist without relying on an external water supply until a management decision was made regarding the removal of the wreck.

Wreck Removal

The removal of the final elements of the wreck required a sound understanding of the wreck's integrity and construction.

The process began with the removal of the frames, which required disassembly and lifting. As a general rule for the frames, it was found that iron fasteners had corroded to such an extent that they no longer functioned, and suction between the wet sediments was holding the components in place. No fasteners needed to be cut to remove the internal frames. Some elements could be removed without any additional tools, while some frames needed the use of palette knives to break the suction of the sediment. Frames were then lifted and removed to the refrigeration area.

This was followed by the removal of the hull planking, which was complex due to the double layer of hull planking and the size and inherent fragility of the planks. As a general rule the planks were connected with wrought iron nails and the occasional use of treenails. Iron fasteners were also detected in the scarf plates. Again, the strongest force holding the elements together was tension between the components and the wet sediments. The same techniques used to free the frames were employed to remove the hull planking, and these elements were also processed then moved to the shipping containers.

Removal of the keel and components of the bow and stern was undertaken using similar techniques. However, much preparation was needed, including the design and construction of custom crates, design of specific packing methods and preparation of the materials, as well as organising a crane lift, and the disassembly and removal of the keel. The keel lifted cleanly off the rider keel, and the ease of separation was due to the unexpected corrosion of the iron fastenings. Due to the length and weight of the keel elements, a team of 17 people was needed for the lift. The keel was lifted from the rider keel and carried to a pre-prepared board placed alongside the wreck for packaging. The two rider keel elements were then lifted in the same manner as the keel. A crane was used to transport the elements to the refrigerated shipping containers.

Figure 12: Removal of the keel. Source: Cosmos Archaeology.

Figure 13: Crane lifting keel from wreck site. Source: Cosmos Archaeology.

What Do We Know So Far?

After the wreck was removed, it was taken to a permanent conservation facility in Yennora, where specialists could commence the long task of cleaning, recording and conserving the elements, to ensure subsequent research could be undertaken on UDHB1. Once clean, the timbers underwent high precision 3D scanning, before entering the conservation process, which is still ongoing today.

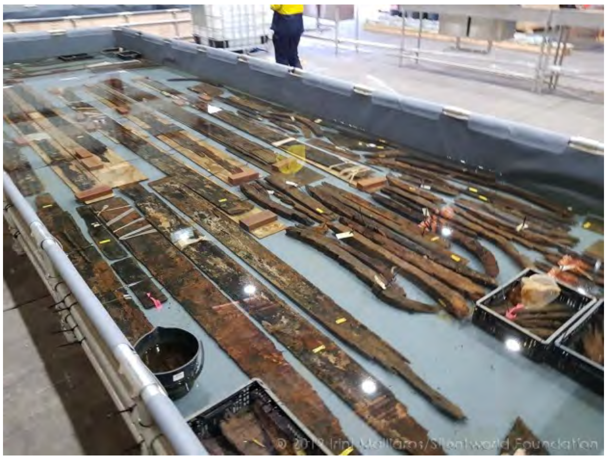

Figure 14: Timbers during conservation at Yennora facility. Source: Silentworld Foundation.

Figure 15: White material, possibly for anti-fouling, being removed during the conservation process. Source: Silentworld Foundation.

Through many months of intense historical record research and analysis of the boat's timbers, fasteners and other elements, the story of UDHB1 is slowly starting to emerge, however there is still much scope for further research.

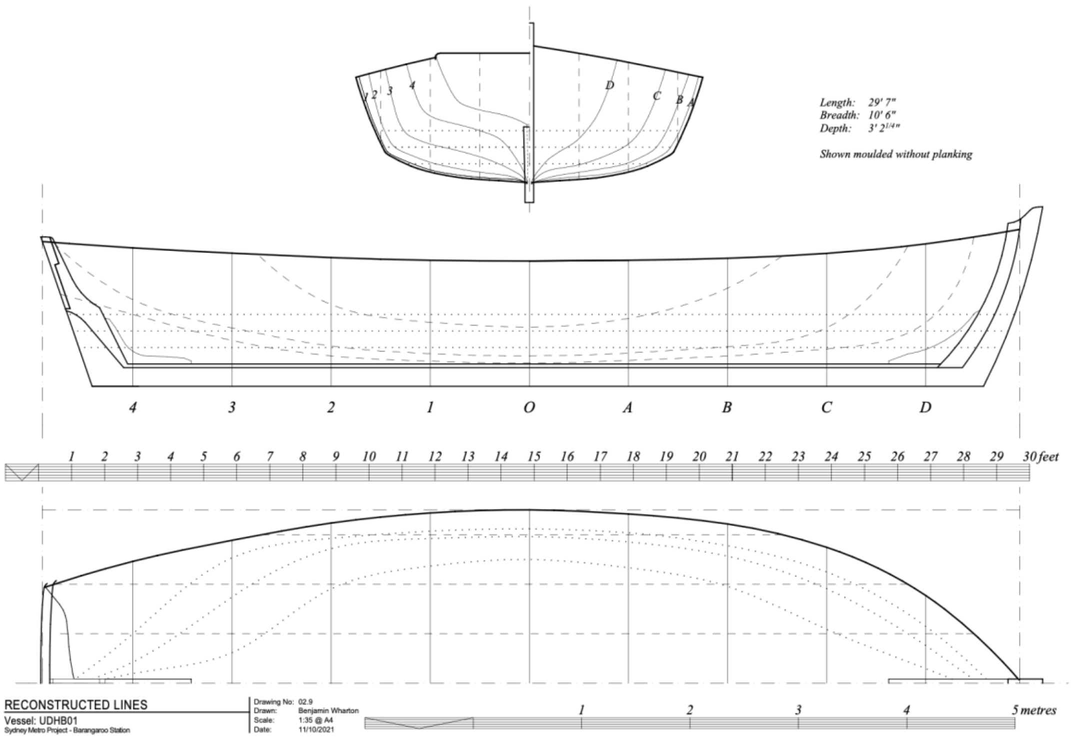

Figure 16: The reconstructed lines of UDHB1. Source: B. Wharton.

Utilising the information captured in the field, including photogrammetry, an informed reconstruction of the vessel's shape has been attempted. The boat was almost 30 ft (9 m) long and had the hull of a late 18th to early 19th century cutter. Though no evidence for a mast has been found, the hull shape suggests that the vessel could have been rowed and had a removable mast for the deployment of a sail if needed.

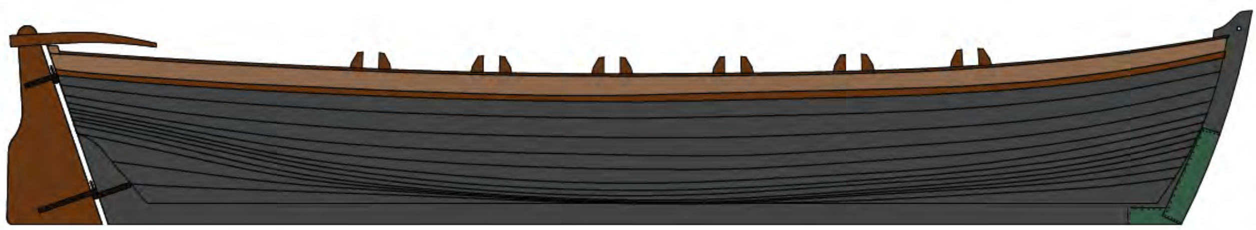

Figure 17: Starboard view of reconstructed vessel. Pitch coated hull with copper sheathing on stem. Sheer strake and rudder natural timber finish with oil or tar mix. Reconstruction by B. Wharton.

The vessel was also originally built with one layer of clinker planking. It underwent major repairs during its lifetime before having a rider keel added (thereby lengthening the boat by 0.5 m) which allowed a second layer of planking to be added.

Figure 18: Port cutaway view of reconstructed vessel showing framing and double planking. Reconstruction and 3D rendering by B. Wharton and K. Edwards.

So far, we know that the vessel UDHB1 was most likely abandoned at this location in the late 1830s or early 1840s. It progressively filled with discarded timber from the adjacent Langford's boatyard as well as from tide, wind and wave-derived sediments and waste, before becoming almost completely buried by sands and debris that had washed down Clyde Street by the 1860s. Diagnostic artefacts broadly support this interpretation.

Establishing the identity of UDHB1 has been problematic, and may never be achieved with a high degree of certainty. This is because official records from the time the vessel was built and operated are lacking, and the vessel's relatively small size means that it may never have been registered. However, based on the available information, it is thought that the vessel was originally built 10 to 20 years before it was abandoned. Therefore, UDHB1's construction could be dated to approximately the 1820s. It is likely to have been used as a general-purpose vessel for conveying goods and people, or possibly as a nearshore fishing boat. The hardness of the chine (turn of the bilge on the hull) indicates it was designed to be dragged ashore.

Figure 19: Clinker boats with hard chine drawn up onto beach at Blues Point in 1850s. Source: Robert Hunt, Mitchell Library. Image SPF/799.

Research to date also suggests that UDHB1 was built, and modified, by builders adept at their craft. The seemingly long life of the vessel is testament to their skill. There is a possibility that these craftsmen may have had experience with building practices originating from Britain's south west region.

While work has begun in earnest to conduct research into the boat's origins, construction methods, materials and work life, there is still much to be discovered. At the conclusion of this report, a table of further research questions is provided, demonstrating the broad scope of opportunity available for future scientific analyses on the remains of UDHB1.

What is significant about the Barangaroo Boat?

UDHB1 was one of perhaps hundreds of such small water craft that plied the waters of Sydney Harbour and the coastline from Wollongong to Newcastle in the early 19th century. This mosquito fleet, which conveyed goods and people, was an integral and crucial part of the survival and subsequent flourishing of early colonial Sydney. They were the equivalent of the small trucks and utilities of today.

Figure 20: View of Sydney Harbour in the 1840s. Source: State Library of Tasmania. Unknown artist.

Up until the excavation at Barangaroo, Darling Harbour there were no surviving examples of these watercraft. UDHB1 is the best preserved early Australian-built boat found to date. It has the potential to not only provide information on what is one of Australia's earliest industries, that of ship and boat building, but also give some insights into what life was like in early colonial Sydney.

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Notes on photograph attribution – All unattributed images in this report were taken by Cosmos Archaeology.

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1 INTRODUCTION

1.1 The Sydney Metro Project and Archaeology

Sydney Metro is a New South Wales (NSW) Government public transport project which is constructing new rail lines and stations across the Sydney region. The new Chatswood to Sydenham component involves the construction of a number of stations along the new metro rail line. One of these stations is located at Barangaroo. AMBS Ecology & Heritage was contracted to manage the archaeological investigations, in response to the impacts arising from the construction works required by the Sydney Metro Project for the completion of the Chatswood to Sydenham component.

Casey & Lowe were engaged by AMBS to undertake the archaeological excavation and monitoring at Barangaroo. In the Construction Heritage Management Plan prepared by AMBS, Cos Coroneos (Cosmos Archaeology) was nominated as the Maritime Archaeologist for the project, and so would be tasked with identifying and managing significant maritime heritage.[2]

1.2 Archaeological Investigations at Barangaroo Station

The archaeological excavations that led to the discovery of UDHB1 took place within, and to the west of Hickson Road, Barangaroo, on the eastern side of Darling Harbour (Figure 1.1 and Figure 1.2). The excavation was undertaken in accordance with the Barangaroo Station Hickson Road, Barangaroo Archaeological Method Statement prepared by Casey & Lowe in November 2017.[3]

Figure 1.1: Location of archaeological investigations (red circle), looking eastwards. (Source: Google Maps).

[2] ***AMBS Ecology and Heritage, 2018, Construction Heritage Management Plan, Sydney Metro City and Southwest TSE Works: pg. 55.***

[3] ***Casey & Lowe, December 2017, Barangaroo Station Hickson Road, Barangaroo Sydney Metro Project – Archaeological Method Statement.***

Figure 1.2: Location plan showing the site outlined in red and excavation areas marked with dashed yellow lines.[4] Wreck was found in Area X.

The archaeological excavation of the area was required due to the potential for archaeological evidence related to the 19th and early 20th century development of wharfage and shipping related industries along the northern shores of Darling Harbour.[5] Such activities were associated with the transformation and modification of the natural foreshore to an industrial hub. It was assessed that the investigation of the archaeological resources would contribute to the knowledge of environmental change, landscape modification, maritime infrastructure and engineering, as well as changing technologies, working conditions and lives on the wharves and shipyards.

4 Casey & Lowe, February 2019, Sydney Metro City & Southwest – TSE Works; Barangaroo Station, SSI 15_7400: Figure 1.2

5 Casey & Lowe, December 2017, Barangaroo Station Hickson Road, Barangaroo Sydney Metro Project – Archaeological Method Statement: pg. 8

The data recovered was expected to provide the opportunity for comparative analysis with other sites from the surrounding area such as Darling Quarter[6], Barangaroo South[7], Barangaroo Headland[8] and Balmain East[9].

The archaeological remains that were identified as being potentially present were those associated with two prominent individuals involved in the development of 19th century Sydney, John Cuthbert, and to a lesser extent, Alexander Brodie Spark. Cuthbert's shipyard was an important business in this section of Darling Harbour. Recent archaeological excavations in the area arising from multiple redevelopment projects have exposed and removed these early waterfront properties. As a result of the removal of archaeological relics from the area, the archaeology remaining *in situ* is considered to be rare. The archaeological remains associated with the early to mid-20th century wharf development and occupation were considered, prior to the commencement of archaeological excavations, to have little research potential.

One of the other establishments within the excavation area relevant to this study was that of William Langford, who established a boatyard around 1833, adjacent to where UDHB1 was found. Langford built a house on the property in the early 1830s, as well as successive wharves.[10] His sons, William and Thomas, still owned the property when they died within a year of each other in 1880 and 1881 respectively.[11]

By 1861, William Langford junior had been operating a boatyard at Blues Point, and it is unclear whether boat building activities were still taking place at the Darling Harbour premises. After the brothers' deaths, the property was transferred to William's widow, Mary, who appears to have sold it soon after to T.A. Dibbs, a bank manager who, in the previous decade, had purchased Cuthbert's shipyard.[12]

A detailed history of the area archaeologically excavated for this project is presented in Volume 1 – Archaeological Investigation Report, Section 2.

The open area excavation, sampling and testing was carried out in two stages; the first in July 2018 for Areas R and T, and the second from August to December 2018 in Areas W, X, Y and Z (Figure 1.3). Two large areas were assessed as having no archaeological potential, the western portion of the site - which was deep within the harbour until the construction of the finger wharves in the early 20th century – and an eastern strip of site corresponding with the eastern side of Hickson Road which would have been significantly cut down during the construction of Hickson Road ca.1909.

A programme of excavation took place across the study area and several historical archaeological phases were identified. These were buried beneath layers of imported fill material relating to the construction of the 1910s finger wharves and the container terminal in the 1960s, or were sealed beneath levelling fills resulting from the construction of Hickson Road.

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[6] ***Casey & Lowe December 2013, Darling Quarter (formerly Darling Walk), Darling Harbour, Sydney.***

[7] *Casey & Lowe October 2012, Archaeological Excavation, Barangaroo South Preliminary Results.*

[8] ***Austral Archaeology August 2016, Integrated Works Zone, Barangaroo, NSW, Historical Archaeological Excavation and Monitoring Report.***

[9] ***Casey & Lowe November 2012, Results of Archaeological Investigation, 2-8 Weston Street, Balmain East.***

[10] ***Casey & Lowe, December 2017: pg 69, 79.***

[11] ***Casey & Lowe, December 2017: pg 82-83.***

[12] ***Casey & Lowe, December 2017: pg 97.***

Table 1: Table of Phases for Barangaroo Station

Phase	Date	Description
1	-	Natural Landscape
2	-	Aboriginal Occupation
3	1788-1855	Early British Occupation
3.1	1788-1833	Early Grant Holders
3.2	1833-1855	Langford's house and Wharf
4	1855-1875	Shipbuilding and Wharfage, Cuthbert, and Osborne's Wharf
5	1875-1900	Commercial Wharves and Stores Expansion, Dibbs
5.1	1875-1890	Dibbs' Redevelopment of the Wharf
5.2	1890-1900	Structural Modifications and Government Involvement
6	1900-1960	Government Resumption of Land – Hickson Road, 20th century Stores and Finger Wharves
7	1960-2006	Containerisation and Hickson Road

Within Area X, the wreck of a timber boat deposited prior to 1865 was found adjacent to Langford's house. This wreck, UDHB1, is the subject of this report.

The overall excavation report for this project is Volume 1 – Main Archaeological Investigation Report.

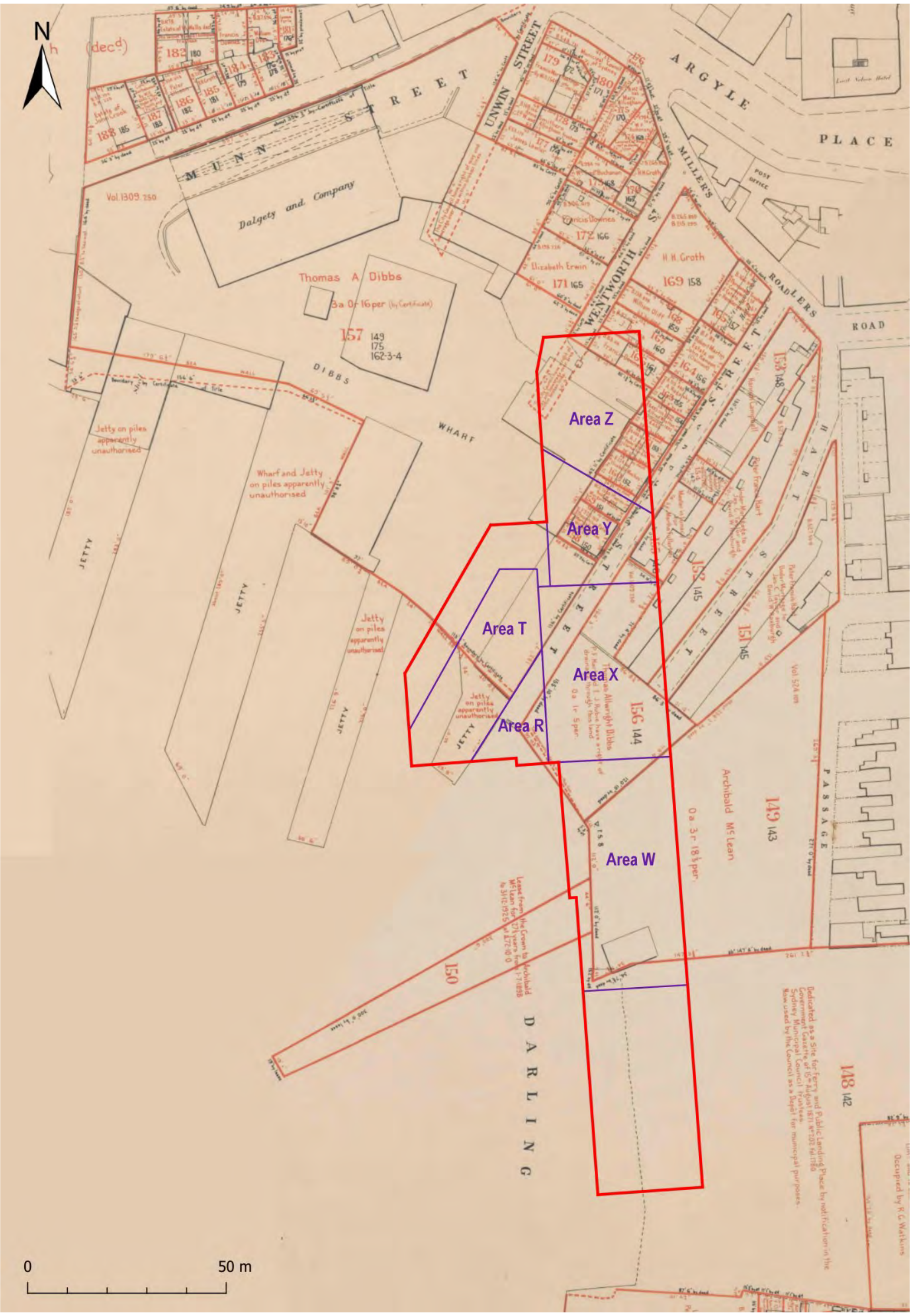

Figure 1.3 : Study and excavation areas overlaid onto City of Sydney 1900 Resumption Plan. [13]

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[13] ***Casey & Lowe, February 2019 : pg 6***

1.3 Discovery and Preliminary Assessment of UDHB1

The wreck of UDHB1 was uncovered by the Casey & Lowe excavation team under the direction of Mike Hincks, Secondary Excavation Director, on Friday 21st September 2018. The archaeologists noted the initial exposure of a curved timber structure that was unlikely to be the remains of a timber deck associated with a jetty/wharf or corduroy surface on boggy ground. After revealing more of the feature, it became apparent that it was the remains of a timber vessel. On the afternoon of 21st September 2018, the project's maritime heritage advisor, Cosmos Coroneos, visited the site with fellow maritime archaeologist, Jane Mitchell, and confirmed that the structure was the stern of a clinker-built timber boat (Figure 1.4).

Figure 1.4: The exposed stern of the wreck on 21st September 2018.

Upon confirmation that a wreck had been found, the most immediate task was to assess its cultural heritage significance. This would determine how the wreck would be recorded and removed. The wreck was located close to the top of a large area that was to be bulk excavated to a depth of more than 20 metres, to accommodate the Barangaroo station box[14]. Leaving the wreck *in situ* was not a viable option.

To prepare a preliminary statement of cultural heritage significance, the following information was required:

- When was the vessel wrecked, or in this case, abandoned? This would provide some indication as to when it may have been constructed. This required a good understanding of the wreck's context within the site, and an examination of the contents of the bilge.

[14] Casey & Lowe, December 2017 : Section 2

- Where was it constructed? This required taking timber samples of the planking and other elements to determine whether it was constructed using local timbers or constructed outside of Australia.
- The vessel's identity. This would require defining the minimum length of the vessel to cross reference it against the Register of British Ships (Australia), which contains records extending back to the 1830s.

The investigation to prepare a preliminary statement of cultural heritage significance commenced with the excavation of the overlaying sediments. This exposed the extent of the intact wreck structure and provided a greater understanding of its context. It appeared during the initial stages of the investigation that the wreck had been dragged up and abandoned on the early to mid-19th century shoreline, and that the remains of a wall, suspected at the time to have been constructed in the 1860s, cut through the port bow of the wreck. It was covered in marine sediments for most of its length, suggesting that it had been abandoned at this location sometime prior to the 1850s. As it was located adjacent to Langford's boatyard, it was postulated at the time that it had some association with the business, which had been established on the site ca. 1833.

The removal of the overlaying sediments revealed that the interior of the remnant hull was filled with loose timbers, the majority of which were not associated with the structure of the vessel. Sufficient hull remains were accessible which allowed for the procurement of timber samples. Four samples were taken – two from planks and two from frames – on October 3rd 2018 (Figure 1.5). These samples were identified as being Sydney Blue Gum (n=2), Stringybark and Spotted Gum, which provided sufficient confidence to state that the vessel was most likely locally built.[15]

Figure 1.5: Timber sample S0004 taken from a frame on the port side of the wreck on 3rd October. Looking eastwards.

The surviving length of the boat was also recorded. Although the bow forward of the keel was missing, the vessel was estimated to have been between 8.5 m (28 ft) and 9.1 m (30 ft)

[15] Know Your Wood, 6th October 2018. Wood identification results for "Assessment of four timber specimens from Barangaroo Site". For the timber sample reports, see Volume 3, Section 12.

long. This assumed dimension of the vessel was compared against the listing of vessels registered in Australia prior to 1850, but no definitive matches were found (see Section 5.6)[16]. The Australian Register of British Ships commences in the 1820s and the surviving records are incomplete until the late 1830s. The apparent absence of the vessel in the Register was interpreted as it being registered in the 1820s/30s but the record having been lost, or that the vessel was not registered as its activities did not attract payment of customs dues, i.e., it was a harbour work boat. The primary purpose of the Register was to allow port officials to efficiently determine port fees and customs duties for vessels entering the port.

By early October 2018, it could be stated that the wreck was the remains of a 28 to 30 ft clinker boat built from local timbers that could have been abandoned as early as the 1830s and may have been constructed in the early 1800s. If this initial assessment was supported by further investigation, UDHB1 would be the earliest colonial Australian-built vessel found at the time in Australia. Its relatively good state of preservation, where a substantial portion of the starboard side was preserved, amplified the significance of the find.[17]

Based on the information available at the time, a Statement of Heritage Significance was prepared on the 8th October 2018 as follows:

> *The significance of this item lies in what it can tell us about the form, method of construction and materials used in the making of a critical component of the early Australian economy and what can be further learned about what was then the frontier industry of Australian shipbuilding. Such information can currently only be obtained from the archaeological record and the item is currently the only existing example of its kind. For this reason, the item can be considered to be of State significance.*[18]

This Statement has been revised based on the findings of this report and is presented in Section 7.

This Statement guided the recording and recovery objectives for the wreck. The key consequence of the Statement was that the relative intactness of the wreck provided a rare opportunity to record the shape of the hull that would permit a more faithful reconstruction – potentially actual and virtual – of the vessel. Therefore, prior to any attempt to remove the wreck, all efforts were focused on the accurate recording of the hull form through traditional planning and photogrammetry. The recovery of the wreck also focused on deconstructing it in a methodical manner, with the objective that it could be reconstructed virtually and/or physically, as accurately as possible. The conduct and approach to the recording and recovery of the wreck is described in detail in Section 2.

1.4 The context of UDHB1 within the Barangaroo Station site

The remains of the wooden boat UDHB1 were found in what was once the intertidal zone of the unreclaimed shoreline of Darling Harbour, west of Sydney Cove. Details on the relationship of the boat with its immediate surroundings are discussed in Section 3 as well as Section 4.7 of Volume 1. What follows below draws upon the aforementioned sections and places the boat within a wider geographical, cultural and temporal context.

The wreck of UDHB1 was located adjacent to Langford's boatyard which was established in 1833 (Figure 1.6). It would appear that the vessel was beached towards the end of the 1830s or early 1840s. The shoreline at the time was relatively undeveloped, with Langford's establishment being one of the earliest active maritime related businesses in the immediate area (Figure 1.7 and see Figure 3.8 for an artist's impression of the shoreline at the time).[19]

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[16] Parsons, R. 1983, Ships of Australia and New Zealand before 1850 (details of ships registered with the Customs at Ports in Australia and New Zealand).

[17] Coroneos, C. 10th October 2018, "UDHB1_Prelim Sig Ass_1810082".

[18] Coroneos, C. 10th October 2018.

[19] Basire, J. 1836, Plan of Sydney with Pyrmont, New South Wales. Mitchell Library

By the time the vessel had become a wreck, gradually filling with marine sediments in the 1850s and 1860s, the area had become the focus of maritime related industries, with Cuthbert's shipyard being established nearby. This resulted in an intense concentration of maritime infrastructure and reclamation (Figure 1.8).[20]

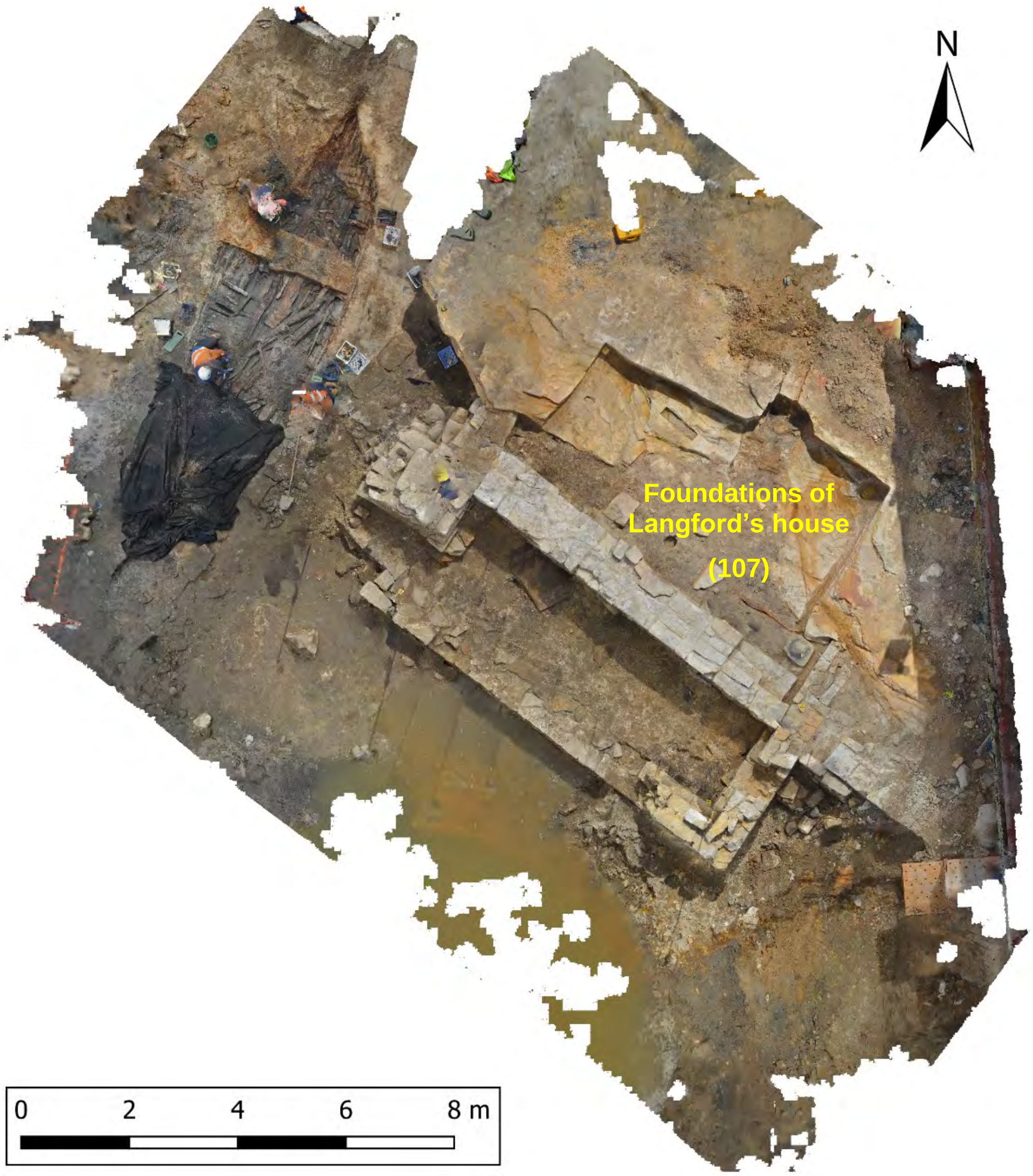

Figure 1.6: Photogrammetry of Area X showing the relationship between Langford's house (107) – which formed part of the boatyard - and the boat (140). Orthophoto G. Hazell (ArcSurv).

[20] ***Woolcott and Clark 1854, Map of the City of Sydney with the environs of Balmain and Glebe, Chippendale, Redfern, Paddington, etc. 1854. Mitchell Library***

Figure 1.7: Excerpt of a map of Sydney in 1836 with approximate location of UDHB1 circled in red.

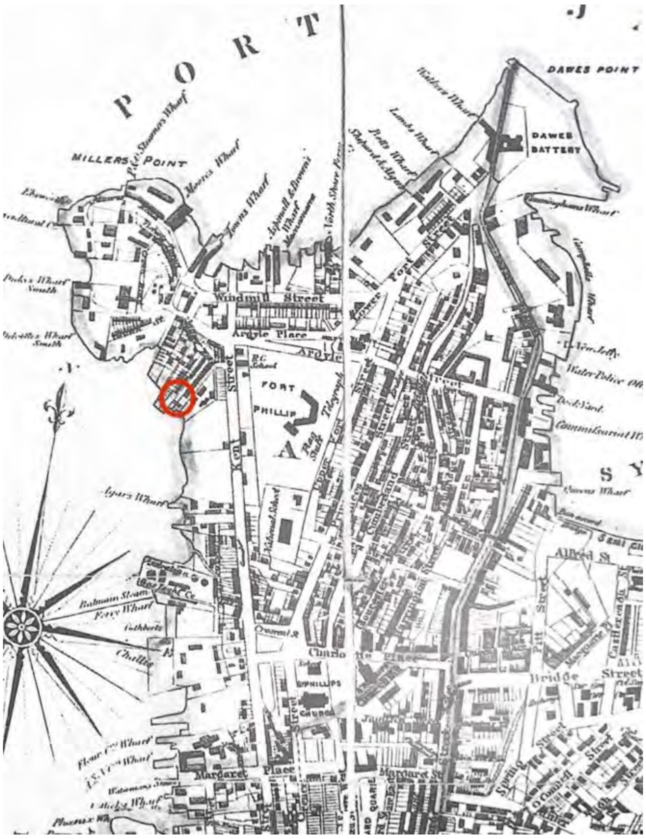

Figure 1.8: Excerpt of a map of Sydney in 1854 with approximate location of UDHB1 circled in red.

It is not unexpected for a boat with a long working life to end up on the periphery of a boatyard, very much like old car bodies accumulating around mechanic workshops. The waterfront at the northern end of Darling Harbour exemplified this practice so much that the cluttered visage seemed to attract the interest of colonial artist Samuel Elyard. Figure 1.9 shows beached boats in various stages of decay at Cuthbert's shipyard, not far from where UDHB1 was abandoned.[21]

Such vessels would be gradually stripped of useful components, with the remainder burnt or discarded. That so much of UDHB1 survived intact was due to its placement within the intertidal zone as an off-site storage bin for timber offcuts from the boatyard. It became a flotsam and sediment trap, facilitating a relatively rapid burial. Located outside the boundaries of Langford's property, it was allowed to silt up, its remaining waterlogged timbers having no useful function even as firewood.

[21] Elyard, Samuel, 'Views of Sydney, 1862-1873' State Library of New South Wales 826108

Figure 1.9: View of abandoned boats Cuthbert boatyard sometime in the 1860s, early 1870s. UDHB1 is located behind the artists position and was almost completely buried by this time.

1.5 Research Design

The Archaeological Method Statement prepared by Casey & Lowe identified research questions relating to shipbuilding, but were specific to the shipyards within the construction envelope, such as Cuthbert's shipyard which commenced operations in the second half of the 19th century.[22] When UDHB1 was discovered, its context within the site indicated that it had been abandoned adjacent to Langford's boatyard for at least a decade if not longer. This suggested that the vessel was most likely built prior to the establishment of the shipyards within the study area. Furthermore, the Archaeological Method Statement did not identify the potential for abandoned vessels to be found during the archaeological investigations. As such, the Archaeological Method Statement did not posit any research questions relating to early Australian-built vessels.

To provide direction and a framework for analysis in this report, a research design has been retrospectively prepared. The research design has been shaped around the known features of UDHB1. These features presented below are examined in detail in Sections 4 and 5:

- The vessel measured approximately 29'7" (9.02 m) in length with a beam of around 10'5" (3.02 m) and 3'2" (0.97 m) depth, possibly with an elliptical stern;
- There was no observable evidence during field investigations that the vessel was masted or that it had a keelson;
- The vessel was iron fastened and pitched on the inside and outside;
- The vessel was originally clinker built;
- During its working life the rabbet on the keel (at port side midships) that received the garboard strake had become worn, resulting in the attachment of a plank or board ('cheek' or 'shelf') to the keel so as to support the port side garboard strake;

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[22] ***Casey & Lowe, December 2017: Sections 7.1 and 7.2.***

- A rider keel was later added. The rider keel was composed of two timber species (Grey Gum and possibly Stringybark) scarfed together;
- Planks were attached to the rider keel to form a shelf for the outer hull (or second layer) of clinker planking;
- The outer hull was iron fastened and pitched on the exterior (saw marks still visible on the interior side of the outer planking);
- It was believed at the time of recovery that there was an interval of a few years between the addition of the outer hull as there is evidence of wear and marine borer damage on the exterior facing of the inner hull;
- It was unclear at the time of recovery whether the rider keel was added solely to accommodate the outer hull or had been added years before;
- The vessel was constructed from local timbers – Sydney Blue Gum, Grey Gum, Stringybark, Southern Mahogany, Spotted Gum and Banksia (secondary frames to support the ceiling planking). Of the 83 timber samples analysed, none were exotic;
- It was deliberately beached, used as a timber offcut 'bin' for Langford's boatyard, progressively becoming buried from possibly the early 1830s. The wreck was completely buried by the early 1860s;
- As the vessel may have been abandoned in the early 1830s and appears to have had a long working life – on account of the wear on the keel and the addition of an outer hull – it is possible that it was built in the early 19th century;
- Of the vessels registered in Australia prior to 1850, there are 31 vessels listed of a similar length, however none seem to match UDHB1 (Table 1).[23]

The original Statement of Heritage Significance (see Section 1.3) has emphasised the physical characteristics and bilge contents of the wreck, with form being the most significant characteristic. Its context (its location next to Langford's boatyard) provides vibrant research opportunities relating to the archaeology of watercraft abandonment and the understanding of the environmental context of Darling Harbour in the second quarter of the 19th century. Analysis of any such evidence is not the subject of this research design.

Though the original Statement of Heritage Significance does not take into consideration that UDHB1 may have been confined to the waters of Sydney Harbour and may never have exited Sydney Heads, this does not make the wreck any less significant. This is because, while archaeological evidence of early Australian shipbuilding and coastal traders is rare, evidence of early Australian boatbuilding and working harbour vessels is rarer still.

The preparation of the research design has taken into account the rareness of UDHB1 and its place within the maritime history and archaeology of NSW. At the time of the recording and excavation of the wreck in late 2018 it was the earliest known Australian-built colonial vessel found in NSW. The discovery of UHRW2 (the 'Windsor Boat') in early 2019 has challenged UDHB1 for the 'earliest colonial' moniker, however the 'Windsor Boat' was in a markedly lesser state of preservation and was carvel built, a late medieval European shipbuilding innovation.

UDHB1 could also claim to be one of the few double-hulled vessels found in Australian waters, the earliest being the ocean going and national heritage-listed 1629 Dutch ship *Batavia*, wrecked off the Western Australian coast, which was also built with two thick layers of double hull planking.[24] More recently identified (February 2020) was the schooner

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23 Parsons, R. 1983 Ships of Australia and New Zealand before 1850 (details of ships registered with the Customs at Ports in Australia and New Zealand).

24 Van Duivenvoorde, W. 2015 Dutch East India Company (VOC) Shipbuilding: The Archaeological Study of Batavia and Other Seventeenth-century VOC Ships, College Station: Texas A&M University Press. Ed Rachal Series in

Barbara, wrecked off the Rye jetty.[25] *Barbara* was built in Tasmania in 1841, probably around the time the abandoned UDHB1 was silting up. Both the *Batavia* and the *Barbara* had carvel planking rather than clinker.

These other finds do not diminish the significance of UDHB1 but in fact highlight its rarity as a class of early Australian-built vessels, and its accessibility coupled with its remarkable level of preservation. This limits what comparative observations can be made with similar sites in NSW and Australia – with North America providing the closest contemporary archaeological examples. The fact that it has been raised and is undergoing conservation treatment, making it available for in-depth study, places it in an important period of the colony's development of local maritime industries like shipbuilding. In effect, the excavation report of UDHB1 will serve as a baseline study from which comparable sites will be assessed against in the future.

The research design presented in this report will focus on the endemic attributes of the vessel – its form, construction, and function to create a baseline of information for thematic questions relating to early Australian shipbuilding.

Themes in early Australian shipbuilding relevant to the Barangaroo Boat

The study of early (< 1850) Australian shipbuilding has been limited by the relative paucity of physical remains. Recent discoveries such as the UDHB1, 'Windsor Boat' and *Barbara* (1841) at Rye have provided a stimulus into this field of inquiry. There are two broad themes in the study of early Australian shipbuilding[26], these being:

- Quality
- Tradition, adaptation and innovation

The broad theme of *Quality* encompasses aspects of availability of suitable materials and expertise in a frontier society which can feed into wider discussions about the characteristics and development of early colonial NSW. *Quality* also covers the discussion of cheaply built versus poorly built and quality versus quantity, as a way of contextualising the high attrition rate of early Australian-built vessels.

The discussion on *Quality* focuses on how an early Australian vessel was built. Such areas of interest are, but not confined to:

- The type and quantity of fastenings used;
- Anti-fouling and marine borer prevention methods;
- Quantity and quality of joinery which reflects standards of craftsmanship, and;
- Scantling dimensions.

These research areas would contribute to an understanding of whether vessels were built for a long working life, under what circumstances, and/or whether they were over or under built, reflecting possible cost cutting, scarcity or uncertainty/overconfidence in working with Australian timbers.

The theme of *Tradition, adaptation and innovation* examines the potential clash between boat building and shipwrights schooled in the European tradition of vessel construction and the Australian environment with its dramatically different timbers and coastal conditions. This

***Nautical** Archaeology. On-line: https://www.amazon.com/Dutch-India-Company-Shipbuilding-Seventeenth-century/dp/1623491797*

25 Flinders University Wreck yields more about nation's shipbuilding https://blogs.flinders.edu.au/fit/2020/03/02/wreck-yields-secrets-of-nations-shipbuilding/

[26] Buller, R. 2006 Quality Assured: Shipbuilding in Colonial South Australia and Tasmania. Flinders University Monograph Series Number 8: Section 3.

theme covers the trial, error and experimentation with the use of Australian timber species.[27] Integral to this theme is the hull design of early Australian-built vessels and if, and how, characteristics influenced by local conditions and timbers were grafted onto, or displaced the United Kingdom templates.[28]

The discussion on *Tradition, adaptation and innovation* focuses on the form of an early Australian vessel. Such areas of interest are, but not confined to:

- The shape of the hull, and;
- The selection and working of timber species.

These research areas would contribute to understanding the antecedents of early Australian vessels, whether they be modelled on ships' boats or certain vernacular forms from the United Kingdom, and how much was influenced by the selection of timbers as opposed to coastal conditions. It would also be interesting to know whether early Australian-built vessels had begun to display the signature shallow draft design that has been identified in locally-built vessels by the second half of the 19th century.[29]

It should be recognised that UDHB1 may have limited potential to contribute to the major themes of early Australian shipbuilding through comparative analysis of contemporary wrecks on account of these themes having been developed around open water sailing vessels. UDHB1 appears to have been propelled by muscle and may never have gone to sea. Nevertheless, as a well preserved, and possibly unique example of a class of early Australian-built watercraft – a clinker-built working boat – UDHB1 can, as noted above, be the baseline against which future finds of similar watercraft will be compared.

The research questions to be addressed for this excavation report are as follows:

When was UDHB1 built?

Knowing the year, or at least the decade, in which the vessel was built would place the wreck within a temporal context from which observations about the vessel's characteristics would have greater relevance in understanding the evolution of early Australian ship/boat building.

This question could be answered by, but not confined to, the following:

1. Understanding the ship/boat building industry of the late 18th/early 19th century (pre-1825) in NSW;
2. Identifying the vessel in the historical record, and/or;
3. Identifying techniques that provide a *terminus post quem*, such as evidence of circular saw use or dated archaeological deposits.

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[27] Veth, P. Richards, V. Philippou, C. et al. 2016 Australian Historic Shipwreck Preservation Project; Excavation and Monitoring Programme Report 2012 – 2015. Clayton, K. 2012 'Australian timbers: their significance in early Australian shipbuilding' Australasian Institute of Maritime Archaeology Bulletin Volume 36, Buller, R. 2020 'Timber Selection in Tasmanian Colonial Shipbuilding: A Preliminary Predictive Model' Australasian Journal of Maritime Archaeology Volume 42.

[28] Buller, R. 2006: pp.19-20.

[29] O'Reilly R. 1999 An assessment of Australian built wooden sailing vessels (constructed between 1850-1899) operating in South Australia intrastate trade: methods and materials. Honours Thesis, Flinders University, Adelaide SA p.35, Jeffery, B 1989 'Research into Australian-built coastal vessel wrecked in South Australia 1840 - 1900.' Australasian Institute of Maritime Archaeology Bulletin Volume 13(2): p55, Jeffery, B. 1992 'Maritime Archaeological Investigations into Australian-built vessels wrecked in South Australia'. The International Journal of Nautical Archaeology, 21(3): p.218.

What are the time intervals, if any, between phases of construction?

Understanding the intervals between construction phases will provide a date range for the working life of the vessel. This in turn could indirectly lead to a more informed estimate of when the vessel was constructed.

This question could be answered by, but not confined to, the following:

1. A closer examination of the vessel could provide an indication of which components are contemporaneous. For example, if the inner garboard shelf was added at the same time as the rider keel was attached to compensate for the worn rabbet on the keel.
2. Identifying whether there are comparative and historical examples of a rabbet on a keel wearing to a point where a plank needs to be attached to support the hull;
3. Identifying whether there are comparative and historical examples of vessels having a second or outer planking added and what were the time intervals;
4. Understanding how often vessels were re-pitched and if there is evidence of more than one application of pitch on the inner hull;
5. Identifying other phases of construction, including repairs. For example, are there remains of previous frames that do not match those of the existing frames as evidenced by fastening holes on the planks, and/or are there 'ghost frames' partially concealed by a later application of pitch?

What differences are there between the inner and outer hull construction?

It could be argued that UDHB1 is actually two vessels – the first being composed of the keel and the inner planking and the second the rider keel and outer planking. This provides the opportunity to identify differences in materials used and construction techniques employed. This in turn could say something about changes in construction techniques and availability of materials over time, change of ownership with a possible accompanying change of prerogatives, and even different 'hands' at work (meaning a different builder or even yard).

This question could be answered by, but not confined to, the following:

1. Identifying differences between the timber species of the inner and outer planking;
2. Identifying any appreciable differences in planking sizes;
3. Differences in fastening patterning between layers;
4. Differences in size and frequency of treenails between layers;
5. Differences in size and frequency of ferrous fastenings between layers;
6. Differences between the inner and outer layer that could be attributed to the physical constraints in overlaying an existing hull with another hull;
7. Differences in composition of pitch on the inner and outer planking, and;
8. Examining timber end grain of inner and outer planking to see if there are differences in the cutting method, tree size and number of trees used in the planking.

What did the vessel look like?

This question directly relates to the form and shape of the vessel, a significant element of the wreck. An understanding of the shape of the hull can help to infer the function of the vessel as well as tracing the hull design to British templates.

This question is to be answered by:

1. Confirming that the vessel did not have a mast step or keelson, and;
2. Preparing line drawings, fit out (how it appeared with its fittings) and a 3D digital model using site measurements and photogrammetry.

What was the vessel's function?

The answer to this question will place the vessel in its own, presently unique, space within the realm of early Australian ship/boat building from which it can be compared to other known and future examples.

This question could be answered by, but not confined to, the following:

1. Through historical research, develop an understanding of what 29 ft, presumably oar-propelled, open-decked vessels were used for in Sydney Harbour, and possibly beyond, in the early 19th century;
2. An understanding of activities that the vessel's hull shape was suited for. Would include examination and comparison of similar hull shapes from the United Kingdom;
3. Determining whether the wearing of the rabbet on the port side may provide an insight into how the vessel was used, and;
4. Examining the bilge deposits to see if a record of the vessel's voyages and cargo could be ascertained.

1.6 Report Philosophy

Shipwrecks are complicated sites and UDHB1, being a doubled hull vessel, is all the more complicated. Those who are familiar with excavating wreck sites will know that a considerable amount of information about the site is recovered during the post excavation phase, before and after conservation treatments. Even more is learned about the wreck if a reconstruction is attempted. Therefore, gaining a comprehensive understanding of a wreck such as UDHB1 could take years and even decades to realise.

The proponent of the development which unearthed the wreck, Sydney Metro, was required under the conditions of the government approval to submit this excavation report within a limited time frame. As conservation treatment on the timbers are on-going and its reconstruction a long way off, this report does not attempt to be the final word on the archaeology of UDHB1.

Instead, this report largely focuses on the process of recovering the wreck and descriptions of the timber elements that comprise it, as they were observed and recorded in the field. The interpretations made about this wreck are based on field records, augmented by historical research and what information was made available from the on-going conservation process.

The report has been prepared with those archaeologists and conservators in mind who will have the task of one day re-assembling UDHB1. The detail provided in Section 2 gives an account of the decisions that were made, and why, as well as comprehensive documentation on the steps involved in its recording and disassembly. It is something remembered by all those involved in this project that a document detailing the disassembly of a timber wreck was not readily available. Section 2 has been written as a kind of 'how-to' guide for those archaeologists in the near future who will be confronted with similar challenges.

Section 3 places the vessel as a wreck in a spatial and temporal setting. The purpose of this section is to attempt to determine when UDHB1 transitioned from a systemic (how it functioned in the way it was designed to – as a boat) to an archaeological context. Knowing this will provide some indication as to when it was built, helping to better understand its importance in the development of early Australian ship building. At this point it should be apparent that this report's primary interest is UDHB1 in its first life as a vessel, not in its second life as an abandoned watercraft adjacent to a boatbuilding yard. This latter story is beyond the scope of this report and has been explored in Volume 1, Section 4.7.3.

Section 4 breaks down the wreck structure in anatomical detail. Its layout is akin to the context section of a terrestrial excavation report (each element being a context) grouped into phases (keel assembly, stern, stem, planking, and frames) broadly conforming with the sequence of construction for a clinker vessel, though as will be seen in Section 5, the construction sequence of UDHB1 was more layered.

Section 5 provides an interpretation of the vessel based on available information including a 3D virtual reconstruction. This no doubt will be one interpretation of many to come, and it will be interesting to compare the interpretation of the vessel in this report against versions created from 3D scanning of the timbers and from future technologies.

It will be seen in Section 6, which addresses the Research Design, that there will be many more questions than answers. This is to be expected at this stage of the investigation into UDHB1. This report aims to transform the field data – both in the body of the report and the Annexes – into a coherent and accessible format, thereby creating a solid footing for future studies by archaeologists, conservators, curators and those with a passion for all things maritime to build upon.

1.7 Authorship

The primary authors of this report are Cosmos Coroneos, Benjamin Wharton and Karina Acton. Karina, who was the leading conservator for the recovery of UDHB1, wrote Sections 2.3.3, 2.4, 2.5, 2.6.2, 2.6.5, 2.6.6 and 2.6.4. Section 4 was written by Benjamin, as were Sections 5.2, 5.3 and 5.5.

Mike Nash prepared the bulk of the Historical Context (Section 5.4) while Dr. Wendy Van Duivenvoorde provided information for Sections 5 and wrote Sections 7.3, 7.4 and 7.5. The analysis of the copper alloy fastenings and sheathing carried out by Wendy appears in Volume 6.

Wendy, Benjamin and Cosmos prepared Section 5.1 together.

Keiran Hosty from the Australian National Maritime Museum, as well as Paul Hundley, Renee Malliaros and Heather Berry from Silentworld Foundation provided their observations obtained from the cleaning and 3D recording of the timbers and other wreck elements.

Guy Hazell processed the photogrammetric models, while the lines, appearance and fit-out of the UDHB1 was prepared by Benjamin Wharton. Benjamin's work was reviewed by Geoff Hewitt, and Kevin Edwards created the 3D models of the vessel.

Photographs and drawings made during the recording and recovery of UDHB1 are attributed to the entity that employed the recorder, such as AMBS, Casey & Lowe and Cosmos

Archaeology. Drawings and photographs made for this report are directly attributed to the individual.

1.8 Abbreviations and Definitions

AHD	Australian Height Datum
ANMM	Australian National Maritime Museum
ca.	Circa
GCP	Ground Control Points
ICS	International Conservation Services
JV	John Holland CPB Ghella JV
MHW	Mean High Water
NSW	New South Wales
RL	Relative Level – in relation to Australian Height Datum (AHD).
RMS	Roads and Maritime Services
SWF	Silentworld Foundation
UDHB1	Unidentified Darling Harbour Barangaroo 1
UHRW2	Unidentified Hawkesbury River Wreck 2

Unidentified Darling Harbour Barangaroo 1 was a wooden watercraft. It was pulled ashore at Barangaroo and eventually abandoned, gradually becoming a wreck. A wreck according to general Australian maritime archaeological usage is a watercraft that has left its systemic context – as a vessel that travelled and/or floated on water – into an archaeological context – where it could not function anymore as a watercraft and served no other cultural function. Wrecks can be created by actions such as navigation error, foundering, weather events, fire, military engagement, scuttling and abandonment.

The terms watercraft and vessel are interchangeable, with the latter term being more commonly used when discussion is confined to a maritime context; the former, though more technically correct, is commonly used in reference to indigenous craft. The term 'watercraft' in some archaeological reports is sometimes used to avoid confusion with the same term when applied to food and drink containers.

According to the NSW *Heritage Act 1977,* a 'ship' is defined as 'any navigable vessel'. Therefore, according to the Act, UDHB1 is defined as a shipwreck. UDHB1 was, however, a boat. In Australian usage a ship is a watercraft/vessel that plies the coast and crosses oceans while a boat is a smaller craft that generally operates in rivers and enclosed waters, staying close to safe anchorages as well as being able to be pulled ashore.

UDHB1 is the wreck of a boat. While it would be technically correct to use the phrase 'the wreck of the UDHB1' or 'the wreck of the boat', UDHB1 will be referred to where appropriate as the 'boat' or the 'hull'. This is consistent with Australian archaeological reporting where excavated building footings are referred to as if the building was still standing, such as 'Langford's house' not the 'remains of Langford's house' or 'ruins of Langford's house'. Apart from reducing the word count, referring to UDHB1 as the boat or hull rather than the wreck in some small way brings it back to life. The term 'wreck' will be used in narrower contexts when discussing site formation processes.

2 CONDUCT OF EXCAVATION

2.1 The Staged Approach

How the wreck was to be recorded and removed was not readily apparent upon its discovery. The process of determining and implementing the ultimate method of recording and removal evolved over a number of weeks. The parameters within which the work could be undertaken to protect the wreck's significance expanded and contracted as on-going field investigations provided new information about its condition and the physical nature of its surroundings. All of this was carried out within the construction site of a Critical State Significant Infrastructure project which had time critical hold points and deadlines.

The following discussion broadly outlines the stages which occurred from the discovery of the wreck, to its removal from site. Further information on the decisions leading to the recording and removal of the wreck is presented in the November 2018 report *Barangaroo Station, Sydney Metro Archaeological Relics Management Plan for the Removal & Conservation of Unidentified Darling Harbour Barangaroo No. 1 (UDHB1)* (see Volume 6).[30]

The process of determining the most appropriate way to record and remove UDHB1 was approached in stages. This is because the completion of each stage provided new data which led to revaluations on the various options for recovery. These stages are discussed in the following table with references to the relevant report sections where they are discussed in detail.

Stage	Dates	Description	Comments
A	25/9/18 to 12/10/18	Removal of loose timbers and artefacts to expose the wreck and prepare preliminary statement of cultural heritage significance.	• See Section 2.3 for further information on the field work in this stage. • Six options for removal submitted on 3/10/18. These options examined the risk and feasibility of *in situ* preservation, lift as one piece and conservation off site, to disassembly followed by conservation off site. Each option had conditions that needed to be met so as to be viable and with minimal risk to the heritage values of the wreck. • 8/10/18 Preliminary cultural heritage significance statement prepared stating that the wreck was a State significant item. • Investigation into feasibility of lifting the wreck as one piece commenced 9/10/18.
B	12/10/18 to 18/10/18	Removal of ceiling planks, bilge deposit and test excavation around the wreck to determine surrounding site conditions.	• See Section 2.3 for further information on the field work in this stage.
C	18/10/18 to 26/10/18	Detailed recording of the shape of the hull and examination of construction details.	• See Section 2.3 for further information on the field work in this stage. • 24/10/18 Investigations into lifting the wreck ceased due to unresolved conservation and archaeological issues resulting in

[30] ***Casey & Lowe, Cosmos Archaeology, ICS 13th November 2018 Barangaroo Station, Sydney Metro Archaeological Relics Management Plan for the Removal & Conservation of Unidentified Darling Harbour Barangaroo No. (UDHB1). Version 4. Prepared for John Holland CPB Ghella JV & Transport for NSW / Sydney Metro.***

			unacceptable risk to the cultural heritage values of the wreck. • 24/10/18 Disassembly option became preferred method as it provided less risk to the heritage significance of the wreck and greater certainty as to time frame for removal.
D	27/10/18 To 13/11/18	Condition analysis and preference discussions to inform preferred option and future conservation strategy.	• Development of recording and removal (disassembly) methodology. • Review of methodology by experts. • 30-31/10/18 Wreck covered in geofabric, polyurethane foam and sand to protect it from forecast heat wave of up to 40º C.
E	14/11/18	Review and determine best option for removal.	• Endorsement of recording and removal (disassembly) methodology by regulatory authorities.
F	16/11/18 to 8/12/18	Implementation of approved removal option.	• See Section 2.6 for further information on the field work at this stage.

As outlined in the table above, the initial desired method of removal of the wreck was to lift it as one piece and conserve off-site. The lift method deemed most viable was to construct a cradle-like structure under and around the wreck.[31] The alternatives were examined but ultimately the lift option was abandoned for the following reasons:

- There were concerns regarding the structural integrity of the wreck as the wreck was resting on the turn of the starboard bilge, the keel was deformed, the hull (floors and planking) had detached from the keel, there was no keelson and the functional load capacity of the ferrous fasteners (which appeared to have completely corroded) was assessed to be minimal.
- Uncertainty surrounding the time it would take to prepare the lift ensuring that the integrity of the hull would not be compromised.
- The longer the wreck was exposed *in situ* while preparing for the lift, the risk of significant/catastrophic damage to the timbers, mainly due to hot dry conditions, increased.
- Detailed recording of the construction methods used on the wreck would not be realised if the wreck was kept and lifted in one piece. Understanding the way the vessel was constructed is a major aspect of its cultural heritage significance.
- Risk of loss of hull integrity during the conservation process.
- Concern that the proposed use of foam to fill the interior of the wreck to ensure the hull did not collapse in on itself would limit, or even prevent changing methodological approach or even switching to disassembly if the lift option became undesirable.

The disassembly method was chosen for the following reasons:

[31] ***Casey & Lowe, Cosmos Archaeology, ICS 13th November 2018: Section 6.2.***

- Advice from experts such as Fred Hocker, James Delgado, David Gregory and Anette Hjelm Peterson that a wreck of this type and size would be best disassembled, conserved and reassembled.[32]
- Disassembly would make it easier and more effective to conserve the timbers, as they could be separately and specifically managed.
- Would allow for the 3D scanning of individual elements as the pieces are placed in conservation tanks.
- Enabled greater control of the management of the conservation of the wreck than if it was in one piece.
- No risk of uncontrolled collapse of hull integrity during disassembly process.
- Less risk of unforeseen problems arising during removal that would require changes to methodology and timings to ensure cultural heritage values are maintained.
- Less likely that the substrate – mix of sandstone bedrock, rubble and marine sediments – would impede the disassembly process.
- Timbers in relatively poorer condition could be prioritised for conservation treatment.

The possibility of a 'block' or 'box' lift was considered early in October 2018. This method was not pursued because of some key issues, some of which could not be resolved until the method was implemented. The key issues were:

- The presence of sandstone rubble around and under the wreck as well as the bow resting on what appeared to be sandstone bedrock and the stern resting on sand. This presented a considerable unknown factor for the potential scale of the destabilisation of the integrity of the wreck during the box installation, the lift and transportation stages, and;
- How would the wreck be stored and conserved at the storage venue? This would require a dedicated facility.

2.2 Personnel

The successful recording and removal of UDHB1 necessitated the use of a variety of skill sets which brought together heritage professionals who had not previously worked together as a team in such a context. Although the subject of the investigation was a shipwreck, it was located in a terrestrial environment. In such conditions, the maritime archaeologists on the team could readily identify the individual components of the wreck, which meant it could be recorded with accuracy and efficiency. The historical archaeologists provided the skills to excavate and recover the timbers, as well as having the physical conditioning to work in a hot and awkward workspace. The conservators brought innovative techniques, care and attention to the handling and packaging of the timbers. The coordination and understanding of the roles and responsibilities of each of these groups was critical for ensuring a positive outcome. See Section 2.6.2 for more information on the individual roles within the team. The team was as follows:

[32] ***Casey & Lowe, Cosmos Archaeology, ICS 13th November 2018: Appendix 12.***

Historical Archaeologists	Maritime Archaeologists	Conservators	Peer Reviewers and Advisors
Byron, Matt	Bendell, Milly	Acton, Karina	Carpenter, Jon (Western Australian Museum)
Casey, Mary	Bennett, Kurt	Bickersteth, Julien	Delgado, James (Search – Search0$_2$)
Cottle, Victoria	Bullers, Rick	Hull, Oliver	Gregory, David (Danish Maritime Museum)
Flood, Hannah	Carter, Matt	Jackson, Amy	Hocker, Fred (Vasa Museum)
Giang, Jason	Coroneos, Cosmos	Paterson, Frances	Kasi, Kalle (Western Australian Museum)
Hardwick, Coral	van Duivenvoorde, Wendy	Reade, Wendy	Panter, Ian (York Archaeological Trust)
Hazell, Guy	Garbov,Dragomir	Ross, Katy	Peterson, Anette Hjelm (Danish Maritime Museum)
Hincks, Mike	Hosty, Keiran	Taylor, Jessica	Richards, Vicki (Western Australian Museum)
Jones, Rhian	Hundley, Paul	Vuissoz, Annick	
Lin, Elaine	Hunter, James	Williams, Kirwan	
Marriner, Gary	Malliaros, Renee	Williams, Rob	
McCormack, Caitlin	McAllister, Maddy		
McDonald, Kylie	McBrian, Connor		
Mc Eleney, Ronan	Mitchell, Jane		
McMaster, Francesca	Polzer, Mark		
McRae, Iona Kat	Straiton, Peta		
Pietrzak, Adam	Zapor, Tim		
Ramage, Lian			
Rollason, Sarah			
Rooke, Jane			
Seifertova, Alexandra			
Seretis, Kylie			
Shanahan, Brian			
Skepasianos, Antonella			
Wharton, Benjamin			
Winter, Holly			

The historical archaeologists were contracted by Casey & Lowe, the maritime archaeologists by Cosmos Archaeology and the conservators by International Conservation Services (ICS).

2.3 Pre-Disassembly

2.3.1 Objectives

The preliminary statement of significance provided guidance on data collecting priorities before the wreck was removed (see Section 1.3). The information gathered would also be used to inform the best method for removing the wreck while maintaining its cultural heritage values.

The key objectives of the investigation of the wreck prior to its removal (Stages A to C) were:

- What was the wreck's physical condition with particular reference to its structural integrity?

- What was the wreck resting on?
- Obtain accurate measurements of the curve of the hull. This would assist greatly in determining the shape of the vessel, which would in turn provide some insights into its function, and from which regional and/or temporal boat building traditions it may have derived.

The objectives of the pre-assembly stage were achieved in the following sequence:

Step 1 – Excavated the sediments within the wreck to expose the wreck contents. These were a collection of loose timbers which were mostly worked. The majority were not part of the structure of the wreck.

Step 2 – Planned and photographed the wreck with its contents. The methods used were:

- Measured drawings by the site planner
- Survey of selected elements using a Total Station
- Photogrammetry (see Section 2.3.4)

Step 3 – Removed the loose timbers and sediments from above the ceiling planking.

Step 4 – Repeated planning and photogrammetry of the wreck with the ceiling planking *in situ*.

Step 5 – Removed the ceiling planking.

Step 6 – Excavated the sediments that had accumulated in the bilge (space between ceiling planking and the hull).

Step 7 – Repeated planning and photogrammetry of the wreck. The lines of the hull were also taken using a Total Station.

These steps are discussed in detail in the following sections. Once Step 7 was completed, the wreck was deemed ready to be removed.

2.3.2 Recording

The recording of the wreck at the pre-disassembly stage was not dissimilar to what would occur on a terrestrial site. The sediments and contents of the wreck were removed according to their stratigraphical contexts.

The sediments overlaying the wreck and contents – contexts 132, 133, 141, 142 and 144 – were excavated as with any other deposit on a land site (for discussion on the contexts see Section 3 in Volume 1 and Section 4.7.3). This excavation commenced with a series of sondages across the wreck, the purpose of this was to get an initial understanding of the extent of the wreck remains and its condition (Figure 2.1). Once the baulks were removed, timber walkways were built that could span the wreck (Figure 2.2).

Figure 2.1: Sondage (test trench) perpendicular to the axis of the keel. Bow left of image.

Figure 2.2: Cleaning timbers using the walkways. Note the sandbags placed at bow to prevent sediments washing into hull during heavy rain.

The loose timbers (context 148) within the wreck were labelled before being planned and removed. The labels were cut from polypropylene A4 tab dividers and marked with permanent black marker. The labelling included the following information: UDHB1 [id number]. The numbering started with 0001 at the stern. UDHB1 0001 therefore was the southernmost or most sternwards of the exposed timbers. The timbers were numbered in order of appearance, irrespective of whether they were a loose or intact structure, moving towards the bow (Figure 2.3). The labels were orientated with the text perpendicular with the axis of the keel and the text reading left to right (from starboard to port).

Some consideration was given to the method of attaching the labels as there was a desire to impact the timbers as little as possible. Stainless steel staples were initially attempted but the timbers were either too hard to be penetrated without using what was feared to be excessive force, or the arms of the staples were too short to grip effectively (Figure 2.4). The labels were attached to the timbers with brass upholstery tacks (see Figure 2.3). Brass was used as it would not corrode and stain the timbers. They were attached by hand, rather than using a hammer. Usually, the tacks were able to grip, however there were some exceptions where the timber was too hard. The use of mylar tags attached with brass tacks was suitable in the short term for immediate recording purposes. They were not suitable long term as they were easily dislodged by the geotextile, which was placed over the wreck to keep it wet.

Figure 2.3: Identification tags on loose timbers. Bow top of image.

Figure 2.4: Tags attached to planking with stainless steel staples, which were not always effective.

Once labelled, the loose timbers (context 148) were photographed to create a photogrammetric model (Figure 2.5 and Figure 2.6 as well as see Section 2.3.4). The wreck and loose timbers were then planned before the loose timbers were removed (Figure 2.7). Only labelled loose timbers were recovered. New loose timbers exposed during the process were left *in situ* until all the labelled loose timbers were recovered. These newly exposed timbers were given new identification numbers and new labels were attached. This exposed layer of timbers was planned and the timbers removed. This process was repeated a third time before all the timbers were removed.

Figure 2.5: Photography with camera mounted on pole.

Figure 2.6: Oblique shots of wreck. Scales in 500 mm increments. Bow in foreground (Source: Casey & Lowe).

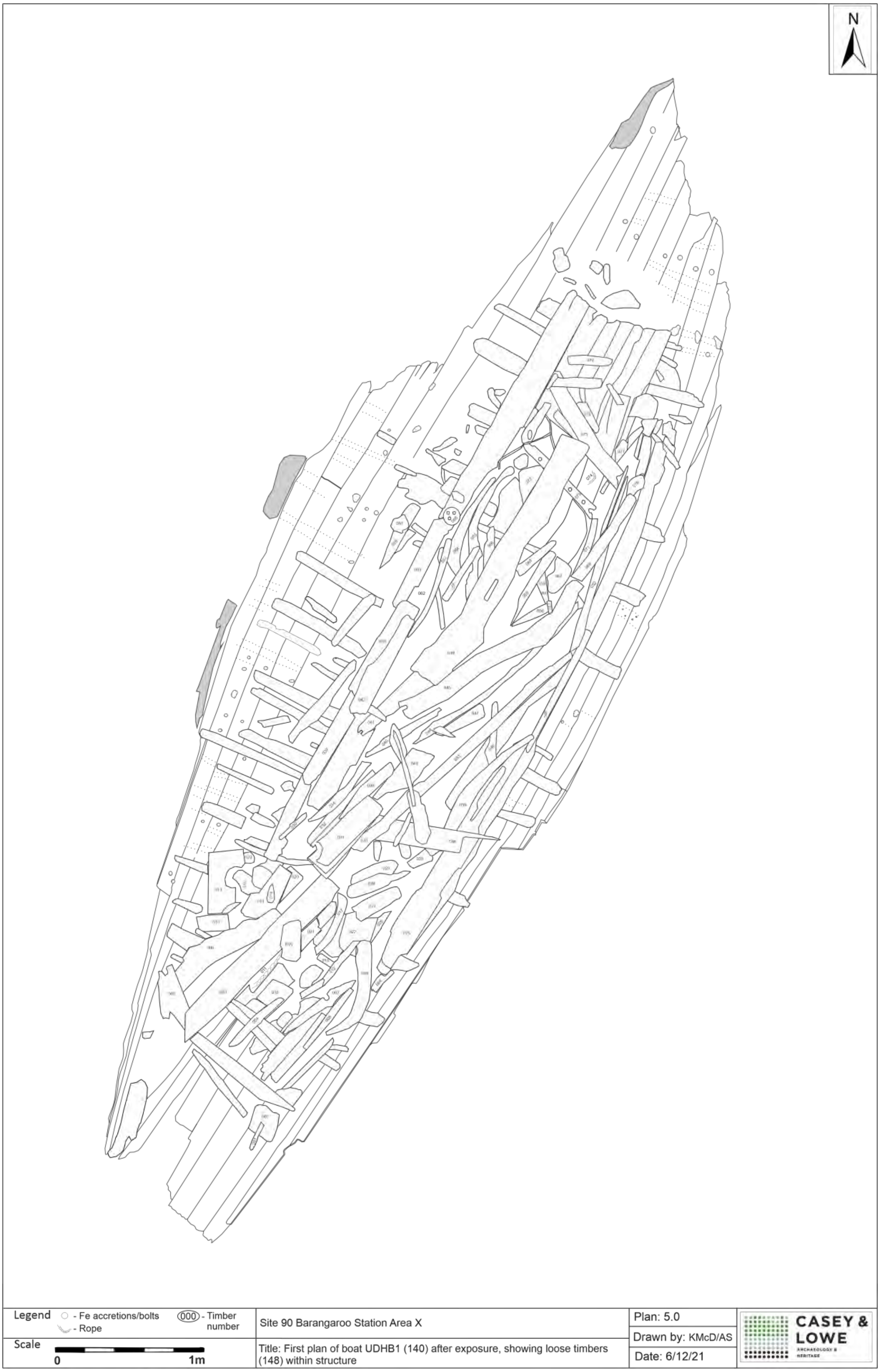

Figure 2.7: UDHB1 prior to removal of loose timbers.

The loose timbers were taken to a table set up near the wreck for further recording (Figure 2.8). Details such as a brief description of the object with length, breadth and depth measurements were recorded. The purpose of the recording at this stage was to provide enough information so that, in the event that the label became separated from the object, it could be identified. The object was given a registration photograph and was then photographed from all angles so that a 3D model could be generated if required (Figure 2.9 and Figure 2.10). See Volume 8.1 for the photographs of the loose timbers as they were recovered from the wreck. There was a cursory cleaning of the sediments from the timbers before they were photographed.

Figure 2.8: Recording table for loose timbers set up adjacent to wreck.

Figure 2.9: Small deadeye.

Figure 2.10: Registration photograph of the deadeye.

The removal of the loose timbers exposed a layer of sediment which overlayed the remains of ceiling planking (Figure 2.11 and Figure 2.12). The sediment was removed as contexts 152, 153 and 156 (see Section 3) and the ceiling planks labelled and tagged. Another series of photographs were taken for photogrammetry purposes (see Section 2.3.4) before the wreck was re-planned with the ceiling planking (Figure 2.13).

Figure 2.11: Sediments, including artefacts such as ceramics, overlaying ceiling planking after removal of loose timbers. Note the sagging ends of the ceiling planking.

Figure 2.12: Wreck with remnant ceiling planking exposed after removal of loose timbers and sediments.

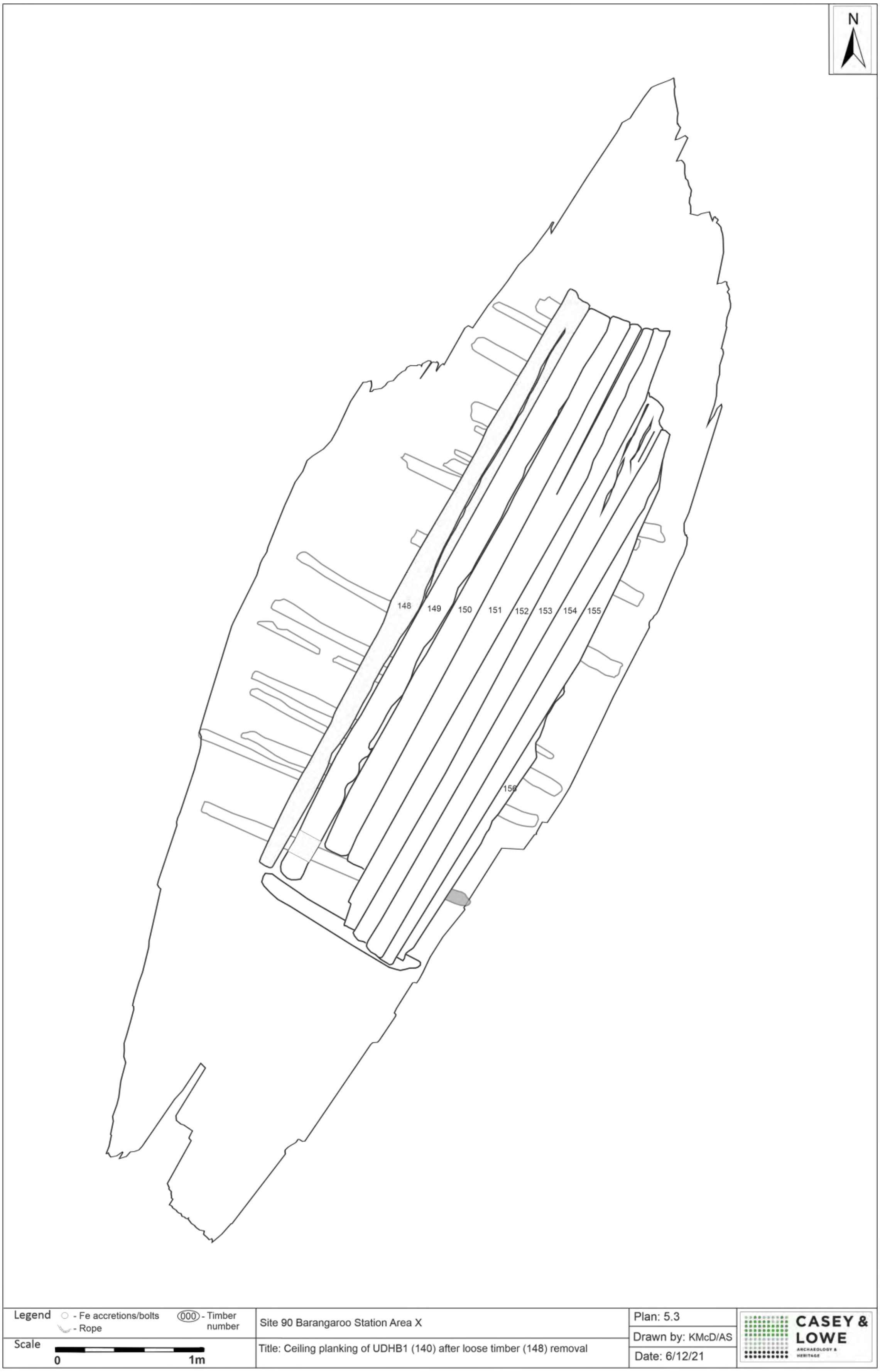

Figure 2.13: Plan of wreck with remnant ceiling planking exposed after removal of loose timbers and sediments.

The removal of the ceiling planking provided a challenge, as most of the planks, where they were in contact with the frames, had been crushed. The loss of structural integrity of the planks along their length resulted in the intact portions of plank sagging between the frames (Figure 2.14). These fragile ceiling planks therefore required direct support prior to lifting to prevent collapse. The ceiling planks requiring additional support typically displayed deterioration such as splintering, longitudinal cracking, fracturing or soft wood.

Figure 2.14: Oblique view of wreck showing the undulating ceiling planks caused by sagging between the frames.

Direct supports were made of thin, rigid/semi-rigid materials of sufficient size to protect the deteriorated area. Where a temporary support was required for the removal only, a large trowel could be used as a support and for lifting. Where more lasting support was required, semi-rigid plastic sheet or film was used. Plastic was cut or shaped into various sizes and inserted below the element. For more fragile areas, the plastic was placed above to sandwich the fragile wood. Polypropylene and polyethylene sheet material was used, supplied in an easily accessible format such as file dividers or the base of plastic plates.

For the ceiling planks, Mylar sheets were also used to wrap around the element (Figure 2.15). The Mylar was inserted by folding an edge and pushing through with a trowel or other blade. Temporary splints were also installed for additional support, and materials used included wooden icy-pole (aka craft) sticks and bamboo skewers. The direct supports were secured with double-jointed cable ties, with the head located at the sides to reduce the risk of imprints/damage.

Figure 2.15: Preparation to lift a ceiling plank. Note the supporting of weak areas (which correspond to the frames) with Mylar sheets and cable ties.

The secured planks were slid onto a plywood board cut to size. Overlaying the board was a layer of black plastic followed by the geotextile used for wrapping (see Section 2.3.3). This was done so that the planks would not have to be moved again for wrapping. Removing the ceiling planks posed a challenge. The length of the planks, and therefore the boards, meant that unless they were fully supported during removal there would be flex in the timbers resulting in the element breaking apart. Furthermore, their location within the wreck meant that team members would still need to be positioned on the timber walkways to safely handle the board/plank recovery. To negotiate the limited space for each lift, the board with the plank attached was slid towards the stern where team members were in place to grab and support the board. The ceiling planks, still fastened to their boards and wrapped, were placed immediately into plywood crates that were custom made for each plank (Figure 2.16). They were not photographed or recorded in the same manner as the loose timbers.

Figure 2.16: Ceiling planking being wrapped before being placed into a custom-made crate (in background) with upside down and unused crate being used as a work table. Note that a layer of geotextile and black plastic had already been placed onto the board before the plank was slid on. This allowed for the element to be wrapped without it being moved for a second time.

The bilge deposits (contexts 151, 154, 155, 157, 158, and 159) exposed by the removal of the ceiling planking were excavated (Figure 2.17). The sediments were sieved and soil samples kept for pollen analysis (see Section 3 for the findings and Volume 3, Section 10).

Figure 2.17: Excavation of the bilge deposits after the ceiling planking was removed.

At the completion of the excavation of the bilge, the wreck was prepared for a final round of planning and photography for photogrammetry, before the wreck was to be removed (Figure 2.18 and see Section 2.3.4 as well as Volume 4.1 for finished models). This was considered to be the most critical of the photo surveys as the removal of the ceiling planking exposed the frames and interior of the hull. This was the best opportunity to obtain an accurate measurement of the curve of the hull, which in turn would allow for a more informed interpretation of the shape of the vessel.

As well as the photogrammetry survey, lines were also taken of the interior of the hull. In a more traditional method of recording the form of the hull, 25 stations, or transects, were run from stern to bow perpendicular to the keel (Figure 2.19). Spot heights were taken along each station where inner planking was exposed using a Total Station (Figure 2.20 and Volume 8).

Legend ○ - Fe accretions/bolts ⌣ - Rope (000) - Timber number

Scale 0 1m

Site 90 Barangaroo Station Area X

Title: Structural elements of UDHB1 (140), following ceiling plank removal

Plan: 5.5

Drawn by: IKM/AS

Date: 6/12/21

CASEY & LOWE ARCHAEOLOGY & HERITAGE

Figure 2.18: Hull plan after ceiling planking was removed, with visible elements numbered.

Figure 2.19: Taking the 'lines' of the hull – from the inside – using a Total Station. Note the brass tacks placed in the hull from where spot heights are to be taken.

Figure 2.20: Spot heights taken inside hull for the purpose of recording its shape. Note the base image shows the loose timbers. Spot heights were taken after the ceiling planking was removed and bilge deposits excavated. (Prepared by Brian Shanahan).

At the completion of the photogrammetry survey of the wreck, with the ceiling planking removed, exploratory work was undertaken to prepare the hull to be lifted. During this time a detailed examination of the wreck took place for the purposes of understanding and documenting the exposed elements and construction techniques (Figure 2.21).

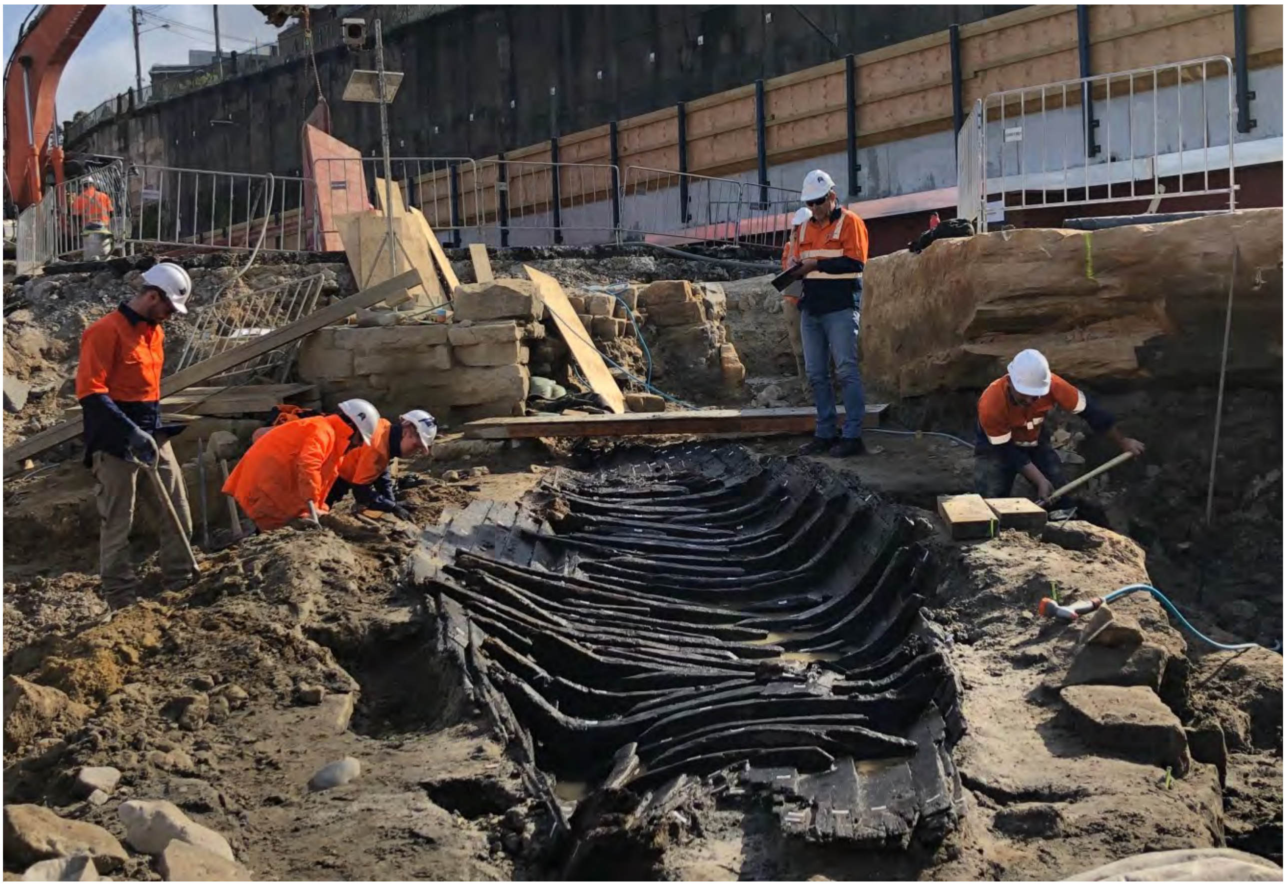

Figure 2.21: Detailed recording prior to removal. During this time, lifting the hull in one piece was the preferred option and an exploratory tunnel was excavated under the wreck. This was done to ascertain the nature of the substrate (which varied from sand, to sandstone rubble to bedrock) and to gauge how long it would take to tunnel under the wreck through which lifting strops would be threaded.

2.3.3 Packing

Once photographed, the loose timbers were recorded then wrapped in a black, coarse, unwoven (felt) geotextile cut to size. The bundle was then soaked in fresh water before being wrapped in thick black plastic. The bundle was cable tied in a manner so as to retain the water for as long as possible (Figure 2.22 and Figure 2.23). The unwoven geotextile at the time was the preferred medium for wrapping, as it was considered to be the best material for retaining moisture. Although the geotextile shed fibres and caught on the timbers, this was seen as an acceptable negative, as it was imperative to keep the timbers as wet as possible until they were placed under conservation. Hessian was used for wrapping when available, but was not preferred as it dried out relatively quickly compared to the geotextile.

Figure 2.22: Timbers being wrapped in unwoven 'felt-like' geotextile. Although the material shed fibres, it was found to retain water better than hessian. The retention of water was seen as a priority as it was unknown how long the timbers would stay in cold storage. Potential for mould growth was also a concern and hessian is more susceptible to such a process than geotextile.

Figure 2.23: Lifting board being prepared with plastic and geotextile wrapping for ceiling planking.

Pink flagging was tied to the bundle with the timber identification details written on with permanent marker. The original identification tags were placed inside the bundle with the timber, without the brass thumb tacks.

The JV carpenters constructed a number of plywood crates to store the timbers. These crates ranged in size from 0.5 m to 2.2 m in length, 0.5 m in width and 0.2 m in height. Special reinforced crates were made for the ceiling planking (Figure 2.24 and Figure 2.25).

Figure 2.24: Crate made on site for the ceiling planking. Note the cable ties stuck to the inside of the crate to better secure the contents.

Figure 2.25: Ceiling planks inside their crates. Note the nylon rope lifting handles.

The crates containing the timbers were placed into refrigerated containers. The JV carpenter also built shelving within the containers to allow easy access to the crates as needed. The crates were labelled, and their contents documented and tracked (Figure 2.26). The refrigerated containers were set at around 3ºC.

Figure 2.26: Crates for loose timbers prepared for being shelved inside the refrigerated container.

It is important to note that the loose timbers were treated with the expectation that some of them may have been associated with the wreck and hence could be used for any potential reconstruction of the vessel. Therefore, it was important to keep the timbers wet for as long as possible. It was unknown at the time of packing how long they would be in the refrigerated containers. They were also packaged and stored in a manner which ensured they would retain their form without bending or being compressed from stacking.

2.3.4 Photogrammetry

The photogrammetry survey of the wreck prior to disassembly was carried out by a combination of pole mounted and handheld camera photography. With the pole mounted photogrammetry, a Nikon D7200 and a fixed 20-mm lens was affixed to the top of a 4 m pole. This gave good coverage for each shot and could produce an image with ground pixels less than 1 mm. Photos were taken using a cable shutter release for quick and immediate response. An overlap of 80% is needed for the software to register the images together.

Agisoft Metashape Pro was used for the photogrammetry processing software as this creates a geo-referenced point cloud that can be used to create a 3D model, and enables exporting to other 3D processing software. The images obtained were used to generate 'Structure from Motion' photogrammetry models of the wreck. This was done by generating orthophotos and dense point clouds of the structure which provided the basis for detailed, three-dimensional modelling and representation of what the vessel looked like.

There were seven photogrammetry surveys of the wreck prior to its disassembly:

1. The wreck in the process of being exposed (Figure 2.27);
2. The wreck with loose timbers in situ – 29th September and 4th October 2018 (Figure 2.28);
3. The wreck with some loose timbers removed – 11th October 2018 am (Figure 2.29);
4. The wreck with some loose timbers removed – 11th October 2018 pm;
5. The wreck with most loose timbers removed – 12th October 2018 pm (Figure 2.30);

6. The wreck with loose timbers removed and ceiling planking exposed – 15th October 2018 pm (Figure 2.31); and
7. The wreck with ceiling planking removed with frames exposed – 19th October 2018 (Figure 2.32).

Figure 2.27: Exposed hull, 25th September 2018 (Rendered by Brian Shanahan).

Figure 2.28: Exposed hull, 26th September 2018 (Rendered by Brian Shanahan).

Figure 2.29: The wreck with some loose timbers removed, 11th October 2018 (am). (Rendered by Guy Hazell).

Figure 2.30: The wreck with most loose timbers removed, 12th October 2018. (Rendered by Guy Hazell).

Figure 2.31: The wreck with loose timbers removed and ceiling planking exposed, 15th October 2018. (Rendered by Guy Hazell).

Figure 2.32: The wreck with ceiling planking removed with frames exposed, 19th October 2018. (Rendered by Guy Hazell).

With regards to the final survey undertaken on the 19th October 2018, a model was generated in a short period of time which allowed for an assessment to be made as to whether there were any gaps in the survey. In this instance, a point cloud was derived from photogrammetry using a sample of 242 photographs out of 786 photographs (Figure 2.33). Camera alignment was set to medium and dense point cloud reconstruction was set to medium. The scene was clipped, and the remaining 3.7 million points related to the surface of the boat.

Figure 2.33: Top view and oblique view of rendered mesh model with the ceiling planking removed using 31% of photographs taken for the survey. (Rendered by Brian Shanahan).

A reclassification of the point cloud according to elevation showing approximately 7 mm space between each point (Figure 2.34). The variable, less-dense resolution on sides of timbers could be improved by using the full photographic dataset which has greater coverage of the timbers.

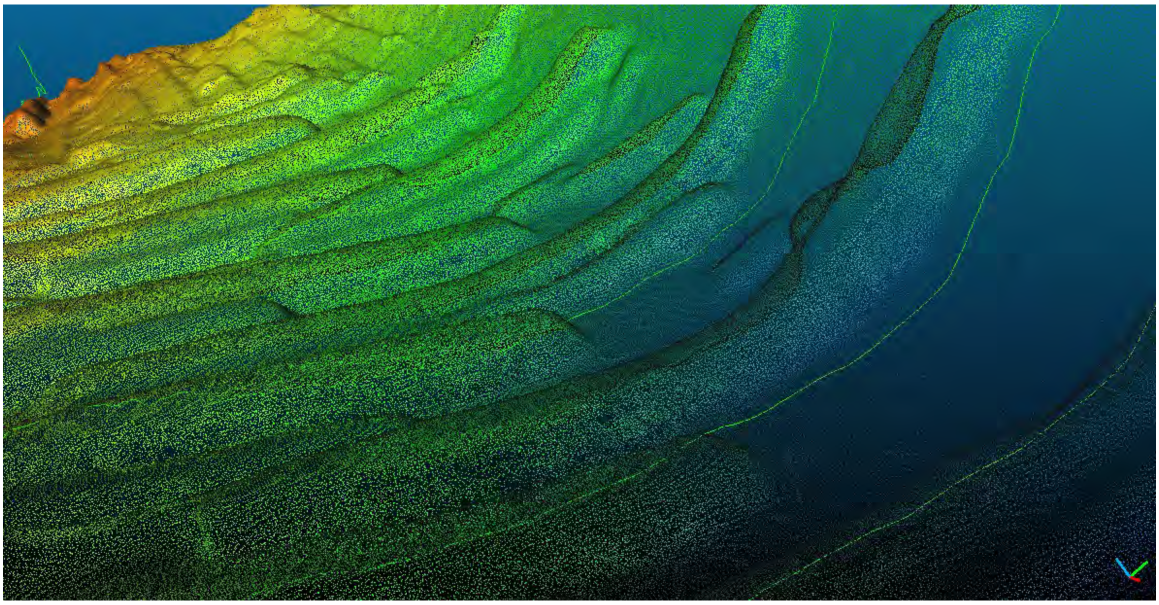

Figure 2.34: Detail of the point clouds. (Rendered by Brian Shanahan).

Figure 2.35 shows a mesh generated from the point cloud and rendered with ambient occlusion filter highlighting the structure of the model surface, which could otherwise be obscured by the photorealistic texture. The mesh quality, as expected with only 31% of the dataset used, is somewhat variable around shadow areas. There is a trade-off between processing time and details because using the additional photographs exponentially increases processing time and required hardware resources. Greater detail could be achieved by using the larger photoset or possibly by using targeted use of smaller photosets highlighting individual areas of interest.

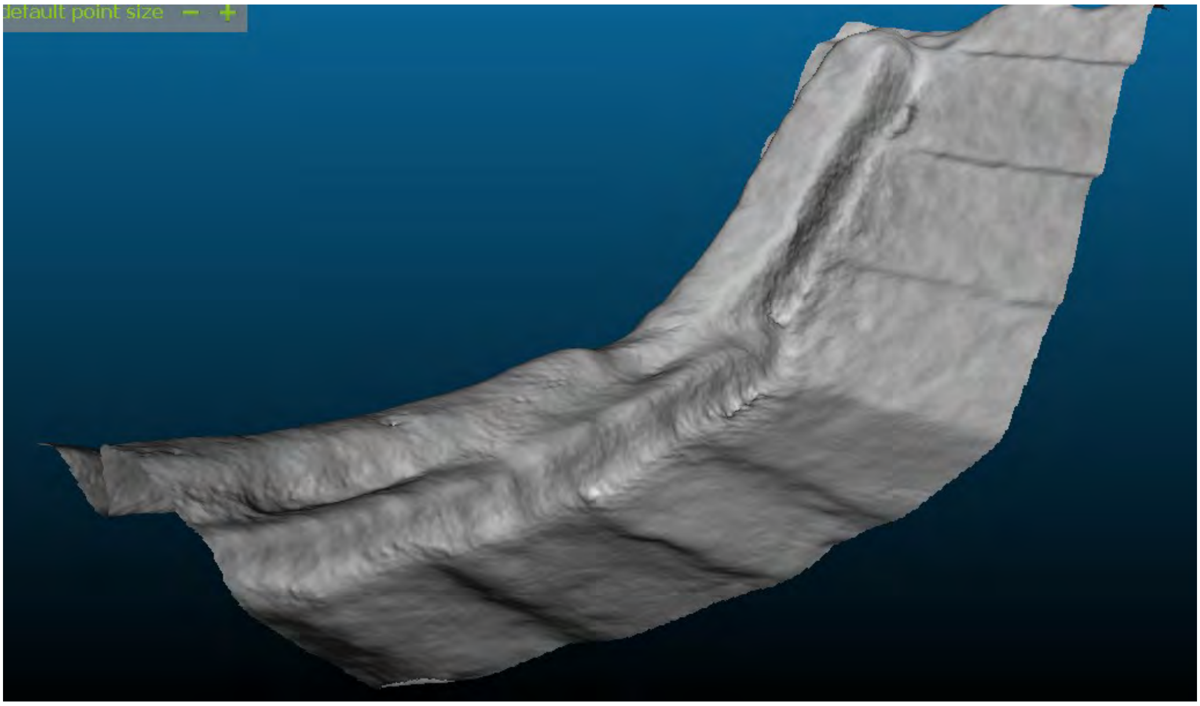

Figure 2.35: Mesh generated from the point cloud and rendered with ambient occlusion filter. (Rendered by Brian Shanahan).

As stated, the above discussion addresses a review that was undertaken to ensure that the survey was completed to a satisfactory level. The model can be further optimised using the ground control points (GCP) measured with a Total Station. Even greater detail could be achieved using a larger photoset and applying higher reconstruction parameters, which would require greater computing power and more processing time.

The generated models of the surveys noted above are presented in Volume 4.

2.4 Site Condition Assessment

The condition of the wreck was assessed prior to recovery, and condition information helped decision making regarding recovery options, and assessment of the risks and benefits of these options.

The hull was incomplete and the upper elements had been lost, as well as parts of the stern and bow structure. The form of the boat was also distorted and appeared to have 'flattened', because the hull had detached from the keel. The integrity of the construction, the fasteners and connection between components could not be determined. While the *in situ* wreck had not been totally submerged, the site is damp/wet and the wood of the wreck was waterlogged.

Prior to recovery, initial conservation observations were as follows:[33]

Wood – general observations

- Wood was waterlogged with varying degrees of deterioration across the remains.
- Some wood had a strong solid core, with softness (indicating deterioration) to the first 2 mm of the surface.
- Other wooden elements were quite soft and could not bear weight or pressure.
- Deterioration was variable across elements with some elements generally firm and robust, with localised softness and deterioration.
- Edge elements were the most damaged with greater loss of material, cracking and splitting. They included the bow, stern and uppermost hull planks and frame ends. This was consistent with greater exposure and erosion in the *in situ* archaeological environment.
- Evidence of some surface drying damage to elements.

Wood – observations on components

Ceiling planking: These components are soft and weak. In comparison to the hull planks, it appeared that the wood may be of a different species and the timber was thinner (see Section 4.7). These components demonstrated extensive longitudinal splitting and localised transverse cracks, evidence of compression and deformation.

Frames: Varying degrees of deterioration; localised areas of softness; end grain deterioration; proud of the hull in areas particularly on the port side, with soil acting as a gap filler; some breaks or cracks; minor to moderate surface cracking.

Hull: Surface deterioration generally evident (to a depth of 1-3 mm). Possible separation of planks at upper layers. The underside of the hull could not be assessed prior to recovery.

Iron: Iron components that were visible were heavily corroded. There are iron concretions bound to the interior of the hull. There were areas of iron corrosion staining of the wood. Iron fasteners were present but were corroded, and prior to recovery, it was not clear if metallic iron remained.

[33] Casey & Lowe, Cosmos Archaeology, ICS 13th November 2018 : p27-28

2.5 Reburial

After the last of the ceiling planks were removed by 18th October 2018, there was a hiatus while methodologies were being prepared and approvals sought to remove the wreck. The timeframe in which further works would commence was unknown and the wreck was considered at risk in the first week of November 2018, when heatwave conditions were forecast. The water supply on site at the time was unreliable and it was deemed too risky to rely on automated sprinklers to keep the timber wet overnight and on weekends. The risk was elevated by the forecast of high winds that would accompany the high temperatures.

To protect the wreck as best as possible under the circumstances, temporary *in situ* protection was installed on 31st October 2018. The aim of the *in situ* protection was to keep the wreck moist without relying on an external water supply until a management decision was made regarding the removal of the wreck.

In situ protection was put in place, starting with the padding of spaces between the frames with wet wads of geotextile (Figure 2.36). The padding was installed until the interior surface of the remains of the boat was even. Multiple layers of wet geotextile were then placed over the wreck surface (Figure 2.37 and Figure 2.38). The geotextile was completely saturated by spray hose. Thick sheets (80-100 mm) of polyurethane foam were then placed over the geotextile (Figure 2.39 and Figure 2.40). Polyurethane foam has good compressive and supportive qualities and allows water movement, so would not isolate the wreck from any rainfall. The foam was also wet by hose and then covered with sand by machine, which was supervised by the archaeology site supervisor (Figure 2.41 to Figure 2.44). Tarpaulins were placed over the sand to reduce the rate of any evaporation and wind erosion.

The *in situ* protection was removed at the commencement of disassembly and the polyurethane foam was reused throughout the project as a packing material.

Figure 2.36: Padding between the frames. (Source: ICS).

Figure 2.37: Keeping wreck wet with hose. (Source: ICS).

Figure 2.38: Final layers of geotextile. (Source: ICS).

Figure 2.39: Installing polyurethane foam. (Source: ICS).

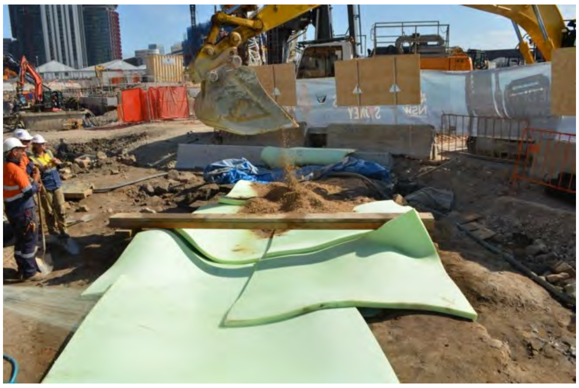

Figure 2.40: Covering with sand. (Source: ICS).

Figure 2.41: Covering with sand. (Source: ICS).

Figure 2.42: Covered with sand. (Source: ICS).

***Figure 2.43: Wreck protected* in situ.** (Source: ICS).

Figure 2.44: Construction works adjacent to wreck during temporary* in situ *protection. (Source: ICS).

2.6 Disassembly

2.6.1 Objectives

To safeguard the cultural heritage significance of UDHB1, the disassembly of the wreck had the following objectives:

- *Capture information on construction methods;*
- *Record, remove and conserve elements of the wreck to allow the opportunity for re-assembly and further study; and*
- *Ensure the preservation of original material and evidence of construction*.[34]

To achieve these objectives a number of essential actions were recognised. These actions were:

- Keep elements wet;
- Keep wet or cool once removed;
- Minimise damage to fabric material;
- Ensure elements retain shape;
- Record relative positions and alignments of elements;
- Record the construction methods as elements are removed and new elements are uncovered;
- Maintain accurate records; and
- Undertake archaeological excavation of contexts within the wreck.

This section of the report outlines how each task in the disassembly was undertaken in line with the essential actions.

2.6.2 Management of the Disassembly

2.6.2.1 Establish Roles and Responsibilities

In preparation for the removal of the wreck, roles were established with key responsibilities. A project team and management structure were designed specifically for the project considering reporting and resourcing requirements. A focus was placed on collaborative involvement with national and international experts, interested parties and organisations and key stakeholders.

A project team of just over 50 people were involved in the disassembly project, with around 25 personnel being on site at any one time. Each team member was assigned a role. Not all roles required full time involvement, and over the course of the project some personnel took on dual roles or personnel were rotated into different teams. The roles and responsibilities are detailed in Table 2.

[34] ***Casey & Lowe, Cosmos Archaeology, ICS 13th November 2018: Section 9.***

Table 2 Roles of the Project Team

Role		Responsibilities	Qty	Experience
Director	ED	- Final decision maker - Manage work-flow between groups - Monitor stores and order as required - Source new materials or equipment as required	1	Senior Archaeologist
Lead Archaeologist	LA	- Manage archaeological components of disassembly including recording and excavation	1	Senior Archaeologist
Lead Conservator	LC	- Supervise conservation components of disassembly including removal techniques, packaging and storage	1	Senior Conservator
Surveyor	Surv	- Surveys in each labelled element - Will undertake photogrammetry when required	1	Surveyor
Archaeology recorder	AR	- Record elements including location, construction, and photography	1	Maritime Archaeologist
Disassembly recorder	DR	- Record observations that would assist in the re-assembly of the wreck - Assist AR	1	Senior Maritime Archaeologist
Videographer	V	- Video the site at the start and end of the day - Video each element as it is being removed	1	Maritime Archaeologist
Registrar	Reg	- Management of element information (recording, packing and storage) - Oversee packing team - Liaise with Director on workflow	1	Archaeologist/ Conservator
Element recorder	ER AR	- Fills in form for each element	1	Maritime Archaeologist
Element photographer	EP	- Photograph each recovered element	1	Archaeologist/ Conservator
Recorder, process	PR	- Maintain records of works undertaken and decisions made - Issue day summary to stakeholders and advisors - Manage daily records and backup	1	Archaeologist
Lead Lifter	LL	- Lead each element lift - Separate and remove elements - Excavate in hull where required	1	Archaeologist/ Conservator
Lift team	Lift team	- Separate and remove elements - Excavate in hull where required	2+	Archaeologist/ Conservator
Lead Packer, **Packing Team**	LP, Packers	- Support and wrap elements - Pack boxes and place in cold storage	4+	Archaeologist/ Conservator
Carpenter	Carp	- Makes boxes on and off site - Custom supports as required	2	Carpenter

2.6.2.2 Project team training & induction

Prior to disassembly commencing, the project team was trained and inducted in the methodology and planned processes. This included provision of an induction pack, documentation that included the methodology, recording processes and technical information on boat construction. The induction pack is provided in Annex A. In-person training included a workshop to discuss the project background, rationale, approved methodology and an outline of the processes. This was followed by a practical session onsite, covering all of the work areas and setups, from the wreck site, through to the recording and packing stations to the refrigerated containers (Figure 2.45 and Figure 2.46).The practical session also incorporated an example element to highlight and explain the processes of surveying, *in situ* photography, removal, recording, photography and packing, including how to use the recording forms, the labelling systems and tools.

Figure 2.45: Training in* in situ *recording and removal.

Figure 2.46: Training in packing processes.

2.6.2.3 Tracking Progress

Progress on the removal of the wreck was managed by communication between the different work groups and by ongoing monitoring by the lead roles and regular communication and reassessment of processes and resourcing. In addition to the daily pre-start for the Metro site carried out by the JV, a separate project-specific pre-start for the disassembly project was carried out (Figure 2.47). All of these measures ensured any issues were resolved or managed as the project progressed.

Figure 2.47 : Daily disassembly project pre-start.

Visual indicators of the progress of disassembly were displayed in the Registration area for the project team. This included whiteboards outlining the status of elements since removal and a diagrammatic site plan tracking elements packed in cold storage, compared to those remaining *in situ* (Figure 2.48 and Figure 2.49).

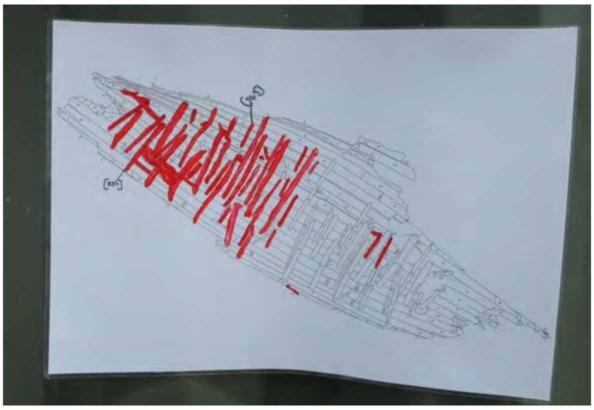

Figure 2.48 : Status of removal at 20th November 2018

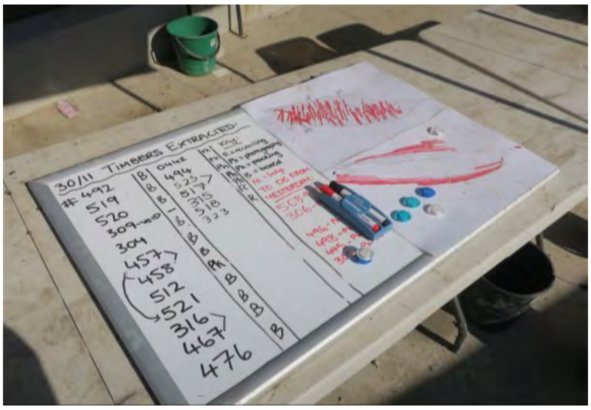

Figure 2.49 : Status of removal at 30th November 2018.

One team member had the daily role of recording the activities on site and preparing a daily summary (see Volume 6). Numbering a few pages, with images, these summaries were emailed the following day to the project's peer reviewers and stakeholders.

2.6.2.4 Work areas and Workflow

Designated work areas were created for different teams/processes: recording, photography, packing (wrapping), packing (boxing or crating). Work areas were arranged to align with the workflow (as far as was feasible on a working construction site). For example, when an element was carried from the boat to the first workstation, it was recorded, then passed to the adjacent and second workstation for photography. Where possible, the first workstation was located closest to the boat, and the last, closest to the storage containers.

Work areas needed sufficient and suitable space to safely move and process the elements. Work stations were flexible (size and personnel) and could be rearranged as required to accommodate changes in workflow and element sizes.

Conditions on site impacted the ability of the project team to carry out work at all, or the rate at which disassembly could progress. Heavy rains and wind caused work to halt on a number of occasions. Strong winds with particulates (particularly sand) created hazards for personnel and damage to equipment such as cameras. High temperatures or direct sun caused increased drying of the wooden elements and increased time and effort was required to ensure an appropriate level of moisture was maintained. Gazebos were installed at the registration station to provide shade protection, but they were unsuitable in high winds.

The registration work area initially was positioned adjacent to the wreck (Figure 2.50). It was relocated to another part of the construction site part-way through the project due to safety issues, including proximity to construction works, site conditions, space requirements and proximity to cold-storage (Figure 2.51 and Figure 2.52).

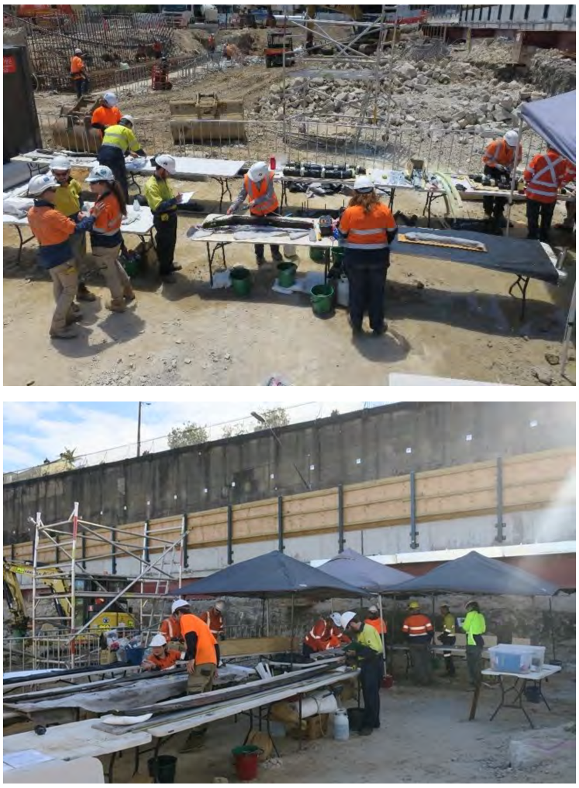

Figure 2.50: Overview of initial processing area.

Figure 2.51: Relocated and larger processing area.

Work stations and processes were modified throughout the project to accommodate variation in the rate of different processes (Figure 2.53 to Figure 2.54). As a general rule, removal was faster than each of the registration processes of recording, photography and packing. As such, there tended to be a backlog in registration for the duration of the project. In addition to bringing in extra resources, the backlog was managed by incorporating systems such as creating a designated holding area and allowing time every day for temporary preventive packing and movement of elements into cold-storage, if processing had been incomplete on the day of removal.

Figure 2.52: Relocated and larger processing area (red arrow) within the construction site which was around 100 m away from the boat (yellow arrow). Note the refrigerated container to the left of the image.

Figure 2.53: Example recording workstation.

Figure 2.54: Example photography workstation.

2.6.2.5 Preparation

Prior to disassembly works commencing, materials and equipment were prepared as much as possible. During the disassembly phase any downtime at workstations, due to differences in workflow, was used to prepare materials and equipment, check supplies and identify options for improvements. As the project progressed, routines were established to ensure supplies of materials were maintained and adequate, to prevent delays or bottlenecks.

Preparation tasks included:

- Labels were pre-cut and pre-numbered;
- Labels were installed in advance (where possible) with an agreed convention on label location to indicate orientation;
- Prefilled spray bottles and buckets of water were prepared and placed at each workstation, and refreshed during downtimes;
- Geotextile and plastic sheeting was cut into standard sizes in preparation for lifting and packing (Figure 2.55 and Figure 2.57);
- Custom padding cushions (polystyrene balls sewn into Tyvek) were prepared off site;
- Polyurethane foam padding was pre-cut into strips and blocks of various thicknesses (the foam used in the temporary protection of the boat was reused);
- Ethafoam was cut into standard sizes for further customisation and use in packing;

- Small strips of geotextile were prepared for padding;
- Cable ties were reused where possible and prepared in downtimes by levering the 'ratchet/pawl' mechanism and untied in downtime;
- Brackets were prepared as much as possible prior to custom shaping.
- Support boards for lifting were prepared in a range of shapes and sizes based on the expected dimensions of the elements;
- Crates (boxes and boards) for element storage were fabricated prior to removal commencing. The sizes and quantities were based on the expected dimensions of the elements. Throughout the project new crates were ordered with sufficient lead time in anticipation of the quantities required.

Figure 2.55: Pre-cut geotextile for packing.

Figure 2.56: Pre-cut polyethylene sheet.

2.6.2.6 Monitoring and maintenance

Throughout the entire period of excavation and disassembly, preventing the remains from drying out was a critical and ongoing activity. It was fortunate that in the months of September and October, the standard seasonal rains assisted in keeping the timbers wet. The spring months in Sydney are also windy, however, and it only took a short time after a solid rainfall before the timbers began to dry out. Entering late spring there were unseasonal heat waves reaching as high as 40°C, which resulted in extreme conditions and challenges in keeping the timbers wet.

Throughout the whole project steps were taken every day to maintain moisture in the remains. Maintenance and monitoring tasks included:

- Ensuring the wreck was covered when immediate access was not required;
- Establishing the *in situ* protection overnight and checking the condition of the wreck every morning;
- Ensuring the exposed wreck was sufficiently wet during works;
- Ensuring the removed wood elements maintained sufficient moisture content during registration and packing processes and during any waiting period; and
- Monitoring and inspecting the elements in cold storage and the cold storage conditions.

The boat was completely covered overnight and localised areas were uncovered for works and then re-covered during breaks and at the end of the day (Figure 2.57). The boat was covered with layers of water-saturated fabric and waterproof plastic (spun-bonded geotextile and plastic tarpaulins). Overnight and on weekends, a 'soaker' hose with fine holes along the length of the hose was placed on the boat, over the geotextile and below the tarpaulin, to prevent drying out.

Figure 2.57: **In situ *maintenance included covering the wreck at the end of the workday.***

The boat was kept wet during works by uncovering the smallest area possible to provide access for the immediate task (Figure 2.58). Where possible, during works a hose would be used to keep a flow of water on the boat (Figure 2.59). Otherwise, it was kept wet by hand spraying water. A multi-pattern trigger spray gun on a garden hose was used on mist and shower functions (Figure 2.60 and Figure 2.61).

Figure 2.58: Examples of wreck uncovered for access.

Figure 2.59: Installing soaker hose and covering wreck, in last stages of recovery.

Figure 2.60: Keeping wreck wet with hose.

Figure 2.61: Often water accumulated in hull which had a minor effect on data gathering, especially with photogrammetry. Keeping the timbers wet was a priority.

2.6.2.7 Uncovering the wreck

The temporary *in situ* protection put in place in October 2018 was removed between 13th November 2018 and 16th November 2018. Sand covering the boat was removed by machine and vacuum truck to a safe depth, and then by hand shovel to expose the polyurethane foam (Figure 2.62 to Figure 2.65). During the manual removal of foam and geotextile, water was regularly applied via a hose to prevent the wreck from drying out during works (Figure 2.66).

The boat was inspected to confirm that no new damage had occurred during the temporary protection (Figure 2.67). The form and structure appeared unchanged. The wood was not dry and there was no evidence of crushing or distortion. No changes were observed and the temporary protection was considered successful. The geotextile was reinstalled and the boat was wet with water again, and covered with tarpaulins.

Figure 2.62: Removal of sand by vacuum truck.

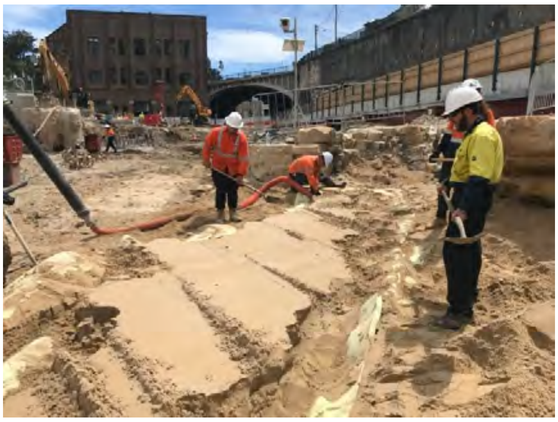

Figure 2.63: Removal of sand by vacuum truck.

Figure 2.64: Removal of sand by shovel.

Figure 2.65: Removal of associated spoil by machine.

Figure 2.66: Removal of polyurethane foam and wetting geotextile.

Figure 2.67: Condition of boat assessed.

2.6.3 Recording

The recording of the disassembly of UDHB1 had to be implemented to a standard that would allow for an accurate re-assembly of the wreck in the future. A number of methods were used, because, at the time, it was unclear whether one or more methods would be successful. Furthermore, it was unknown if one method alone would provide all the information needed to re-assemble the wreck, whether as a complete reconstruction or as a display replicating how it was found. The method devised also provided ample opportunities in the recording process to pick up human errors in recording.

The recording methods used were as follows:

a) Labelling the elements as they are exposed in a methodical manner.
b) Recording each element *in situ*.
c) Photographing each element *in situ*.
d) Surveying or position fixing each element *in situ*.
e) Videoing each element being removed.
f) Complete recording in element registration compound.
g) Detailed photography of element in registration compound.

The methods listed above were undertaken at various steps during the disassembly process for each element. The step sequence is presented in Annex A. The steps related to recording are described below.

2.6.3.1 Labelling the elements as they are exposed in a methodical manner

Any timbers that had been previously labelled with the white polypropylene tags were replaced by rectangular strips of yellow thick plastic cut up from cattle tags (Figure 2.68 and Figure 2.69).[35] Such tags had been used by Cosmos Archaeology for over 10 years on *in situ* underwater remains and had performed well, retaining their integrity and markings.

The ID number was etched into the plastic using a soldering iron. This ensured that the number would not be erased during the removal, packing and conservation process. These tags were secured to the timber by two stainless steel screws, one at each end of the strip, using a hand-operated power drill.

The tags were orientated on each element to read port to starboard when facing the bow. For the frames, the tags were attached on structurally sound timber as close to the port side-sided face as possible (Figure 2.70). The planks were tagged on the interior, that is, the upper face, at the fore end (Figure 2.71). All other timbers were tagged at the fore end, port end and upper face. Any variations were noted on the registration form (see below).

Elements newly exposed, such as the outer planks, were tagged in the manner noted above. To avoid possible double ups with numbers already assigned, including those given to the loose timbers inside the hull and ceiling planks, the new elements were assigned an ID number onwards of 300.

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[35] ***Image from Ozdingo Marketplace https://ozdingo.com.au/products/100x-cattle-ear-tag-set-blank-yellow-medium-label.***

Figure 2.68: Cattle tags come in a variety of sizes and colours, with yellow or green being the preferred colour for use in maritime archaeological applications.

Figure 2.69: It was decided not to use the complete tag as it would require more than two attachments to secure. Instead, the tag was cut into strips. Also, tags can be purchased pre-numbered but etching the number into the plastic was a more durable solution.

Figure 2.70: Yellow tags being fixed to a frame – on the upper face and on port end (bow at right of image).

Figure 2.71: Yellow tag fixed to fore end of inner plank, reading port to starboard. Note the white polypropylene tags were often left on the timber after the yellow tag was attached.

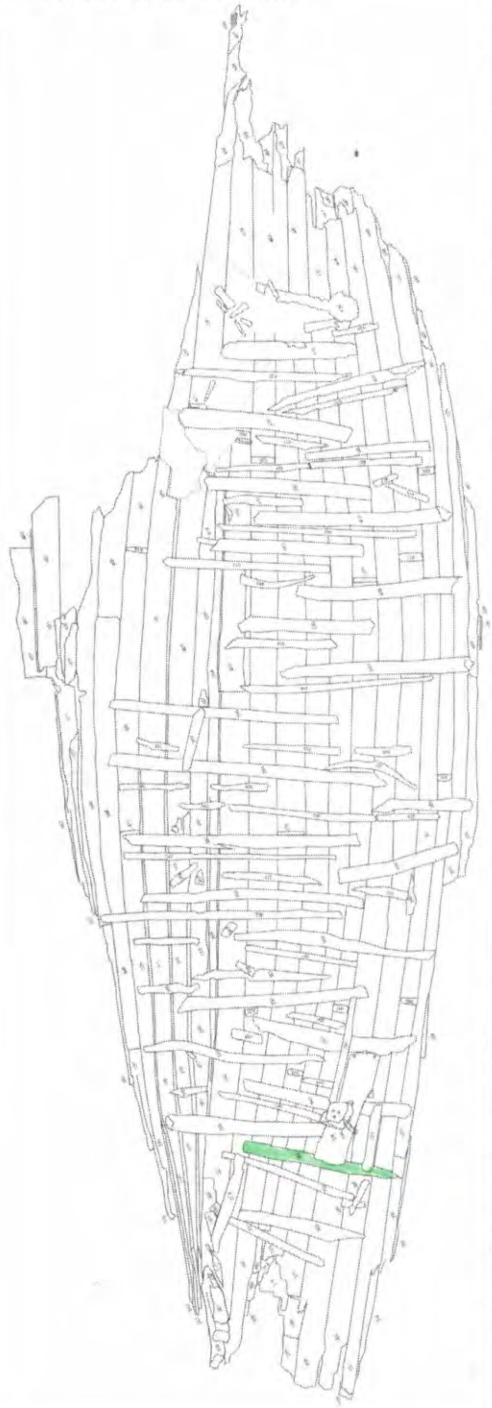
2.6.3.2 Record each element *in situ*

Once the element tag was replaced, details about the elements were entered onto a specially designed registration form (Figure 2.72). Each element had its own registration form. At this stage of the process, with the element still *in situ,* the front page of the registration form was filled out.

C&L Site: 90
SM2: Barangaroo Stn UDHB1 2018

Element ID: 334
Element Type: CANT FRAME
(Plank) Layer No.

Wreck Map
Highlight location of element on wreck



Description of position and function

CANT FRAME AT VESSEL STERN

334 IS ABOVE PLANKS 313, 302, 333, 323, 316, 305, 306, + 307

IT IS ABOVE, BUT NOT TOUCHING, 330 DUE TO DETERORATION OF 334

IRON CONCRETION ON THE TOP OF 334 ABOVE PLANK 306

*334 IS NUMBERED AS 343 ON SITE PLAN - ERROR

Displaced? Yes (No) **Warped?** Yes (No)

Sketch of position and/or connection with other timbers:

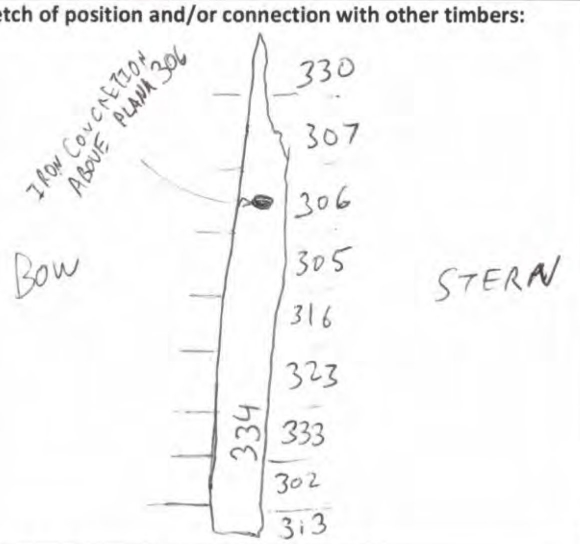


Photo Nos. 107-2736, 37, 38, 39, 40, 35 **Camera No.** 1

Relationship	**Element No.**	
Overlaps		
Overlapped by		
Abuts	Fore	Aft
Underneath		
Above	313, 302, 333, 323, 316, 305, 306, 307, 330	
Other (specify)		

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Figure 2.72: Example of front page of element registration form.

A site plan of the wreck after the ceiling planks had been removed dominated the left side of the form. The recorder was to colour in the element that was removed. As the vessel had been double planked, the planks shown on the map in Figure 2.72 correspond to the inner layer of hull planking. The outer layer of hull planks, which were exposed, could be coloured in by eye as they were adjacent to, although under, the inner layer of hull planks shown on the plan. This was the same for the rider keel elements and the garboard shelves for the outer planking.

Other information required was the element number, a short one or two-word description of the element followed by a written description of its position and function. Because of the potential confusion that could result from the fact that the vessel was double planked, there was a specific question on the form that asked whether the plank was from the inner or outer layer of hull planking. There were also prompts asking if the elements were displaced and/or warped; important information for any re-assembly attempt.

A sketch of the position of the element in relation to other elements was required. To ensure accuracy and increase the chance of identifying possible errors, a 'stratigraphic' matrix also had to be filled out.

2.6.3.3 Photograph each element *in situ*

The *in situ* photography required the following to be documented:

- An image of the ID tag with the information clearly readable (Figure 2.73);
- An image of the element showing the orientation of the tag as the element sat in the wreck (Figure 2.74);
- An image showing the relationship between the element and the surrounding elements (Figure 2.75), and;
- Any noteworthy features.

The photo numbers were entered onto the front page of the registration form, which was then transferred to the registration team.

Figure 2.73: ID tag clearly visible. (Source: Casey & Lowe).

Figure 2.75: Photograph showing the relationship of the element with the surrounding elements. (Source: Casey & Lowe).

Figure 2.74: Photograph of element showing the orientation of tag and element in relation to the rest of the wreck. Facing bow. (Source: Casey & Lowe).

2.6.3.4 Survey or position fix each element *in situ*.

The team surveyor had the task of obtaining the position of each element using a Total Station. This task was initially viewed as an 'if required' method of recording but it quickly became part of the standard operating procedure on account that it did not take long to do. A position was taken of one of the screws that attached the tag to the element and another position taken at the opposite end of the element. This method provided an absolute position for each element fixed in space (

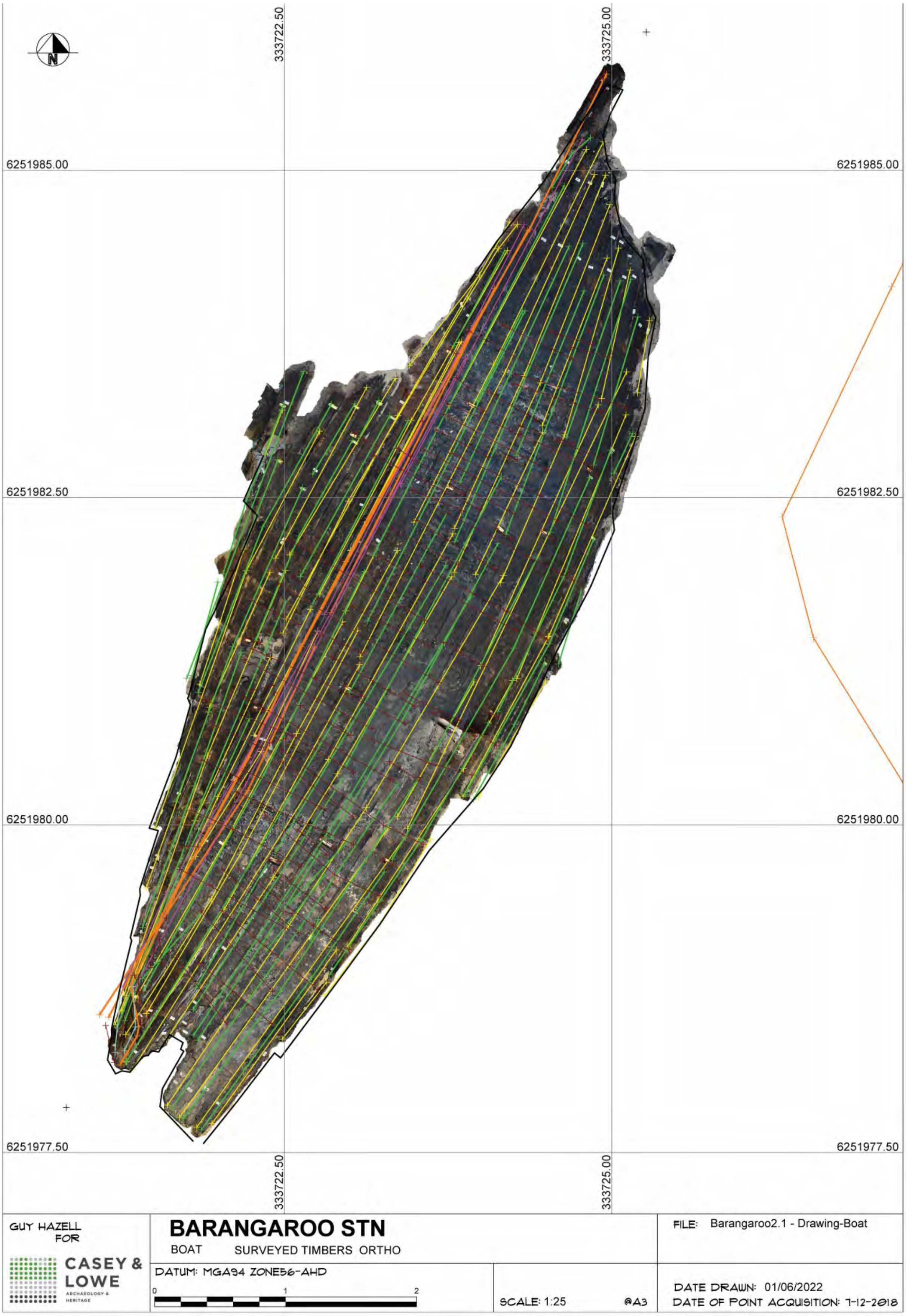


Figure 2.76). This information is not seen as the primary data source that will guide re-assembly but is there as back up if there are gaps in the other forms of recording undertaken.

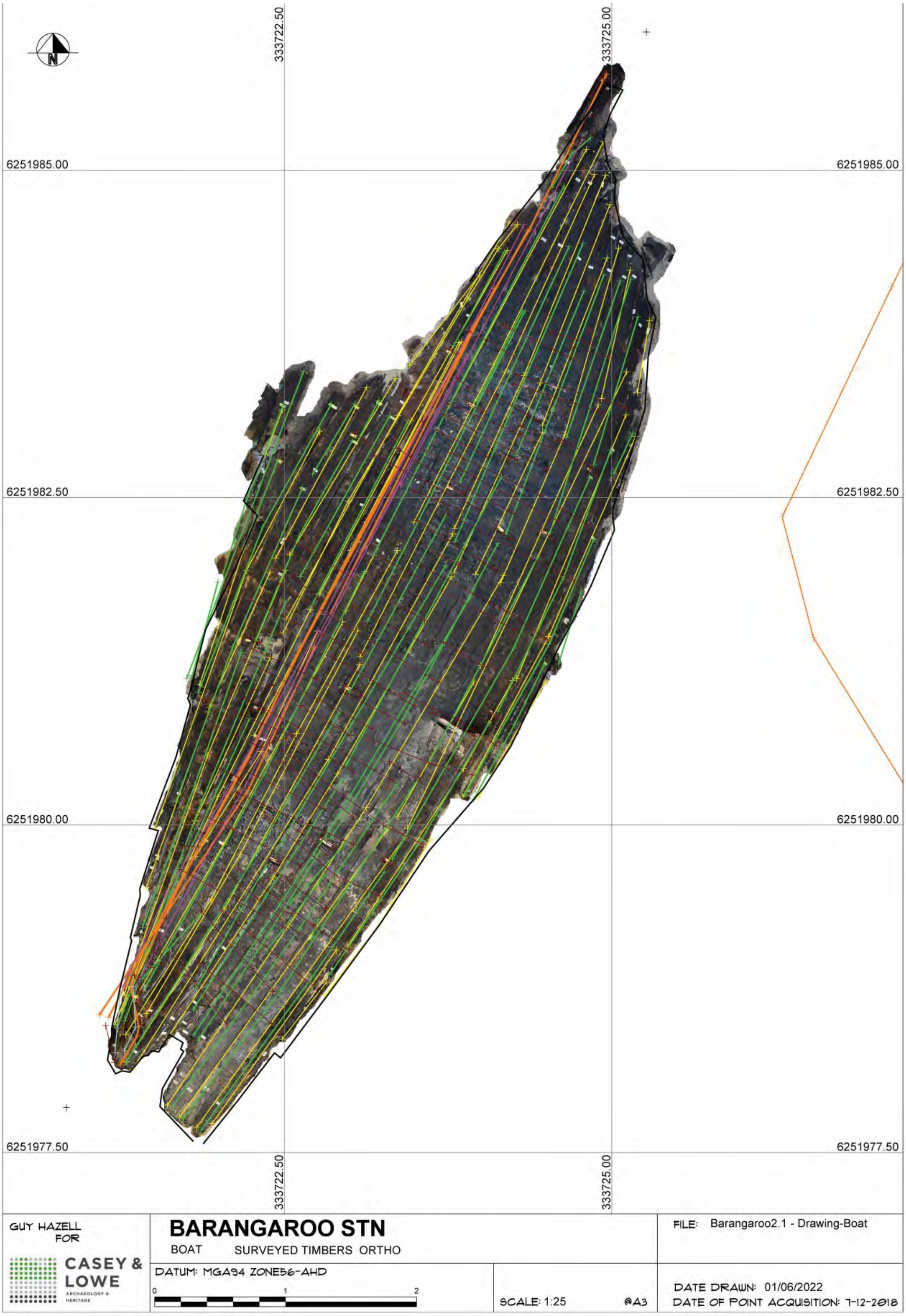


Figure 2.76: Surveyed positions of wreck elements. Green lines represent the outer planking, yellow lines the inner planking, thin red lines the frames, and thick orange lines are the keel, rider keel and stern assembly. Purple lines are the shelf panels.

2.6.3.5 Video each element being removed

A video recording was made of each element as it was being removed from the wreck. Understanding how the element fitted in with the surrounding elements will be of great assistance in the re-assembly of the hull. The video recording, saved in MP4 format, commenced with the element as it was loosened for removal, and continued until it was clear of the wreck (Figure 2.77). A log sheet was kept separately which noted the video file number and which element was videoed.

Figure 2.77: Video recording, recorder standing to right of image.

2.6.3.6 Complete the recording of element in the registration compound.

Once the element was taken to the registration compound, it was examined in detail and the second page of the registration sheet was completed by a maritime archaeologist (Figure 2.80). The fields on this side of the sheet focused on the characteristics of the element itself. A written description of the elements accompanied by a sketch were required, with prompts to record dimensions, key features, presence of fasteners and ferrous.

C&L Site: 90 **SM2: Barangaroo Stn UDHB1 2018**	**Box #:** 61	**Element ID:** 341 **Element Type:** PLANK

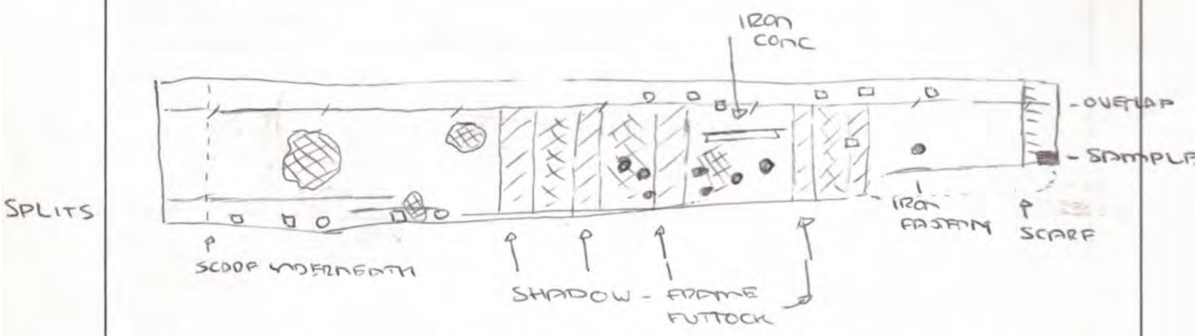
Description PORT STRAKE 4
PLANK UNDERNEATH 365, 391, 391 489
ABUTS PLANK 406 AT FOR END WITH SCARF JOINT

PLANK BETWEEN 2730 & 2740mm LONG AND
BETWEEN 112 & 185mm WIDE
OBVIOUS SCARF, BOTH ENDS
SMALL SPLIT FORE END.
OVERLAP 24-30 mm

Length mm	Sided Depth mm	Moulded Depth mm
min: 2730 max: 2740	min: 112 max: 185	min: 12 max: 20

Photo Nos. 6887 - 6932 **Camera No.** 2

Sketch (not to scale):



Side Shown: INNER = TAR / PITCH ; = SHADOW ; = IRON CONC FASTENING ; = NAIL HOLES

Features:
OBVIOUS OVERLAP -
PLANK WITH SCARF AT BOTH ENDS
CONCENTRATION OF IRON CONCS MID WAY ALONG -
TO LOW DOWN TO BE CHAINPLATE

Condition (circle):	Type of fasteners (if present):
A (B) C D E F (Good) (Poor)	

Softness (pin depth in mm):	Surface moisture (%)	Iron (if present), condition and description:
0-2 2-5 5-10 >10		SQ IRON FASTENINGS ROUND IRON FASTENINGS - CONC

Recorded by: KIERAN HOSTY **Date:** 27 NOV 2018

2

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Figure 2.78: Example of second page of registration form.

Condition information was also noted to aid with the packing, storage and conservation. It is important to note that the decision was made not to clean the elements of all sediment, so as to retain moisture and not to inadvertently damage the elements in a hot and busy environment. As such, some details on the elements may have been obscured at this stage. Condition recording for each element included:

1. Assessment to determine if warping was present (Yes/No);
2. Subjective assessment of condition on a 6-point scale (A to F) of good to poor;
3. Recording of softness as measured by pin depth in mm on a 4-point scale (0-2, 2-5, 5-10 & >10mm) as an indication of the degree of wood deterioration (Figure 2.79); and
4. Location of iron as detected by an earth magnet as an indicator of possible fasteners, contamination and consideration for future conservation (Figure 2.80).

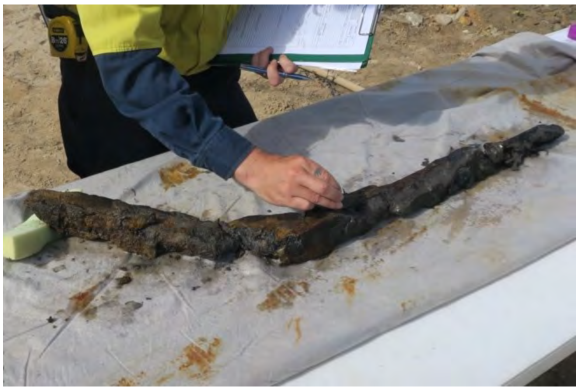

Figure 2.79: Assessing wood softness with pin.

Figure 2.80: Detecting iron with earth magnet.

Additional condition recording included a measurement of surface moisture (%) as displayed by a FX-2000 Delmhurst moisture meter (Figure 2.81). Measurements were taken on a sample selection of elements in the first week of removal to confirm to what extent the wood of the wreck was wet.

Figure 2.81: Surface moisture measurement station.

A decision was made at the commencement of the removal not to systematically obtain timber samples. There were two reasons for this. Firstly, it was not seen as desirable at this stage to cut into the timber to obtain suitable sample sizes, and secondly, this added step would slow the recovery process down. Alternatively, timber samples were taken on an opportunistic basis, where fragments of sufficient size would be detached manually from the timber. It was thought that this process would give a reasonable overall sample of the timbers used in the vessel, at least in the initial stages of analysis of the wreck. The repercussions of this approach were that some of the samples obtained were too small for a positive species identification to be made.

2.6.3.7 Detailed photography of element in the registration compound

After the recording at the registration compound was completed, the elements were photographed in detail. As noted previously, they were not cleaned of sediment prior to their packaging.

The element's ID tag was photographed, followed by shots of all faces (so if needed, some 3D modelling could be attempted) as well as any noteworthy features (Figure 2.82). The photo numbers were then added onto the registration form.

Initially, features such as fastening holes were highlighted by placing plastic arrows on the elements. However, windy conditions sometimes made it difficult to keep the arrows in place without resorting to intrusive fastening measures (Figure 2.83 and Figure 2.84).

Figure 2.82 : Detailed photography of an element from an oblique angle.

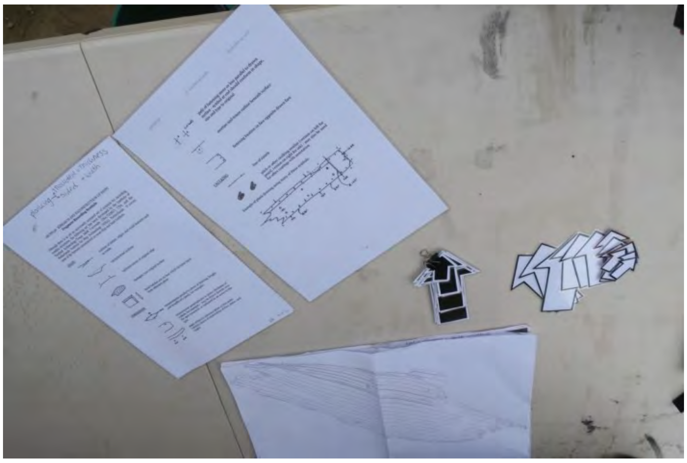

Figure 2.84 : Arrows and recording convention sheet.

Figure 2.83 : Arrows placed on plank fastening holes.

2.6.4 Removal – Disassembly and Lifting

2.6.4.1 Removal of the Frames

Removal, that is disassembly and lifting, of the remains of the boat commenced with removal of the frames on 16th November 2018. The last of the frames were removed on the 21st November 2018. The work platforms, used for previous works, were reinstalled to provide access to the interior.

Removal of the frames commenced close to the bow, with works generally progressing to the stern. The integrity of the bond between frames and planks (and other elements) was tested by gentle hand pressure. As a general rule for the frames, it was found that (iron) fasteners had corroded to such an extent that they no longer functioned and suction between the wet sediments was holding the components in place. No fasteners needed to be cut to remove the internal frames.

Some elements could be removed without any additional tools - components were freed by hand with a gentle side-by-side movement. Other frames were separated from the boat by breaking the tension using thin, flexible and long-bladed palette knives (artist's style) or similar tools to remove or cut through the mud. Thin, custom-made Teflon[36] wedges were then used along the length of the components to lever the component free, evenly and gently.

Preparations for lifting were made when the component was free. A solid board (6-12 mm plywood) of appropriate size was placed adjacent to the component. A piece of geotextile was wrapped around the board, which would be used in packaging to minimise handling risks in subsequent recording and packing. Where necessary, padding or support under the board was used to protect the wreck from sharp edges or pressure, or to match the alignment of the piece to be removed (Figure 2.85).

Figure 2.85: Padded alignment of support board.

Figure 2.86: Carrying frame to Registration.

When preparations were complete, the element was lifted. Frames were removed and lifted by 1 to 3-person teams depending on the size of the element. The frame was generally rotated 90 degrees when lifted to lay flat on the board (Figure 2.87). Once secure, the board would be passed out of the wreck and carried to the registration area for recording and packing (Figure 2.86).

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[36] Teflon wedges were made from approximately 10 mm thick Teflon sheeting.

a

b

c

d

e

f

g

h

Figure 2.87 (a-h): Removal of frame element.
(Source: Casey & Lowe).

2.6.4.2 Removal of the Planks

Once all the frames and internal components were removed, removal of the hull planking commenced on 21st November 2018. Their removal was complex due to the double layer of hull planking and the size and inherent fragility of the planks. The final plank of the outer layer of hull planking was removed on 6th December 2018.

The work platforms were removed before removal commenced on the vertical and angled planks on the starboard then the port side. This was followed by removal on both sides of the more horizontally-aligned planks until only the keel components remained *in situ*.

The integrity of the bond between planks (and other elements) was tested by gentle hand pressure. As a general rule the planks were connected with wrought iron nails and the occasional use of treenails. Iron fasteners were also detected in the scarf plates. As for the frames, the strongest force holding the elements together was tension between the components and the wet sediments. Due to the extensive corrosion of the metal fasteners, fasteners did not need to be cut to remove the planks. On three occasions, treenails were cut where elements could not be separated or lifted together safely. If components were securely joined (such as the scarf plates) the preferred approach was to leave them connected where possible.

Planks were separated from one another (and the sediment) by breaking the tension using thin, flexible and long-bladed palette knives (artist's style) or similar tools to cut through the mud (Figure 2.88a). Folded strips of Mylar were sometimes pushed into the join with the knife when the knife alone failed to break the tension. As with the frames thin, custom-made Teflon wedges were then used along the length of the components to lever the component free - evenly and gently (Figure 2.88b). Thin, plastic spatulas (the blade edge of which had been smoothed) were also used.

A

b

Figure 2.88 (a-b): Separating the planks.

The selected plank was loosened along the face where it overlapped the adjacent plank, and along the bottom edge abutting/overlapping the next plank, and at any scarf joints. The location of the scarf joint was not necessarily immediately apparent due to surface materials, mud and accreted sediments. Scarf plates generally indicated the location of a scarf joint on the interior surface. Separation at the scarf joint required precise and gentle movements to prevent marking the edges, and following the angle of the joint correctly.

Preparations for lifting were made prior to any separation of the component. The length of the plank was estimated and a pre-prepared support board was selected. Once the scarf joint had been located, if the dimensions were not as anticipated, an alternative support board was provided. Support boards consisted of 6-12 mm plywood of appropriate size wrapped in geotextile. As removal progressed, longer boards were required (up to 5 m). Lengths of plywood were butt jointed with a strap to create support boards of sufficient length. The geotextile was secured in place with rubber bands to create a smooth, flat panel. Unlike for the frames, this geotextile remained on the support boards and was not used in packing. Where possible, the support board would be placed directly underneath the plank *in* *situ* (Figure 2.90 to Figure 2.93). When this was not possible, it was placed as close as possible to the plank to be removed.

Figure 2.89: Separating the hull planks.

Figure 2.90: Removal of a plank.

Figure 2.91: Preparation for lifting.

Figure 2.92: Preparation for team lift.

Planks were removed and lifted by teams (Figure 2.93). For the removal of planks, a team of six people was usually required to support the element, however this varied based on the element being removed, and for each lift, the team size could range from 2 to 10 people. When preparations were complete, the plank was removed by slowly separating it from adjacent planks until clear of any fasteners or other elements. Separation occurred through synchronised movements by the lift team including gentle pulling, lifting, lowering and/or rotation along the length. The lead lifter would call the movements. For larger or more complex lifts a spotter would observe from the opposite side of the boat and relay observations to the lead lifter.

The plank was slid, lowered or lifted directly onto the waiting support board. The plank was padded on the support board as appropriate to account for any warping or curvature. Padding materials included rolled geotextile, Oasis foam, and polystyrene Tyvek cushions. At the same time, the newly exposed *in situ* timbers of the boat were also supported using the same materials and sandbags as appropriate.

Once all elements were secure, the excavated plank was carried away from the boat and transferred to the processing area. Excavation was often required prior to the removal of a plank to create access. Areas were excavated with trowels. Areas of deposit were left in place at regular intervals to support the plank *in situ* prior to removal. Additional or alternate supports included the use of sandbags, Oasis foam, polyurethane foam and polystyrene filled Tyvek cushions. Excavated deposit was assigned a context number, collected in

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b

c

d

e

f

g

h

Figure 2.93 (a-h): Removal of plank element. (Source: Casey & Lowe).

buckets and sieved. In localised areas, iron corrosion had formed over the timber elements, concreting them in place. Deconcretion with hammer and chisel was undertaken to the extent that the elements could be freed. For the planks, this typically only involved creating a break at the overlapping join sufficient to separate the pieces.

2.6.4.3 Removal of the bow, keel and stern

Removal of the keel and components of the bow and stern was undertaken using similar techniques and methods as used previously. Before all the strakes could be removed, components of the bow and stern had to be removed. Removal of the bow timbers commenced on 1st December 2018 and excavation of the entire hull was completed with the recovery of the last component of the keel on the 7th December 2018.

To understand the construction of the bow and stern, discrete trenches were excavated with sediment left in place on at least one face to support the structure. The aft and port side of the stern were excavated to reveal the vessel's aftermost construction and any remaining rudder components. Drainage channels were excavated to the south, to move water collecting at the stern, and improve access and visibility.

Recovery of the remaining stern assembly commenced with removal of the stern knee using the same techniques of separating and gentle levering. Removal of this timber allowed removal of the strakes to continue.

The bow of the boat was in worse condition overall, with significant loss of material and severe deterioration of remaining material. Excavation of the remnant stem at the port side exposed the deteriorated remains of this component of the wreck *in situ* (Figure 2.94). The timber of what appeared to be the stem and apron were in extremely poor condition, with almost no structural integrity remaining. Detailed recording was carried out *in situ* and the 'mud-like' consistency of the remnant timber was recovered to allow for the possibility of further recording and assessment. Other elements of the bow and construction details at the stem were visible after removal (Figure 2.95).

***Figure 2.94: Remains of the stem and apron* in situ.** (Source: Casey & Lowe).

Figure 2.95: Bow after removal of stem and apron. (Source: Casey & Lowe).

Removal of the stern continued in conjunction with recording and archaeological investigation (Figure 2.96 and Figure 2.97). The stern was heavily concreted compared to other parts of the wreck and thick iron-based concretions were removed from the keel and stern. The components detached easily, with no fasteners preventing removal, and were recorded and retained for further assessment and analysis, including radiography. These components could be what remains of (or provide evidence of) fittings such as the gudgeons and pintles, which form part of the rudder assembly.

Once the concretions in this area were removed, further disassembly of the stern area continued with removal of the sternpost and the shelf piece which supported the garboard strake of the outer hull. The removal of the outer garboard strakes of the keel followed. By 6th December 2018, only the keel and rider keel remained *in situ*.

***Figure 2.96: Remains of the sternpost* in situ.**

Figure 2.97: During removal of sternpost.

Due to the length and weight of the keel elements, the process of removal was altered. It was determined that it would be safer to crane lift the elements to the storage area rather than carrying the elements by hand to the packaging area and then to the store. Therefore, the packaging of the keel would be carried out directly after removal and adjacent to the wreck. Preparation for the removal of the keel involved the design and construction of custom crates, design of the packing methods and preparation of the materials, organisation of the crane lift, and the disassembly and removal of the keel. Intensive preparation and planning occurred during the week prior to removal to ensure works could progress smoothly, safely and efficiently.

The keel consisted of three main elements, i.e., keel and two sections of the rider keel, that were lifted separately. The keel lifted cleanly off the rider keel, and the ease of separation was due to the (unexpected) total corrosion of the iron fastenings. Due to the length and weight of the keel elements, the removal was undertaken by a larger team of people. Due to the size of the elements, practice lifts were carried out on-site to ensure that the project team was clear on their roles and tasks during the lift, and that the lifting team worked in co-ordination. The keel lift was undertaken by 17 people. Twelve people were placed evenly along the starboard side and took the majority of the load of the lift while five people along the port side assisted in the lift and guided the movement. The Lead Lifter called the entire removal process from a central viewing point with two additional spotters as support. In addition, 2 to 3 people recorded the process and 2 to 4 people were at hand to provide materials and supplies as required.

The keel was lifted from the rider keel and carried to a pre-prepared board placed alongside the wreck for packaging (see Section 2.6.5). The two rider keel elements were then lifted in the same manner as the keel (Figure 2.98 to Figure 2.100).

Figure 2.98: Removal of the keel.

Figure 2.99: Removal of the keel.

Figure 2.100: Removal of the last element. (Source: Casey & Lowe).

2.6.5 Packaging and on-site storage

After recording and photography, elements were packed for short-term cold storage prior to the commencement of pro-active conservation treatment. Packaging elements occurred on site between 16th November 2018 and 6th December 2018. If there was a backlog of elements, those excavated earliest were prioritised for packing.

Elements were sprayed with water prior to packing (Figure 2.101). As noted previously, elements were not cleaned prior to packing on the basis that conservation would commence in the short-term and that valuable information could be lost. Furthermore, the wet surface dirt and mud would reduce the rate of the wood drying in cold-storage.

An outline tracing was taken of elements considered at risk of distortion during conservation. Tracings were made on Mylar with permanent marker. Later, tracings were made on Cell-Aire foam when Mylar became unavailable. The tracings were packed with the elements (Figure 2.102).

Figure 2.101: Keeping elements wet. (Source: Casey & Lowe).

Figure 2.102: Example tracing of element. (Source: Casey & Lowe).

2.6.5.1 Wrapping

Each element was wrapped in wet Bidim K (a non-woven polyester geotextile) and polyethylene sheet (Figure 2.103). Plastic-spun bonded geotextile was selected due to its ability to hold water and because it would not biodegrade in storage or imprint the wood. It was noted that water would pool due to gravity and that the upper surfaces would be most likely to dry in the event of any storage issues, or delay in the next phase of conservation. Thick polyethylene sheet was used to limit/reduce water loss in cold storage. The edges were folded over to reduce the rate of water loss in storage through the plastic.

The wrapping was secured with nylon cable ties. Cable ties were extended by double or triple connections where required, and the head/s were carefully located to avoid imprinting on the element. An identification label (usually Tyvek and permanent marker) was secured on the outside via one of the cable ties.

Figure 2.103: Wrapping element in wet geotextile and polyethylene sheet. (Source: Casey & Lowe).

2.6.5.2 Securing and supporting

Possible warping and other distortions of the disassembled elements were of concern. To minimise the risk of damage due to any movement, disassembled elements were secured to plywood crates (either a box or board). This reduced the risk of distortion in storage, minimised handling of elements, made future transport easier and used storage space more efficiently (Figure 2.104). Each element was secured to the board or in the box with a series of brackets. 'Carinya Make-A-Bracket'[37] was used to prepare custom-made 'saddle' brackets that conformed to the shape of the element and secured it in place (Figure 2.105 to Figure 2.107). Once full, the board/box was placed in cold storage.

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[37] ***Galvanised steel pre-formed strips in various thicknesses, perforated to allow easier folding and shaping, while retaining strength and rigidity.***

Figure 2.104: Partially packed boards. (Source: Casey & Lowe).

Figure 2.105: Securing elements with 'saddle' brackets. (Source: Casey & Lowe).

Figure 2.106: Locally available brackets.[38]

Figure 2.107: Shaping a bracket. (Source: Casey & Lowe).

The brackets were shaped to fit the profile of each element at a specific point - selected prior to packing - with sufficient space for padding. The locations selected for the brackets were

[38] ***Carinya Make-a-Bracket https://www.bunnings.com.au/brands/c/carinya.***

based on the condition, shape and size of the element. Brackets were installed in the more robust areas and with sufficient quantity and positioning to protect any fragile areas.

Each bracket was padded with strips of polyurethane foam or polystyrene foam to protect the element from the edges of the bracket and distribute the force. For the more solid and stable frame elements that were less prone to distortion, the brackets were padded with polyurethane foam. For the more fragile planks at greater risk of distortion, the brackets were padded with polystyrene foam. Polystyrene was selected as it allowed the bracket to strongly clamp the plank in place, while protecting the surface of the wood.

The alignment of the elements in storage was also considered, and a determination was made based on risk of distortion and condition. Planks were packed and secured in place upright instead of flat to maintain the existing curvature (Figure 2.110). Unstable or fragile planks were packed and secured flat when upright storage was considered too risky (Figure 2.111). Ethafoam wedges and additional brackets were provided for planks with a significant curvature or lean, where the standard brackets may not have been sufficient.

Figure 2.108: Packaged plank. (Source: Casey & Lowe).

Figure 2.109: Locating plank in crate. (Source: Casey & Lowe).

Figure 2.110: Shaping and fitting plank bracket. (Source: Casey & Lowe).

Figure 2.111: Flat packed curved plank. (Source: Casey & Lowe).

Custom padding and supports were placed inside the packing material where required for particularly fragile or damaged elements. This included the use of Ethafoam[39] wedges or cut-outs, geotextile rolls or wads, Cell-Aire foam wrapping, cable ties, bamboo skewers and wooden splints (Figure 2.112 and Figure 2.113).

Preference was given to materials that would hold moisture against the surface of the wood and not be susceptible to biodeterioration in storage (such as hessian or cotton). Consideration was also given to the surface texture of the packing material and the risk of imprinting caused by dense or woven materials. Large and numerous splits were wrapped (bandaged) to maintain the correct shape with geotextile or Cell-Aire foam and secured with

[39] ***Closed cell polyethylene foam.***

cable ties. The heads of the ties were carefully located. Wooden or bamboo splints were incorporated above the bandage if additional structure was required. Geotextile wads or rolls were used when a softer filler of padding was required.

Figure 2.112: Shaped Ethafoam cut-outs to mimic edge. (Source: Casey & Lowe).

Figure 2.113: Bandaging split element. (Source: Casey & Lowe).

2.6.5.3 Crating and shelves

After packaging, elements were placed in crating – either on plywood boards or in plywood boxes - and placed in cold storage (see Section 2.6.6). Each board and box was given a unique crate number and the elements in each crate were recorded on a register.

Timber and plywood shelving was custom built in the refrigerated containers by the JV carpenters (Figure 2.114). Shelving was designed with different configurations at standard distances for either boards or boxes.

When designing the crating system for the disassembled boat, the following considerations were taken into account: the existing storage systems for material previously recovered; the availability and timeframes for supply of alternative systems; the storage capacity; space efficiency; handling considerations (processing and into storage); manual handling considerations; transit and transport; planned duration of storage and the potential for extended timeframes if conservation was delayed.

Plywood was used as the crating medium due to project constraints. The crates were heavy and required multiple people to handle and lift. Lighter and more inert alternatives are recommended if possible, due to manual handling risks and the risk of water damage in storage.

During Phase 5, smaller disassembled elements such as frames or other components were secured to plywood boards (Figure 2.115). Boards were used for easier handling and access and reduced manual handling risks. Handles were cut into the short end of each board. Larger or longer elements were packed in custom-built plywood boxes (Figure 2.116). Planks were packed upright in plywood boxes, nesting one another where there was a distinct curvature.

The crates and boards were secured to the plywood shelves with bolts, or wedged in place with bolted blocks in preparation for the containers to be transported to the conservation facility (Figure 2.117).

Figure 2.114: Custom-made shelving.
(Source: Casey & Lowe).

Figure 2.115: Crating on plywood board.
(Source: Casey & Lowe).

Figure 2.116: Crating in plywood box.
(Source: Casey & Lowe).

Figure 2.117: Crate secured for transport.
(Source: Casey & Lowe).

2.6.5.4 Packaging and crating the keel

The keel was packaged and crated adjacent to the location of the wreck between 7th December 2018 and 8th December 2018. This was to minimise handling risks associated with these large elements. Prior to the removal of the keel, storage boxes for the elements were designed and constructed by JV carpenters based on the dimensions of the elements as measured *in situ*. The crates were designed to be assembled around the keel elements to prevent additional handling or lifting after removal.

The crates consisted of a plywood base reinforced with timber bracing. The base was covered with polyurethane foam. This provided a supportive base for the warped and physically distorted elements. Immediately prior to the removal of each keel element, the base was delivered to the wreck site. Plastic sheet and geotextile was prepared prior, and cut in single units sufficient to wrap the length of each individual element. The geotextile was laid on the plastic sheet, folded and rolled up in preparation for packing.

Packing stations were prepared so packing could commence as soon as each element of the keel was removed. The keel was lifted and moved to the packing station. Prior to the lowering of the keel onto the base of the box, the keel was held in place by the lift team, and the wrapping material was unrolled on the base of the box. The keel was immediately placed down. Where there was a gap between the keel and the wrapping material (due to distortion) the area was padded with polyurethane foam offcuts. The geotextile and foam padding was saturated with water and the keel was wrapped in the same manner as the other elements (see above). The keel was wrapped temporarily to allow for the removal of all the keel elements to be completed (Figure 2.118). The removal and placing of the two rider keel elements followed the same process.

Figure 2.118: Temporary wrapping of the keel (right) with the rider keel* in situ *(left). (Source: Cosmos Archaeology).

Once all elements had been removed from the wreck site, packing of the keel elements could occur at this location. Each element was wrapped securely with an initial layer of wet geotextile and a waterproof polyethylene outer layer (Figure 2.119). The edges of the plastic film were placed on the upper surface and folded over double to reduce water loss. Custom brackets were shaped using wider 'Carinya Make-A-Bracket' to provide additional strength. The brackets were secured through the polyurethane base into the plywood base with large hex-head screws (Figure 2.120).

Once the element was safely padded, packed, and secured, the crate could be constructed. An open crate (or stillage) was designed and sides were installed into the base and secured by cross bracing at the top (Figure 2.119).

On 8th December 2018, the keel elements, secure in their crates, were lifted by crane and transported across the construction site and placed in the refrigerated containers (Figure 2.121). The rigging, lifting and transport of the keel was undertaken by JV with conservation and archaeology personnel present throughout.

Figure 2.119: Carpenters installing the sides to the crates (left), keel unwrapped for recording prior to packing for storage (right). (Source: Cosmos Archaeology).

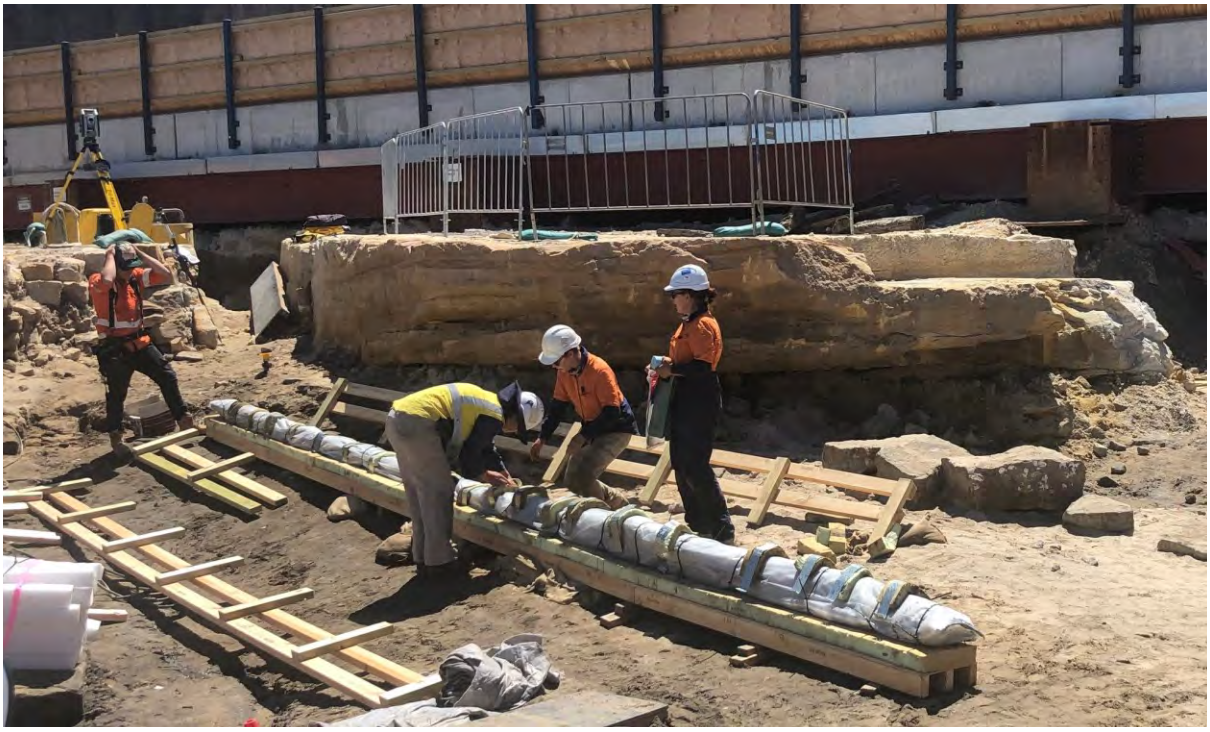

Figure 2.120: Securing the brackets in place, with the sides of the open crate (to the front and rear) prior to installation. (Source: Cosmos Archaeology).

Figure 2.121: Removal of the keel from the wreck site by crane. (Source: Cosmos Archaeology).

2.6.5.5 Handling

All processes in the disassembly of the boat required handling: removal, lifting, recording, packing and storage.

Due to the size and weight of the (packed) elements, the project involved significant manual handling risks. The use of wood to create custom boxes and carrying frames increased the mass of the loads being carried. Risks were reduced by increasing the number of people involved in lifting, and reducing the size of boxes and the number of items contained within. An alternative, more lightweight material would be preferable. Wood was selected due to the flexibility offered, availability to the project, and the ability to create custom handling aids immediately.

Support boards were used to handle elements once removed. Elements were carried from the boat to the processing area and moved around the processing area on these support boards.

When the processing area was relocated to another part of the construction site, new support trays were fabricated. The trays consisted of a rigid wood frame with ply cover and handle grips. The sturdier tray was necessary to support the removed elements when carried to the processing area, which was a greater distance away, and up a slope. The elements were secured (on their support board) to the support tray with ratchet straps.

An alternative to the support tray was plywood boxes with cut-out handles. The elements were placed (on their support board) into the box. Strips of geotextile were pre-installed in the box to be used as slings and handles to safely lift and remove the elements.

Handling in the processing area was managed on support boards. Handling was minimised by adjusting the work area layout to maximise efficiencies, and frequent adjustments were required as the project requirements changed during the process.

The packed boards and boxes were heavy and required large teams to handle them, impacting the project (Figure 2.122 to Figure 2.125). Recommended improvements included alternative materials, reduced load sizes, improved manual handling and team communication. Eliminating manual handling on the project was not considered feasible.

The crated keel components were oversized and handling was minimised by crane lifts to relocate the components to the storage area and place them into the storage container (Figure 2.126 and Figure 2.127).

Handling was a substantial and potentially underestimated component of the project with inherent safety risks.

Figure 2.122: Carrying element from boat to processing area. (Source: Casey & Lowe).

Figure 2.123: Carrying element from boat to processing area. (Source: Casey & Lowe).

Figure 2.124: Delivery to processing area. (Source: Casey & Lowe).

Figure 2.125: Delivery to processing area. (Source: Casey & Lowe).

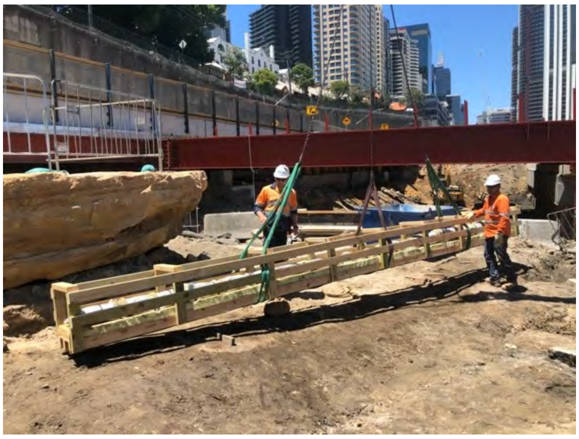

Figure 2.126: Crane lift of keel. (Source: Cosmos Archaeology).

Figure 2.127: Crane lift of keel. (Source: Cosmos Archaeology).

2.6.6 Storage and monitoring

Refrigerated intermodal (shipping) containers were provided by Sydney Metro and maintained by JV for the temporary cold storage of the elements. Shipping containers were selected as they provided flexible storage and the ability to increase storage capacity throughout the project with the supply of additional containers. Additionally, the modular and transportable nature of the containers negated the need to transfer the elements from one storage container to another, therefore reducing the risk of damage through excessive handling.

Cold storage was set at a temperature of 4°C and conditions were monitored by Registration. Monitoring of the cool storage conditions occurred throughout the project, with daily records of monitoring established in Phase 5 (disassembly) of the project, which occurred between 17th November 2018 and 16th December 2018. The records are summarised below (Table 3). Records were kept on paper in a sealed plastic sleeve on the exterior of the unit. Late in the project, the forms were water damaged by rain and replaced with laminated forms.

Power failures occurred on a number of occasions over the project due to issues with power supply via generators (generator failure or insufficient fuel). When operational again, a maximum temperature reading of 20°C was recorded. The actual maximum interior temperature is unknown. These temperature increases due to power failure increased the risk of biological growth and drying related damage. With power failures a known issue, requests for transport of the full containers to a more stable power supply and better storage conditions were made throughout the disassembly phase of works.

Table 3: Summary of storage monitoring records

Container ID	Date range	Temperature Range[40]	Issues
Unit #1	17 November 2018 to 16 December 2018	3.6°C – 6.4°C	Unit failure on 3 separate days. Thermostat display issues.
Unit #2	17 November 2018 to 16 December 2018	3.8°C – 20°C	Unit failure on 2 separate days. High temperatures.
Unit #3	19 November 2018 to 16 December 2018	2.7°C – 17°C	Unit failure on 3 separate days. High temperatures.
Unit #4	7 December 2018 to 16 December 2018	3.6°C – 10.1°C	None.

The interior of each container was fitted out for transport once full, with the works completed by the project team on 16th December 2018. Transport of the material secured onto the shelving systems in the containers reduced the need for additional handling. Transport of the elements in the containers was undertaken by Sydney Metro to a facility in western Sydney.

2.6.7 Photogrammetry

Photogrammetry during this disassembly phase took place after the frames were removed (Figure 2.128) and when only the keel remained (Figure 2.129). A total of 4,873 photographs, for photogrammetry and general recording, were taken over the duration of the

[40] Temperature range recorded in log based on unit thermostat display. No additional or independent temperature monitoring was undertaken.

dismantling of UDHB1. The generated models of the surveys noted above are presented in Volume 4.

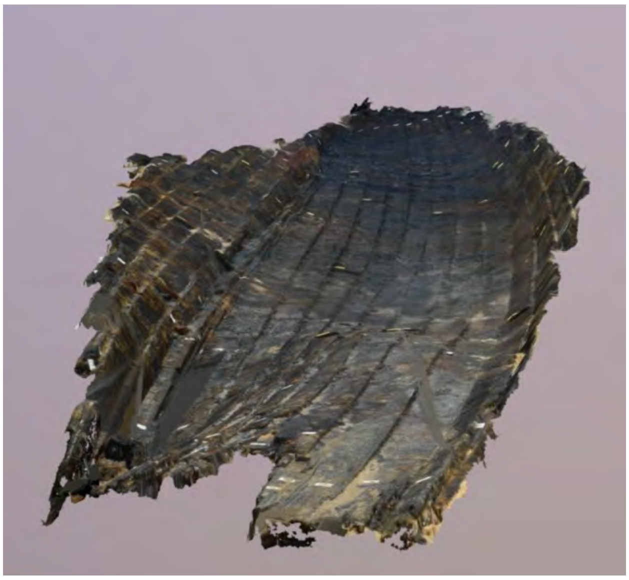

Figure 2.128: Wreck after frames were removed, 20th November 2018. (Rendered by Guy Hazell).

Figure 2.129: Wreck with only keel remaining, 5th December 2018. (Rendered by Guy Hazell).

2.7 Post Excavation Recording

Following the excavation of the wreck of UDHB1, the Sydney Metro Shipwreck Conservation Facility was set up in the Sydney suburb of Yennora. This would provide a purpose-specific location to undertake the work of recording and conserving the timbers. This part of the project was a collaboration between Sydney Metro and Silentworld Foundation (SWF), and also involved conservation experts from York Archaeological Trust and Ubi3D. The Australian National Maritime Museum (ANMM) also provided collaborative support.[41]

To achieve professional documentation and conservation of the boat's structural hull elements, the following process was undertaken.

Firstly, timbers were retrieved from cold storage and unwrapped in order to clean their surfaces. It was particularly important that any remaining sediment be removed to reduce the risk of bacteria and fungus causing further damage to the timbers. At this point, pitch from some of the planks, and a white substance which may have been used for anti-fouling was removed and set aside for further analysis. Detached oyster shells were also retained for research purposes.[42]

Once clean, the timbers were then documented using a relatively new 3D scanning process. Known as the Annotated Scans method for recording shipwreck timbers, this new technology allows for much faster recording, while still retaining a high level of accuracy, using a

[41] Silentworld Foundation 2021 Barangaroo Boat in Projects and Research, available at www.silentworldfoundation.org.au/projects/barangaroo-boat/ Accessed 7th September 2021.

[42] Berry, H. 2021 Cleaning the Barangaroo Boat, blog post available at www.silentworldfoundation.org.au/2021/01/21/cleaning-the-barangaroo-boat/ Accessed 7th September 2021.

Structured Light Scanner/Rhino combination.[43] The scanning process ensured that every feature on each timber could be annotated with a high level of precision, including fastening holes, saw marks and timber grain direction. CAD software was used to process the 3D digital models of the timber and detect features.

Once the recording process was complete, the timbers were then treated to remove any excess iron which may have been deposited within the timber by iron fasteners. Iron can be detrimental as it is often consumed by microbes which in turn produce damaging sulphur. The iron is mitigated by adding ethylenediaminetetraacetic acid (EDTA), which is a chelating agent.[44]

Finally, the timbers were soaked in increasing concentrations of polyethylene glycol (PEG) wax, which will maintain the current shape of the timbers, once they are no longer being conserved in water.[45]

Conservation work at the Yennora facility is ongoing, and the information presented in this section was the latest available at the time of writing this report.

Figure 2.130: White material, which may have been for anti-fouling, being removed from a plank during the cleaning process. (Source: Silentworld Foundation for Sydney Metro).

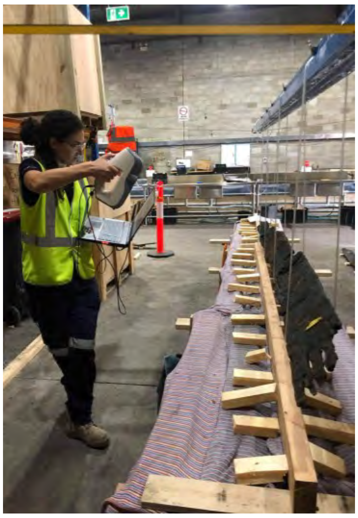

Figure 2.131: SWF Maritime Archaeologist Renee Malliaros scanning timber for 3D analysis. (Source: Silentworld Foundation for Sydney Metro).

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[43] Malliaros, R. 2021 Scanning the Barangaroo Boat, blog post available at www.silentworldfoundation.org.au/2021/08/27/scanning-the-barangaroo-boat/ Accessed 7th September 2021.

[44] Berry, H. 2021 Cleaning the Barangaroo Boat.

[45] Berry, H. 2021 Cleaning the Barangaroo Boat.

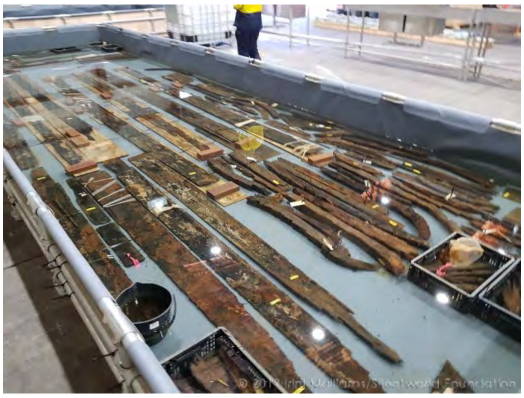

Figure 2.132: Timbers being conserved in water tank at Yennora facility. (Source: Silentworld Foundation for Sydney Metro).

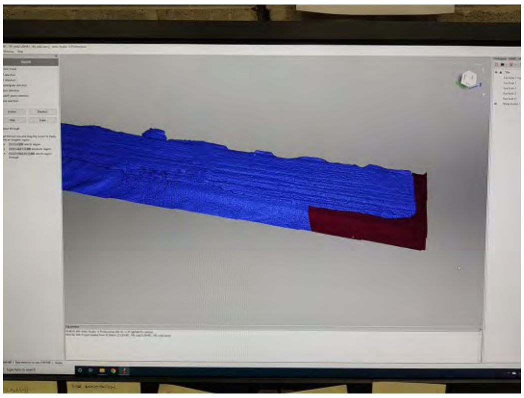

Figure 2.133: 3D model of a timber being processed in Artec Studio. (Source: Silentworld Foundation for Sydney Metro).

3 INTRA-SITE CONTEXT

The wreck of UDHB1 (context 140) was found at the foot of the historical location of Clyde Street (see Section 4.3.5.3 in Volume 1 Main Report). It was located in a former intertidal zone, between Langford's boatyard to its immediate east and the open water to the west (Figure 3.1 and Figure 3.2). William Langford's boatyard operated from around 1833 up until possibly the late 1870s/early 1880s, while John Cuthbert, who appears to have started his business further west along the shore of Darling Harbour as early as 1849, did not acquire the land adjacent to the wreck until the late 1850s.

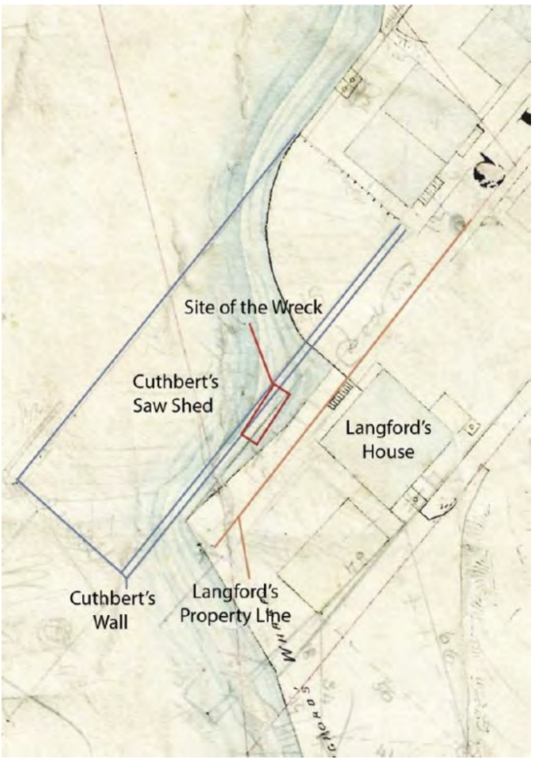

Figure 3.1: Detail of City Detail sheets (1855), Sheet 2, showing the site of the wreck relative to Langford's house and Wharf, and the alignment of Cuthbert's sawshed and wall.[46]

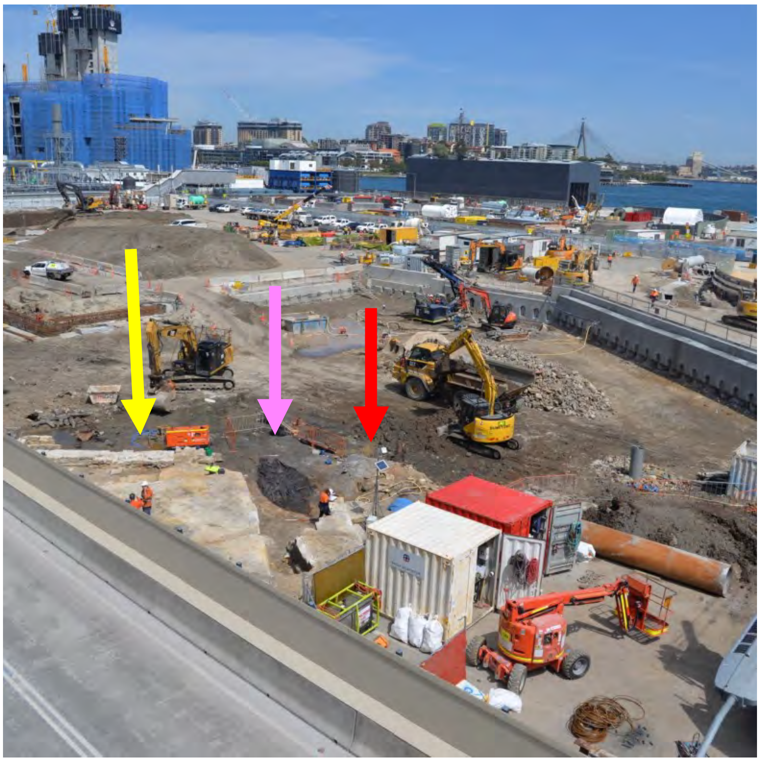

Figure 3.2: View of UDHB1 (pink arrow) looking to the south west. Hickson Road in foreground. Remains of Langford's house (yellow arrow) and location of Cuthbert's sawshed (red arrow). (Source: Casey & Lowe).

Orientated with its bow northwards towards the land, it was situated in the intertidal zone at what would have once been a small shelving sandy cove between rising sandstone outcrops. The remaining size measured 9.07 m in length and 2.63 m in width. Its lowest point, RL -0.11 m was at the turn of the bilge on the starboard side. Its stern was positioned less than a metre east of the western edge of a wharf wall (145) on Langford's property, and the wreck was angled slightly away from the wharf towards the north west. On its port side the footings of the eastern wall (127), which formed the pad for Cuthbert's sawshed, cut through the port bow of the wreck. This wall was constructed in the 1860s.

The vessel was resting on its starboard side with a cut sandstone block (no context assigned) underneath its portside keel (Figure 3.3 and Figure 3.4).[47] This block, with oyster shells on its underside, had been deliberately moved into position under the vessel to keep it in place. This indicates that the vessel did not sink at its moorings adjacent to Langford's western wharf wall (145) or drift into the small cove and beach itself. It is likely to have been

[46] Historical Atlas of Sydney, City of Sydney Archives and Casey & Lowe July 2020: Figure 11.
[47] Casey & Lowe July 2020: Figure 1.21.

deliberately brought to this location and beached, with the 'keel block' ensuring the vessel would be less likely to move with the tide and keeping it in a fixed heel to starboard.

The vessel was drawn up to a point where the gunnels at the bow would have been above water during most high tides. This assumption is based on the recording of the top of the keel at the bow having an RL of 0.57 m and with the top of the bow estimated at 1 m above the keel (see Section 5.2.5). Its stern may however have been submerged most of the time, as the lowest point at the end of the stern had an RL of 0.1 m. Mean high water (MHW) has increased in Sydney Harbour over the last 100 years, the MHW at Fort Denison in 1918 was 1.43 m AHD while in 2002 it was 1.49 m AHD.[48] Although it could be expected that MHW in the middle years of the 19th century would have been lower than 1.43 m AHD, it would be a reasonable assumption that the interior of the wreck would have been awash up to the bow even at most high tides.

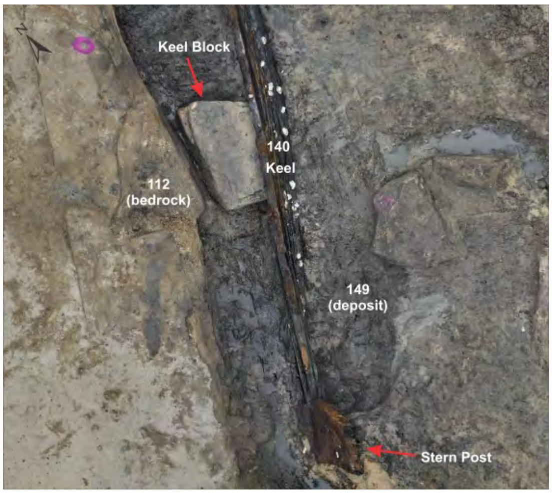

Figure 3.3: Detail of photogrammetry of the stern with the keel remaining. The keel block which kept the vessel in place is *in situ*. Note the oyster shell on the keel indicating how this part of the wreck was almost always immersed. (Photogrammetry by Guy Hazell).

Figure 3.4: View to the west of keel block after keel has been removed. The keel block has been moved to reveal the underside of the block. The oysters present indicate the block was moved into this position and in its new location oysters did not grow on the exposed surface. Perhaps the top of the block was often out of the water. Scale in 100 mm increments.

The earliest definite depiction of the western wall (context 145) of Langford's wharf dates to an 1855 plan of the area (Figure 3.5). A plan from around 1833 however, which clearly shows Langford's house (107), also shows a rectangular projection which does not appear to align squarely with Langford's western property boundary, as is the case with the western wall (145) of the wharf in the 1855 plan (Figure 3.6 and Figure 3.7). This projection may be an annotation on the base map indicating a later addition but a drawing dated to 1835 shows that this projection seems to be present (Figure 3.8).[49] It is unclear whether what is depicted is a timber structure or reclamation.

[48] Clerke, A. October 2004 Determination of Mean High-Water Mark within New South Wales. Dissertation submitted to the Faculty of Engineering and Surveying, University of Southern Queensland: pg 23, Figure 7.

[49] Robert Russell, March 1835. Image H38124, State Library of Victoria. In Volume 1

Figure 3.5: 1855 plan showing Langford's wharf and small beach to the north. [50]

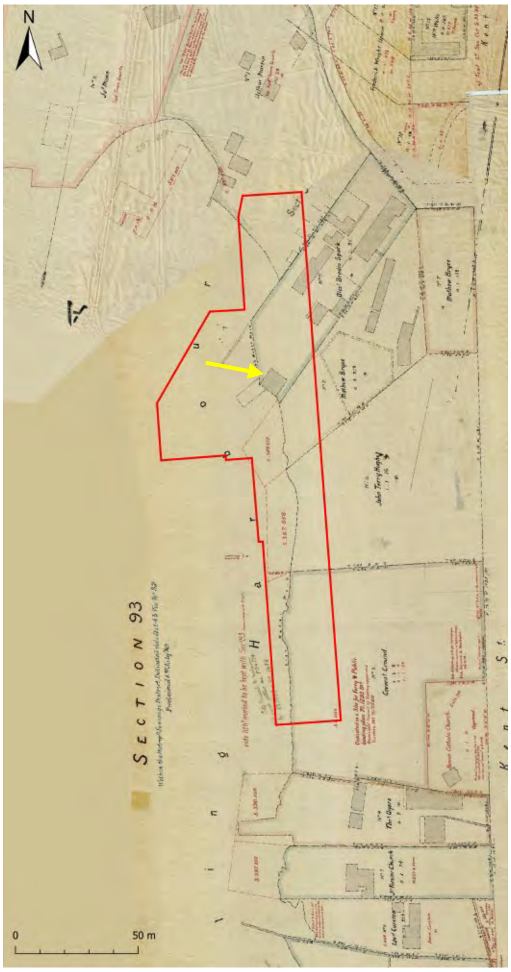

Figure 3.6: Detail of ca. 1833 plan showing Langford's house (yellow arrow) and what appears to be the commencement of reclamation in front of the building. Annotation by Casey & Lowe. [51]

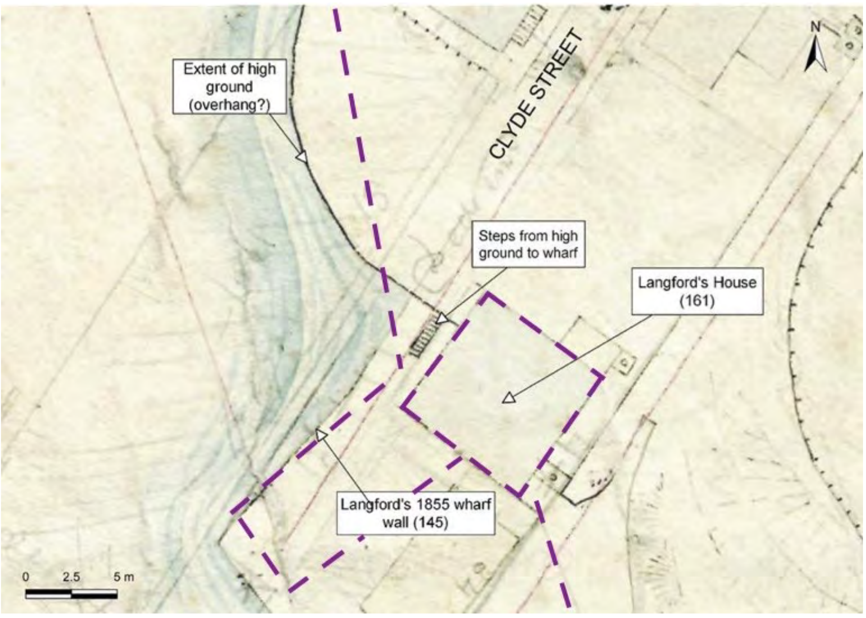

Figure 3.7: 1833 plan (Figure 3.6) overlayed onto the 1855 plan (Figure 3.5). Shows projection in front of Langford’s House in the ca. 1833 plan in similar alignment to the wharf which had been completed by 1855.

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[50] City of Sydney. City of Sydney – Detail Plan, 1855: Sheet 2 (01/01/1855), [A-00880164]. City of Sydney Archives, accessed 18 June 2020, https://archives.cityofsydney.nsw.gov.au/nodes/view/1709091. In Casey & Lowe July 2020: Figure 1.21

[51] City of Sydney. Detail of Sections 92 and 93, c1833, City of Sydney Survey Plans, Historical Atlas of Sydney, City of Sydney Archives. In Casey & Lowe, December 2017: Figure 3.23.

Figure 3.8: View to the south along the eastern foreshore of Darling Harbour ca. 1835 with the Langford house highlighted in orange.

The 1855 plan shows that there is solid line along the shore indicating that Clyde Street may have ended on the edge of a rock cliff or shelf. The depiction of steps leading down to Langford’s House (107) supports this assumption. The excavation showed that Langford’s House was partially built on a sandstone overhang (112) that was at least 1.5 m high above the former beach and partially on the foreshore sediments (134).

An 1865 plan shows the area around the wreck by that time had been substantially altered. The western wall (145) of Langford’s wharf, as it appeared in the 1833 and 1855 plans was realigned with the orientation of Clyde Street (Figure 3.9). On the western side of the wreck, the eastern wall (127) of Cuthbert’s sawshed had been constructed, which resulted in the cutting away of the port bow (see Figure 3.1).

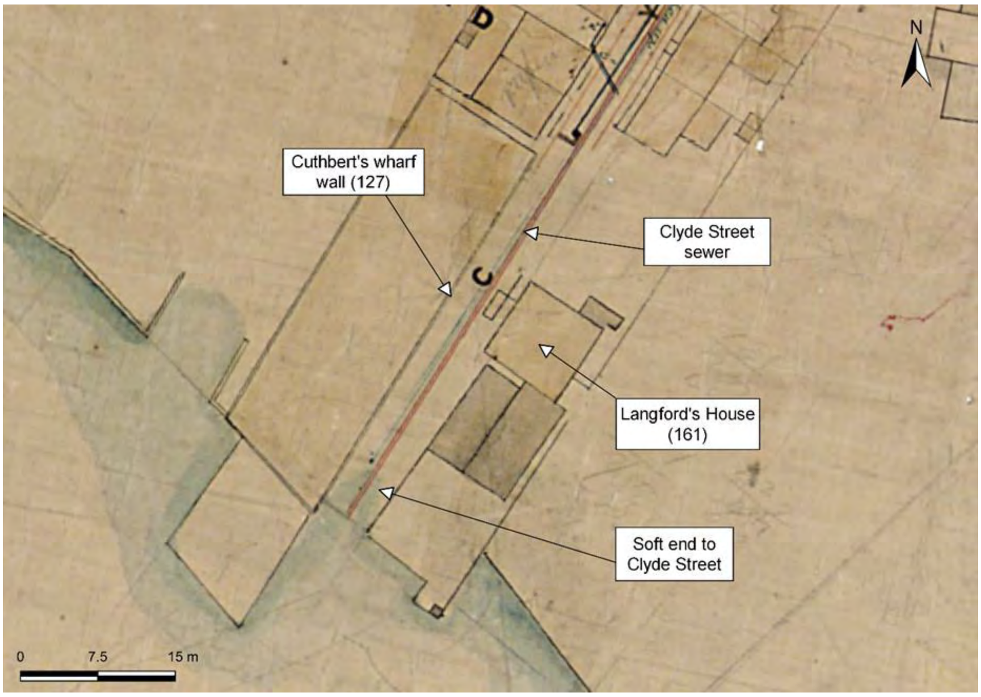

Figure 3.9: Detail of the 1865 Trig Survey showing changes to the properties and beachfront at the foot of Clyde Street. [52]

It was likely that between 1855 and 1865, the sandstone ledge/low cliff/overhang (112) at the base of Clyde Street was cut away, presumably to give easier access to the water. A large, deep linear cut (111) into the sandstone bedrock along Clyde Street was probably a drain or sewer shown in the 1865 plan. This drain/sewer line ran over the top of the wreck.

The wreck (140) was covered by sandy intertidal deposits (132 and 133) of around 100 mm to 200 mm thick. These sands ranged in colour from oxidised yellow-orange towards the high-water mark to the north and light-mid grey towards the south where they would have been submerged most of the time. The sediments closest to shore contained considerable corrosion products which had originated from large ferrous boiler pipes that had cut into the fills above.

These sandy deposits abutted the western wall of Langford's wharf (context 145) and the eastern wall (127) of Cuthbert's wharf – dating to around 1860 - was built upon them. This indicates that by the 1860s the wreck was mostly, if not completely, buried (Figure 3.10)[53]. An analysis of the diagnostic ceramic and glass fragments found in context 132 suggests a date range for the deposit of 1830 to 1860, while those found in context 133 provided a temporal range of 1850 to 1870.[54] The artefact evidence from the contexts support the timeline based on archival maps. Supporting this date estimate is the absence in samples from context 133 of pollen of wind – pollinated conifers, such as pine (Pinus sp.) from the Northern Hemisphere.[55] Pollen from these exotic trees first appear in the fossil pollen record in the Sydney CBD in the mid-1800s, which suggests that contexts 132 and 133 had been formed by the 1850s.

[52] City of Sydney. Historical Atlas of Sydney, City of Sydney Archives. In Casey & Lowe, July 2020: Figure 1.5.

[53] Casey & Lowe, July 2020: Figure 1.9.

[54] See Ceramic and Glass artefact reports, in Volume 3

[55] Macphail, M. September 2020 The Barangaroo Boat (UDHB1) – what does the pollen evidence tell us?

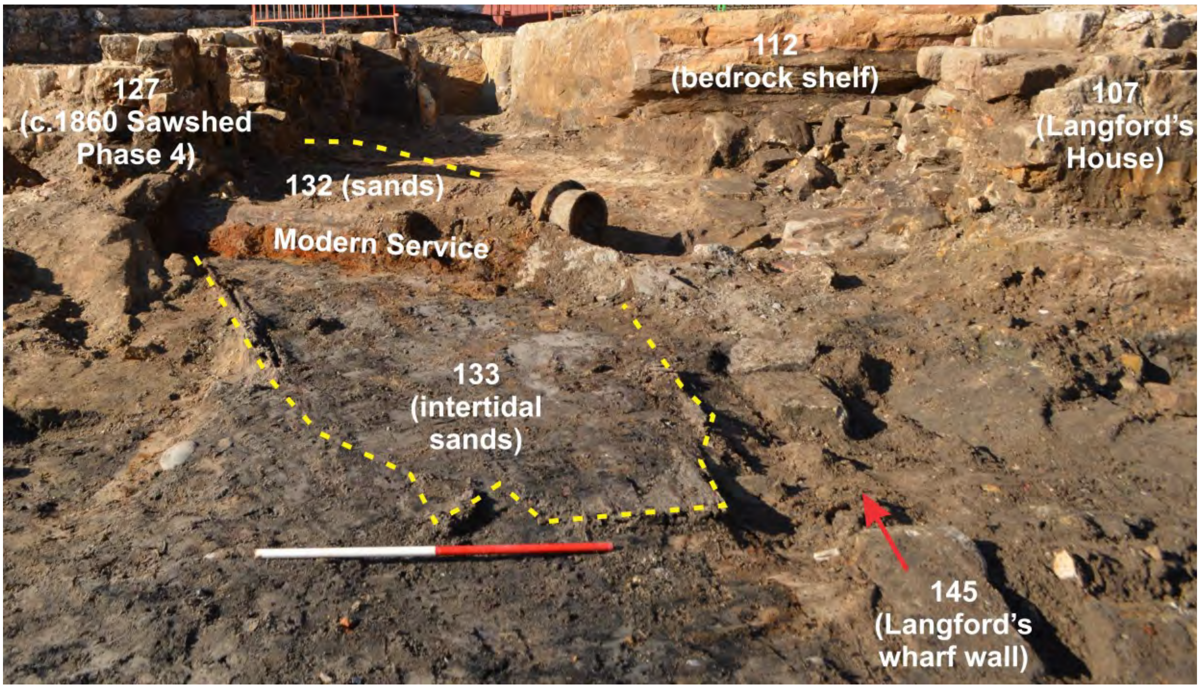

Figure 3.10: View to the north of the UDHB1 (marked by dashed yellow line) prior to its excavation with the eastern wall of Cuthbert's ca. 1860 sawshed (127) partially overlaying the bow. A modern service cut through context 127 and across UDHB1 but did not appear to have caused extensive damage. Langford's wharf (145) is to the east. Scale is in 500 mm increments. (Source: Casey & Lowe).

The coarseness of the sediments suggests a relatively high energy environment where water velocity was sufficient to mobilise coarse grained sediments. Such conditions would have arisen when the sandstone ledge/low cliff/overhang (context 112) at the base of Clyde Street was cut down, thereby allowing sediments and other detritus flow down the street into the harbour in heavy rain events. Such episodes in contexts 132 and 133 can be identified in Figure 3.11 and Figure 3.12 which show micro-layers or laminations of sediments. Run-off was so significant in Darling Harbour around this time that 'shoaling' was becoming an issue, where the seabed along the foreshore was becoming shallower by a rate of around 1 m per year.[56]

[56] ***Macphail, M. September 2020.***

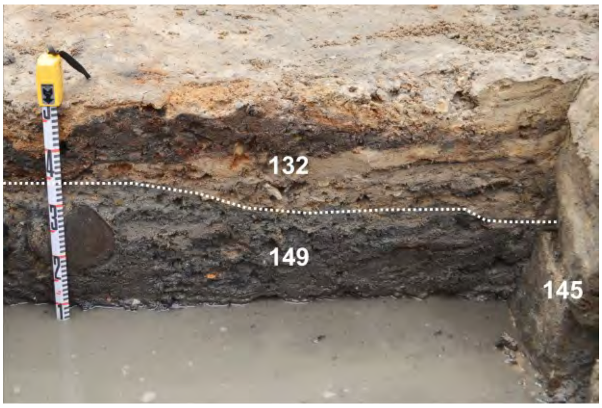

Figure 3.11: South facing section of test trench 6 showing context 132 overlaying context 149, both of which were built up against the western wall of Langford's wharf (context 145). [57] (Source: Casey & Lowe).

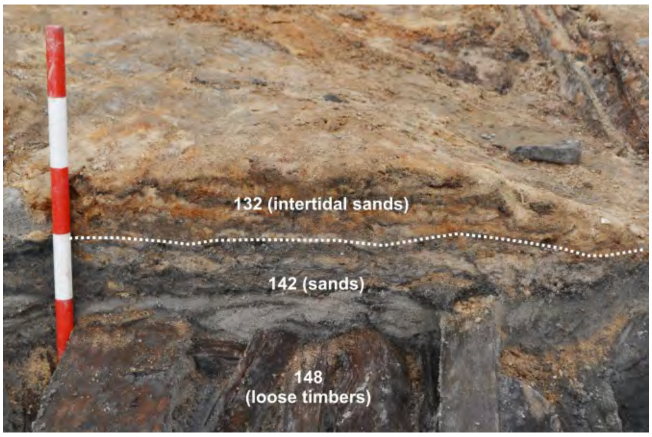

Figure 3.12: South facing section of deposits overlaying UDHB1 at midships. [58] Alternating strata of estuarine sand and siltier organic material comprises context 132. The grey sediments below are context 142. Scale is in 100 mm increments. (Source: Casey & Lowe).

The immediate area where the wreck was found would have been, prior to 1865 when the and sandstone ledge/low cliff/overhang (112) was removed to allow Clyde Street to run straight into the water, a *cul-de-sac* of sorts. There would have been no easy access from the water onto Clyde Street and the possible continuation of the overhang observed at Langford's House (107) would have contained dead space which could not be utilised for much else other than shelter and storage. This would have been a perfect place to leave objects that would not impede traffic or neighbouring allotments. Although effectively public land, it could be easily seen that nearby landowners could have informally utilised this area without inconveniencing others. The orientation of Langford's pre-1865 western wharf wall suggests that William Langford may have had a similar opinion of the intertidal area at the foot of Clyde Street.

Conversely, with the removal of the sandstone ledge/low cliff/overhang to allow for more effective drainage and the connection of Clyde Street to the intertidal shoreline, the leaving of a vessel at the foot of the street would not have been an acceptable situation in the long term and it would have been broken up and removed/scavenged relatively quickly. The sensitivity to Langford's encroachment into public space can be seen in his re-orientation of the western wall of his wharf between 1855 and 1865 to conform with his property boundary.

UDHB1 was already mostly buried by the time Cuthbert's eastern wharf wall (127) was built in the early 1860s. It was also very unlikely that UDHB1 was brought ashore and fixed in place with a 'keel block' after the sandstone ledge/low cliff/overhang had been removed, allowing easier access from Clyde Street to the water's edge.

Underlaying the sandy matrix of contexts 132 and 133 were silty anerobic marine sediments – contexts 141, 142 and 144 within the remains of the hull of the vessel and context 149 which lay between the starboard hull side of the wreck and the western wall of Langford's wharf (145). These deposits were characterised by grey to black anaerobic sands with lenses of silty material.

Context 149 was composed of a 300 mm thick deposit of medium grained sand with the frequency of fine particle clay increasing with depth. It contained a relatively high density of artefacts but there was no apparent evidence that suggested re-sorting of the deposits despite a preponderance of heavier objects towards the base of the deposit. This matrix

[57] Casey & Lowe, July 2020: Figure 1.11.
[58] Casey & Lowe, July 2020: Figure 1.13.

would have formed after the wall was built. The anaerobic nature of the deposit provided excellent conditions for the preservation of organic materials such as bone, rope, coconut and leather.

Context 142 extended across the interior of the wreck. Similar to context 149, it was composed largely of pale grey sand (Figure 3.13). Context 141 was a thin, 10 mm, patchy lens of fine clay and organic material including timber splinters. It overlayed context 142 and was observed mostly in the higher parts of the wreck, and did not appear to have been a marine deposit. Contexts 141, 142 and 144 contained relatively less artefacts and finer sediments than context 149.

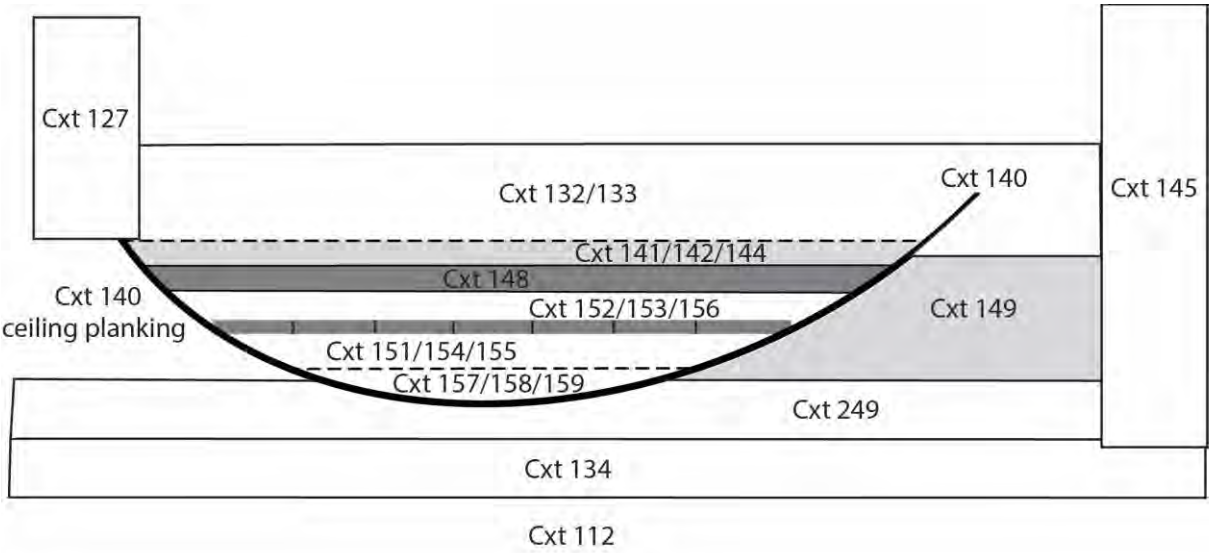

Figure 3.13: Schematic context matrix within and adjacent to UDHB1, looking north east towards bow.

The build-up of marine sediments (149) between the western wall of Langford's wharf and within the wreck (141, 142 and 144 – see Figure 3.12) very likely occurred when both features were in place. The anaerobic and siltier nature of these deposits could indicate that they formed when water movement was relatively low, constrained as it would be within the interior of the hull for context 141, 142 and 144 and the confined space between the wreck and the western wall of Langford's wharf (145). They would also pre-date the modification of the sandstone ledge/low cliff/overhang (112) as this action may have resulted in the wreck being subjected to intermittent, relatively higher velocity water flows which created the overlaying sediments of context 132 and 133.

As it would appear that Langford's wharf was in the process of being constructed as early as 1833, it is an obvious connection to make that UDHB1 had some association with Langford's operation. The shoreline next to his wharf, though public land, was until sometime between 1855 and 1865 underutilised and a perfect location to lay up a vessel for an indeterminate period of time. While the initial reason for this action is not known, the installation of a keel block suggests that it was expected that the vessel was to remain at that location for some period of time. Perhaps there were plans to make some repairs or re-pitch the vessel, however its positioning within the intertidal zone more likely indicates an acceptance that it would not be re-floated. It seems probable that it was beached at this location with the intention to salvage and re-use components of the vessel. It also became a receptacle for off-cuts and other timbers, presumably from the boatyard, as will be discussed below.

The beaching of UDHB1 most likely took place after Langford's boatyard business was established in 1833. As the vessel gradually became filled with marine sediments (141, 142, 144, 152, 153 and 156) before being overtopped by coarser sands (132), a date closer to 1833 would seem more likely. It would also seem more likely that the vessel was deliberately placed close to the western wall of Langford's wharf to allow easy access to the interior from the wharf. If this is what happened, then orientation of the wreck in relation to the wharf wall is unusual as the bow is angled slightly away from the wharf (Figure 3.14 and Figure 3.15). If the vessel was placed in this location by Langford to be salvaged, it would have been expected that the entire hull would have been drawn alongside the wharf. This raises the possibility that the vessel may have been beached during or just prior to the construction of Langford's wharf.

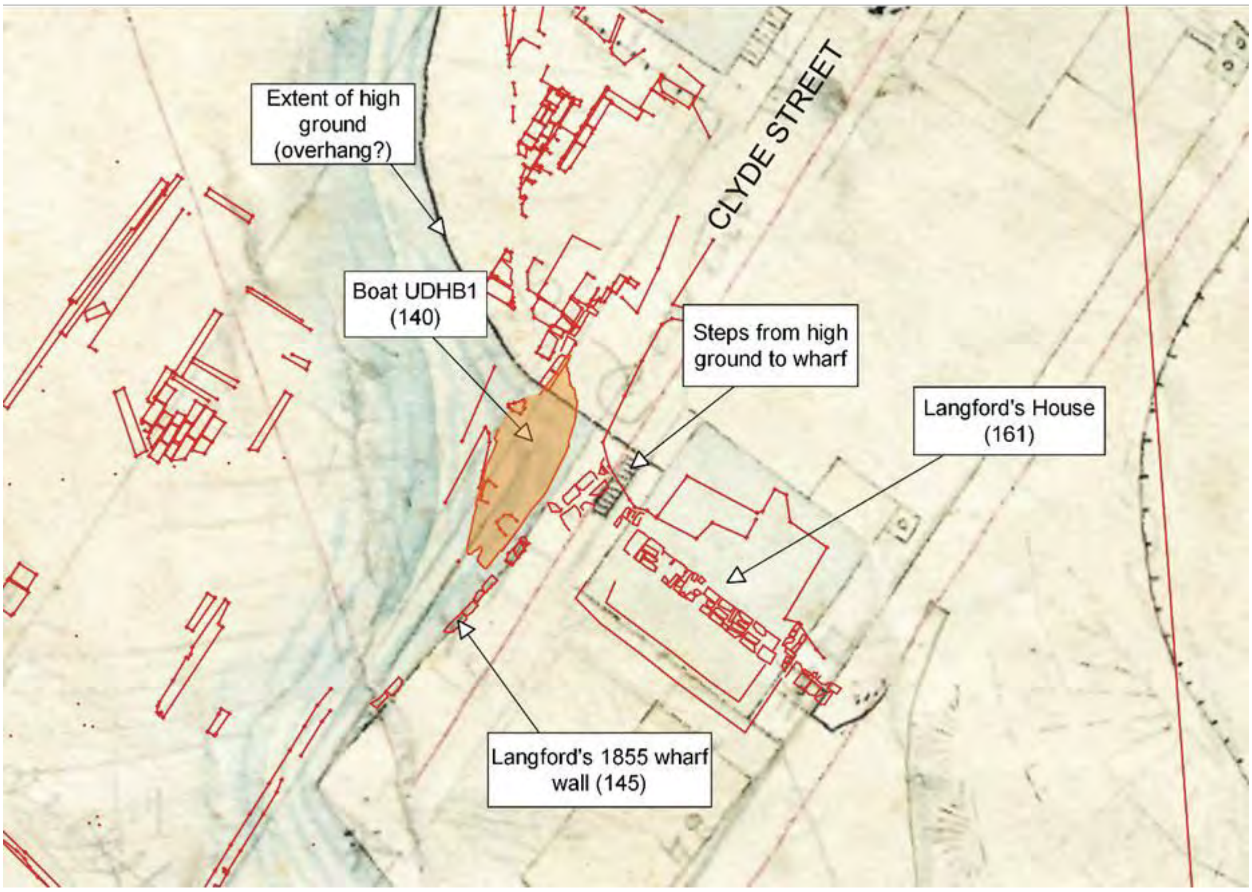

Figure 3.14: Overlay of the site survey (red) onto the 1855 City Detail Sheets (Sheet 2). Historical Atlas of Sydney, City of Sydney Archives.[59]

[59] ***Casey & Lowe, July 2020: Figure 1.8 and 1.11.***

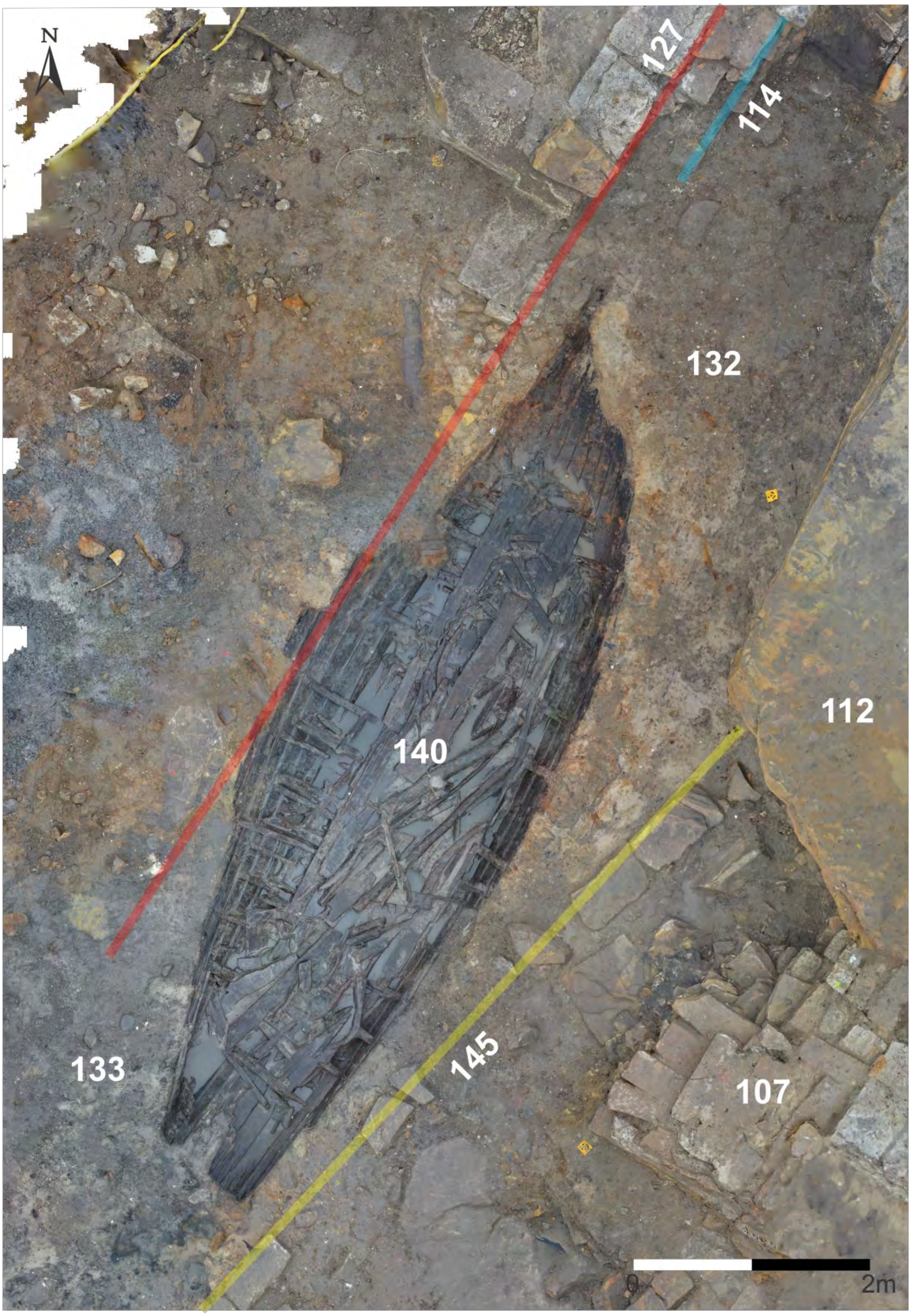

Figure 3.15: Photogrammetry during the excavation of UDHB1 showing location of vessel in relation to Langford's house (107) and wharf (145 yellow line) along with features since removed; the eastern wall of Cuthbert's sawshed (127 red line) and the western curb of Clyde Street (114). The loose timbers within the wreck are context 148 and the wreck itself is context 140.

Cultural evidence found within context 149 (outside the wreck) and contexts 141, 142 and 144 (inside the wreck) provides some insights into how long the wreck may have been at this location before it was buried by sediments (132 and 133) sometime in the early 1860s.

In context 149, the diagnostic ceramics (n=194) provide a broad date range of between 1800 and 1890.[60] With regards to the glass approximately 73 % (n=35) of the recovered glass fragments provide temporal information. About half of the objects have a calculated 1780-1830 date range while the other half have a date range of 1820-1870s. Apart from two further bottles with wide ranging dates of 1800-1900, no glass artefacts from this context post-date 1870. This equates well with the assumption that the vessel was abandoned sometime after 1833, context 149 having formed from around that time until the early 1860s when it was covered by contexts 132 and 133. The diagnostic glass and ceramics from these contexts ranged from 1830 to 1870, which brackets the period when it is thought the vessel was finally buried.

Diagnostic evidence from the contexts inside the wreck provide some indication as when the vessel was abandoned. The upper deposits within the boat, contexts 141, 142 and 144, contained diagnostic artefacts (glass and ceramics) which ranged in date from 1788 to 1880.[61] These contexts overlay and encased a collection of timbers (148) which had accumulated within the hull. Loose timbers have been used as packing material, also referred to as 'dunnage', to protect cargoes but the size and arrangement of the loose timbers make this unlikely. Some of the timbers, such as branches, seem to have floated in with the tide but the majority are offcuts or discards from a boatyard (Figure 3.16). These timbers are discussed in detail in Volume 3, Section 11. As it relates to this discussion, the presence of the timbers, highly likely to be associated with the activities in Langford's boatyard, shows that the interior of the wreck had not silted up appreciably before it was used by Langford as a skip for discards. There was a relatively thin, 10 mm to 15 mm deposit of dark grey sticky clay (153 [bow], 152 [midships] and 156 [stern]) between the loose timbers (148) and the vessel's remnant ceiling planking. This fine-grained matrix may have formed through the filtering of sediments above the loose timbers, indicating that it formed during and after the accumulation of the loose timbers. This in turn means that the vessel was unlikely to have been abandoned at this location before the establishment of the boatyard in around 1833. The diagnostic glass and ceramic artefacts from these contexts date from 1820 to 1870, which supports a post 1830s abandonment.[62]

Further indications as to when the vessel was discarded come from the 100 mm to 200 mm thick sediment deposits (151, 154, 155, 157, 158, 159) excavated from within the bilges, i.e., the cavities in between the frames in the bottom of the hold where bilge water tends to collect, and the space between the ceiling and the hull planking. Such cavities can contain evidence that could provide insights into the cargoes carried, the personal possessions of the crew, and also when the vessel stopped sailing. The latter point is made on the understanding that the bilges was kept relatively clean of obstructions such as thick sediment deposits while the vessel operated, with such deposits forming during abandonment. A bilge excessively blocked or filled during the life of a vessel would have been cleaned out if it was properly maintained.

Because of the potential importance of the bilges' context, intact (formed at time of abandonment) deposits were isolated that could be from any contamination arising from artefacts percolating into the cavities as the wreck broke down. Such contamination could have entered into the cavities from exposed gaps at the extremities of the wreck (Figure 3.17). For this purpose, contexts were assigned for the bilge deposit above the turn of the bilge on the starboard side and under three ceiling planks closest to the keel (151, 154 and 155). The reason for the three contexts was to enable the potential capture of spatial organisation within the vessel, i.e., the bow and stern being where crew normally occupied,

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[60] See Ceramic and Glass artefact reports, in Volume 3

[61] See Ceramic and Glass artefact reports, in Volume 3

[62] See Ceramic and Glass artefact reports, in Volume 3

and midships being the cargo carrying space on a vessel of this type (Figure 3.18). Contexts 157, 158 and 159 delineated not only the bow, midships and stern zones of the vessel but also the lowest point of the starboard side of the wreck, the turn of the bilge.

Figure 3.16: Loose timbers (148) within the wreck (140) were a mix of flotsam that came in with the tide, offcuts of frames, planks and rigging from presumably Langford's boatyard. (Source: Casey & Lowe).

Figure 3.17: Ceiling planking sealing deposits in the bilges can provide information on the voyages of the vessel and when it was abandoned. [63] (Source: Casey & Lowe).

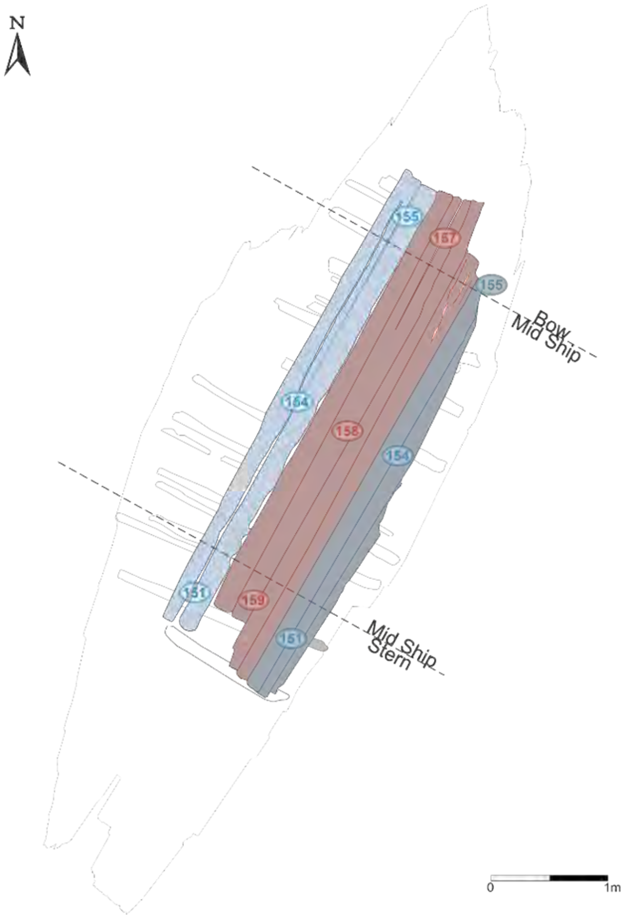

Figure 3.18: Simplified plan of UDHB1 highlighting the ceiling planks and the possible cavities beneath. [64] The planks highlighted blue represented those areas that likely had contaminated or disturbed deposits underneath. The planks highlighted red represent the zone considered to have intact deposits beneath. Context numbers were allocated to three different zones in the wreck and both potentially intact and disturbed deposits within each zone.

[63] Casey & Lowe, July 2020: Figure 1.18.
[64] Casey & Lowe, July 2020: Figure 1.17.

Within 'contaminated' contexts of the bilge – 151, 154 and 155 – the dateable artefacts such as glass and ceramic gave an expected date range from 1830 to 1860 while a hand forged nail gave a broader date from 1788 to 1890. [65] While for the more 'secure' contexts – 157, 158 and 159 – diagnostic artefacts that could be used for dating were few. Nine ceramic fragments were recovered from 158 and 159 whose manufacture postdated 1800 and 1830 respectively. [66] The outsole of a turned leather shoe predated ca. 1860.[67] In 157, at the bow, a brass pin with a spherical wound wire head dating it to around 1880 was recovered. [68] Such a small object however could have easily have filtered into this context through the overlaying deposits.

Pollen samples from three contexts, i.e., 154, 158 and 159, include cereal.[69] The potential sources of this pollen could be from the nearby Dickson's Mill established in 1815, where pollen would have been blown over a wide area, waste discarded into the harbour, human sewage or remnants of grain cargo.

The presence of the microfossil *Cloacasporites sydneyensis*, presumed to be the egg case of a gut parasite or insect using faeces as part of its breeding cycle, in the bilge samples strongly suggests high levels of human sewage in the water at the time the wreck was awash.[70] By the 1860s, sewerage and offal from slaughter houses polluted Darling Harbour and offered a smell that '*on a close morning [was] almost overpowering*'.[71] Such an environment is likely to have been developing in Darling Harbour from the 1830s. It is also possible that the wreck may have been used as a toilet, a facility that would have been less convenient or desirable when the vessel was afloat.

As noted above, the wreck had been dragged up into the intertidal zone which in this location was composed of undulating degraded sandstone bedrock (112) which gradually fell away from the shoreline. Sand (134 and 249) that had accumulated around and on top of the bedrock provided patchy coverage. Context 134, a sandy marine deposit, was recorded as being below Langford's wharf (145), the wreck and adjacent to Langford's House (107) while context 249 was recorded beneath the wreck. This matrix (249) comprised homogenous dark grey to black, medium grained sands consistent with beach sands with a sandstone substrate. These contexts were excavated and the diagnostic artefacts recovered (glass, ceramics, smoking pipes, shoes and buttons) were manufactured from between 1800 and the 1870s. [72] This does not conflict with the earliest deposition period of the vessel, that of the late1830s. It could be argued that context 249 was present around the time that the wreck was dragged ashore and context 149 which built up around the wreck was a continuation of the sediment accretion that was occurring in this area.

Based on the above discussion, it would appear that through an analysis of the historical sources in the form of maps coupled with the described stratigraphical relationships of the wreck with surrounding features, the vessel UDHB1 was most likely abandoned at this location in the late 1830s or early 1840s. It became progressively infilled with discarded timber from the adjacent Langford's boatyard as well as from tide, wind and wave derived sediments and detritus before becoming almost completely buried by sands and debris being washed down Clyde Street in the early 1860s. Diagnostic artefacts and pollen samples broadly support this interpretation.

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[65] See Ceramic, Glass and Metal artefact reports, in Volume 3

[66] See Ceramic artefact report, in Volume 3

[67] See Organic artefact report, in Volume 3

[68] See Miscellaneous artefact report, in Volume 3

[69] Macphail, M. September 2020, Volume 6.

[70] Macphail, M. September 2020, Volume 6.

[71] Hoskins, I 2009 Sydney Harbour – a History.

[72] See Ceramic, Glass, Organics and Metal artefact reports, in Volume 3

4 DESCRIPTION OF BOAT’S HULL REMAINS

4.1 Overview

This section describes the individual components of the boat’s construction, their relationship with each other and how they fit together. The section draws primarily on the field records — registration sheets, plans, photogrammetry, videos, notes and photos — taken prior to, and during, the recovery of UDHB1. The team conserving the wreck, Silentworld Foundation (SWF), in conjunction with the Australian National Maritime Museum (ANMM) have been scanning and cataloguing the timbers to yield further information on the wreck. The team from SWF and ANMM have also been generous with their time in discussing their observations of the timbers during the conservation process.

The overall keel components combined measure 8.268 m (27’ 1 $^{1}/_{2}$”) in length. The remains include more than half of the boat and comprises the bottom of the hull on both port and starboard sides. On the starboard the vessel is preserved up to its topside hull, while the port side only extends out 2.45 m (7$^{1}/_{2}$’) from its keel to the turn of the bilge (this is basically the maximum breadth of the vessel, where its bottom transitions to its side). The stern is complete up to the tuck with no transom timbers remaining. At the bow, less than 300 mm remains of the stem and there is little hull planking that extends forward of the preserved keel (Figure 4.1). A breakdown of the timber elements of UDHB1 is shown in Table 4.

The hull was double-planked and built using the shell-first construction method with lapstrake planking (also known as clinker-built). The planking was up to 230 mm (9”) in width and up to 19 mm ($^{3}/_{4}$”) in thickness and the two layers of hull planking were fastened together with double-clenched iron nails. These nails had square shafts that measured 6 mm by 6 mm ($^{1}/_{4}$”) in section. The frames that braced the hull were square in section and their moulded and sided dimensions measured approximately 75 – 100 mm (3” – 4”). These frames were fashioned using grown, or crooked timbers that were selected to suit the required angles and curves of the planked hull. The whole vessel was coated in pitch inside and out, the frames were lined internally with ceiling planks up to 200 mm (7”) in width by 6 mm ($^{1}/_{4}$”) in thickness. No other internal fit-out components such as thwarts or decking remained.

Table 4: Breakdown of timber elements that comprise the hull of UDHB1

Deadwood	1	Total 203
Frame	30	
Frame, cant	8	
Frame, cant half	2	
Frame, floor	19	
Keel	1	
Keel, rider	2	
Plank, ceiling	13	
Plank, garboard shelf	8	
Plank, inner	46	
Plank, outer	45	
Scarph strap	12	
Stem	1	
Stem knee	1	
Stemson	1	
Stern post	1	
Stern, component	1	
Wedge	11	

***Figure 4.1: UDHB1* in situ *plan and side elevation looking starboard*.** Side elevation cut through keel line shows the bulge from where the vessel rested on the sandstone chock and then slumped over, shifting frames and pulling planks out of the keel. (Source: Photogrammetry by Benjamin Wharton 2018).

The following section uses the following naming and numbering conventions:

The identification number of an element is written with the number inside square brackets - [#]. With the planking, the element number is followed by a code which places the plank within the wreck. The code is as follows:

- Element number
- Element from Starboard (S) or Port (P) side
- Element from Inner (I) or Outer (O) hull planking
- Strake number, counting from keel. Therefore, garboard strake is S1
- Where element along the strake – Fore (F), Midships (M) or Aft (A)

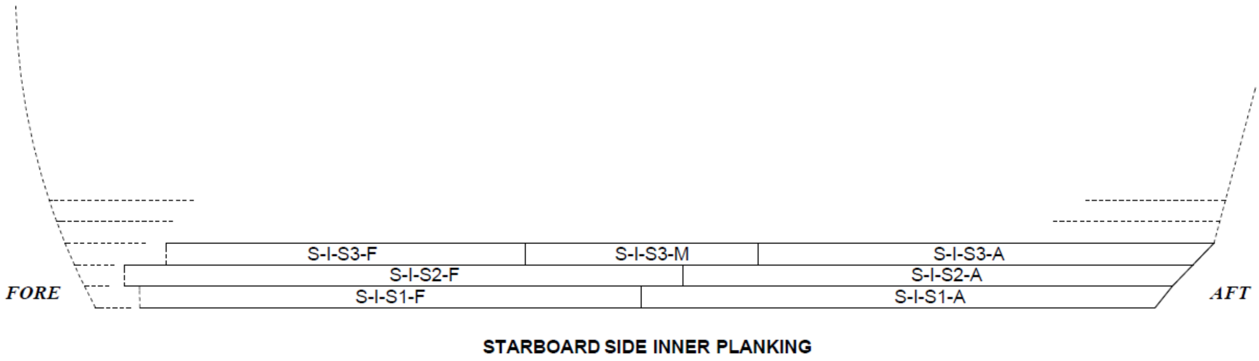


Figure 4.2: Example of planking identification.

Therefore [495 S-I-S2-F] = element 495 is on the starboard side, part of the inner planking, second strake and towards the bow.

With the frames the element number is followed by a code which places the frame within the wreck. The code is as follows:

- Element number
- Element whether Floor (FL), Futtock (FT), Cant (C) or After Cant (AC)
- Where element along the keel from stern to bow, arranged A,B,C… for primary Floors and 1,2,3,4… for secondary floors and futtocks.

Therefore, [495 S-I-S2-F] = element 495 is on the starboard side, part of the inner planking, second strake and towards the bow.

Therefore [433 FL-E] = element 433 which is a primary floor frame, the fifth along the keel from the stern's aftermost primary floor.

Both metric and Imperial measurements are used when referring to the cut dimensions of an element. The use of Imperial is listed after metric measurements because the builders would have cut the timber using the aforementioned measurement system. Imperial measurements are not provided when referring to the dimensions of the remains of the wreck.

4.2 Keel Assembly

The keel is the longitudinal centreline and backbone that supports the axillary structural members of the boat (Figure 4.3). The keel assembly in UDHB1 consists of four components to achieve a keel required for the double-planked hull. First is the primary keel which the sternpost, stern and stem knees, floor frames and inner layer of hull planking are fastened to. Second is a rider keel underneath the primary keel to add structural rigidity to the vessel, and to which the stem and apron are attached (Figure 4.4). Finally, the keel and rider keel are flanked on both sides with planks or boards which provide a shelf to support the second layer of hull planking and laterally brace the keels.

Figure 4.3: Keel [055]* in situ *remaining on top of rider keel lengths [550 & 551]. Aft to fore being left to right of image. (Source: Casey & Lowe).

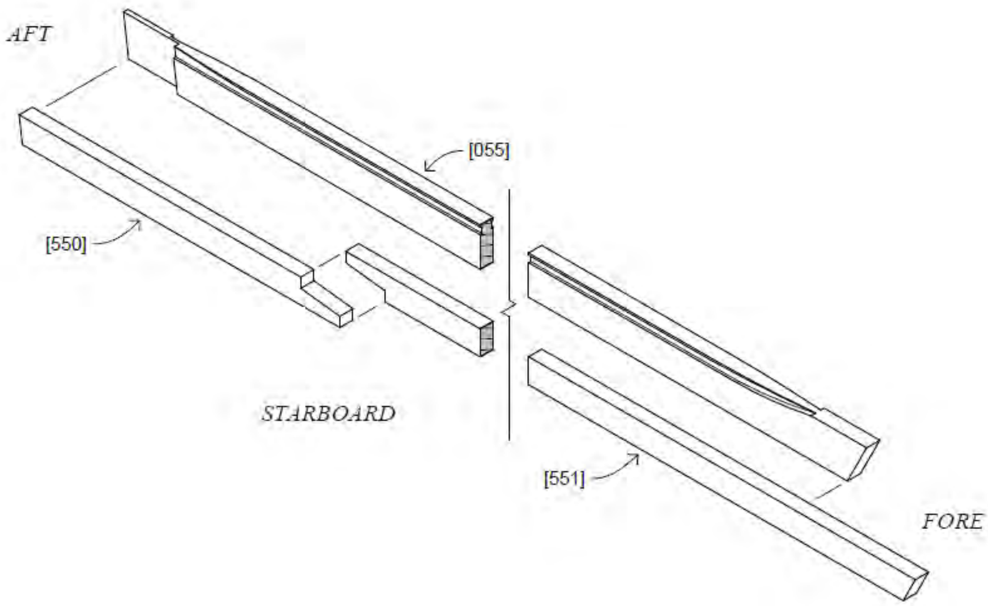


Figure 4.4: Keel and rider keel assembly isometric drawing. Diagrammatic only – not to scale. (Source: Benjamin Wharton 2021).

4.2.1 Keel [055]

Keel [055] is the primary keel of UDHB1. It is from the keel that the boat derives its longitudinal strength. The keel is also the structural foundation to which most other structural members join; this includes the garboard planking from which the hull shape is derived (Figure 4.5).

4.2.1.1 Condition at time of Excavation

The keel was complete, but longitudinally twisted and kinked upwards abaft midships where there was a sandstone block underneath. There are some significant areas of decay on the keel of up to 30 mm in depth into the underside of its aft end, and a significant amount of decay or deterioration on the upper side of its fore-most end.

4.2.1.2 Dimensions

The total length of the primary keel component [055] is 7.790 m (25 $^{1}/_{2}$').

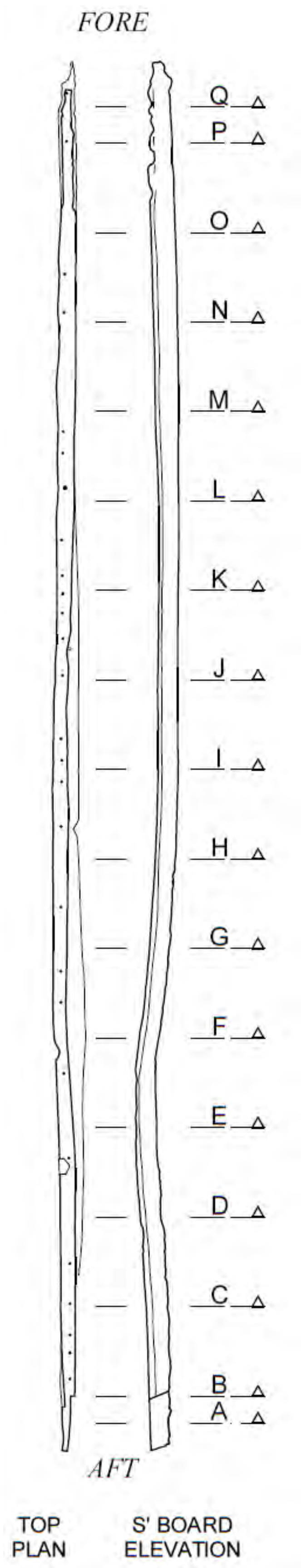
In plan, the keel's sided profile tapers outwards from bow to midships and reduces back to the stern. It also tapers vertically in cross-section being narrower at its underside at both bow and stern, however, is plumb amidships (Figure 4.5). The dimensions are (from bow to stern): 68 mm (2 $^{5}/_{8}$") at the bow, 76 mm (3") amidships, then 63 mm (2 $^{1}/_{2}$") at the stern where it joins the sternpost. The aft-most end of the keel, in its sided profile, is vertically halved along the centreline for a half-lap joint to seat the sternpost to.

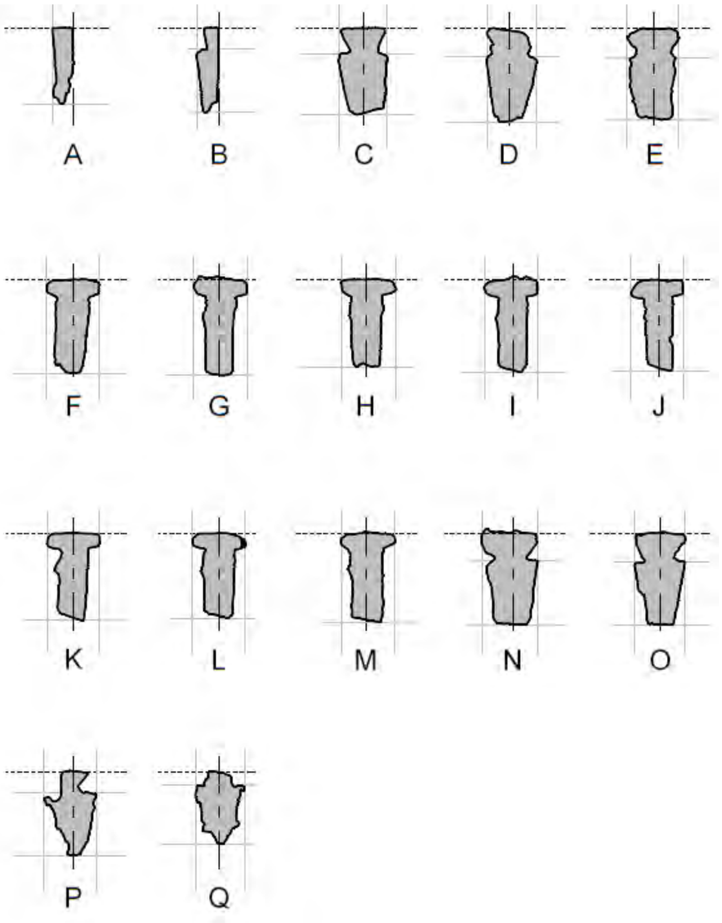
The keel's moulded profile shows that its cross-sectional shape tapers towards its bottom in the bow and stern areas. It is currently unclear if this was an intentional taper or if it is the result of decay. The overall moulded dimensions (which are indicative of its size) measure 105 mm (4$^{1}/_{8}$") at the bow, 134 mm (5$^{1}/_{4}$") amidships, and108 mm (4$^{1}/_{4}$") at the stern. The approximate dimensions for the rabbet's placement at midships measure 85 mm (35$^{1}/_{4}$") below the rabbet line, 19 mm ($^{3}/_{4}$") above the rabbet, and 19 mm ($^{3}/_{4}$") for the rabbet itself.

4.2.1.3 Keel Rabbet

The rabbet along the sides of the keel (see Figure 4.4 and Figure 4.5) is used to house the edges of the garboard strake planking and helps direct the deadrise angles and twist of the planking. The profile of the rabbet is complex in its geometry. The shape of the rabbet is required to hold the garboard plank in a vertical position at the stem, then pull the plank down and outward as it moves to a near horizontal position amidships, then pull back up to near vertical position at the stern and in close to the centreline. The moulded height of the rabbet at midships is approximately 19 mm ($^{3}/_{4}$") and is cut at an angle to raise the inner, lower edge of the attached garboard plank upwards to align with the horizontal plane of the top face of the keel.

As the rabbet approaches the stern, approximately 1.5 m (5') forward from the sternpost, the sided face of the keel begins to disappear as the rabbet sweeps up vertically and moves in towards the centreline to bring the garboard planking to a near vertical position to attach to the sided faces of the sternpost. Although the foremost end of the keel is too deteriorated to clearly define the movement of the rabbet line, it probably had a similar sweep up and in, as the remains show that the uppermost face of the keel narrows to reveal the bottom face of the rabbet.





CROSS SECTION	SIDED		MOULDED		BELOW RABBET		DISTANCE FROM DATUM	
	In.	mm	In.	mm	In.	mm	Ft. In.	mm
A	1 1/4	30	4 1/4	108			5 7/8 aft	150 aft
B	1 1/4	31	5	123	3 1/2	92	0	0
C	2 3/4	70	5 3/8	126	3 3/4	88	1-7 5/8	500
D	2 7/8	73	5 1/4	137	3 1/2	95	3-3 3/8	1000
E	2 7/8	74	5 1/4	133			4-11	1500
F	3	76	5 3/8	135			6-6 3/4	2000
G	3	77	5 1/2	139			8-2 3/8	2500
H	3 1/8	80	5	127			9-10 1/8	3000
I	3	77	5 1/4	134			11-5 3/4	3500
J	3	75	5 1/4	132			13-1 1/2	4000
K	3	75	5	127			14-9 1/8	4500
L	3	76	4 7/8	123			16-4 7/8	5000
M	3 1/8	78	5 1/8	129			18-0 1/2	5500
N	3 1/4	81	5 1/4	132	3 5/8	93	19-8 1/4	6000
O	2 7/8	73	5 1/4	133	3 5/8	92	21-3 7/8	6500
P	3	75	4 3/4	122	3 5/8	92	22-11 5/8	7000
Q	2 3/4	71	4 1/8	105	3 3/8	85	23-7 1/2	7200

Figure 4.5 : Top plan & elevation of keel [055] with cross sections. (Drawn by Benjamin Wharton 2021 using Casey & Lowe drawings Plan16.W9 and scans taken during the cleaning and conservation phase. Note that the original surfaces of the timber have not survived in all cross sections).

4.2.1.4 Timber Species & Cut

The primary keel [055] is constructed from a single piece of Grey Gum timber (*Eucalyptus punctate*). It was cut from a trunk approximately 125 mm (5") from the centreline and 25 mm (1") from the quarter line (Figure 4.6). The trunk would have been at least 560 mm (1'10") in diameter and its preserved length measured nearly 8 m (26') without knots.

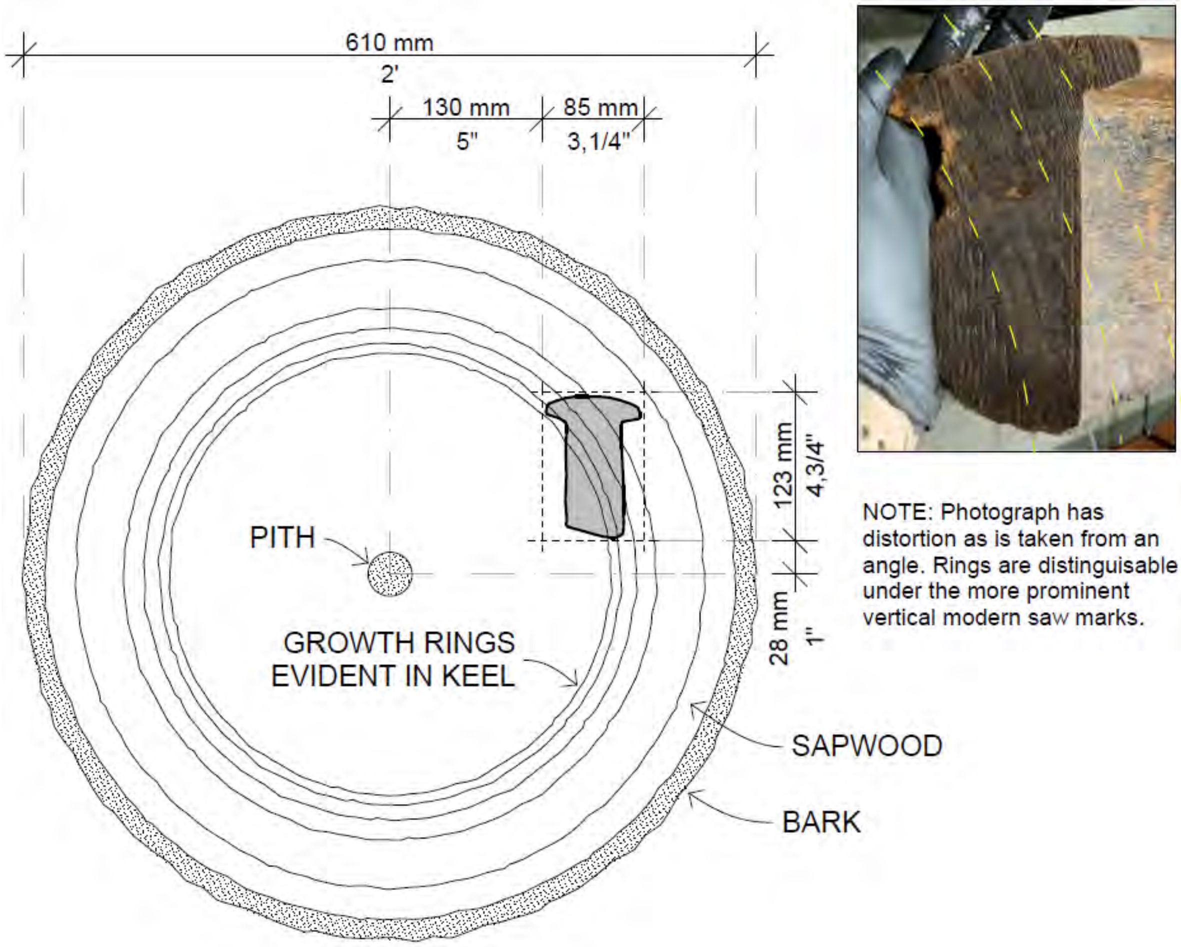


Figure 4.6: Diagram of the cross-sectional part of the trunk that the keel [055], shown here in section, was cut from. Note that trunk would have been 2 feet or more in diameter. (Drawn by Benjamin Wharton 2021).

4.2.1.5 Repairs and/or Modifications

There are apparent repairs and/or modifications to the keel. The sides of the keel amidships below the rabbet line were infilled with lengths of planking to provide a bottom face for the rabbet on which the garboard planking of the inner hull would sit on. It is unknown whether this was due to either deterioration or damage. On the starboard side of the keel, the area removed was filled in with plank [541] for a length of 3.624 m (11'10$^{5}/_{8}$"). At the time of excavation, however, the corresponding port side of the keel does not appear to have had such an infill piece. It is possible the garboard shelf board for the external layer of planking ran through this area and provided support for both layers of inner and outer planking (Figure 4.7).

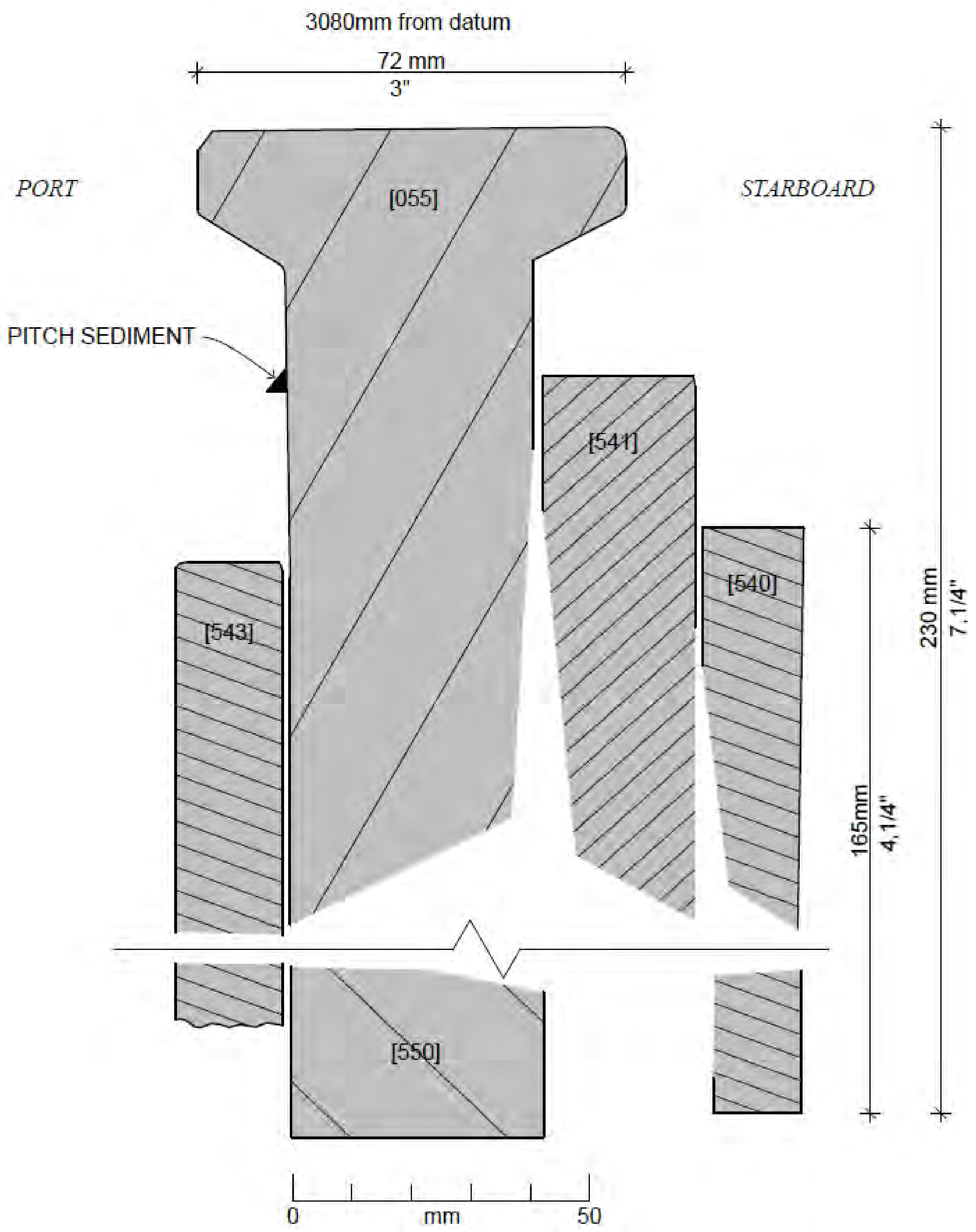


Figure 4.7: Cross-section of keel, infill piece, and garboard shelf boards. (Source: Benjamin Wharton 2021).

4.2.1.6 Fastenings

There are fastening holes throughout the keel corresponding with the various attached components and will be discussed in more detail in their respective categories (Figure 4.8). There remains a vast array of different size fasteners evident, such as dump bolts or spikes from structural members including the sternpost, sternpost knee and floor timbers. There is also one large treenail [535], driven into the keel from inside the hull, down through both infill plank [541] and keel [055]. Treenail holes measure 9.5-10 mm ($^{3}/_{8}$") in diameter and indicate where they were used to fasten the keel [055] to the sternpost [300].

Figure 4.8: Keel [055] half-lap to sternpost. Note various fastener holes and tool marks. (Source: Benjamin Wharton 2020).

4.2.2 Rider Keel [550, 551]

The rider keel supports the primary keel, reinforcing its rigidity and increasing its overall moulded depth. The rider keel of UDHB1 consists of two pieces [550] and [551] flat-scarfed abaft midships (see Figure 4.4). Some vessels were built with a false, or shoe, keel whose primary purpose is sacrificial and made to be replaced easily during the vessel's working life. This rider keel is fastened, however, in a more permanent fashion, and its sequence in construction places it before the garboard shelf strakes which support the hull planking, therefore it would not be replaceable without disconnecting the hull planking.

4.2.2.1 Condition at time of excavation

The aftermost rider keel component [550] is extensively bent and twisted where the vessel rested against a sandstone block and over time began to wrap around it. There was considerable amounts of decay and wear on the underside of both pieces. Most obvious damage appeared to be marine borer degradation, as the underside appears to have been left unprotected. Further investigation after cleaning and conservation will determine if there may have been a keel shoe fastened underneath, however the evidence of sheathing at the bow suggest this may not be the case.

4.2.2.2 Dimensions

Due to the bend in the afterward end of the rider keel [550], its overall length was obtained using the scans from the conservation and cleaning phase. The three-dimensional scans were converted to two-dimensional CAD drawings, from which a centreline could be drawn, straightened, and measured. Due to the deterioration of the timber, measurements are approximate, and as such the sizes are dimensioned to a 1/8" tolerance to account for the deterioration.

The overall length for the rider keel as a single component consists of the two rider keel lengths minus the overlap of the scarf, which equates to 8.27 m (27' 1 $^{1}/_{2}$"), sided from fore-to-aft it is 58 mm (2 $^{1}/_{4}$") at the bow, widening to 63 mm (2 $^{1}/_{2}$") amidships, then tapering down to 43 mm (1 $^{3}/_{4}$") at the stern. Its moulded height along the whole length is 78 mm (3") at the bow, 86 mm (3 $^{1}/_{2}$") amidships, then 73 mm (2 $^{7}/_{8}$") at the stern – although it may have originally been 3" (the same as at the bow), or perhaps 3 $^{1}/_{2}$" over the whole length, however, over time it wore down fore and aft. Each end is raked, the fore on rider keel [551] is raked at

28 degrees, while the aft rake on rider keel [550] is approximately 11^{o} in line with the sternpost backing piece [545].

The length of the forward end rider keel [551] is 4.747 m (15’ 6 $^{1}/_{2}$”), its sided dimensions are 58 mm (2 $^{1}/_{4}$”) at the bow and continuing the same to its aftermost end. Its moulded height is 78 mm (3”) at the bow and increasing to 86 mm (3 $^{1}/_{2}$”) at its aftermost end before the scarf.

The length of the aftermost end rider keel [550] is 3.783 m (12’ 4 $^{7}/_{8}$”), its sided dimensions are, from fore-to-aft: 63 mm (2 ½”) at midships which tapers down to 43 mm (1 $^{3}/_{4}$”) at the stern where it sits underneath the sternpost. Its moulded depth abaft the scarf is 86 mm (3 $^{1}/_{2}$”), which reduces to 73 mm (2 $^{7}/_{8}$”) at the stern, however, this may originally have been 3” or 3 $^{1}/_{2}$”. Table 5 displays the dimensions of the rider keel components.

Table 5: Dimensions of rider keel components. Dimensions shown from fore to aft.

ID #	Length	Sided	Moulded
551	4.737 m 15’ 6 $^{1}/_{2}$”	58 mm – 57 mm 2 $^{1}/_{4}$” – 2 $^{1}/_{4}$”	78 mm – 86 mm (before the scarf) 3” – 3 ½”
550	3.783 m 12’ 4 $^{7}/_{8}$”	63 mm – 43 mm 2 $^{1}/_{2}$” – 1 $^{3}/_{4}$”	86 mm – 73 mm 3 $^{1}/_{2}$”– 2 $^{7}/_{8}$”.
TOTAL	8.268 m 27’ 1 $^{1}/_{2}$”	58 mm – 63 mm – 43 mm 2 $^{1}/_{4}$” – 2 $^{1}/_{2}$” – 1 $^{3}/_{4}$”	78 mm – 86 mm – 73 mm 3”– 3 $^{1}/_{2}$” – 2 $^{7}/_{8}$”

The scarf joint in the rider keel is known as a flat scarf, and being horizontal as opposed to vertical, the diagonal face was cut nibbed perpendicular to the moulded faces (Figure 4.9). From the underside of rider keel [551] the first cut was 27 mm (1”) in depth up into the timber, then a tapered horizontal cut tapering upwards for a horizonal length of 252 mm (9 $^{7}/_{8}$”), then nibbed off perpendicularly again leaving 41 mm (1 $^{5}/_{8}$”) remaining depth at the end of the scarf. This end nib cut went into the keel timbers above it, as previously described. The afterward end rider keel [550] had a scarf to match into. At this point it is noticeable that the two rider keels differed slightly in their sided dimensions, with [550] being wider by only 6.35 mm ($^{1}/_{4}$”) leaving 3 mm ($^{1}/_{8}$”) protruding out either side.

Figure 4.9: Scarf joint of rider keels* in situ *[550, 551]. (Source: AMBS).

4.2.2.3 Timber Species & Cut

Timber samples were taken for each rider keel component; the results were of both locally acquired timber. The afterward piece [550] was a type of eucalyptus; possibly Stringybark or gum. The forward piece [551] was identified as Grey Gum which is the same timber type as the primary keel [055].

4.2.2.4 Fastenings

The rider keel components show evidence of square iron nails or spikes being used to fasten them to the primary keel, connect the flat-scarf joint, and attach the stem [457]. There is also evidence of square iron nail holes, used to affix the garboard shelves to their sides. Further examination after the cleaning and conservation process will determine exact fastening quantities, positions and sizes. Copper sheathing tacks also remain on the fore-most end of rider keel [551] which would have been used to attach copper sheathing.

4.2.2.5 Features

The fore-most end of the fore-end rider keel [551] was raked to begin the upward curvature of the stem [457], which was affixed to the top surface of the rider keel and fastened with iron dump bolts or spikes. Wrapping around the fore-most surface on the rake of the rider keel were remains of copper sheathing fastened in place with copper sheathing tacks. The sheathing continued around the portside and underneath for a length of approximately 150 mm (6"). The portside garboard shelf board [457] was held in place by this copper sheathing (Figure 4.10). The starboard side of the sheathing remains on the garboard shelf board plank [539].

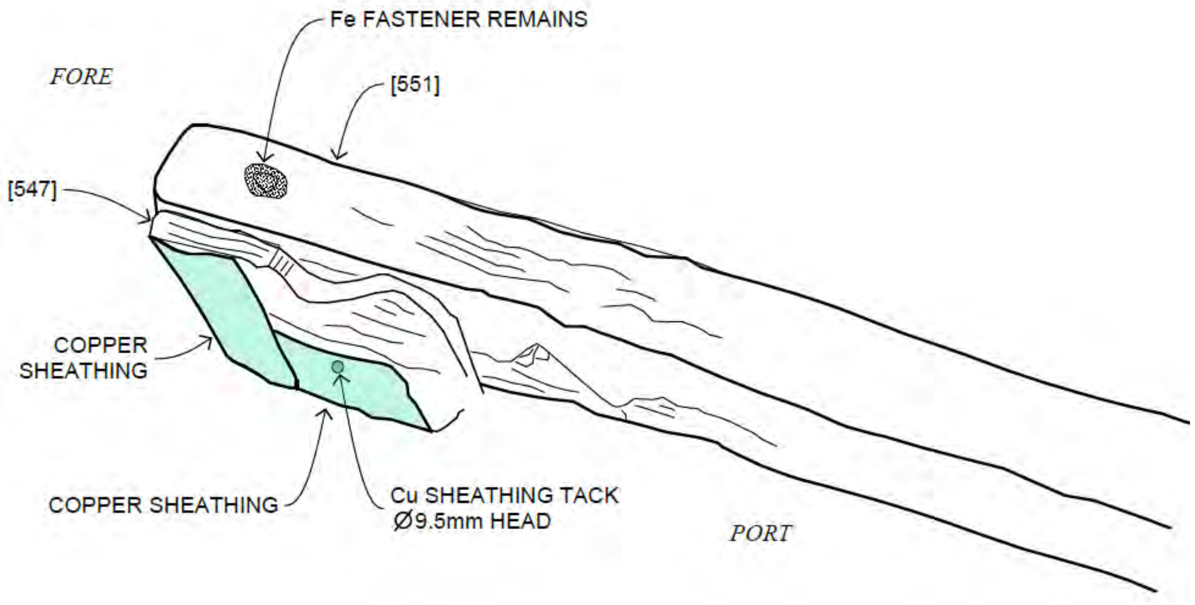


Figure 4.10: Outer garboard strake shelf 547 part of 542 with copper sheathing intact. (Source: Benjamin Wharton 2021).

There is a saw cut into the keel in-fill piece [441] and the primary keel [055] and is in line with the aft-end of the scarf of the fore piece [551] (Figure 4.11). It could be a mark of repair; replacing a worn-out aft end of the rider keel, or it could have been made during construction, fitting the scarf to the aft end piece [550]. The sequence of construction requires this to have been carried out before the garboard shelf boards were fitted, and prior to the hull planking being fastened to the shelves.

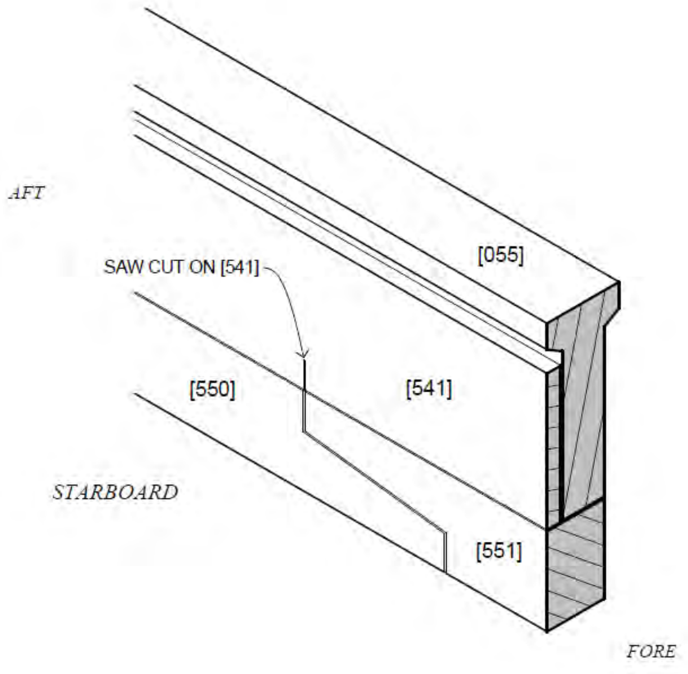


Figure 4.11: Saw cut shown on starboard elevation of rider keels [551 and 550], with infill piece [541] and primary keel [055]. (Source: Benjamin Wharton).

4.2.3 Garboard shelf boards [458, 521, 527, 539, 540, 542, 543, 546, 547]

The keel and its infill piece, together with the rider keel pieces underneath, were braced on either side with planks that formed vertical reinforcement to the keel assembly however, their primary purpose was to provide a shelf, or 'rabbet' line for the garboard strake of the second layer of hull planking (Figure 4.12). On the portside this shelf was comprised of two individual planks; [542] and [543] scarfed together. The starboard side was also comprised of two pieces; [539] and [540] scarfed together (Figure 4.13). Smaller broken pieces were found at the bow attached to the stem assembly components. On the port side there was plank [547] which would have been a part of [542], and plank [546] which would have been a sliver from [543] originally. It has been calculated that there is approximately 790 mm (2'7$^{1}/_{8}$") missing between planks [547] and [542], 235 mm abaft the stem.

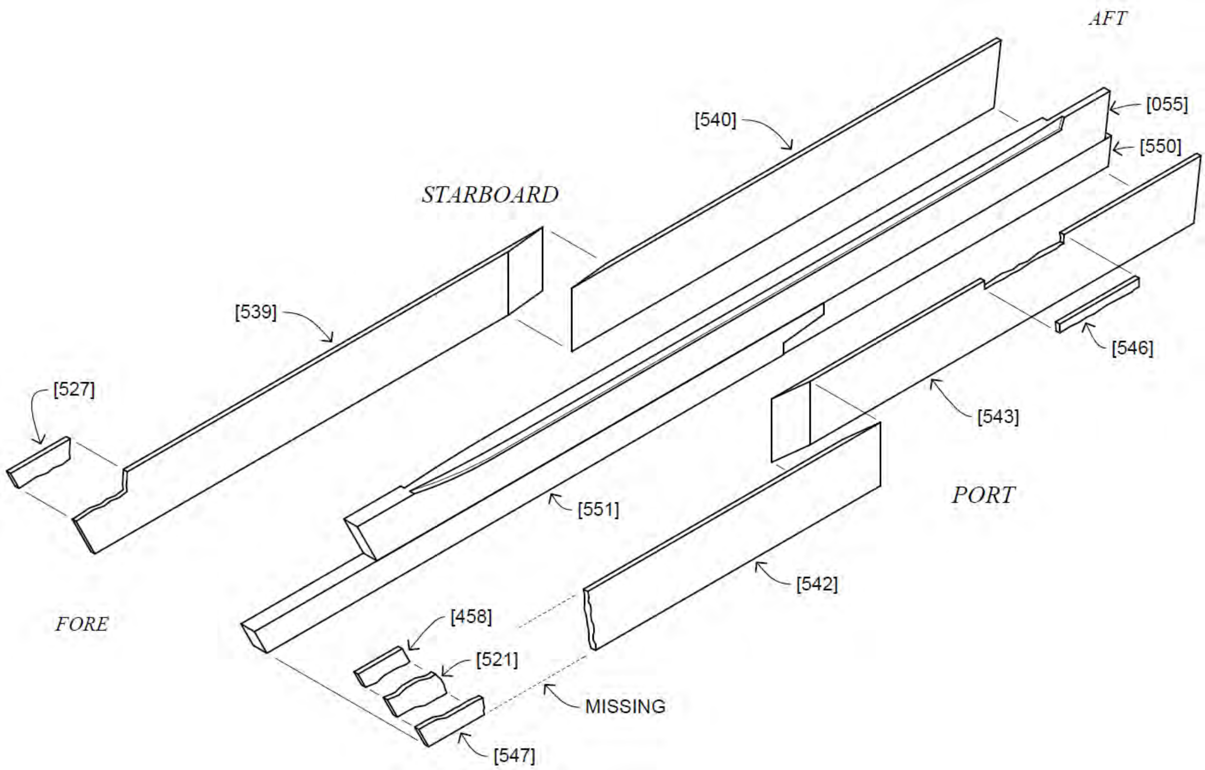


Figure 4.12: Exploded view of garboard shelf board fragments and placements. Fore to aft being left to right. Diagrammatic only – not to scale. See Figure 4.46 for how the planks fitted into the garboard shelf plank. (Source: Benjamin Wharton 2021).

Figure 4.13: Starboard side of keel [055], rider keel [551] under, infill [541], and after-end outer garboard shelf plank [540]. (Source: AMBS).

4.2.4 Dimensions

On the starboard side, plank [539] measures 3.55 m (11 ft 7$^{3}/_{4}$”) in length, 90 mm in width at the bow, 115 mm in width at midships, and reaching its maximum width at the aftermost end of 130 mm (5$^{1}/_{8}$”). It is possible that the plank originally would have been closer to the maximum width all the way along. Its thickness is 15 mm ($^{5}/_{8}$”) at the bow and changes to 20 mm ($^{3}/_{4}$”) at its aftermost end.

Plank [540] which is scarfed to [539] is 4.8 m (15’9”) in length, 170 to 220 mm in width, and 19 to 20 mm in thickness. Its scarf measures approximately 80 mm (3$^{1}/_{8}$”) in length, however, it shows a degree of deterioration indicating that it may originally have been longer. The two planks when scarfed form a strake that has a total length of 8.26 m (27’1$^{1}/_{4}$”); approximately the same length as the rider keel.

On the port side, the planks are less complete, however, beginning at the bow, plank [547] has a preserved length of approximately 235 mm (9$^{1}/_{4}$”), measures 80 mm (3$^{1}/_{8}$”) in moulded width, and is approximately 10 mm in thickness. Plank [542] has a length of 3.79 m (12’5$^{3}/_{16}$”), and a width of 155 mm (6$^{1}/_{8}$”) at its fore-most end where it is broken from [547] and 128 mm (5$^{1}/_{16}$”) at its aft-most end amidships. Its thickness from fore-to-aft is 15 mm which thickens out to 35 mm (1$^{3}/_{8}$”) aft. It is possible that this extra thickness filled out the missing portside section of the primary keel. The scarf on plank [542] is 100 mm long. Scarfed to [542] is plank [543] which is 3.545 m (11’7 $^{9}/_{16}$”) long, has a maximum moulded width of 105 mm (4$^{1}/_{8}$”), and is 20-35 mm thick at its fore-most end amidships, which reduces at the stern to 15 mm. The scarf is 55 mm long. The remaining total length of the portside garboard shelf board, not including the scarf, is 7.47 m (24’6$^{1}/_{8}$”) with 790 mm (2’7$^{1}/_{8}$”) missing from its original length. See Table 6 for garboard shelf fragments.

Table 6: Dimensions of garboard shelf fragments.

ID #	Length	Width	Thickness	Scarf Length	Features	Species
PORTSIDE – bow to stern						
547	235 mm**	80 mm**	10 mm**		Copper sheathing & tacks	
521	214 mm	60 mm	25 mm		Copper sheathing & pitch	Sydney Blue Gum
458	110 mm	60 mm	20 mm		Copper sheathing	
542	3790 mm	155 mm F 128 mm A	15 mm F 34 mm A	100 mm		
543	3545 mm	105 mm max.	20 mm F 35 mm M 15 mm A	55 mm	Iron concretions aft end presumably pintle strap^	
546	2035 mm	95 mm max.	10-20mm		Possibly a piece of [543]	Eucalypt – Stringybark or gum
STARBOARD SIDE – bow to stern						
527	100 mm		20 mm		Copper sheathing	
539	3550 mm	90 mm* F 130 mm M 115 mm A	15 mm F 20 mm A	90 mm	Copper sheathing & tacks	
540	4800 mm	170-220 mm**	19-20 mm	80 mm	Iron concretions aft end presumably pintle strap^	

Notes: * dimension from scanning written records; **dimension taken directly off scan. Letters: F denotes 'fore'; M denotes 'mid'; and A denotes 'aft'. These represent the individual pieces – not placement within vessel. Normally the gudgeon is fixed to the stern, however it appears the opposite appears to be the case for UDHB1 – see Section 4.3.5.

4.2.5 Timber Species

Two timber samples were taken from the garboard shelf boards. One was from plank [546], which in turn is representative of plank [543]. This timber was too degraded to obtain an absolute identification, although it was recognised as a eucalyptus timber species, either Stringybark or a gum. A small section of garboard shelf [521] remaining on the rider keel [551] was sampled and identified as Sydney Blue Gum. The timber shows evidence as having been sawn with a pit saw (for further discussion on the saw cuts see Section 5.6).

4.2.6 Fastenings

The garboard shelf boards were fastened with iron nail into the ides of the keel, keel infill piece and rider keels. It is likely that the nail shanks, which are square in section, would be 6.5 mm ($^{1}/_{4}$") square at the throat as this is the most common size iron nail used throughout the vessel. This may be clarified after cleaning and conservation.

Sheathing tacks were also used on the garboard shelf boards at the foremost end at the bow where copper sheathing was tacked on. These are found on plank [547] for the portside, and plank [539] for starboard (Figure 4.14).

Figure 4.14: Copper alloy fastener from garboard shelf [539]. (Source: Benjamin Wharton 2020).

4.2.7 Copper sheathing and ferrous concretions

Remains of copper sheathing was fastened to the forward end of plank [539] in the same manner as plank [547] on the rider keel [551] (Figure 4.15).

At the stern, on the after ends of planks [540] and [543] are long iron concretions presumably being or originating from the pintle strap (see Figure 4.34), which provide information regarding the use of a rudder on the vessel.

Figure 4.15: Plank [539] with copper sheathing and sheathing tacks intact. Rake and curvature of stem can be seen at the foremost end (right). (Source: Benjamin Wharton 2020).

The garboard shelf is comprised of two planks or boards for each side, requiring them to be scarfed together. As the scarf ends of these planks were not in the best condition, the ratios have been rounded up to the nearest whole number. The two planks on the port side, [542] and [543], were scarfed with a ratio of 1:3, while on the starboard side plank [539] and plank [540] had ratios of 1:6 and 1:4 respectively. The high level of deterioration on the scarf on plank [540], however, could mean that the ratio may have been 1:6 at the time of construction. The scarfs were positioned in the usual manner for hull planking, pointing outward aft so as not to catch incoming water as the vessel moved forward.

The outer surfaces of the garboard shelf boards, as the final external surface of the keel assembly, were heavily coated in pitch. Attached to the pitch were oyster shells which would have accumulated towards the end of the working life of the vessel, or when it was pulled ashore to its final resting spot (Figure 4.16).

Figure 4.16: External surface of the starboard garboard shelf boards [539] and [540], view of starboard side. Showing scarf joint, heavy application of pitch, and the accumulation of shells. (Source: Benjamin Wharton 2018).

4.3 Stern Assembly

The stern assembly extends the longitudinal structural centreline upwards from the keel to provide a structure that defines the shape of the stern of the hull and an attachment point for the aft end of the planking (Figure 4.17). The stern assembly of UDHB1 consists of firstly, the sternpost and the stern knee to provide the primary structural support. Secondly, a vertically tapered backing plate which was fastened to the aft-most face of the sternpost. Thirdly, rabbet cheeks were affixed to both port and starboard sides of the sternpost to accommodate the second layer of planking (Figure 4.18). There were no remains of the transom evident during the recovery of the vessel, however the profile of the planking and framing in this area can provide an indication as to the general shape.

Figure 4.17: Stern assembly* in situ *prior to disassembly, portside. Visible are the keel [055], stern post [300], Stern knee (or sternson) [301], Outer garboard shelf stern section [465] and Outer garboard shelf [543]. (Source: AMBS).

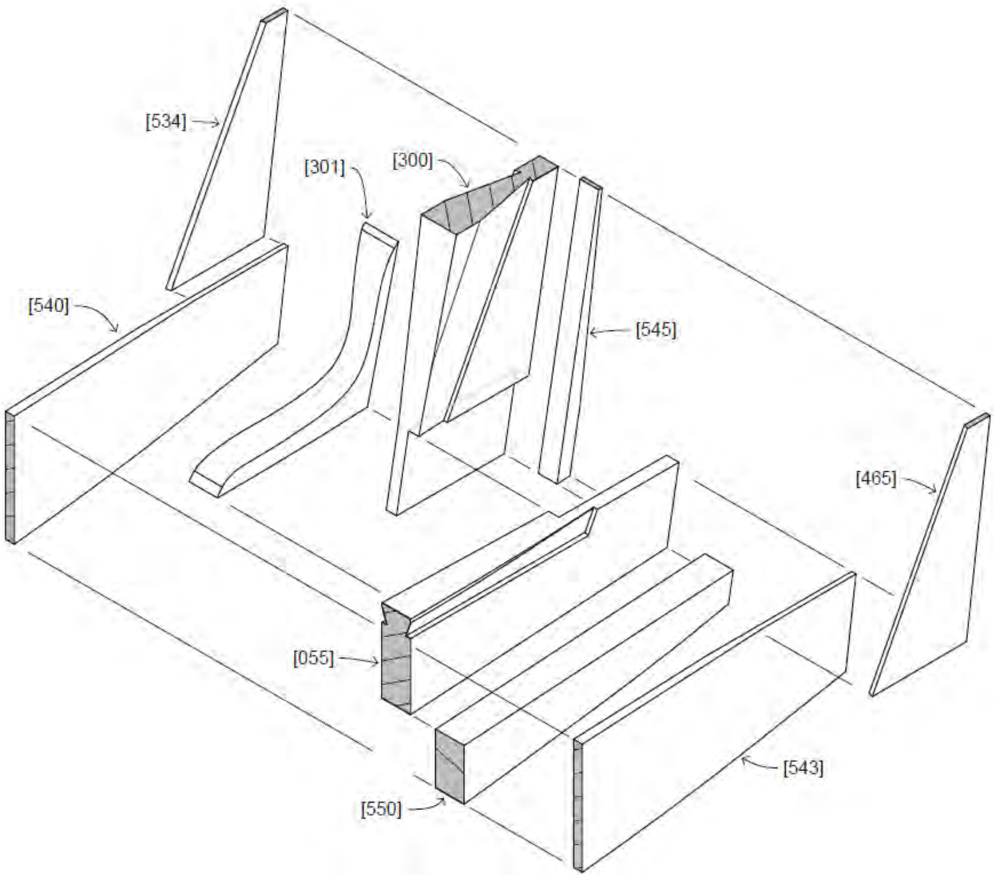


Figure 4.18: Stern components exploded view. (Source: Benjamin Wharton 2021).

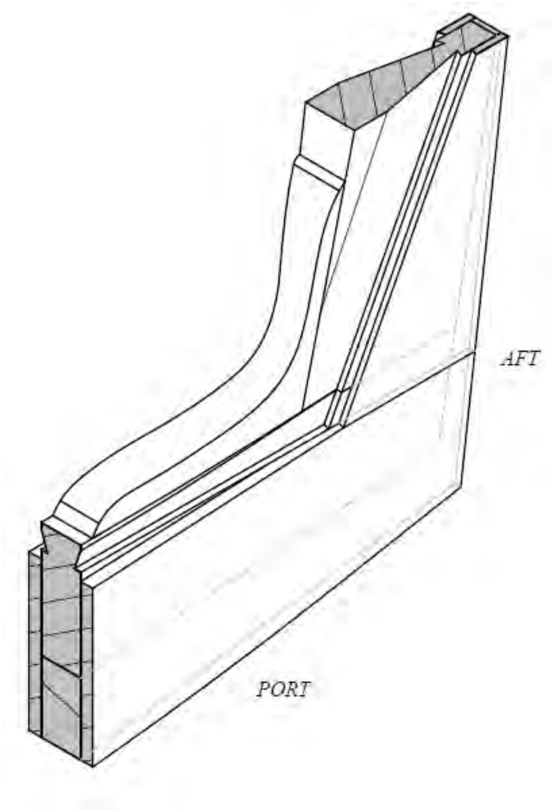


Figure 4.19: Stern components isometric view. (Source: Benjamin Wharton 2021).

4.3.1 Sternpost [300]

The sternpost continues the longitudinal structural frame of the keel upwards to support the after end of the planking and the transom. It has a rabbet line that continues from the keel and projects the planking upwards and aft at a rake (Figure 4.20). The face of the rabbet to the bearding line flares the planking outwards to begin their spread to the desired beam at midships (Figure 4.20). The sternpost is fastened to the keel with a vertical half-lap joint.

4.3.1.1 Condition at time of excavation

The sternpost at some point in time has been damaged from above the rabbet line. The decay on the underside of the keel [055] continues on in a similar fashion to the underside of the sternpost.

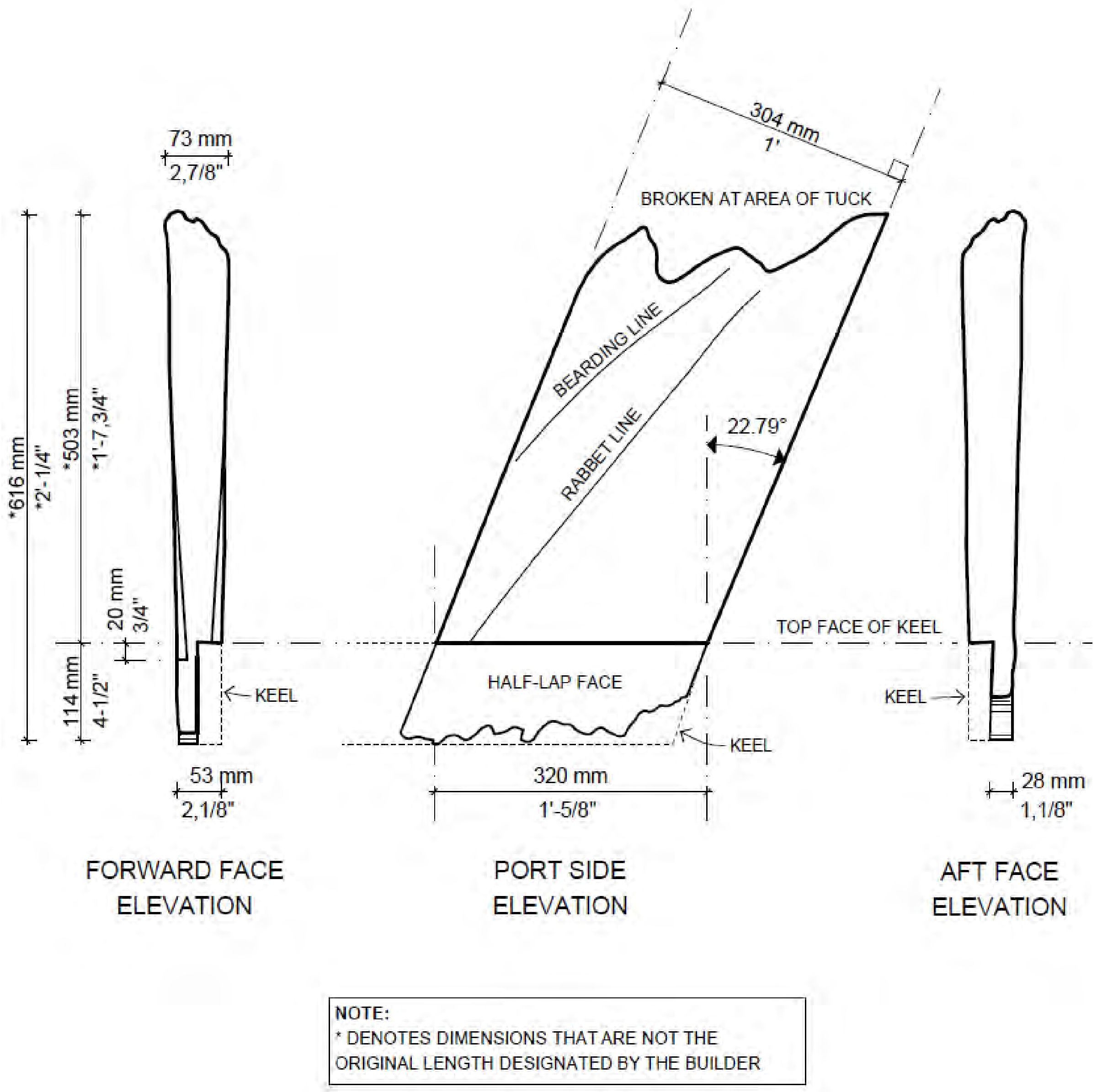


Figure 4.20: Sternpost [300] forward and portside elevations. (Source: Benjamin Wharton 2021).

Figure 4.21: Sternpost [300]* in situ *attached to keel [055]. Rabbet line shown red; bearding line shown blue. (Source: AMBS).

4.3.1.2 Dimensions and shape

Measuring perpendicular from the forward face, the sternpost is 304 mm (12"). At its widest point it is 73 mm ($2^{7}/_{8}$") thick with remains lengthways 616 mm (2'-$^{1}/_{4}$") long. Above the keel line vertically the sternpost stands 503 mm (1'-$7^{3}/_{4}$"), and below is 114 mm (4½"). Below the top face of the keel line, the sternpost is half-lapped to fit to the keel and is 28 mm ($1^{1}/_{8}$") thick. The thickness of the sternpost tapers from the bottom upwards. At the keel line it is 53 mm ($2^{1}/_{8}$") thick and widens out to 73 mm ($2^{7}/_{8}$") – it may have been three inches thick at the tuck, but is now broken there. There is no taper in width from the keel line up – the inner face continues parallel to the aft-most face up to the breakage at the tuck. It is unknown if, after the tuck, it continued parallel or tapered up the transom. It could also have terminated altogether at the tuck to facilitate a counter stern.

The portside and starboard side faces are cut in at an angle from the bearding line to the rabbet line to produce the flare of the planking. The rake, or drag, of the sternpost is 22.8^{o}.

4.3.1.3 Repair and/or Modifications

There appears to be a repair of an abandoned modification on the port side, where the second rabbet for the outer layer of planking was cut parallel to the aft-most face of the sternpost instead of the rabbet line. This would have introduced too much flare of the planking which therefore would not have sat flush with the inner planking layer. It was repaired with a piece of in-fill timber for the majority of the cut area. To remedy this error, a second rabbet line was added using cheeks either side to make the sternpost wider so that the outer planking would lay flush with the inner layer (Figure 4.22).

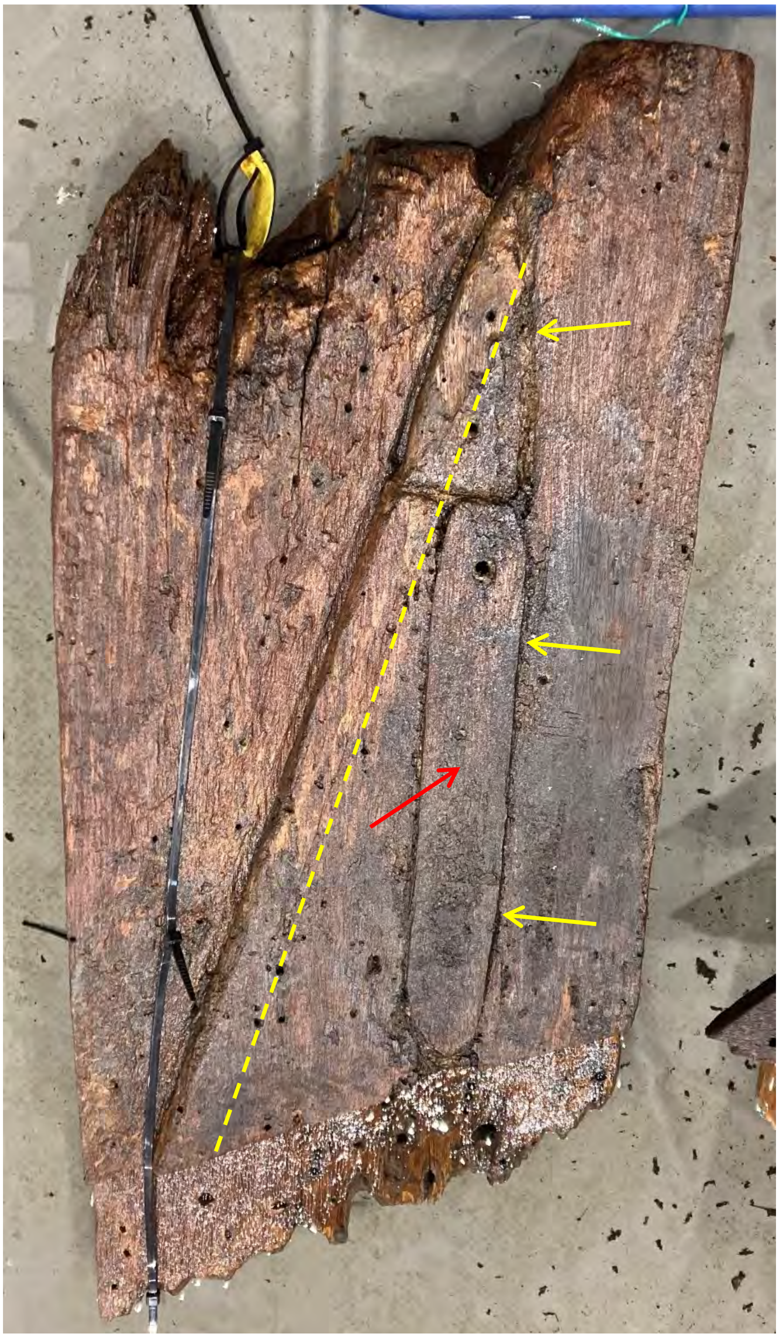


Figure 4.22: Sternpost [300]. Portside showing in-fill repair piece (red arrow), attempted second rabbet line (yellow arrows) and attempted bearding line (dashed line). (Source: Benjamin Wharton 2020).

4.3.1.4 Timber Species & Cut

A sample was taken of the sternpost and was identified as Southern Mahogany. The timber grain runs parallel along its length (Figure 4.23).

Figure 4.23: Sternpost grain orientation, port side. Aft edge on the right. Grain direction shown in red. (Source: Benjamin Wharton 2020).

4.3.1.5 Fastenings

The sternpost has remains of numerous fastenings. The most common are the iron nails with square shafts that measure 5-7 mm in width ($^{1}/_{4}$") at the throat. They were used to fasten together the hull planking, second rabbet cheeks, backing plate, sternpost knee, and the keel. Two treenails, 16 mm ($^{5}/_{8}$") diameter, were also used to fasten the keel at the half-lap joint.

4.3.2 Stern Knee [301]

The stern knee provided structural reinforcement and lateral support to the keel and sternpost (Figure 4.24). It was constructed using grown timber utilising the existing matching angle of a branch to suit the requirements and taking advantage of the grain direction for strength.

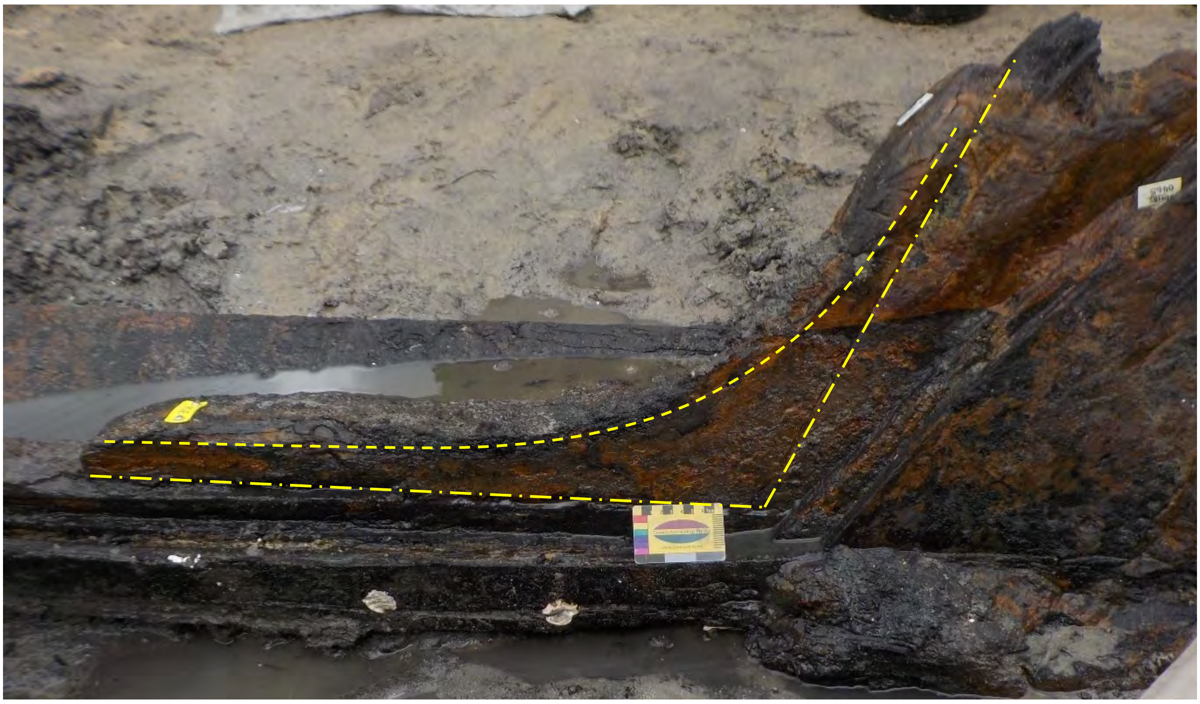


Figure 4.24: Stern knee* in situ *before removal. Yellow dashed line showing bearding line, and yellow dash-and-dot line showing edges of the stern knee where fastened to the keel and sternpost. (Source: Casey & Lowe).

4.3.2.1 Condition at time of excavation

The stern knee survived in excellent condition with no breakage or decay and the original shape has been preserved. The surfaces of the knee where not pitched but was heavily oxidised from the fasteners.

4.3.2.2 Dimensions and shape

The stern knee is 610 mm (2') long along the keel line and 455 mm ($1^1/_2$') along the inner face of the sternpost to below the tuck; a ratio of 1 to $^3/_4$ length to height. The moulded dimension starts as 103 mm (4") thick, and from the bearding line cuts in with an angled face the same as its respective adjoining keel and sternpost (Figure 4.25 and Figure 4.26).

Figure 4.25: Underside face of stern knee that connects to the top face keel line. Note the taper in plain view reducing abaft. Also note the bearding line shown dashed which in cross section tapers also down from this line. (Source: AMBS).

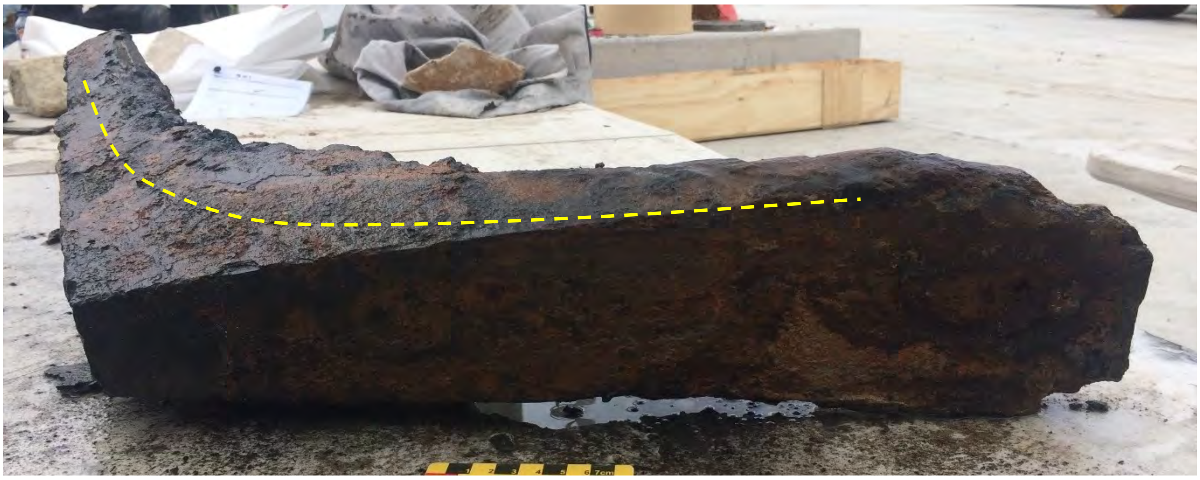


Figure 4.26: Aft-most face of the stern knee that connects to the sternpost. Note the taper from top to bottom, also from the bearding line (shown dotted) down too. (Source: AMBS).

4.3.2.3 Timber Species & Cut

As the stern knee was preserved in excellent condition, no timber sample was taken to determine the timber species. However, from the collection of samples taken from elsewhere on the vessel it is likely that it would have been locally procured hardwood. Tea tree is common for use as knees and may be the most probable species, however, any of the timbers used for the framing could suffice as well, such as Spotted Gum.[73]

The stern knee is *grown*, also known as crooked or compass, timber which is either part of a trunk where a branch grew; or a branch with the required angle bend in it.

[73] Cosmos Archaeology Pty Ltd, April 2021, Windsor Bridge Replacement Project : Report on the early 19th century timber vessels and other finds on the north bank of the Hawkesbury River, PowerHouse Collection 'Melaleuca (tea tree) timber specimen from Hawkesbury, NSW' https://collection.maas.museum/object/222776, Ian Smith Boats 'Traditional Clinker Construction Episode 3: Setting Up, Part 1' https://www.youtube.com/watch?v=aAQ6i2xKqgY&t=227s

4.3.2.4 Fastenings

Remains of 5.5 mm (1/4") square iron nails were identified as the fasteners used to fasten the knee to the keel and the sternpost. Up to six were located at the keel face and four at the sternpost.

4.3.2.5 Features

Distinct tool marks were noticed on the upper port side of the knee for cutting in from the bearding line (Figure 4.27).

Two individual timbers [312] and [468] were positioned on top of the knee, presumably as deadwood as a filler for cockpit planking or a beam.

Figure 4.27: Tool marks on upper port side of stern knee [301]. Presumably from an adze or hand axe/hatchet. (Source: Casey & Lowe).

4.3.3 Sternpost Backing Cover Plate [545]

The aft-most surface of the sternpost [300] was covered with a backing plate that extended down to also cover the aft-end of the primary keel [055] (Figure 4.28).

4.3.3.1 Dimensions and shape

The overall length of the backing piece from top to bottom is 582 mm (1'11"), however, due to the decay at the base of it, it may have been originally 610 mm (2') long. Its sided dimensions follow the increasing upward taper of the sternpost it is attached to. At its base it measures approximately 53 mm (2") increasing up to 68 mm (2 3/4"). With the backing plate added to the sternpost, the rake is changed from 22.8° degrees to 18°.

4.3.3.2 Timber Species & Cut

No sample was taken of the sternpost backing cover plate.

4.3.3.3 Fastenings

The backing piece was fastened to the sternpost with five square iron nails which were only evident in the scanned three-dimensional model from the cleaning and conservation phase. Three nails were approximately 7 mm (1/4") in shank thickness, and two larger nails had an approximate shank thickness of 10 mm ($^3/_8$"). The rabbet shelf pieces were also fastened to the sides both port and starboard with smaller square iron nails, measuring approximately 3-4 mm ($^1/_8$") shank size.

Figure 4.28: Backing plate [545]* in situ *prior to removal of garboard shelf [543]. (Source: AMBS).

4.3.3.4 Other

At the time of excavation, the lower part of the backing plate had deteriorated to a degree where a heavy amount of pintle concretion could be seen. It is also in line where a great deal of deterioration existed in the sternpost and the primary keel. The outer face, being the aft-most end of the vessel, was coated in a heavy amount of pitch, in some places up to 12 mm ($^1/_2$") thick.

4.3.4 Shelf Panel [465, 534]

The secondary rabbet line that was added to the keel with the additional shelf pieces in the keel assembly had to continue at the stern also and so shelf panels were added on both sides of the sternpost. The shelf panels were triangular shaped timber pieces fastened to both port [465] and starboard [534] sides of the sternpost to provide the shelf for the second layer of hull planking to abut into (Figure 4.29).

***Figure 4.29: Port side image of rabbet shelf [465]* in situ**. The secondary rabbet line (yellow arrow) provided by the shelf panel abaft the primary rabbet line (red arrow). (Source: AMBS).

4.3.4.1 Condition at time of excavation

Both of the rabbet shelf panels were in good condition when excavated, except for the top of [465] which had broken in line with the break of sternpost [300] and shelf panel [534], which had a segment splintered off along the grain at its bottom aft corner.

4.3.4.2 Dimensions and geometry

The dimensions for both shelf panels are different, so are presented port [465] to starboard [534] respectively. The height of the shelf panels from atop the garboard shelf boards to their tips, or broken end at the tuck, are 469 mm (1'6$^{7}/_{16}$"), and 539 mm (1'9¼"). Their base dimensions running from the point of the secondary rabbet line abaft is 300 mm (11$^{13}/_{16}$") and 310 mm (1'$^{13}/_{16}$").

The profile and geometry of the shape of these shelf panels do not appear to have been sized during design, but appear to be governed by filling the space aft from the set-out line of the secondary rabbet to create a continuation of the external surface from the planking abaft. This is also reflected in the moulded thicknesses which should be flush to the planking, being 10-19 mm ($^{3}/_{8}$"-$^{3}/_{4}$"), and 15-25 mm ($^{5}/_{8}$"-1") thick respectively.

The secondary rabbet line on the sternpost was set out approximately 25 mm (1") abaft the primary rabbet line. The rabbet line was bevelled 10 to 15 degrees inwards so as to hold the receiving planking in a half-dovetailed fashion.

4.3.4.3 Timber Species & Cut

Timber samples were not taken from the shelf panels as it was thought that doing so would irreversibly alter their shape and integrity. However, it is likely that the timber species would be of locally procured timber, in keeping with the results of the overall species used in the vessel.

The timber shows that the grain orientation was running parallel to the rabbet line edge, with angled pit-saw marks running approximately 12^{o} perpendicularly.

4.3.4.4 Fastenings

Numerous fasteners remaining as iron concretions were located during the conservation and cleaning phase. These were measured as being approximately 5-7 mm ($^{1}/_{4}$") square. There were 19 located on the portside panel [465] and 26 on the starboard side panel [534]. The main line of fasteners run parallel to the rabbet line offset approximately 25 mm (1"). From there, the lines of fasteners roughly run perpendicular off that line to the opposing edges, spacing the nails by three divisions or more (Figure 4.30).

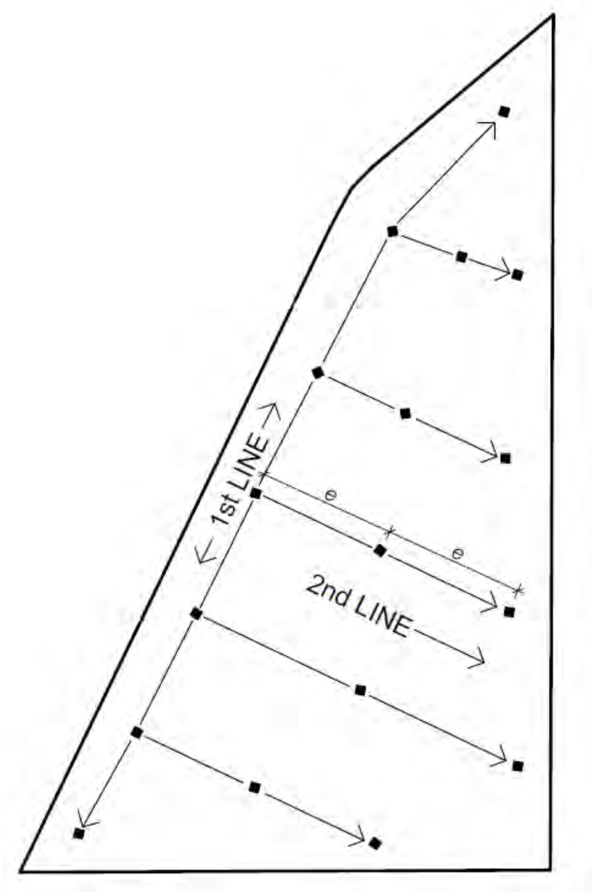


Figure 4.30: Possible outer garboard shelf on stern fastener layout plan. First line of fasteners run parallel to the rabbet line. Second run perpendicular to distribute load. Space is divided equally. (Source: Benjamin Wharton 2021).

4.3.4.5 Other

The outer surfaces, more particularly for the starboard panel [534], were coated in pitch and shells. The internal faces, upon removal had a layer of the assembly white putty also found between planking layers (Figure 4.31 and Figure 4.32).

Figure 4.31: Internal side of starboard rabbet cheek panel [534]. Showing assembly white putty, nail holes. Scale is in 100 mm increments. (Source: Casey & Lowe).

Figure 4.32: External side of starboard rabbet cheek panel [465]. Scale is in 100 mm increments. (Source: Casey & Lowe).

4.3.5 Gudgeon and Pintle [544a, 544b]

There appears to be the remains of a gudgeon and pintle in the form of an iron concretion attached to the aft-most end of the portside garboard shelf boards [540] and [543] (Figure 4.33). Further conservation and cleaning of the artefact pieces will provide a clearer understanding of what exactly was removed. At the time of excavation, within the main concretion [544A] removed from the aft end of garboard shelf board [543], there was a ghost image or imprint of a rectangular section of strap being approximately 250 mm (10") long, with a cross section approximately 10 mm x 35 mm ($^{3}/_{8}$" x 1 $^{3}/_{8}$"). Two nail holes were also evident along this ghost impression (Figure 4.34 and Figure 4.35). Concreted to the end was what appeared to be 'U' shaped remains of the corresponding strap for the rudder, with a pin protruding upwards. The strapping for the rudder, although removed in one piece, broke before the recording and packing stage which resulted in the loss of the dimension of the rudder thickness. Conservation and reconstruction of these parts will be beneficial to a greater understanding of the details of the gudgeon, pintle and rudder components. Due to the fact that the pin was above the rudder strap, not below, it is presumed that the assembly consisted of the pintle being affixed to the stern of the vessel while the gudgeon held the rudder. With the placement of the pintle strap on the garboard shelf board the pin would have to be bent to the angle of the rake for the rudder to turn, or the strap could have been higher and affixed to the rabbet cheek panels and slipped down after the fasteners corroded (see Figure 4.36).

Figure 4.33: Gudgeon and pintle prior to removal. (Source: Casey & Lowe Recovery Video still, #150, 2018, 0:00:07).

Figure 4.34: Rudder gudgeon strap at time of removal. (Source: Casey & Lowe Recovery Video still, #151, 2018, 0:00:54).

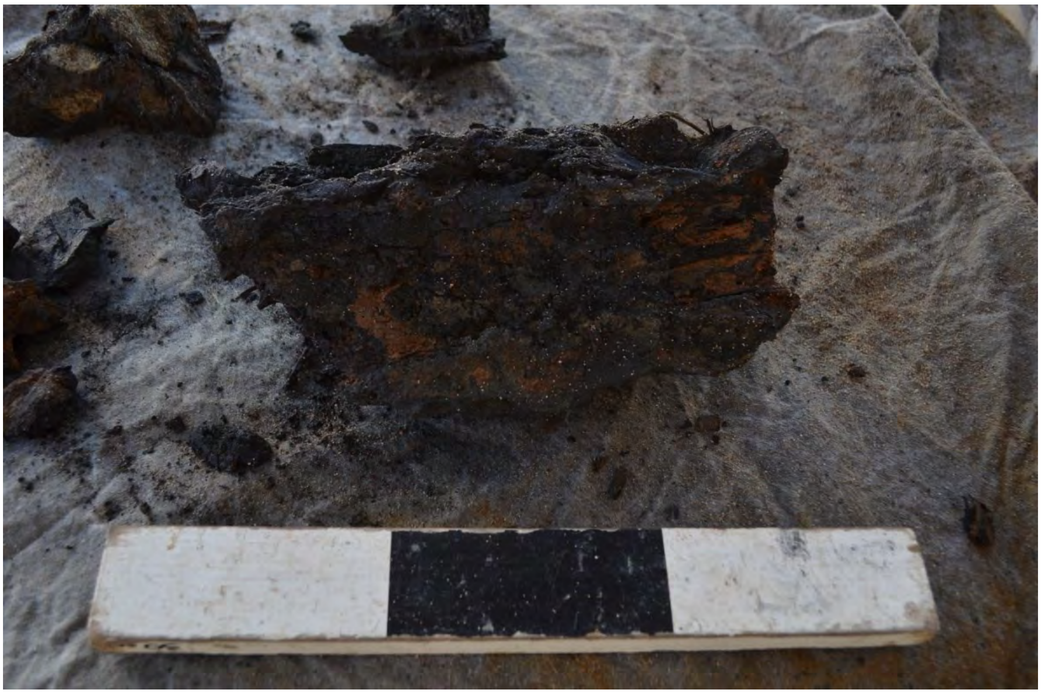


Figure 4.35: Iron concretion ghost of pintle strap [544A] removed from the portside aft end of garboard shelf board [543]. Scale is in 100 mm increments. (Source: Casey & Lowe).

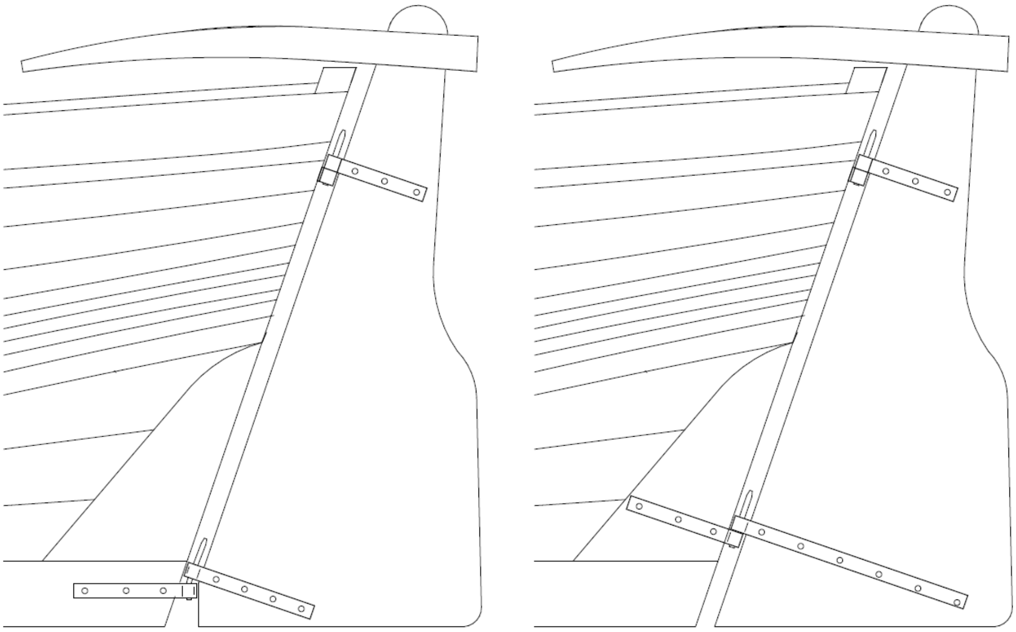


Figure 4.36: Diagrams showing pintle affixed to the stern of the vessel while the gudgeon was attached to the rudder. Example on the left shows pintle strap aligned with garboard shelf board, and on the right shows aligned perpendicular to the rake. (Source: Benjamin Wharton 2021).

Figure 4.37: Gudgeon and pintle on model longboat.

4.4 Stem Assembly

The stem assembly provides the vertical structural framework at the bow of the vessel to which the hull planking is attached. Very little remains of the stem assembly, however from what does remain, the stem assembly most likely consisted of a stem, apron and stem knee. The stem was the fore-most vertical component to which the hood ends of the hull planking were fastened to. The apron supports the stem abaft and provides a larger area for the bearding line to affix the planking hood ends. Supporting the apron and stem is the stem knee, which, in the same way as the stern knee, provides structural reinforcement and lateral support to the joint of the keel and stem (Figure 4.38.) In terms of its construction, the stem and apron were fastened to the top face of the rider keel [551]. Abutting the apron was the keel [055], to which the knee was fastened. In this assembly, no construction joints were used, such as the half-lap joint used for the sternpost.

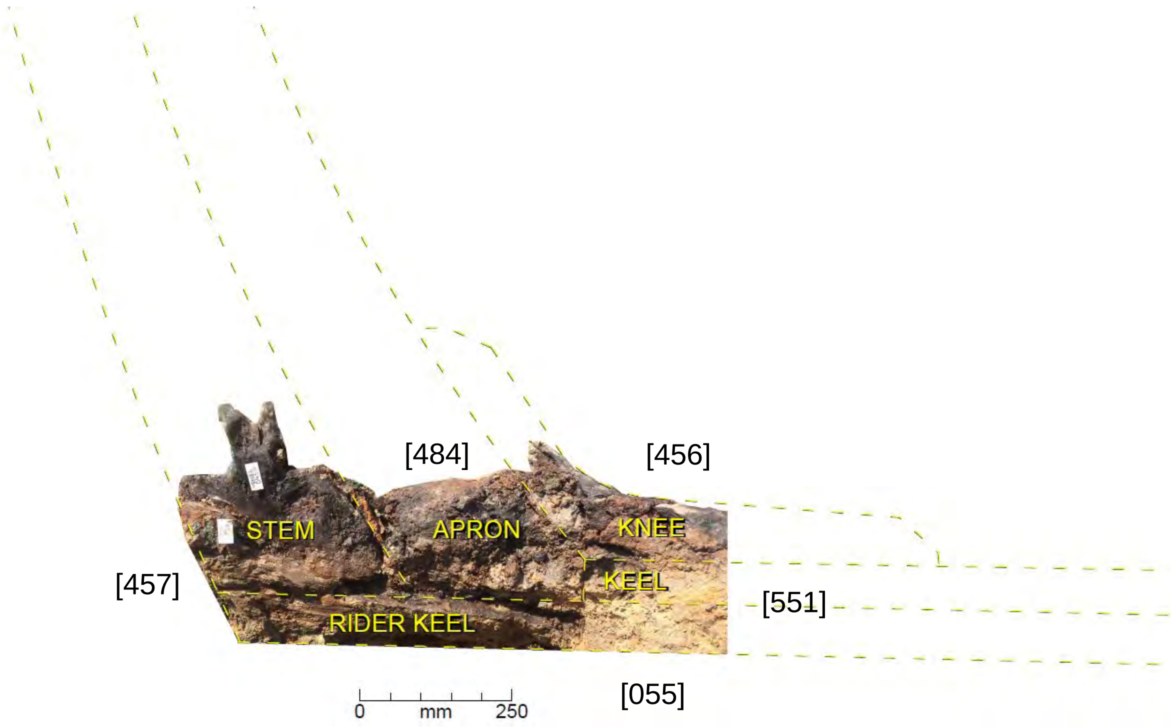


Figure 4.38: Stem assembly* in situ *partly excavated, portside. Dashed lines indicating likely projection of timbers originally. (Source: AMBS, 2021).

4.4.1 Stem [457]

Very little remains of the stem, however, what remains provides useful information to assist in understanding the form and construction of the vessel (Figure 4.39).

Figure 4.39: Stem [457] starboard side with garboard strake plank pieces [521] and [458] in place. Scale is in 100 mm increments. (Source: Casey & Lowe element recording photograph collection 2018).

4.4.1.1 Condition at time of excavation

The stem was highly degraded when recovered with approximately only 10% remaining. The integrity or composition of the timber was poor. The aft-most end was fragile. The stem *in situ* was leaning over to the starboard side by approximately 45°.

4.4.1.2 Dimensions and shape

What remains of the stem is a preserved length along the keel line, with the sided thickness and fore rake, being 243 mm ($9^{5}/_{8}$") long, 44 mm ($1^{3}/_{4}$") thick, with a rake of approximately 23° forward. Approximately 240 mm ($9^{7}/_{16}$") remains of the height of the highly degraded stem.

4.4.1.3 Timber Species & Cut

A timber sample was taken of the stem and was identified as Sydney Blue Gum.

4.4.1.4 Fastenings

During the cleaning, scanning and conservation stage, fasteners were identified in the stem. Three large iron nails, spikes or dump bolts were vertically positioned to fasten the stem into the rider keel with approximately twelve iron nails driven into the rider keel from the lower edge of the starboard side of the stem, and nine on the port side.[74]

Remains of copper nails were also found with copper sheathing on the fore end of the stem.

4.4.2 Apron [484]

Very little remained of what would have most likely have been the apron. The apron supports the stem and provides a surface to attach the hull planking while their respective hood ends fit into the rabbet of the stem. The apron is positioned between the stem [457] and the stem knee [456], abutted to the fore-most end of the primary keel [055] and on top of rider keel [551].

4.4.2.1 Condition at time of excavation

At the time of the recovery and disassembly of the vessel the timber of the apron [484] was heavily degraded, and as such was only recoverable in a number of pieces. The state of the timber was noted as being 'spongy' with sediment and wood remains. The sediment appears to be a mix of pitch.

4.4.2.2 Dimensions

The remains of the apron were 270 mm ($10^5/_8$") long fore-to-aft along the keel line, and as wide as the rider keel below it - approximately 58 mm ($2^1/_4$") wide. There was approximately 160 mm ($6^5/_{16}$") of remaining height where it had been broken at some time along with the rest of the stem components.

4.4.3 Stem Knee [456]

The stem knee provided structural reinforcement and lateral support joining the keel and apron of the stem. The element [456] in the remains of wreck UDHB1 was positioned on top of the primary keel [055] and behind the stem and apron (Figure 4.40). There was a slight upturn in the remains, which together with its location, makes it likely this element is the stem knee. A small triangular ferrous plate was recorded as having been on the side of this element, presumably the starboard side.

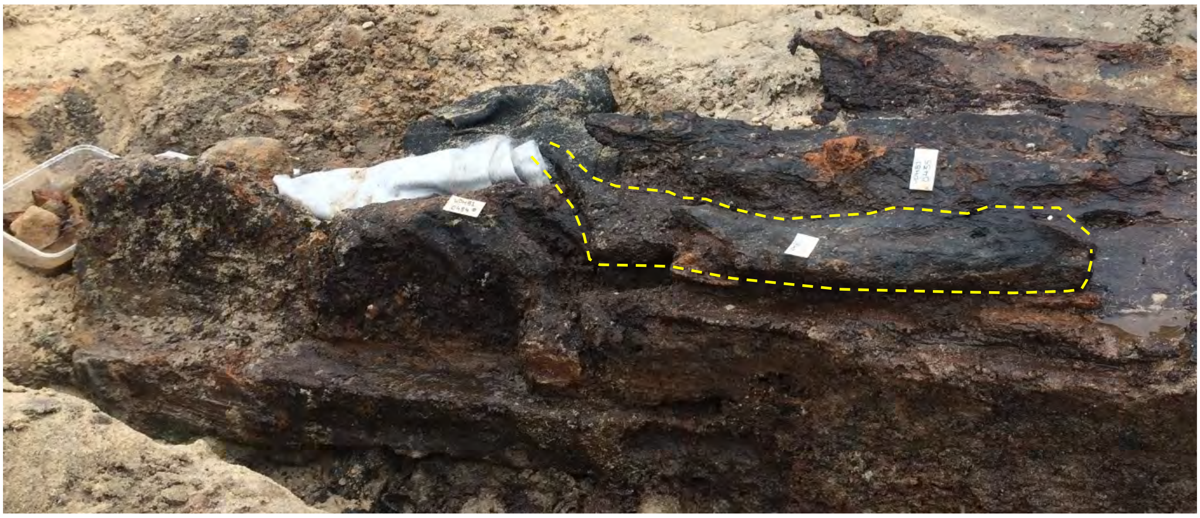


Figure 4.40: Stem knee* in situ *prior to removal. Note the stem is leaning over starboard side. (Source: AMBS).

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[74] *Silentworld Foundation 2020 Digitised record sheet 'UDHB1_457',*

4.4.3.1 Condition at time of excavation

Little remains of what was identified to most likely be the stem knee. Along with the rest of the bow end of the vessel, the remains were severely degraded and in poor condition (Figure 4.41 and Figure 4.42). What remains of the stem has broken into two pieces, about halfway.

Figure 4.41: Stem knee [456]. Scale in 100 mm increments. (Source: Casey & Lowe).

Figure 4.42: Stem knee [456] view aft from stem. Scale in 10 mm increments. (Source: Casey & Lowe).

4.4.3.2 Dimensions

The length of the stem along the keel line is approximately 460 mm ($1^{1}/_{2}$'), however, it may have originally been longer, as the stern knee is 610 mm (2') long. A forward rake of approximately 27 degrees was recorded during on-site recording (Figure 4.43).

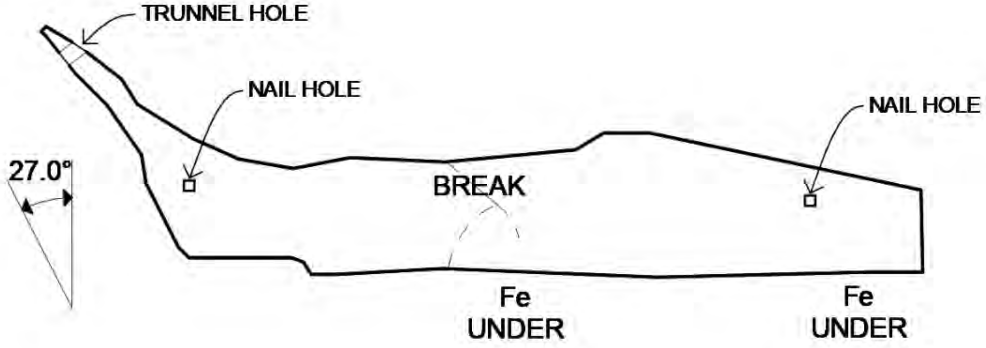

Figure 4.43: Stem knee [456] portside drawn elevation of remains. Diagrammatic only – not to scale. Traced photograph with features from recording sheet and site drawings added to approximate locations. (Source: Benjamin Wharton 2020).

4.4.3.3 Timber Species & Cut

No samples were taken for the stem knee; however, it is most likely, from the collection of samples taken elsewhere on the vessel, that it would have been locally procured hardwood. As with all of the framing in this vessel, the stem knee would be expected to be a grown/compass/crooked timber, selected for its required angle. This would be determined by closer examination during the conservation phase.

4.4.3.4 Fastenings

Fastener holes were identified during the recording phase. There were two square holes, approximately 5-7 mm ($^1/_4$") in size in the sides of the knee, and a possible hole of a 9-10 mm ($^3/_8$") treenail at the broken end of the upturn which could have fastened the stem to the apron (Figure 4.44). The size of the fastening suggest it might have served as a substantial fastening, such as a dump bolt.

Figure 4.44: $^3/_8$" treenail hole in stem knee [456]. Scale in 1 mm increments. (Source: AMBS).

4.5 Hull Planking

After the keel had been laid and the stern and stem assemblies constructed, the planking of the hull was then added. The hull of UDHB1 was double planked, constructed with clenched lapstrake planking, vernacularly termed 'clinker,' which means the edge of each plank overlaps the one below it and are then fastened together. The planking will be described in its two categories of inner planking and outer planking.

As the boat had been pulled up onto the shore, it was located resting on its starboard side and tilting upwards at the bow. Resting on a level horizontal plane has resulted in most of the port side, and the bow of both port and starboard sides to have been lost. Twelve strakes remain on the starboard side and eight on the port, with the majority of those remaining at the stern and midships.

With regard to the hull shape, the planks from the garboard strake to the eighth strake form the bottom of the hull, then the ninth to the twelfth strakes formed the topside of the hull with possibly another two strakes that are missing. The bottom and topside planks were lapped with little to no bevelling, with only the strakes at the bilge using a bevel to change the hull shape leaving a visible single chine between the bottom and topside (Figure 4.45).

Figure 4.45: Isometric view of inner hull planking after frames removed. Chine visible between the eighth and ninth strakes being the intermediate bilge area between the bottom and topside strakes of the hull. Bow bottom left. (Source: photogrammetry recording and model by Guy Hazel 2018).

4.5.1.1 Condition at time of excavation

On the port side, eight strakes remained on the wreck. The majority of the planks that remained were from the garboard strake and were nearly whole. Each strake above the garboard diminished from both the stern and bow with the result that only the midships planks remained at the eighth strake. On the starboard side it is similar, although the planks extend up to the twelfth strake, with the majority of the remaining planks being at the stern and midships and less at the bow.

The condition of the planks, except for those extending to the bow, were in relatively good condition, with their integrity being maintained by the covering of pitch (see Section 4.10). The majority of damage to the individual lengths of planking have been either splits that have occurred along fastening lines or broken and deteriorated ends. The planking has distorted and sagged under strain when the vessel was rested over on its starboard side, and eventually filled with loose timber offcuts and infill. An example of this distortion can be seen where the garboard planks fit into the rabbet of the keel, and the sagging has altered the shape of the hull (see Figure 4.1).

A pin test was carried out on each plank as it was removed from the vessel. This measured the softness of the timber by how far the pin would easily press into the wood and was classified in groups of 0-2 mm, 2-5 mm, 5-10 mm and >10 mm. The results were that the majority of the planks had relatively retained their hardness, as there were forty-seven recordings of the pin depth at 0-2 mm and thirty-two at 2-5 mm. There was one account each for the 5-10 mm grouping and the >10 mm group and a few planks returned multiple recordings along the length of the plank ranging from 0-2 mm to >10 mm.

4.5.1.2 General planking characteristics

Both the inner and outer layers of planking were made of various local hardwoods used throughout the hull. The planks were laid over one another in the lapstrake, or clinker, tradition and fastened together with clenched iron nails (Figure 4.46). The planks were scarfed together to make the full length of a strake of the hull by using two or three planks to make up each strake. The planks were generally between 179-230 mm (7-9”) wide and 15-20 mm ($^{5}/_{8}$”-$^{3}/_{4}$”) thick. The planking was coated inside and out with pitch for anti-fouling.

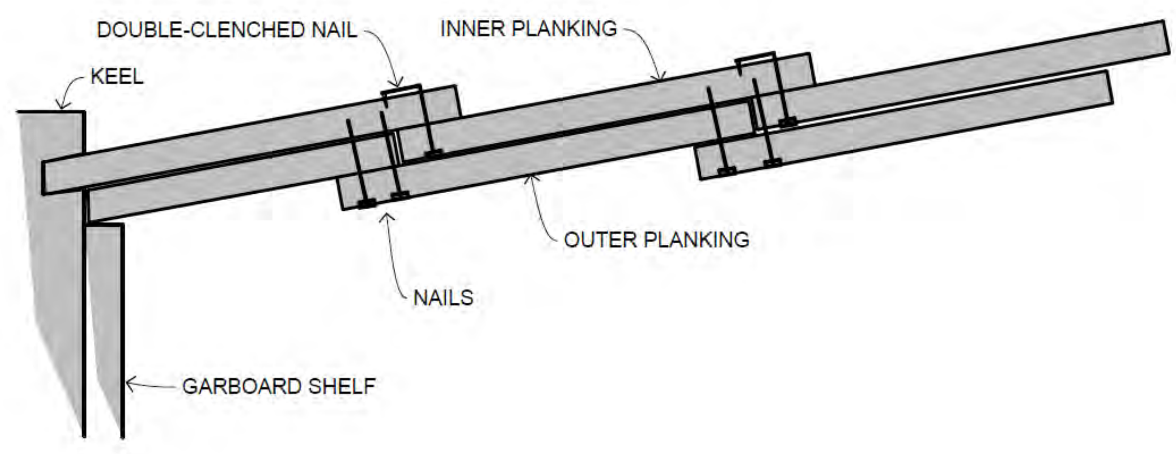

Figure 4.46: Cross section diagram of inner and outer layer planking. (Source: Benjamin Wharton 2021).

4.5.2 Inner Planking

The inner, or primary planking, was the first layer of the hull constructed on the vessel. The hull planking strakes are not complete, with eight strakes remaining on the port side and twelve on the starboard side. To make up the full length of a strake, two to three planks were needed for each. A total of forty-six planks of the inner hull remain, with fourteen on the port side and thirty-two on the starboard side. In total a length of 110.059 m (361 ft) of timber remains of the inner hull planking.

4.5.2.1 Dimensions

The maximum length of a single plank [495 S-I-S2-F] in the inner hull is 4.17 m (13’8$^{1}/_{8}$”), however it is not its original length, and would have been longer; likely closer to 4.57 m (15’) in length. The average plank length is 2.43 m (7’11$^{3}/_{4}$”) and the shortest length of planking – discounting broken lengths – was plank [523 S-I-S3-M] with a length of 1.78 m (5’9$^{7}/_{8}$”).

The majority of planking widths at midships were from 179 – 230 mm (7”-9”) wide). The width of the planks was tapered, being narrower at the aft end above the tuck, widening at the midships and then reducing in width towards the bow.

The thicknesses of the inner hull planks varied in size, however, the most common thickness recorded on the inner planking of the vessel ranged from 15-17 mm ($^{5}/_{8}$”) to 18-20 mm ($^{3}/_{4}$”) thick. A number of factors have likely affected the planking thickness, including how they’ve been ripped, the fairing, the amount of pitch covering and deterioration. As the planks were ripped by hand – either with an open pitsaw or a frame pitsaw – the thickness can vary by the cut, meaning the variation could be 3 mm ($^{1}/_{8}$”) or more. In fairing the hull of the vessel, planks become thinner towards the bow and stern, in order to shape the plank better to fit the next one for a smooth continuation of shape.

Outside of the most common thicknesses outlined above, the greatest recorded thickness of the inner planking was 30 mm (1$^{1}/_{8}$”) thick, being the fore-most garboard plank [438 P-I-S1-F] of the port side close to midships. The thinnest recorded thickness was just 9 mm ($^{3}/_{8}$”) for plank [440 S-I-S3-F] on strake three of the starboard side towards the bow.

4.5.3 Outer Planking

The outer, or secondary, planking was the second layer constructed on the hull. The remains of the hull planking strakes of the outer planking follow those of the inner, with eight strakes remaining on the port side, and twelve on the starboard side. A total of forty-five planks remain of the outer hull, with seventeen on the port side and twenty-eight on the starboard side. In total a length of 114.063 m (374’2”) of timber remains of the outer hull planking (Figure 4.61).

4.5.3.1 Dimensions

The maximum original length of a single plank [529 S-O-S2-A] in the outer hull is 4.9 m (16’). The average length is 2.54 m (8’3¾”), while the shortest original remaining length of planking – discounting broken lengths – was plank [509 P-O-S4-M] with a length of 1.28 m (4’2$^{3}/_{8}$”).

As the outer layer of planking followed the constraints of the inner layer, the widths of the planks were generally the same. The majority of planking widths at midships were from 179 - 230 mm (7”-9”) wide. As with the inner planking, the width of the planks was tapered, being narrower at the aft end above the tuck, widening at the midships and then reducing in width towards the bow.

The thicknesses of the outer hull planks varied in size, however, the most common thicknesses recorded were 12-14 mm ($^{1}/_{4}$”) to 18-20 mm ($^{3}/_{4}$”) thick.

The variance in thickness of the second layer of planking was again the same as the first with the number of factors that affect the recording of plank thickness, including how they've been ripped, the fairing, pitch covering and deterioration. Due to the nature of the planks being ripped by hand – either with an open pitsaw or a frame pitsaw – the thickness will vary by the cut, meaning the variation could be 3 mm ($^{1}/_{8}$") or more. Outside of the most common thicknesses, the thinnest thickness was 10 mm ($^{3}/_{8}$") on planks [531 P-O-S1-F, 532 S-O-S1-A] from both the garboard strakes of the port and starboards sides.

4.5.4 Scarf joints

The planking lengths were scarfed together to make one strake. All of the scarf joints followed common practice for their placement and direction, however, by modern standards were relatively small in ratio.

The scarf joints alternated positions from strake to strake so that no joint lined up above or below any other to ensure structural stability and strength. However, they were not necessarily positioned in a planned manner in respect to the framing, as the frames were installed afterwards.

The direction that the scarf angle faced was angled so that it projects from the inside face of the planking outward aft to ensure that water flows past the hull and not into the joint (Figure 4.47).

On the inner planking the scarf joints were sealed with a strip of fabric to provide a matrix for a sealant to adhere to both surfaces (Figure 4.48). It is unknown at this stage what type of fabric was used, nor what was used for the sealing mixture. Further research is required to analyse the type of fabric used and what constituted the sealant. Future research is also required to examine the outer plank scarfs more closely, in order to determine if fabric was also used on these.

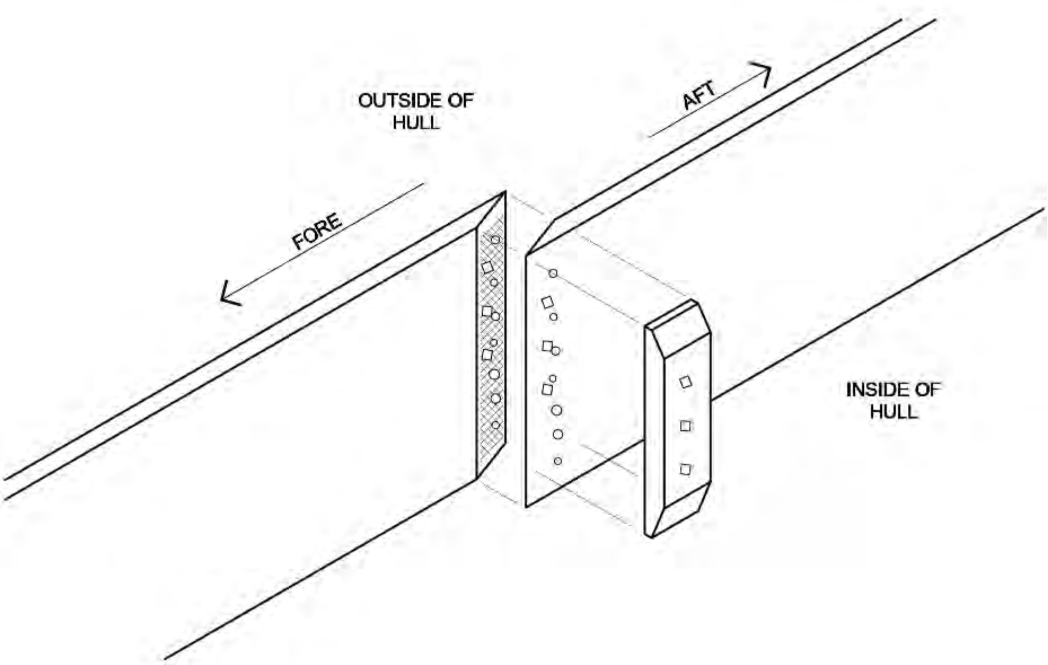

Figure 4.47: Diagram of UDHB1 typical 1:3 scarf joint with sealing fabric strip and scarf plate (see Figure 4.49). Diagram shows the correct way for a scarf to angle outwards and aft. Example 200 mm wide plank, 17 mm thick with a 50 mm scarf. Backing plate 150 mm long (to account for the lap) x 12 mm thick. (Source: Benjamin Wharton 2021).

Figure 4.48: Scarf joint on aft end of portside plank [346]. The weave of the fabric can be seen under the film of iron staining. Scale in 1 mm increments. (Source: AMBS).

4.5.4.1 Scarf ratios

The scarf ratios of the inner and outer planking varied slightly throughout the vessel. Further research is required to take exact measurements of the scarfs with respects to understanding relationships plank-to-plank. Not all of the information required for calculating ratios was recorded during the excavation phase, however, enough information was gained to provide a general idea of the scarf ratios.

Of the inner planking, fifty-two were calculated. To account for variance in recording accuracy and condition of the timber, the calculations were rounded to the nearest whole number. Of the fifty-four scarf angles calculated, the majority were from 1:2 to 1:3. The largest calculated were four angles of 1:4, one each of 1:5, 1:7, 1:8 and 1:11. These larger calculations may be a result of an error during recording, as the corresponding scarf ratios do not necessarily match.

The outer planking ratios were larger than the inner planking. Thirty-nine scarf angles were calculated, of which the general sizes ranged from 1:5 to 1:7 with the majority of seventeen being 1:6 – twice as large as the inner planking. The smallest size was 1:3 and the largest sizes being three of 1:8 and one 1:10.

4.5.4.2 Scarf plate

Twenty-six scarf joints were identified in the remains of the inner planking. Sixteen of the these were reinforced with a scarf plate, and the remaining ten were either covered with frames at the joint, or if now exposed may have originally been covered (Figure 4.49).

The scarf plates were made from timber, generally the same thickness as the planking, and was as wide as the scarf that it was covering. The length varied, however, they were shorter than the plank width as the overlap from the plank below reduced the surface area required to cover. The edges were treated with heavy chamfers, either at just the top and bottom or around each edge.

It appears that some of the plates that have visible fastener holes had less fasteners than the scarf itself; meaning that they may have been attached afterwards and nailed into the already fitted planks from inside the hull.

Figure 4.49: Scarf plate [478]* in situ *on plank [324 P-I-S3-A]. Note the length of scarf plate ends at land of overlapping plank. (Source: Casey & Lowe).

In some cases, as shown in Figure 4.50 and Table 7, the frames were located where a scarf plate was, and the frame was simply joggled to fit over the top. It has been suggested that scarf plate [348] over plank 518 may have been a thwart shelf.

Figure 4.50: Scarf joint layout. Diagram shows placement of frames over scarf joints, and scarf joints with scarf plates. (Source: Benjamin Wharton 2020 using Casey & Lowe base plans: Plan_16.W5 and Plan_16.W6).

Table 7: Scarf joint table of inner planking. *'Cover' displays whether a scarf joint was covered or not, and by what: a scarf plate or a frame.*

Strake	Port fore-to-aft					Starboard fore-to-aft				
	Plank	cover	plank	cover	plank	plank	cover	plank	cover	plank
1	438	474 plate	407	488 plate	318	400	open	341	n/a	n/a
2	494	short frame	311	n/a	n/a	495	425 plate	495	frame	313
3	492	414 plate	393	478 plate	n/a	440	486 plate	523	479 plate	302
4	406	missing frame	346	broken frame	311	441	frame	518	348	333
5			366			442	525 plate	517	frame	323
6			403			444	411 plate	512	467 plate	316
7			481			466	496 plate	498	open	305
8			480			448	412 plate	497	open	306
9						450	422 plate	381	360 plate	307
10						462	388 plate	338	n/a	n/a
11						499	tingle	375	n/a	n/a
12						460	n/a	374	n/a	n/a

4.5.5 Repairs and/or Modifications

There were noticeable repairs to the planking that were observed during the disassembly of the vessel. The majority of repairs was the use of lead tingles on the hull and there was also an infill repair, or 'Dutchman' to a plank edge.

Two planks [461 S-O-S12-F] and [501 S-O-S10-F] on the starboard side of the outer planking, above the waterline on strakes 10 and 12, had squares of lead identified during on-site recording.

Plank [461 S-O-S12-F] tingle was 65 mm x 70 mm ($2^{1}/_{4}$" x 3") and tingle of plank [501 S-O-S10-F] was 40 x 80 mm ($1^{3}/_{4}$" x $3^{1}/_{4}$" in).

Tingle [515] was not recovered from the vessel directly; it was located in the soil deposit near the bow on the starboard side. It was made of lead and measured approximately 80 x 75 mm ($3^{1}/_{4}$" x $2^{15}/_{16}$") with a step of 22 - 25 mm ($^{13}/_{16}$"-1"), and 1.5 – 2 mm thick. At the time of recording only one fastener hole was visible, and measured 3 mm ($^{1}/_{8}$") diameter (Figure 4.51 to Figure 4.52).

***Figure 4.51: Tingle [515] external view*.** Smallest box on graph paper = 1 mm. (Source: Benjamin Wharton 2020).

Figure 4.52: Tingle [515] internal view. Smallest box on graph paper = 1 mm. (Source: Benjamin Wharton 2020).

Tingle [516] was recovered during the planking disassembly attached to plank [306 S-I-S8-A] and stepped down to lap plank [304 S-O-S7-A]. It too was made of lead and measured approximately 95 mm ($3^3/_4$") long by 92 mm ($3^5/_8$") wide, with a thickness of 1.5 mm (Figure 4.53). No fasteners remained, however the holes around the edges were 2-3.5 mm ($^1/_8$") diameter. There are also two larger holes from square nails which line up to where frame [376 FT-2] was originally positioned. Further examination is required to see if these nail holes were to fasten the frame in place, or if the outer plank simply fastened itself to an existing frame location for strength.

The third tingle was attached to an inner plank [499 S-I-S11-A] on the eleventh strake of the starboard side towards the bow. From the recording context sheet of the plank, it appears that it was used to either reinforce the scarf joint or close a gap in the joint, which, could provide context for the other tingles (Figure 4.54 and Figure 4.55).

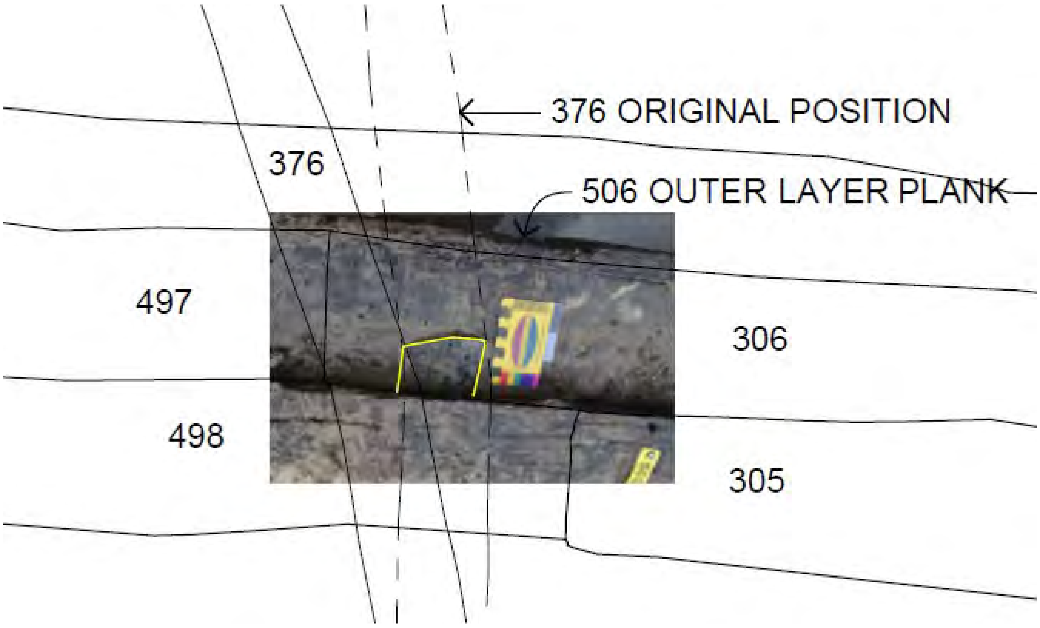

***Figure 4.53: Tingle [516] location* in situ**. Location shows that tingle (yellow line) sat behind where frame [376 FT-2] originally was positioned, which shifted when the hull disformed from the sandstone block underneath. Note that plank behind tingle in photograph is outer hull plank [506 S-O-S8-A] – planks [497 S-I-S8-M] and [306 S-I-S8-A] had been removed revealing the tingle in place (Source: Benjamin Wharton 2021, using Casey & Lowe Plan_16. W6 and Casey & Lowe *in situ* photographic recording 2018).

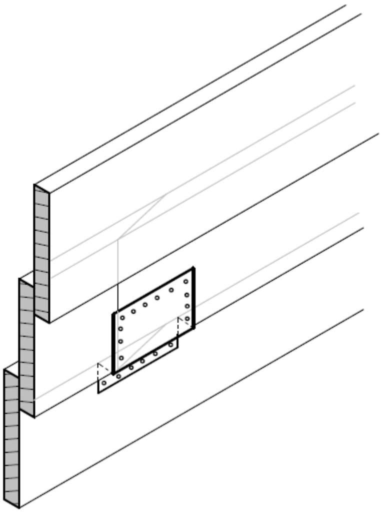

Figure 4.54: Tingle over scarf joint diagram. Probable location of tingle after example found on plank [499 S-I-S11-A]. The upper side of the joint would be reinforced by the plank laid above. (Source: Benjamin Wharton 2021).

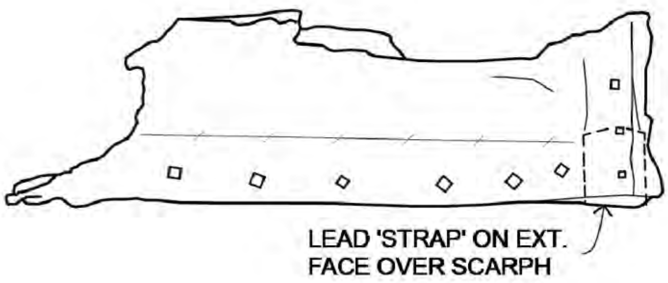

Figure 4.55: Internal face of Plank [499 S-I-S11-A] with lead strap tingle on the outside of the scarf joint. Tingle is on the lower side of the plank. (Source: Casey & Lowe element recording context sheets 2018 redrawn by Benjamin Wharton 2021).

The fourth tingle was located as a separate item during the cleaning phase and it is not known what timber it was attached to. It is possibly also made from lead, though it is iron stained. It is approximately 200 mm ($7^{7}/_{8}$") long and 55 mm ($2^{3}/_{16}$") wide. The angle may provide a clue as to the strake from which it came (Figure 4.56).

Figure 4.56: Lead square [601] from unknown timber located in tanks during cleaning and conservation phase. Reverse side has pitch coating on it. (Source: Silentworld Foundation 2021).

The edges of the tingles are jagged, which makes it probable that they were cut to shape with a cold chisel and mallet as opposed to shears.

It is interesting to note that the tingles have been located above the waterline, the placement of which would not require such watertightness as opposed to lower on the hull. The tingles do not appear to be covering over any holes in the planking, therefore, their purpose could have been to simply tighten an overlap of two planks. More so for the unknown narrow tingle found during the cleaning phase allocated number [601]. This, however, does not necessarily explain the tingles with the larger surface areas on lower planks. It appears, however, that the small squares of lead sheet appear to be infill pieces for a hole.

The other repair noticed during the recovery disassembly stage was a filler piece, or a 'Dutchman' repair. The bottom edge of plank [508 P-O-S5-M] of the fifth strake, midships port side, had a section that had been attached with fasteners driven in from the edge (Figure 4.57 and Figure 4.58). This sort of repair does not necessarily have to be a repair from damage during working life, but could simply be added to a plank, or could fix a break during the working of shaping or fitting the plank during construction. The plank [345 P-O-S5-A] of the same strake scarfed to [508 P-O-S5-M], also had this infill repair on the same edge, however, the infill piece was missing and only the caulking material remained (see Section 1.9.1.3).

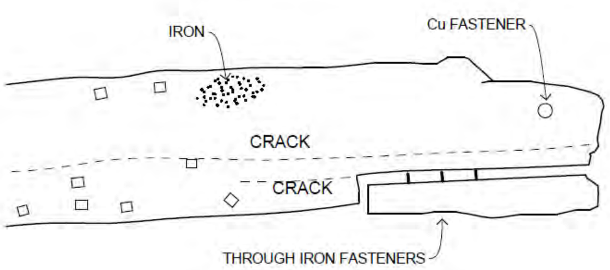

Figure 4.57: Plank [508 P-O-S5-M] 'Dutchman' infill edge repair. (Source: Casey & Lowe element recording context sheets 2018, redrawn by Benjamin Wharton 2021).

Figure 4.58: Plank [508 P-O-S5-M] 'Dutchman' repair. (Source: AMBS).

Another plank [338 S-I-S10-M], on the aft end of strake 10 on the starboard side, had evidence of what at first appeared to be a Dutchman repair with two square 5-7 mm ($^1/_4$") nail holes on its top edge (Figure 4.59). However, when analysed more closely, the nail holes should have continued along the length of the edge face to a shoulder for this type of repair, which it does not. Also, the edge of the land on the outer face continues evenly suggesting this was the top edge of the plank with no damage. It is possible that these two nail holes, given they are high in the strake order, would perhaps be for fastening something inside the hull such as support for a stringer or rising or shelf.

Figure 4.59: Starboard plank [338 S-I-S10-M] with 2 x $^1/_4$" square nail holes on top edge.
(Source: Benjamin Wharton 2020).

Another repair that was identified on the vessel planking was the use of wooden treenails to replace missing or perished old iron nails. These were recognisable as treenails that were square shanked and tapered the same as a hand-forged iron nail. The example shown below was extracted from the scarf of plank [495 S-I-S2-F] during the cleaning and conservation phase (Figure 4.60).

Figure 4.60: Treenail in plank [495 S-I-S2-F].
(Source: Benjamin Wharton 2020).

4.5.6 Timber Species & Cut

Timber samples were taken from various parts of planking, such as the ends of breaks, so as not to ruin the integrity of a plank (Figure 4.61 to Figure 4.64).

On the port side, eight of the fourteen (57%) planks were tested. Six (75%) of the tested planks were identified as being Sydney Blue Gum and two (25%) were identified as Grey Gum.

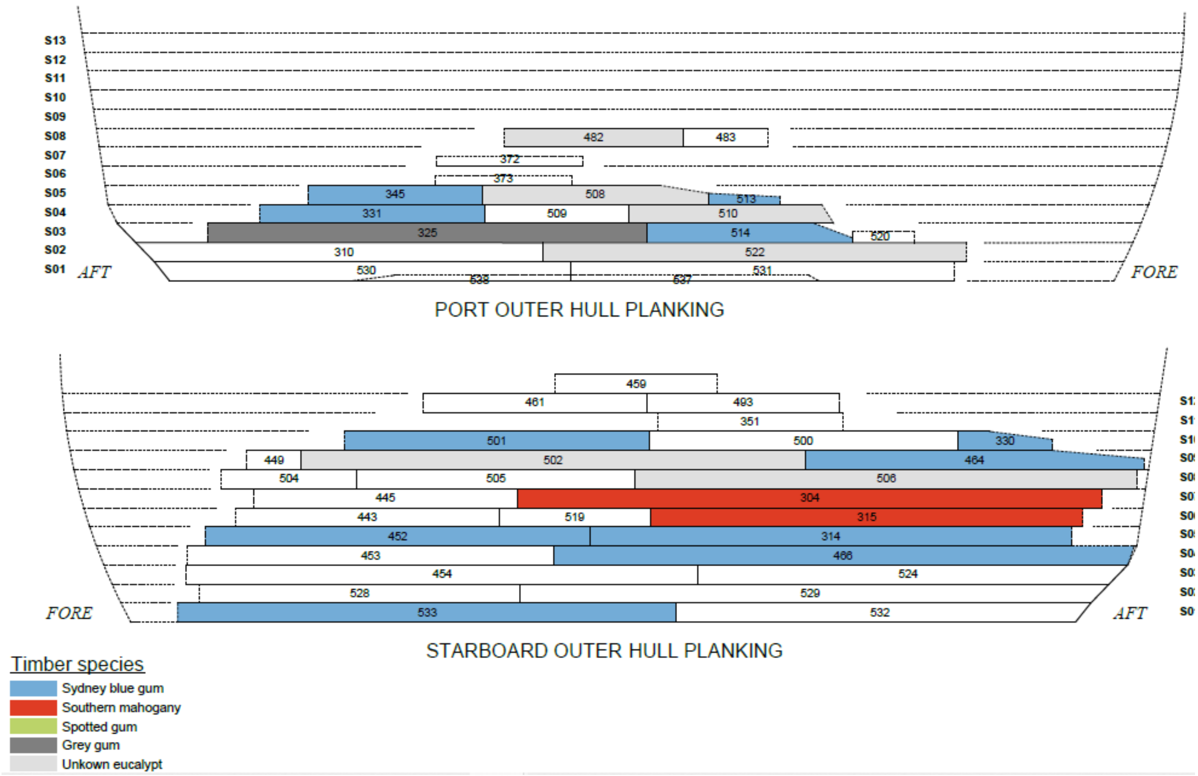

Figure 4.61: Outer planking layout. Showing element numbers, timber species. (Source: Benjamin Wharton 2021).

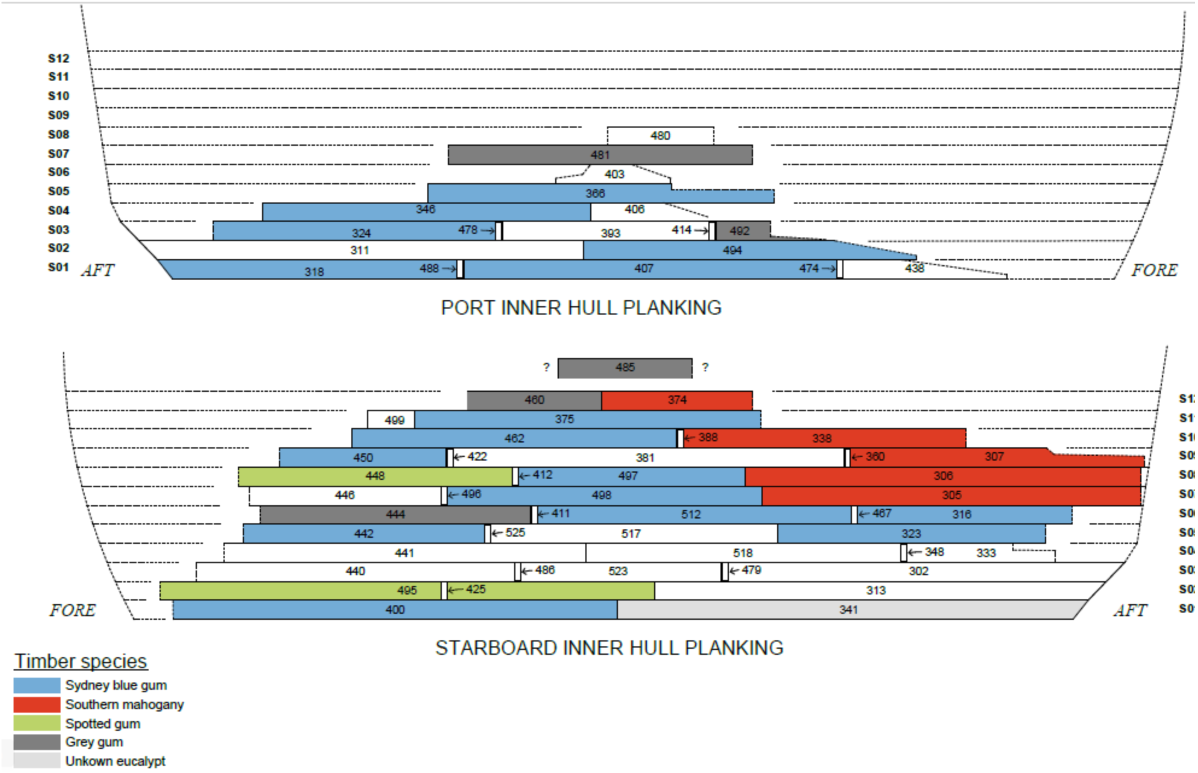

Figure 4.62: Inner planking layout. Showing element numbers, timber species, and scarf plate. (Source: Benjamin Wharton 2021).

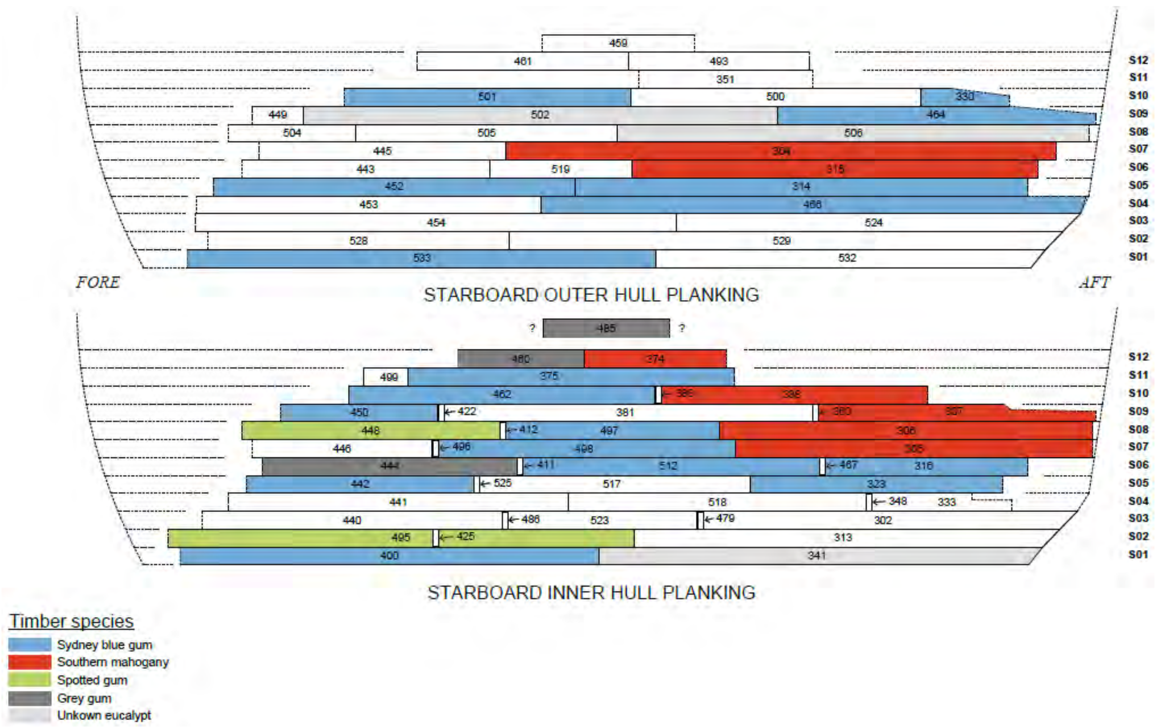

Figure 4.63: Starboard side planking layout. Showing element numbers, timber species, and scarf plate. (Source: Benjamin Wharton 2021).

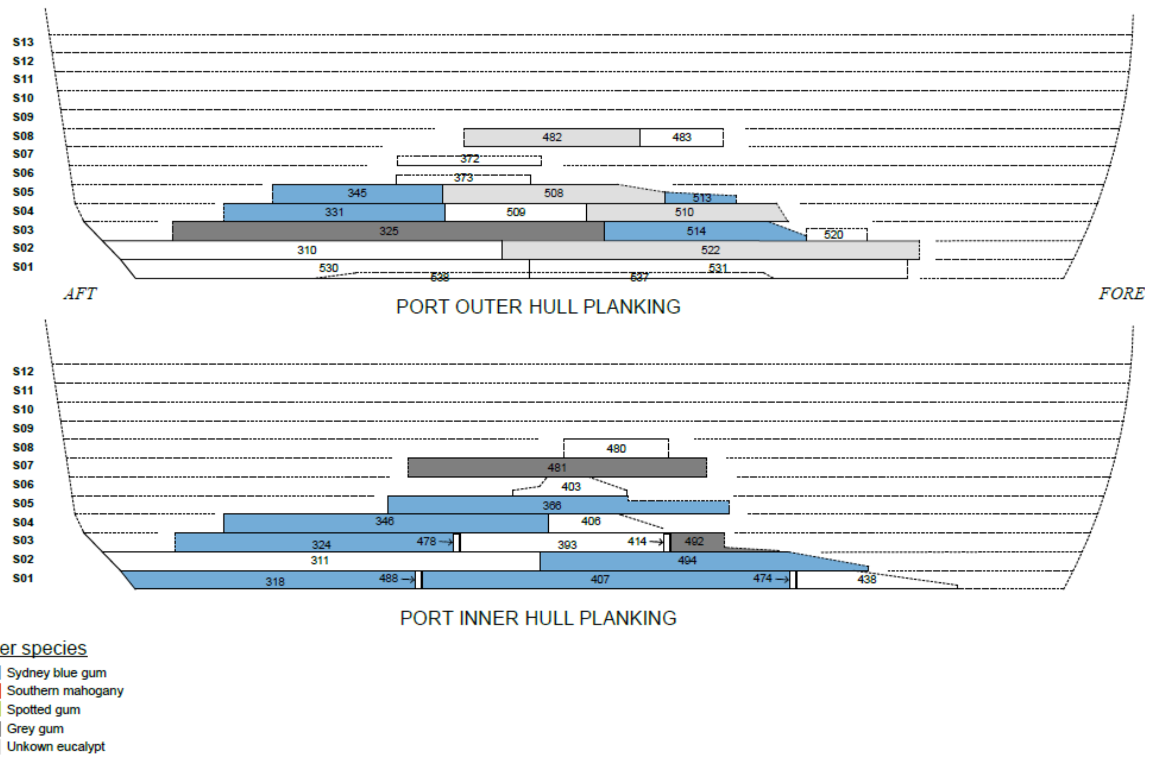

Figure 4.64: Port side planking layout. Showing element numbers, timber species, and scarf plate. (Source: Benjamin Wharton 2021).

On the starboard side there were more species identified. Of the thirty-two planks, twenty-one (66%) were sampled. The results were that ten (31%) planks were identified as Sydney Blue Gum, five (16%) identified as Southern Mahogany, three (9%) identified as Grey Gum, two (6%) identified as Spotted Gum, and one (3%) was too degraded for a specific identification, however, was recognised as being a eucalypt such as Stringybark or gum (Table 8).

On the port side, nine of the seventeen (53%) planks were tested. The results were that four (44%) of the tested planks were identified as being Sydney Blue Gum; four (44%) were identified as unknown eucalypt; and one (11%) was identified as Grey Gum.

On the starboard side, twelve of the twenty-eight (43%) planks were tested. The results were that eight (67%) were identified as being Sydney Blue Gum; two (17%) were identified as being Southern Mahogany; and another two (17%) were identified as being an unknown eucalypt (Table 8).

Table 8: Hull planking timber species. *Bottom row of total being the number of samples to total planks in part of hull.*

Timber species	Inner planking			Outer planking			
	Port	Starboard	Total	Port	Starboard	Total	TOTAL
Sydney Blue Gum	6	10	16	4	8	12	28
Southern Mahogany		5	5		2	2	7
Spotted Gum		2	2				2
Grey Gum	2	3	5	1		1	4
Unknown eucalypt		1	1	4	2	6	9
Total	8/14	21/32	29/46	9/17	12/28	21/45	50/90

4.5.6.1 Type of cut and selection of timber

It appears by the variance of timber species used for the planking that trees were selected not so much for their species type, rather their desirable qualities in shape and condition and perhaps within close proximity to the boatyard as opposed to having access to quantities of felled timber to choose from.

The planking shows signs of saw marks that appear to have been pit sawn, either with an open blade pit saw, or a frame pit saw (Figure 4.65 and Figure 4.66).

While the majority of pit-saw marks are relatively uniform, there are examples with anomalies, such as curved marks. These curved marks were found on planks that also had a majority of pit saw marks (see Section 5.6 for further discussion). These are usually either made from the non-cutting free upstroke of the tiller man, or 'top dog', or are evidence of a difficult section of the timber to cut through, either the timber itself, or the positions and stances of the sawyers changing and shifting to a better position.

Figure 4.65: Pitsaw marks on plank [529] S-O-S2-A. (Source: AMBS).

Figure 4.66: Pitsaw marks on plank [310] P-O-S2-A. Some cut lines with a pit saw sometimes appear curved from when sawyers changed stance or grip. (Source: Benjamin Wharton 2020).

While not every plank will be able to be analysed for its cut from within the log, the grain should be seen more clearly after the cleaning and conservation phase. All of the planks where grain was visible, showed characteristics of having been quarter sawn, except one. Quarter sawn timber is required for its integrity to hold a shape without cupping or warping where the rings of grain attempt to straighten out after being cut. The stability and straight running grain of quarter sawn timber is required when forming the wood into shape by purposeful bending and twisting achieved through steam, heat or a period of submergence in water (Figure 4.67). The one timber which was recognised as plain sawn [517 S-I-S5-M] was positioned midships, meaning that it wasn't required to be bent and strained too much, allowing this plain sawn cut of timber to be suitable for this area of hull (Figure 4.68).

The lengths of timber for planking were rip-cut either with an open or frame pit saw to acquire quarter sawn or as close to quarter sawn as possible.

Not all the planks used were straight grained. Garboard plank [407 P-I-S1-M] of the port side had swirled grain around a *sound* knot, – being a knot which is part of the surrounding timber and will not separate from the parent material (Figure 4.69).[75]

[75] Lucas, A. 1978 The Tools and Materials of Boat Building. Horwitz Publications, p. 94.

Figure 4.67: Scarf showing perpendicular grain having been quarter sawn [498 SI-S7-M]. (Source: Benjamin Wharton 2021).

Figure 4.68: Scarf showing rings of grain having been plain sawn [517 SI-S5-M]. (Source: Benjamin Wharton 2021).

Figure 4.69: Garboard plank [407 P-I-S1-M] of the port side. Swirl evident on plank (direction shown with yellow dashed line) around a 'sound' knot in Sydney Blue Gum. (Source: Casey & Lowe).

4.5.7 Fastenings

Three types of fasteners were identified in the hull planking of UDHB1, the majority were iron, with some copper alloy nails and various uses of treenails. See Figure 4.70 below for an example of starboard plank [304 S-O-S7-A] that contained all three types.

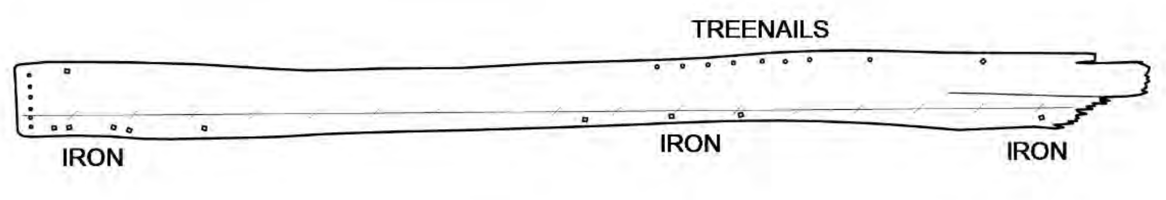

Figure 4.70: Example of various fasteners in a plank [304 S-O-S7-A]. Not noted in the recording was a copper alloy fastener located during the cleaning and conservation phase. (Source: Casey & Lowe element recording context sheets 2018, redrawn by Benjamin Wharton 2021).

It is apparent from what remains that the nails used to fasten the planking together were iron, with a 5-7 mm ($^{1}/_{4}$") square shank (Figure 4.71). One iron nail was recovered from the surrounding context near the stem of the boat which provides an example of a hand-forged rosehead with angled facets up to a point (Figure 4.72). Although there were no other remains of nail heads, it is likely they would have been hand-forged with a rose head.

Figure 4.71: Ferrous ¼" framing nail* in situ *on plank [375 S-I-S11-M]. (Source: AMBS).

Figure 4.72: ¼" hand forged iron square shanked nail with rosehead. Catalogue #2245. (Source: AMBS).

At the time of writing, there does not appear to be any evidence of the nails ending with a rove on the internal face of the inner planking. However, there is evidence to suggest that the nails were clenched, where the nail is driven through an augered or awled hole in the planks and the protruding tip is bent over. Then either the tip is bent again and hammered back into the plank, known as double clenched, or is left flat against the plank as clenched.

Nail holes that are smaller squares, about an inch away from the main size shank of 5-7 mm ($^1/_4$") with an indent in between the two holes are typically identified as signs of clenching, as the smaller square is formed from the tapered tip. Plank [375 S-I-S11-M] is one example where this is evident, as recorded on the context sheet.

It is possible to measure the double clenched holes and the distance between to gain an idea of approximately how long the nails would have been, whereby the length would be equal to twice the thickness of the plank adding the length of the clench and the length of the tip. An approximation of this would equal to about 50-65 mm (2"- 2$^1/_2$"); which were known as 6-8d (penny) nail size.

Copper/copper alloy nails, or clouts, were identified in the planking during the recording phase and later in the cleaning and conservation phase. The nails were located in the outer planking, mostly at the aft-most end in planks [464 S-O-S9-A], [506 S-O-S8-A], and [304 S-O-S7-A], where the transom may have been (Figure 4.73 to Figure 4.75). There were also two copper alloy nails identified amidships on planks [504 S-O-S8-F] and [508 P-O-S5-M].

Figure 4.73: Tips of copper fasteners* in situ*. Aft-end of plank [464, SO-S09-A]. (Source: AMBS).

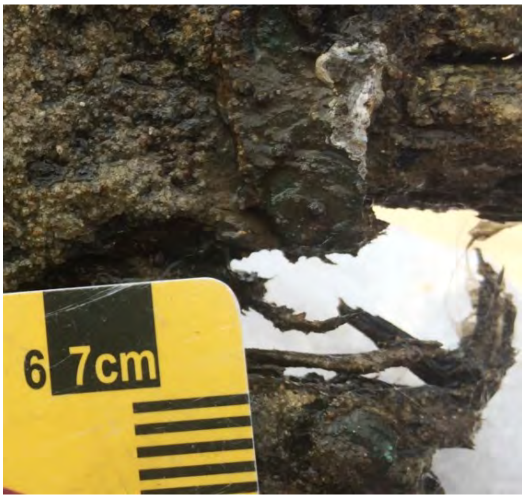

Figure 4.74: Head of copper fastener* in situ*. Aft-end of plank [464, SO-S09-A]. (Source: AMBS).

Figure 4.75: Copper alloy fasteners from plank [506 S-O-S8-A]. (Source: Benjamin Wharton 2020).

In the planking there were two recognisable types of treenail fasteners: one being round-shanked and the other square-shanked. It is likely that the smaller square-shanked treenails in the planking are repairs to replace failed iron nails, with the square shanks to match the existing hole made by the iron nail (see Figure 4.60). Figure 4.76 and Figure 4.77 are examples of square shanked treenails *in situ*.

Figure 4.76: Treenail in plank [545 S-O-S3-F]. (Source: AMBS).

Figure 4.77: Treenail in plank [545 S-O-S3-F]. (Source: AMBS).

4.5.7.2 Fastening patterns

Within the planking there remains evidence of the fastening patterns which aids in determining what fastens to what, where, and when.

Figure 4.78 shows some possible fastener locations and sequence. Frame to keel is attached using a dump bolt or spike. The inner layer planking is fastened with double clench nails, and the outer layer is nailed to the inner layer – note both examples showing different patterns of pairs of nails from the outer into the inner plank – both resulting in nails close to the edges of the planks. The framing is fastened in pairs per plank, one option being driven from the inner planking only, and the other being driven from the outer planking. In either of the options, it is clear that the inner planking will demonstrate an array of fastener holes in its surface. It is likely the nails would have been driven in at a slight angle and in a dovetail fashion to lock the timbers into position.

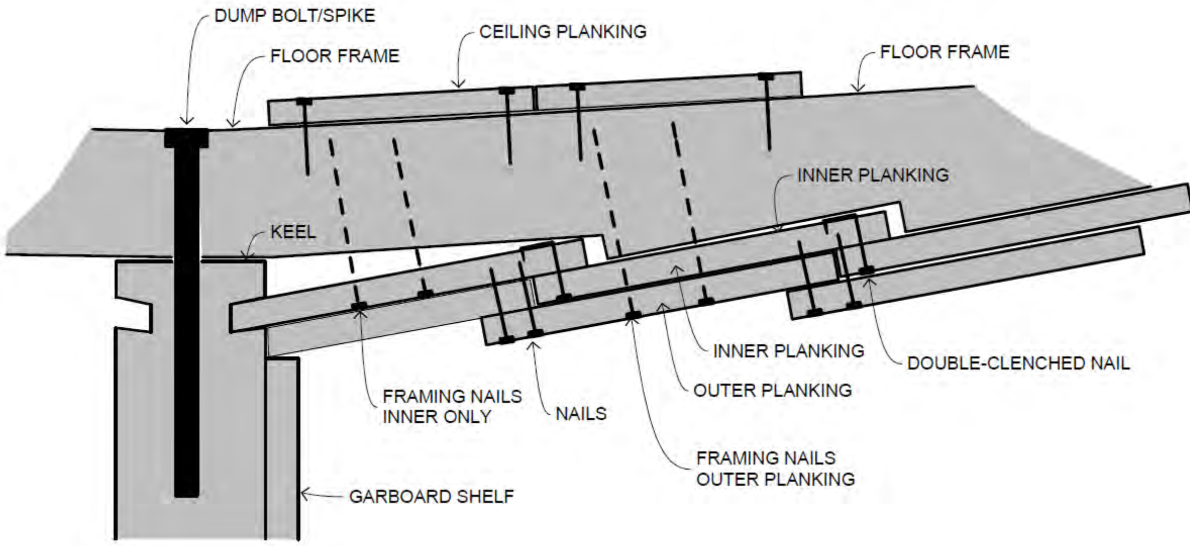

Figure 4.78: Hull cross-section diagram of possible fasteners placement of framing nails either from inner or outer layer planking. (Source: Benjamin Wharton 2021).

The nail holes that remain in the planking will have been used for various reasons. Horizontally at the land in the inner planking there will be holes for plank-to-plank, which will be evenly spread about 75-100 mm (3"-4") apart; possibly two holes near each other – a standard 1/4" size with a small blind hole for a tip representing the double-clench (Figure 4.79). On the vertical there will framing fastener holes. Some of these holes may finish close to one another unintentionally. The same may happen for fastening holes from the outer layer of planking, where the lands are close to each other. Some may end up too close, as they were fastened without thought to the inner planking edges or other existing fasteners (Figure 4.80).

While the inner planking fasteners along the land are likely singular, as they can be clenched to increase holding power, the secondary outer planks appear to use pairs of fasteners, perhaps in a dovetail fashion to increase their holding power where it is not possible to use the clench (Figure 4.81).

Figure 4.79: Plank [311 P-I-S2-A] nail holes on land. Fastener holes positioned approximately 100 mm (4") apart. (Source: Casey & Lowe).

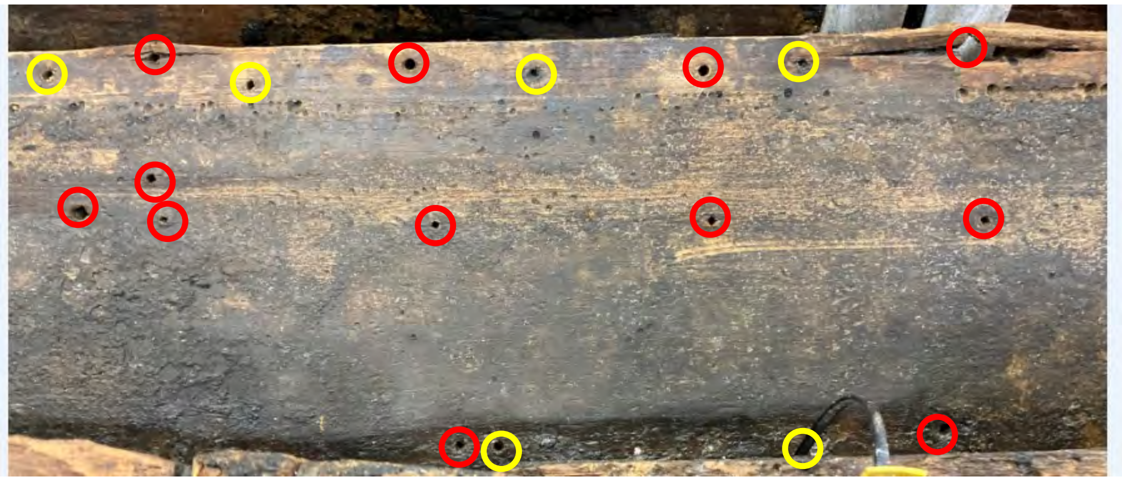

Figure 4.80: Plank [313 S-I-S2-A] possible fastener pattern. Red circles for plank-to-plank, yellow for frame-to-plank. External side of plank may show blind holes from secondary outer planking. (Source: Benjamin Wharton 2020).

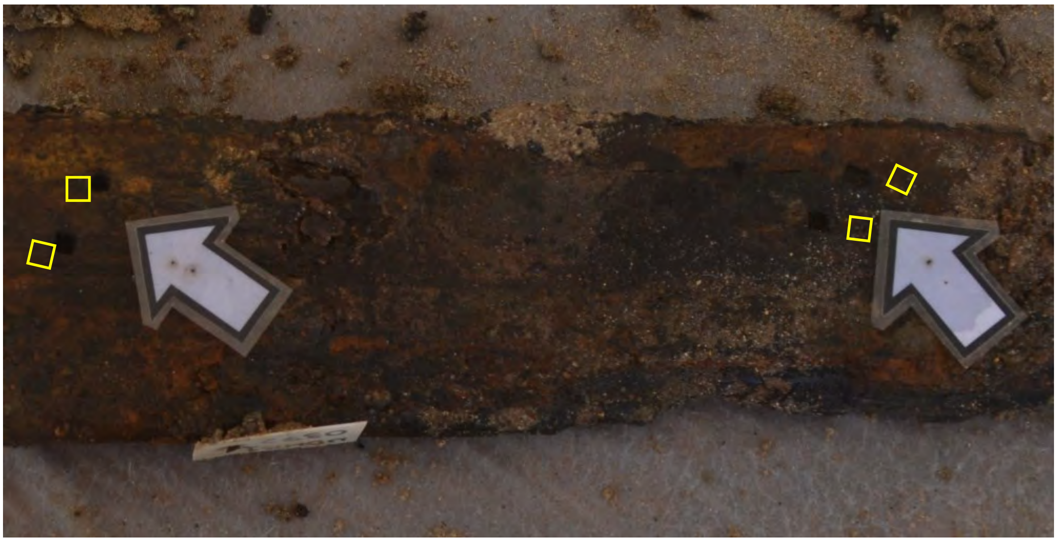

Figure 4.81: Plank [372 P-O-S7-M] fastener pattern for paired nails used in outer planking. Square nails shown in yellow. (Source: Casey & Lowe).

4.5.8 Other features and observations

4.5.8.1 Outer layer planking features

It appears that the outer layer of planking used pairs of fasteners to secure the plank to the previous plank below. Pairs of fasteners, possibly dovetailed, were most likely used due to not being able to clench a single fastener on the inner side with the nails either being blind, or from having just a small tip protruding through to the inner side (Figure 4.82).

The outer layer scarf joints were longer, since they could not be backed with a plate and the nails could not be clenched in the joint. Therefore the joins were longer, with the fasteners being positioned more towards the end of the outer edge, so it limited the chance of the scarf opening (Figure 4.83 and Figure 4.84). The fasteners in the inner planking, in contrast, are located in the middle of the join.

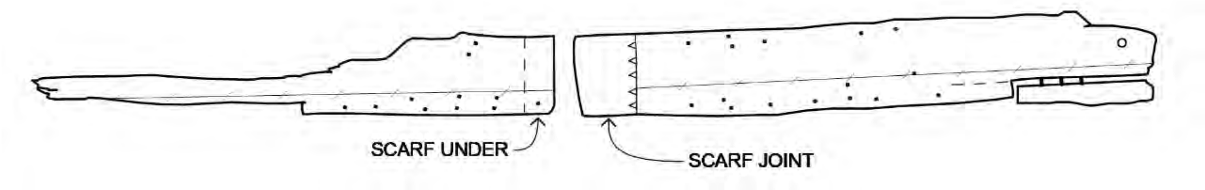

Figure 4.82: Planks [345 P-O-S5-A] and [508 P-O-S5-M] recording sheets. Shown right way up from inside the hull. These two drawings together demonstrate the fastening pattern top and bottom of an external planking strake whereby fasteners were used in pairs along the wide lands to ensure secure holding. (Source: Casey & Lowe element recording context sheets 2018. Redrawn by Benjamin Wharton 2021).

Figure 4.83: Scarf joint of plank [345 P-O-S5-A]. Fastener holes evidently closer to the heel of the scarf, indicating a need to be closer to the outer edge of the complementing outer scarf to ensure it does not open. (Source: AMBS).

Figure 4.84: Scarf of plank [452 S-O-S5-F]. Fastener holes for scarf towards the tip being the outer scarf. (Source: Benjamin Wharton 2020).

4.5.8.2 Gerald rabbets

The aft-end planks of the first three strakes of both the inner and outer planking attached to the sternpost had a gerald rabbet cut into them to ensure that there was no gap in overlap at the aft end below the waterline.

At the stern, twelve planks would have had gerald rabbets on them to enable them to fit flush into the sternpost. Three planks each side for both inner and outer plank layers would be required to fit into the sternpost, however, two are missing from the remains due to damage on the aft end of the port side (Table 9). At the stern, the geralds are only necessary at the sternpost, while higher strake planks that fit to the transom can be simply lapped and the transom joggled to match.

Each plank fitting into the stem, known as a *hood end*, would also have had gerald rabbets. Each plank hood end from the first to the highest strake would have had the gerald rabbeted for a flush edge.

The gerald rabbet is cut with a rabbet plane using a fence to control the width of the cut which needs to be the width of the land for the plank. This can also be achieved with a chisel, though it is more difficult to provide a long even surface. The rabbet can be cut as a half-lap which divides the overlap in half requiring both upper and lower edges of the planking to be rabbeted. The other method, used in this case, is a full rabbet, whereby the entirety of the rabbet is removed from the upper edge of each plank only and the lower edge of the plank above does not have a rabbet (Figure 4.85 to Figure 4.87). This method does not require as much fitting and matching work, however, requires rabbetting down to a feather edge which is a weaker join, although fastening the plank above will assist in securing it in place.

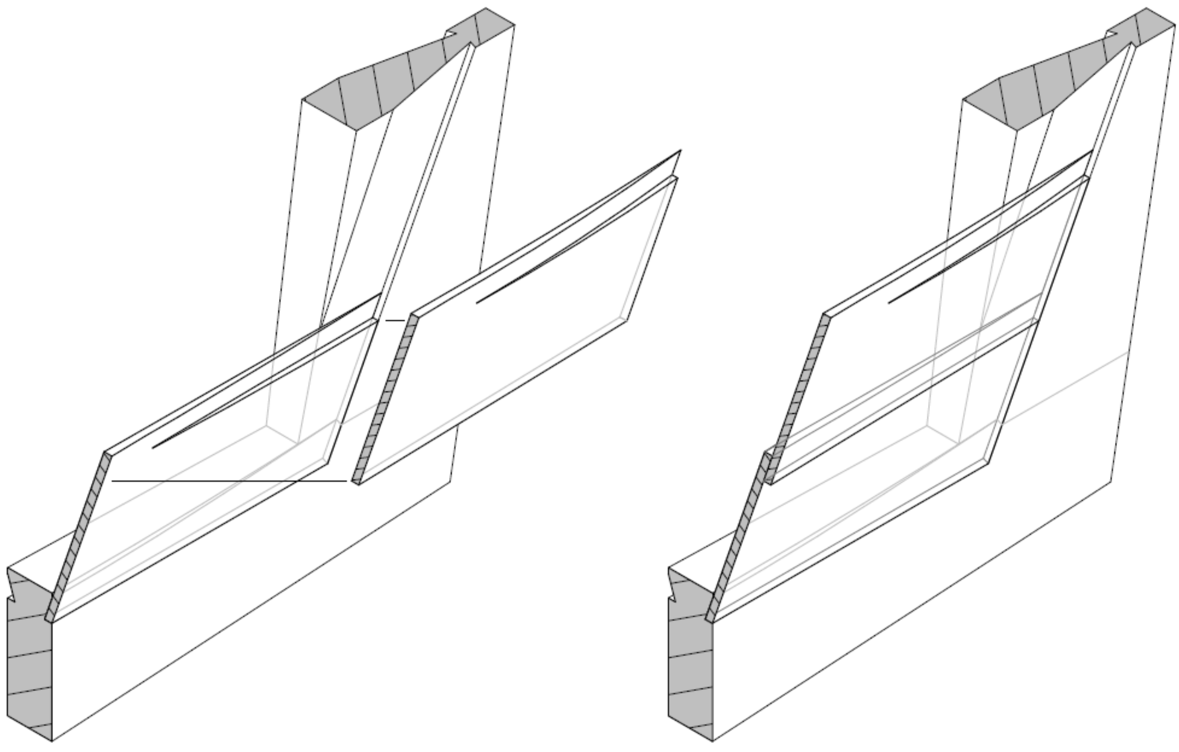

Figure 4.85: Gerald rabbet diagram of planks at sternpost from the port side. Cross section showing overlap of planks. Rabbet is cut at land for overlapping plank above to terminate at end flush with lower plank. (Source: Benjamin Wharton 2021).

Table 9: Stern planks with Gerald rabbets

	Inner planking		Outer planking	
Strake	Port	Starboard	Port	Starboard
1	318 P-I-S1-A	341 S-I-S1-A	530 P-O-S1-A	532 S-O-S1-A
2	311 P-I-S2-A	313 S-I-S2-A	310 P-O-S2-A	529 S-O-S2-A
3	Missing	302 S-I-S3-A	Missing	524 S-O-S3-A

Figure 4.86: Gerald rabbet (red arrow) in plank [341 S-I-S1-A] looking forward from the end. (Source: AMBS).

Figure 4.87: Gerald rabbet (red arrow) in plank [341 S-I-S1-A] looking from outside of hull. (Source: AMBS).

4.6 Framing

The framing of UDHB1 was fitted after the planking was complete. Three main types of framing were identified in the vessel: floor, futtock and cant frames (Figure 4.88 and Figure 4.89).

Figure 4.88: Hull framing as seen after removal of ceiling planks. Bow to stern shown front to back***.*** (Source: AMBS).

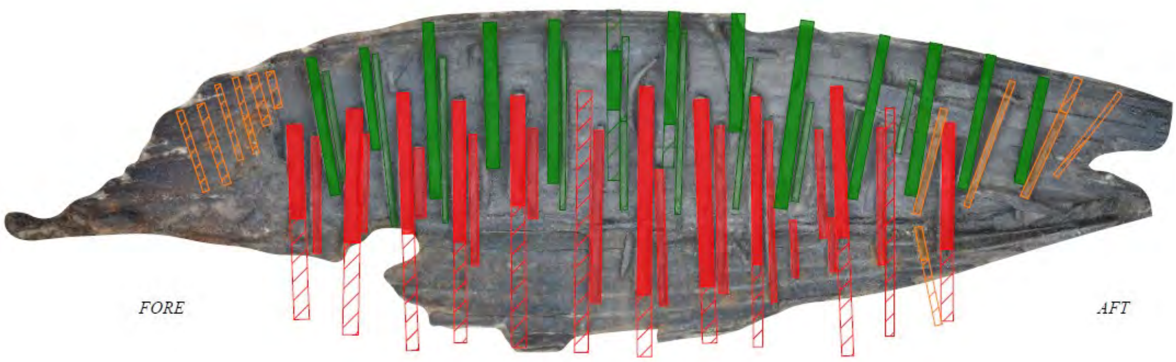

Figure 4.89: Framing layout. Red: primary floors, shaded red: secondary sistered floors, green: futtocks, shaded green: secondary sistered futtocks, orange: cant frames in the bow and after cant frames in the stern. Hatched being probable missing frames. (Source: Benjamin Wharton 2021).

The floor and futtock frames appear to have had primary and secondary components of each, whereby the primary components have larger scantlings, with the secondary being smaller in size and typically sistered, though not fastened to, aft of the primary. The sister frames are smaller as the siding dimension had to fit between frames, to maintain an approximate square cross section.

Due to the nature of the condition of timber recovered from the inside of the hull, such as fragments or displaced loose timbers, only those frames whose position and purpose are known will be discussed in this section.

The spacing of the framing is derived from the placement of the primary floors, being spaced approximately 400-485 mm (16"-19") apart on their centres.

In frame-first vessel construction, the frames are orientated perpendicular to the keel and the outer moulded face of the frame is shaped fair prior to planking. In the case of UDHB1, which was constructed hull-first, the frames have been placed square-on to the planking – perpendicular to the sheerline, but oblique to the keel, which means they fan out from the keel. As such, there is no uniform parallel spacing of futtock frames or cant frames.

The frames, along with the rest of the hull, were coated in pitch after being installed with the inner moulded face and both forward and after sided faces coated.

4.6.1.1 Condition at time of excavation

The framing of UDHB1 was not as well preserved as the planking. Those parts of the frames that were coated in pitch after installation remained in better condition. However, the underside, or outer moulded faces, did not fare as well due to the nature of their construction process. Having been cut from a branch with the widest diameter of the frame being used as the outer moulded face means that it is mostly the pith, or centre, of the branch that is exposed, and is the section of wood most prone to rot. It is unknown at this stage if any assembly sealant/adhesive/preserver, such as pine tar, was used during fitting the frames. Unlike planks that are sawn to utilise the grain of a uniform piece of trunk and therefore minimise the variance in rot, branches contain all the parts of timber such as the pith, heartwood, sapwood and even the cambium (net-like structure underneath the bark) of branches and have been noticed on the frames. All of these variants in the growth of the tree will decay or respond differently to environmental changes, with rot beginning at the centre, or pith, of the branch and spreading out from there.

A pin test was carried out on each frame as it was removed from the vessel. This measured the softness of the timber by how far the pin would easily press into the wood and was classified in groups of 0-2 mm, 2-5 mm, 5-10 mm and >10 mm. However, it is was not recorded where on the frame the pin was tested, which could have produced differing results.

Of the fifty-nine elements listed in the inventory as a frame, disregarding the loose timbers collected in the hull, the majority of results had a recorded depth of softness greater than 10 millimetres with 23 (39%). Accounts of 5-10mm in depth was 17 (29%), 15 (25%) accounts of 2-5 mm, and 4 (7%) accounts of being 0-2 mm. There does not appear to be an immediate connection between softness and location or type of frame timber. However, the four hardest timbers with a recorded depth of 0-2 millimetres were secondary timbers and a midships futtock frame [349], [377], [383] and [384].

An indication of the poor condition of the majority of the frames was, when recording the frame condition during excavation, the most common written terms used were cracked, broken, soft, spongy, decay, and rot.

4.6.1.2 Joggled notches

In order to fit the frames to the planking, notches, known as joggled notches, were cut into the moulded outer face to match the planking where the frame will fit.

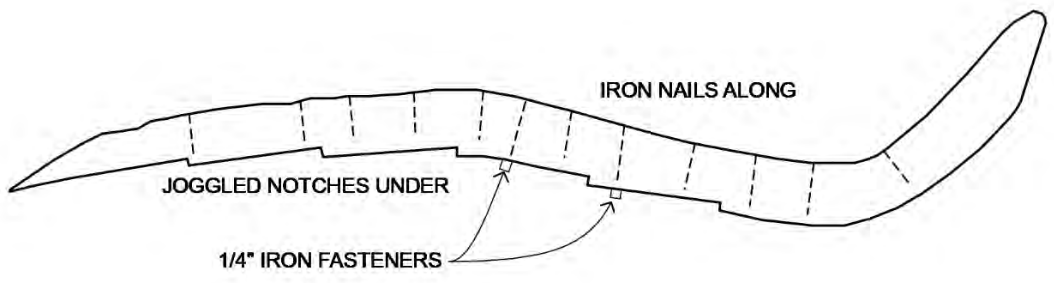

Figure 4.90: 'S' shaped frame [343] FT-5. Recording of frame showing joggle notches and iron fasteners two per plank. Note also the chine where no joggling is needed as the upturn begins. (Source: Casey & Lowe element recording context sheets 2018. Redrawn by Benjamin Wharton 2021).

4.6.1.3 Timber Species & Cut

Fourteen frame timbers were sampled. Of these fourteen, the results were that 5 (36 %) were identified as Spotted Gum, 3 (21 %) were identified as Banksia, 2 (14 %) were identified as Stringybark, 2 (14 %) Southern Mahogany, and 1 (7 %) identified as Grey Gum.

The majority of the primary floor and futtock frames sampled were identified as being Spotted Gum and Stringybark, while secondary framing timbers that were sampled were identified mostly as being Banksia, but also included Grey Gum, Stringybark and Southern Mahogany. It is likely that more primary frame timbers would be Spotted Gum, as it is known for its strength in these structural members (Figure 4.91).

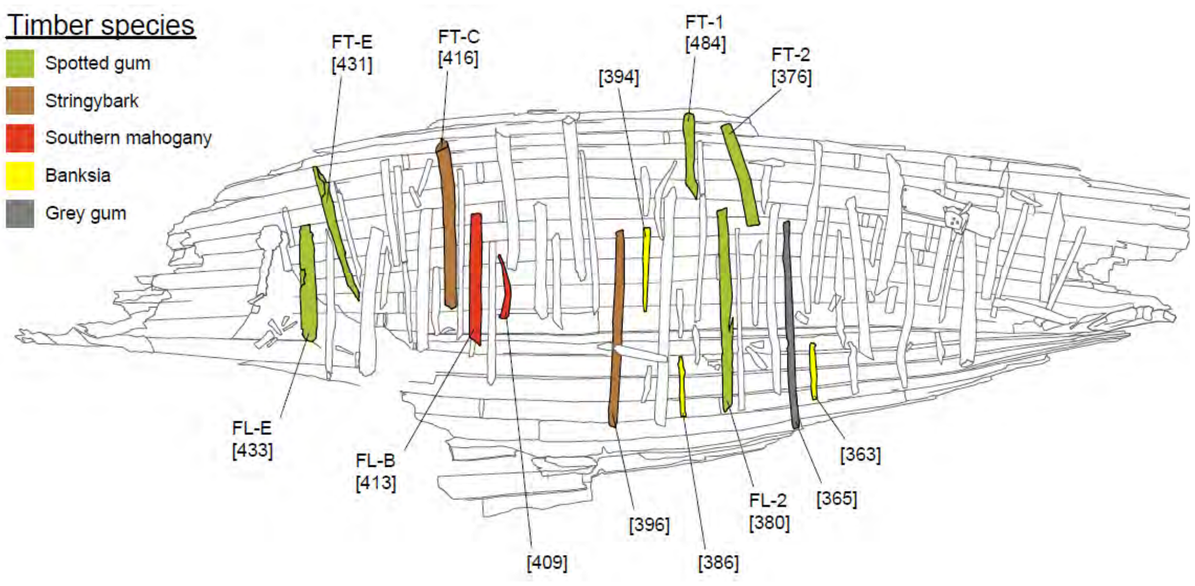

Figure 4.91: Timber species of framing. Spotted Gum – [376], [380], [484], [431], [433]; Stringybark – [396], [416]; Southern Mahogany – [409], [413]; Banksia – [363], [386], [394]; Grey Gum – [365]. (Source: Benjamin Wharton 2021 using base drawing: Plan16.W5 prepared by Casey & Lowe).

The timber used for the frames is grown, also known as crooked or compass timber, which is either part of a trunk where a branch is growing or is a branch with the required angle bend in it – the latter generally considered the more suitable for framing timbers.

Observations of some of the floor frames show that they have had minimal shaping to reach the finished dimensions as the pith is visible centred in the port-side rungheads and the radially curved edges of the original branch circumference is noticeable in cross-section (Figure 4.92 and Figure 4.93). Another example is on frames which exhibit the 'netting' pattern of the sapwood under the bark indicating that little-to-no material was removed after de-barking. Interestingly, branch collars, or pressure ridges, can also be seen on futtock frames at the chine such as [399] and [362], which are common on Spotted Gum trees (Figure 4.94 to Figure 4.95). These points indicate that the builder of the boat used timbers of the required sizings and angles, with minimal shaping.

Figure 4.92: Runghead of [396] secondary to FL-O. Yellow arrow indicating the pith, or centre of branch and radius of branch circumference noticeable. (Source: AMBS)

Figure 4.93: Runghead of [391] FL-01. Yellow arrow indicating the pith, or centre of branch and radius of branch circumference noticeable. (Source: AMBS)

Figure 4.94: Branch collars on futtock frame [399] FT-A. (Source: AMBS)

Figure 4.95: Branch collars (red arrow) on futtock frame [362] FT-3. (Source: AMBS).

Figure 4.96: Spotted Gum tree exhibiting characteristic branch collars (red arrow). (Source: AMBS).

The frames that require the most complex form in the tree for its shape is the crotch frame – which requires a fork in a trunk and the 'S' frames in the stern. The remaining frames need only either a slight bend for floor frames, or a more acute bend which requires a branch of compound curves for futtocks and sweeping curves for cant frames.

4.6.1.4 Fasteners

There were no complete fastenings in the framing to analyse; only ferrous concretions and small sections of fastening shanks remaining (Figure 4.97). However, from what remains, two types of fasteners were identified.

Floor frames were fastened to the keel with square-shanked iron spikes. The keel was examined after cleaning and during the conservation phase, and some selected fastener concretions and holes were measured. The results were that the shank cross section sizes ranged in size from approximately 6.5 mm ($^{1}/_{2}$") square to 15 mm ($^{5}/_{8}$") square. The difference in these measurements could indicate the larger sizes were for the primary floor frames, while the smaller size was used for the secondary frames. Further research into matching the fastener holes to their respective frame would provide some clarification in this regard. One large treenail [535] that was driven into the keel may have been a supplementary fastener holding a floor frame in place or securing the repaired garboard strake (see Section 5.1).

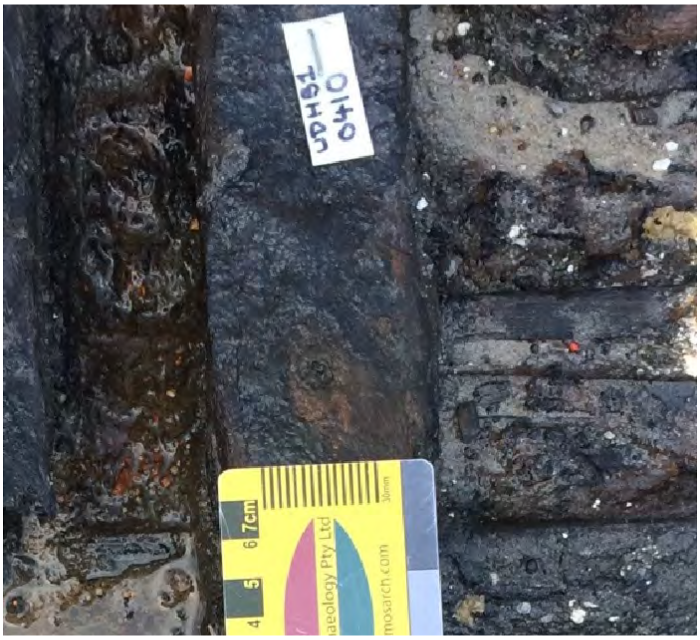

Figure 4.97: Dump spike fastening frame [410] to keel [055]. Spike measures approximately 10 mm ($^3/_8$") in size. (Source: AMBS).

Evidence from the recording phase identified that 5-7 mm ($^1/_4$") square-shanked iron nails were used to fasten the frames to the hull planking.

Fastener holes will also be present in framing from the inner moulded face where ceiling planks were fastened, as well as any other internal components that fastened to the framing, such as rising plank or decking beams for example.

4.6.2 Floor Frames

The floor frames stretched across the keel on both sides to support the bottom of the hull area. In UDHB1, the floor frames extend as far as the sixth and seventh strake.

There were twelve primary floor frames, five forward of midships, one midships (though missing at time of excavation) then six aft including the crotch frame.

The floor frames are positioned centrally over the keel and range in angle from 8° to 2.5° deadrise at the bow, 1° to 7.5° deadrise amidships and 9° upwards deadrise in the stern, ending with a crotch [355 FL-6] frame of 35° deadrise located approximately 850mm fore of the sternpost.

4.6.2.1 Dimensions and shape

The majority of sided dimensions of the primary floor frames were $3^1/_2$"-4", with the smallest of those being $3^1/_2$" and the largest being the first floor in the bow at $4^1/_2$ in [433 FL-E]. The majority of moulded dimensions were from 3"- $4^1/_4$" thick, with the largest being the crotch frame [335 FL-06] (Table 10).

Table 10: Primary floor frames and corresponding secondary sister frames.

Frame ID	Element ID	Max Sided	Max Moulded	Secondary Element ID
FL-E	[433]	4¹/₂"	3³/₈"	[432]
FL-D	[429]	3⁷/₈"	3 ½"	[427]
FL-C	[420]	3 ½"	4 ¼"	[418]
FL-B	[413]	3 ½"	3"	[410]
FL-A	[405]	3³/₄"	3 ½"	[404]
FL-O	Missing			[396]
FL-1	[391]	3 ½"	3"	[386], [389]
FL-2	[380]	3 ½"	3"	[379]
FL-3	[368]	3 ½"	2 ¾"	[365]
FL-4	[355]	3 ½"	4³/₈"	[356], [357]
FL-5	Missing			[347]
FL-6	[335]	3⁷/₈"	6¹/₈"	n/a

4.6.3 Futtock Frames

The futtock frames braced the topside planks to the bottom planks. The spacing of the primary futtock frames does not rely on measured distances along a keel line, however, are perpendicular to the sheerline and oblique from the keel line. This means that it is less complex to shape the joggling required to fit the planking. The futtock positions are determined by being square-on to the planking while fitting into the space between two floor frames.

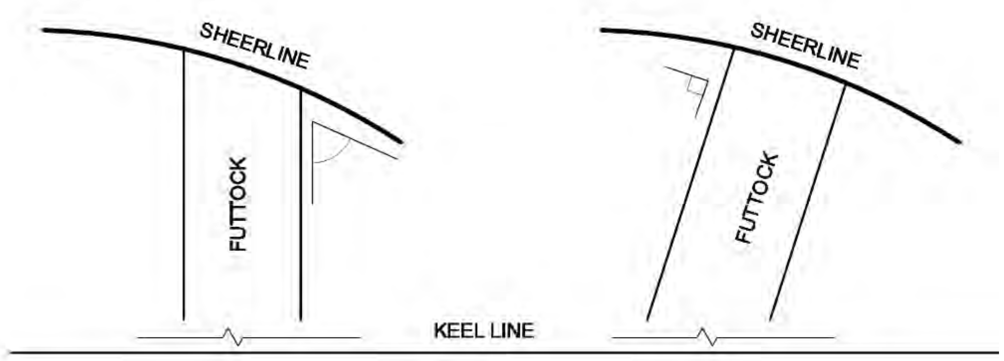

Figure 4.98: Diagram of perpendicular vs. oblique framing. (Source: Benjamin Wharton 2021).

4.6.3.1 Dimensions

The sided dimensions of the primary futtock frames ranged in size by ¾". The smallest being $3^{1}/_{8}$" inches [426 FT-D], (second frame from the bow), and the largest sizes were located abaft midships, being $3^{7}/_{8}$" [384 FT-1], [376 FT-2] and [343 FT-5], with the majority being 3½" and $3^{7}/_{8}$" in size.

The moulded dimensions had a larger range in size, with a $1^{3}/_{8}$" variance. The smallest was $2^{1}/_{2}$" [416 FT-C], (third frame from the bow) and the largest $3^{7}/_{8}$" inches at midships [384 FT-1] (Table 11).

Table 11: Primary futtock frames and corresponding sister frames.

Frame ID	Element ID	Max Sided	Max Moulded	Secondary Element ID
FT-E	[431]	$3^{3}/_{8}$"	$3^{1}/_{8}$"	[430]
FT-D	[426]	$3^{1}/_{8}$"	$3^{1}/_{8}$"	[423], [424]
FT-C	[416]	3 ¼"	2 ½"	[417]
FT-B	[408]	3 ¾"	2 ¾"	Missing
FT-A	[399]	3 ½"	3 ½"	[398]
FT-O	[395]	3 ½"	2 ½"	[387]
FT-1	[384]	$3^{7}/_{8}$"	$3^{7}/_{8}$"	[383], [382]
FT-2	[376]	$3^{7}/_{8}$"	3"	[370]
FT-3	[362]	3 ½"	$3^{1}/_{8}$"	[361]
FT-4	[353]	3 ½"	$3^{3}/_{8}$"	[349] ?
FT-5	[343]	$3^{7}/_{8}$"	3"	[342]
FT-6	[334]	3 ¾"	$3^{1}/_{8}$"	[332] after cant
FT-7	[322]	$3^{5}/_{8}$"	$2^{7}/_{8}$"	[321] after cant

4.6.4 Cant Frames

The cant frames are angled oblique to the keel and positioned in the bow, and the after-cant frames, which are oblique to both the keel and sheerline, are positioned in the stern.

There were no remaining cant frames in the bow, however, during excavation seven ghost frames became apparent (Figure 4.99). Three after-cant frames remained in the stern, with the ghost mark of another further aft, given the frame ID 'AC-4' (Figure 4.100).

Figure 4.99: Ghost marks of cant frames in the bow. (Source: AMBS).

Figure 4.100: After-cant frames in the stern of the vessel. (Source: AMBS).

4.6.4.1 Dimensions

The ghost marks of the cant frames in the bow – numbered C-A to C-G – measured approximately 50 mm (2") in sided width. The after-cant frames in the stern – numbered AC-1 to AC-4 – are 50-55 mm (2"-2$^{1}/_{8}$") sided, and 45-55 mm (1¾"-2$^{1}/_{8}$") moulded thickness (Table 12).

Table 12: Cant frames

Frame	Element ID	Sided max	Moulded max
C-G	missing	2"	
C-F	missing	2"	
C-E	missing	2"	
C-D	missing	2"	
C-C	missing	2"	
C-B	missing	2"	
C-A	missing	2"	
AC-1	[342]	2"	1¾"
AC-2	[332]	2"	2$^{1}/_{8}$"
AC-3	[324]	2$^{1}/_{8}$"	1$^{7}/_{8}$"
AC-4	missing		

4.6.5 Secondary Framing

Sistered, though not fastened, to the primary framing were smaller cross-sectioned secondary frames (Table 10 and Table 11). The majority of maximum sizes for sided dimensions were in the range of 50-61 mm (2"-2$^{3}/_{8}$"), with the smallest being 45 mm (1¾") for frame [349], and the largest maximum sided dimension being70 mm (2¾") for frame [396].

The majority of maximum moulded dimensions were also in the range of 50-61 mm (2"-2$^{3}/_{8}$"), with the smallest maximum size being 42 mm (1$^{5}/_{8}$") inches for frame [356], and the largest maximum moulded dimension being 77 mm (3") for frame [365].

4.6.6 Features

4.6.6.1 Limber holes

A number of frames that were preserved well exhibit possible limber holes. Floor frame [416 FT-C] was one recorded as such (Figure 4.101). Further research would be required to investigate further examples.

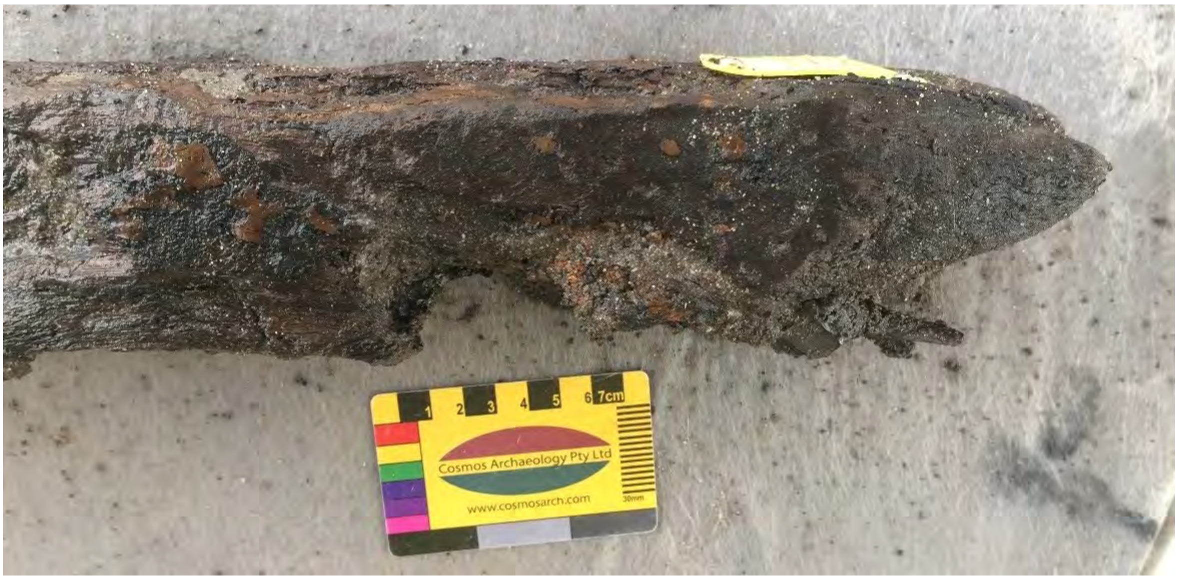

Figure 4.101: Floor frame [416 FT-C] with possible limber hole. (Source: AMBS).

4.7 Ceiling Planks

The inside of UDHB1 was lined with ceiling planks butted longitudinally edge-to-edge for complete coverage. All that remained at the time of the uncovering of the vessel were nine planks on the starboard side and none on the port side (Figure 4.102 and Figure 4.103).

The ceiling planks were positioned approximately 1.8 m (6') in from the inside of the stem, starting on the first-floor frame in the bow [433 FL-E] to approximately 1.8 m (6') from the inside of the sternpost terminating on the first primary cant frame at the stern [353 FT-4]. The planks extend beyond these frames, indicating that other planks did not butt-up against them, that is, fixed to the same frame. The overhang suggests that this was the extent of the ceiling planking.

Figure 4.102: Ceiling planking* in situ *prior to removal. (Source: AMBS).

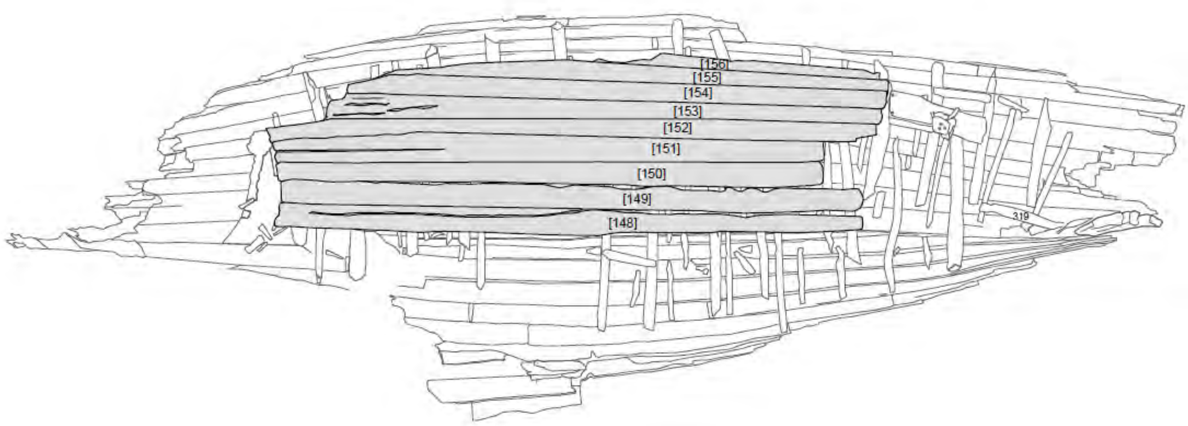

Figure 4.103: Ceiling planking plan. (Source: Benjamin Wharton 2021 using Casey & Lowe drawings Plan16.W4, and Plan16.W5 as base).

The remaining ceiling planks lined the inside of the hull from the garboard first strake up to the ninth; just above the bilge. It is unclear at this stage if they continued higher (Figure 4.104). There are indications of iron staining from fasteners higher up the topside, however, further examination and analysis is required to determine of these can be attributed to ceiling planking or a rising.

There was no ceiling plank over the keel. This could either be due to the planks having been removed after it became a wreck or that the keel was deliberately left exposed in order to provide regular access to clean out the bilge. It is possible that there was no ceiling plank over the keel, as there may have been a keelson that may have been removed when the vessel was abandoned. This would require a closer examination of the fastenings on the floors that could suggest keelson, however it can be expected that one bolt would have gone through the keelson, floor and keel.

Figure 4.104: Starboard side ceiling planks futtock frames. Iron staining evident on frames suggest possibility of ceiling planks existing higher up the topside, or where a rising was fastened to. (Source: AMBS).

4.7.1.1 Condition at time of excavation

The ceiling planks were fragile during the recovery phase. Being thinner than the hull planking they did not retain as much integrity to their structure.

There were nine planks remaining in total. Three of which were complete [148], [149] and 152], while others were broken at either the bow or stern ends.

4.7.1.2 Dimensions

The ceiling planks that are complete, range from 4.32 m (14'2") to 4.35 m (14'3½"). The shortest remaining broken length was 2.1 m (6'10$^{3}/_{4}$") for plank [156]. The widths range from 145 mm (5¾") [152] to 230 mm (9") [150], however, the majority are around the 200 mm (7") range. The planks range in thickness with the majority being 5-6 mm ($^{1}/_{4}$") and one plank [156] was 10 mm ($^{3}/_{8}$") thick.

4.7.1.3 Timber Species & Cut

One plank [151] was sampled to determine the timber species used. The sample was identified as being a eucalypt. However the sample was too degraded to find an exact species identification, but was possibly a Stringybark or Gum.

At the time of writing, no analysis has been carried out to determine the method of sawing and its cut type.

4.7.1.4 Fastenings

There was no clear evidence of fasteners recorded during the recovery excavation phase. Further research is required to examine fastener holes in both the ceiling planks and the respective frames they were fastened to.

4.7.1.5 Other

There were three other short lengths of timber which were attributed as ceiling planking in the inventory [319], [336] and [350]. These shorter lengths, located in the stern, could be bracing structural timbers, or deadwood or stingers to support cockpit decking boards.

4.8 Fasteners

4.8.1 Ferrous

While the vessel was mostly fastened with iron nails and spikes, no examples survived well enough to document. However, from the holes that remain we can ascertain that the ferrous nails were square shanked 5-7mm ($^{1}/_{4}$") at the throat and tapered down on for sides to a point. The sizes of the heads were evident in indents left on the surface of timbers. One such example measured from scan of timber [541] showed that the heads were approximately 10 to 12mm diameter ($^{1}/_{2}$"). The length of the nails will be determined by analysis of the holes including the double-clench, and whether different sizes were used from framing and planking. See figure below for an example of a typical hand forged iron nail that would have most likely been used on the vessel.

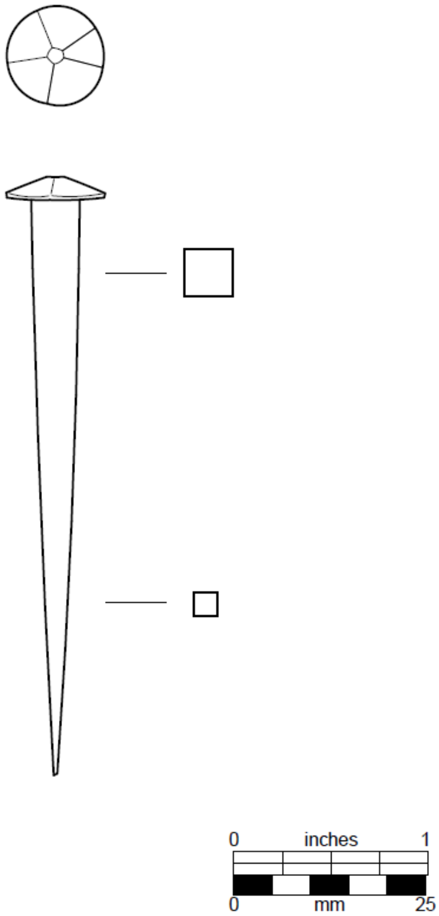

Figure 4.105: Typical hand forged iron nail. (Source: Benjamin Wharton 2021).

4.8.2 Copper alloy

Below are various copper alloy nails recovered from the vessel during the conservation and cleaning phase (Figure 4.106 to Figure 4.109). The composition of the copper alloy nails and sheathing from the rider keel [551] were analysed by Dr. W. van Duivenvoorde from Flinders University (see Volume 6). Though the sample tested had no solid matter remaining and mainly consisted of corrosion products, it was possible to obtain satisfactory results. Two tacks were examined, one from the garboard shelf planks [539] and the other from the rider keel [551]. They were of a copper alloy comprising 80.14–85.58% copper, up to 4.55% zinc, 14.30% tin, and 3.04–4.7% lead.

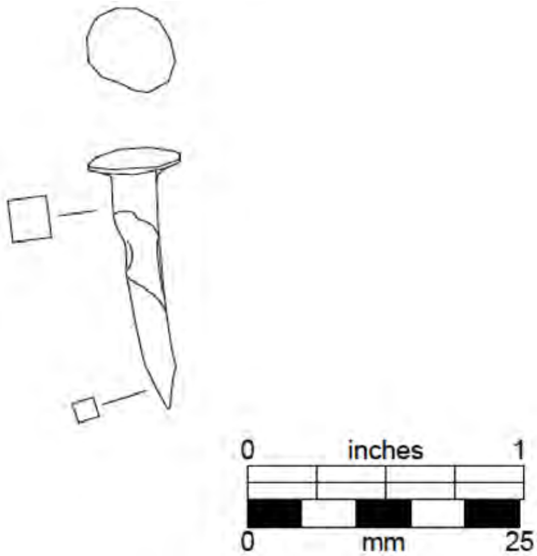

Figure 4.106: Copper nail from plank [304 S-O-S7-A]. (Source: Benjamin Wharton 2020).

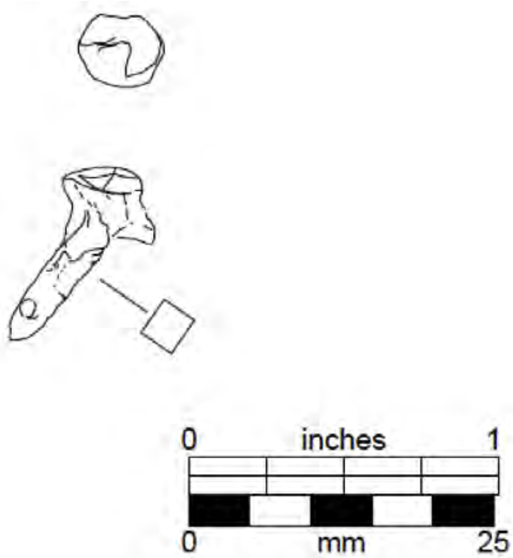

Figure 4.107: Copper nail from garboard shelf plank [539]. (Source: Benjamin Wharton 2020).

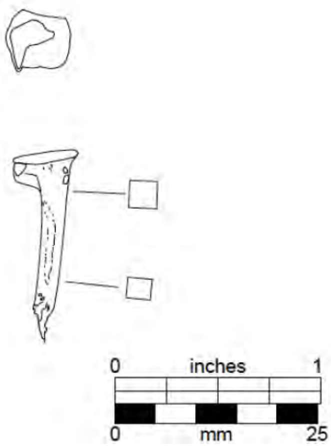

Figure 4.108: Copper nail from plank [506 S-O-S8-A]. (Source: Benjamin Wharton 2020).

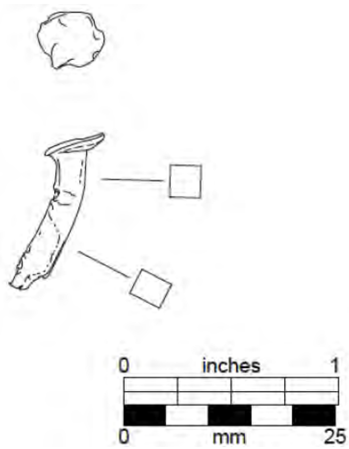

Figure 4.109: Copper nail from plank [506 S-O-S8-A]. (Source: Benjamin Wharton 2020).

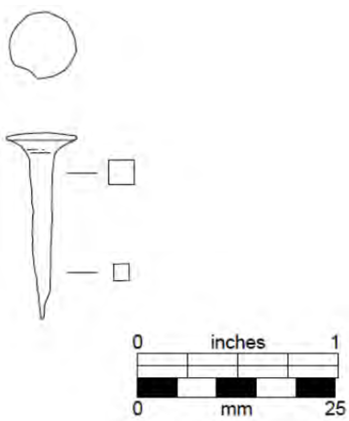

Figure 4.110: Copper alloy nail from plank [304 S-O-S7-A]. (Source: Benjamin Wharton 2020).

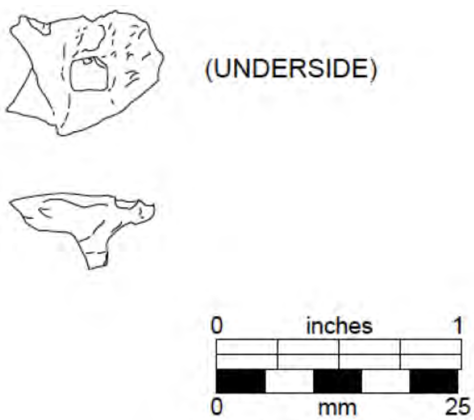

Figure 4.111: Copper alloy nail in copper sheathing from rider keel [551]. (Source: Benjamin Wharton 2020).

4.8.3 Treenails

Selected drawings and cross sections of treenails are presented below (Figure 4.112 to Figure 4.116).

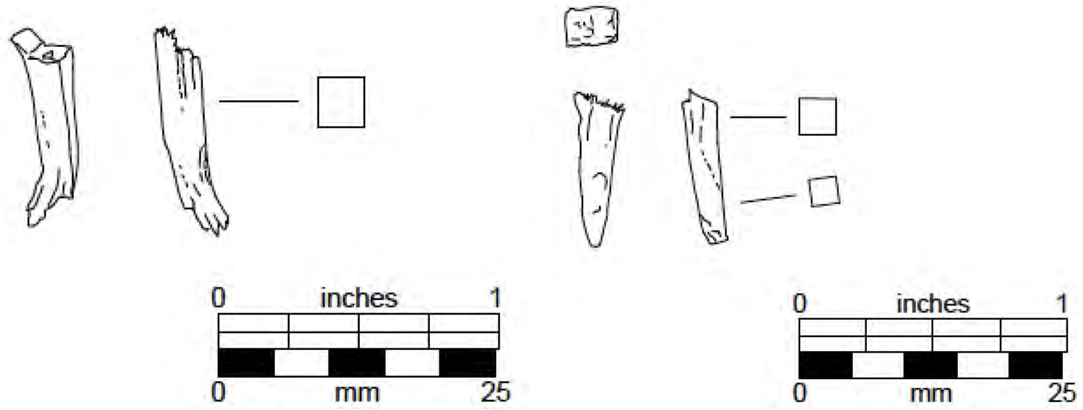

Figure 4.112: Treenail from plank [313 S-I-S2-A]. (Source: Benjamin Wharton 2020).

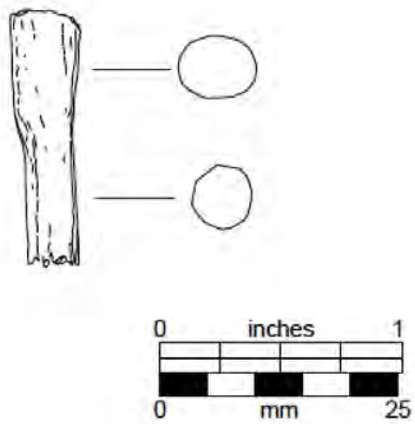

Figure 4.113: Treenail from plank [502 S-O-S9-M]. (Source: Benjamin Wharton 2020).

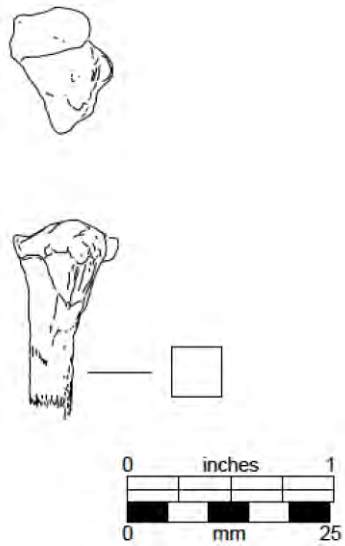

Figure 4.114: Treenail from plank [495 S-I-S2-F]. (Source: Benjamin Wharton 2020).

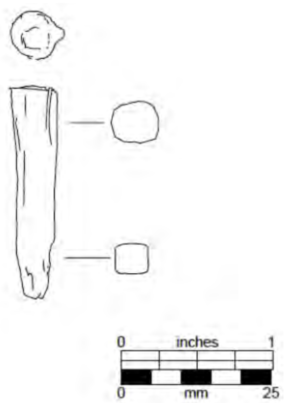

Figure 4.115: Treenail from plank [532 S-O-S1-A]. (Source: Benjamin Wharton 2020).

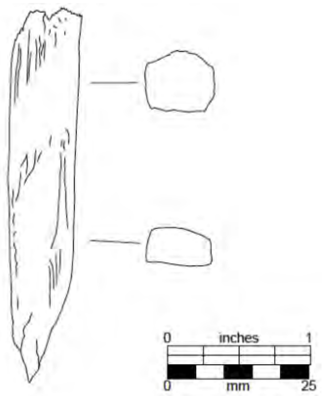

Figure 4.116: Treenail in keel [055]. (Source: Benjamin Wharton 2020).

4.9 Cordage

A length of cordage [490] 760 mm long was found within the aft end of the hull threaded under frame [347] over the keel [055]; possibly it was used for cleaning out the limber holes, or to tie something down. The cord has a right-hand lay and measures approximately 5 mm ($^{3}/_{16}$") in diameter. It consists of three strands made up of a rough fibrous yarn that is orange brown in colour and flat-shaped; possibly flax or hemp (Figure 4.117 to Figure 4.119).

Future research is required to identify the plant species and origin used to make the cordage. This information would provide a greater understanding of the cordage industry of the period. If locally produced, it would provide a rare piece of evidence of the early colony's agricultural practices for industrial purposes, such as the production of hemp and flax.

Figure 4.117: Cordage [490]* in situ *on keel [055]. Stern to the left of the photo. (Source: AMBS).

Figure 4.118: Cordage [490] overall length. (Source: Casey & Lowe).

Figure 4.119: Cordage [490] close-up view of fibrous yarn. (Source: Casey & Lowe).

4.10 Antifouling / Sealing

UDHB1 used various methods of antifouling and sealing. Pitch, white putty or 'white stuff' called 'chunam', copper sheathing and possible remains of caulking were identified during the disassembly.

4.10.1.1 Pitch

UDHB1 was coated in pitch inside and out for antifouling. Samples were taken from various parts of the vessel for future research to analyse the pitch and determine its material composition and possible origin.

The pitch was thickest at the lower parts of the hull in between the internal framing and on the outside, the pitch was thickest on the external surfaces of the keel assembly components (Figure 4.120 and Figure 4.121). Pitch was also observed on the outside of the inner planking, though this appeared inconsistent. Perhaps the hull was scrapped back before the chunam was applied and the second layer added.

Figure 4.120: Pitch on internal side of Plank [495 S-I-S2-F]. Internally applied between framing as thick as the planking itself. (Source: Casey & Lowe).

Figure 4.121: Pitch embedded with shells on garboard shelf [543]. (Source: AMBS).

Samples of the pitch were analysed by Therese Harrison from Sydney Analytical, Vibrational Spectroscopy Facility (see Volume 6). Two sets of samples were taken from the interior of the hull - one of the futtocks [353] and the inside of an inner plank [302] while a third set was from one of the garboard shelf planks [539] for the outer planking. All three samples were largely consistent and were coal tar based. The samples from the inner planking and the garboard shelf also contained a tree resin substance similar to abietic acid, which is derived from coniferous trees such as pine.[76] The sample from the garboard shelf also contained a siliceous substance similar to kaolin clay. This supports the observation that the pitch with a 'gritty' texture was found on the outside planks.

The futtock sample contained some form of plant resin which could also be abietic acid. One of the samples from the futtock [sample 5d] also contained traces of substances similar to sulphate sodium anhydrous and silicon dioxide, as well as organic materials similar to methyl cellulose, saffron and hemp.

4.10.1.2 White putty

Between the inner and outer layers of hull planking was a thick white putty substance much like chunam, or vernacularly '*schannam*;' which is a mix of lime and fish oil used between planking and sheathing materials on hulls (Figure 4.122 and Figure 4.123).[77] Samples of this material were also tested at the Sydney Analytical, Vibrational Spectroscopy Facility (see Volume 6). They were obtained from the inner planks [313 and 495] and one of the garboard

[76] Encyclopedia Britannica, Abietic Acid https://www.britannica.com/science/abietic-acid

[77] Observer, 1829, 'LAUNCH OF THE AUSTRALIAN.', The Sydney Gazette and New South Wales Advertiser (NSW : 1803 - 1842), 2 April, p. 2. , viewed 29 Jan 2021, available at http://nla.gov.au/nla.news-article2192141

shelves [400] for the inner layer of planking. The three samples contained ingredients consistent with calcium carbonate, of which seashells are composed. In early Sydney, seashells obtained mostly from Aboriginal middens were used for the making of lime.

Figure 4.122: White putty between planking layers on outside of inner plank [311 P-I-S2-A]. Note also the fastener holes protruding through from the outer layer planking. (Source: AMBS).

Figure 4.123: White putty between planking layers on outside of inner plank [313 S-I-S2-A]. (Source: AMBS).

4.10.1.3 Caulking

There were two recordings of caulking during the recovery excavation of the boat. Plank [333 S-I-S4-A] on the starboard side of the inner planking on the fourth strake was recorded as having caulking present on the edge of the overlap at the land, while another recorded caulking being present on the edge of the infill repair 'Dutchman' on plank [345 P-O-S5-A] (Figure 4.124). A sample of this caulking was taken for further analysis to identify the material type. It is possibly oakum, cotton, wool, linen, de-stranded hemp line, or any of the other fibrous materials used during the period. It is likely that caulking was only used in repair work on timber such as this.

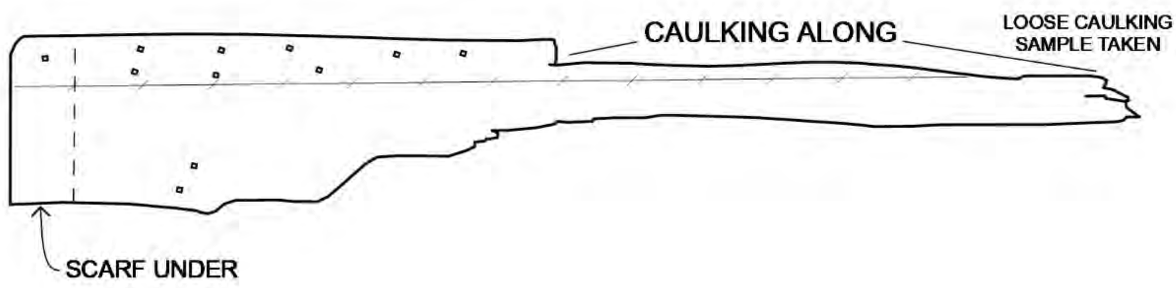

Figure 4.124: Plank [345 P-O-S5-A] Caulking. Note the paired nails in land for outer planking. (Source: Casey & Lowe element recording context sheets 2018 redrawn by Benjamin Wharton 2021).

4.10.1.4 Sheathing

Copper sheathing was located covering the forward most face of what remained of the stem and adjacent components such as the rider keel, and garboard shelf planks. This would have wrapped around the fore face of the stem, possibly up to or above the waterline. The sheathing was held in place with copper alloy sheathing tacks. One of the fragments of sheathing that could be tested contained pure copper with trace elements of other metals at levels that occur naturally (see Volume 6).

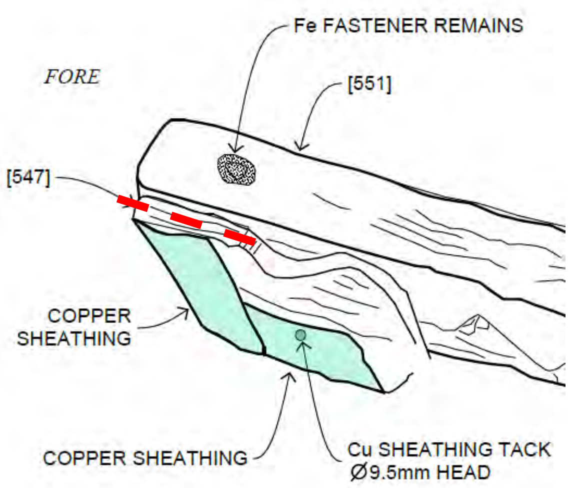

Figure 4.125: Outer garboard strake shelf 547 part of 542 with copper sheathing intact. Red dashed line showing where joins to copper sheathing remains on stem. (Source: Benjamin Wharton 2021).

Figure 4.126: Stem [457] starboard side with garboard strake plank pieces [521] and [458] in place. Red dashed line showing where joins to copper sheathing remains on rider keel and garboard shelf plank. Scale is in 100 mm increments. (Source: Casey & Lowe).

5 INTERPRETATION

5.1 Construction Sequence

UDHB1 was a vessel with a seemingly long working life. This is demonstrated by the phases of construction of the vessel and the wear evident on the timber surfaces of the vessel elements, the latter indicating that periods of time elapsed between some phases.

This section provides a relative chronology of the construction sequence of the vessel with estimates of the time range between construction phases. The sequence of construction of the vessel has been determined by identifying not only the relationship of key structural elements to each other, but also of the condition of those key elements. The sequence of construction is based on the following observations:

The underside of the keel [055] shows evidence of wear while the upper side of the rider keel [550 and 551] does not (Figure 5.1 and Figure 5.2). This indicates it was exposed to water, and shore, for a period of time before the rider keel was attached. Consequently, this points to the vessel being originally built with a single planked hull.

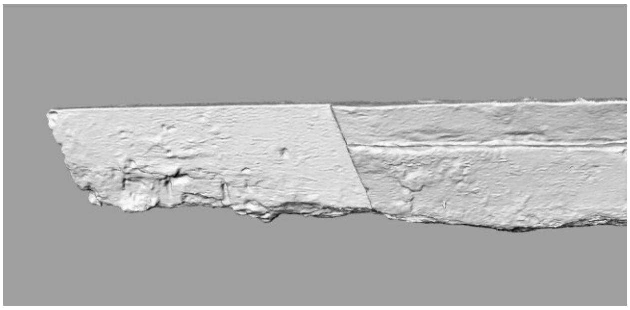

Figure 5.1 : View of aft end, starboard side of keel [055]. Note the worn underside. (3D scans supplied by SWF)

Figure 5.2 : View of aft end, starboard side of rider keel [551]. Note the worn underside but smooth topside. This upper side was in contact with the underside of the keel. (3D scans supplied by SWF)

The outside of the inner planking in places has surviving evidence of a coating of a resinous substance as well as marine borer damage. This indicates that the vessel once operated as a single hulled boat. Figure 5.3 shows the worn and coated exterior surface of inner plank 494 while the inner surface of the outer plank adjacent to inner plank [522] retains clear evidence of saw cuts (Figure 5.4). Figure 5.5 shows the remains of pitch under the chunam/white stuff on the outer side of inner plank [486].

Figure 5.3: Wear and remains of pitch on exterior of inner plank [494], positioned on port side in the second strake.

Figure 5.4: Saw marks observed on the inner surface of the outer plank 522 which was adjacent to inner plank [494]. (Source: Casey & Lowe)

Figure 5.5 : Remains of pitch visible under chunam on outer side of inner planking [486]

The filler plank [541] attached to the starboard side of the keel at midships was a likely repair to the garboard strake rabbet, and shows evidence of wear as well as chunam and pitch on its exterior surface. This piece is mostly covered by the starboard garboard shelf plank [540] (Figure 5.6 and see Figure 4.7) for the outer planking. The evidence of wear indicates that the vessel underwent substantial repairs to the keel when it was still single hulled. This notion is further reinforced by the fact that the plank sat on the rider keel which is wider than the keel at this point, the saw cut clearly visible on the plank having been made when the scarfed rider keel pieces were attached to the keel (Figure 5.7).

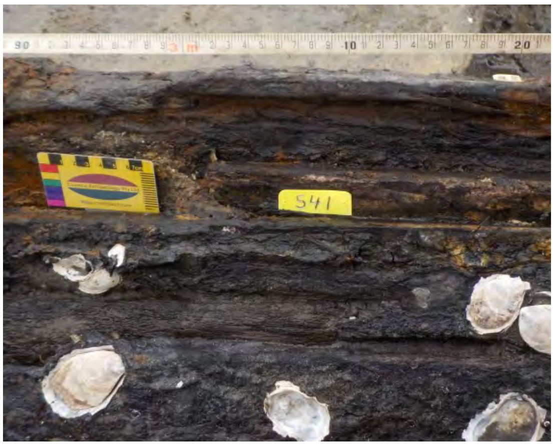

Figure 5.6: Around 30 mm of the filler plank [541] as indicated by the yellow tag. Abuts the keel [055] and is covered by the starboard garboard shelf plank [540] – which has oyster shell on its outer face.

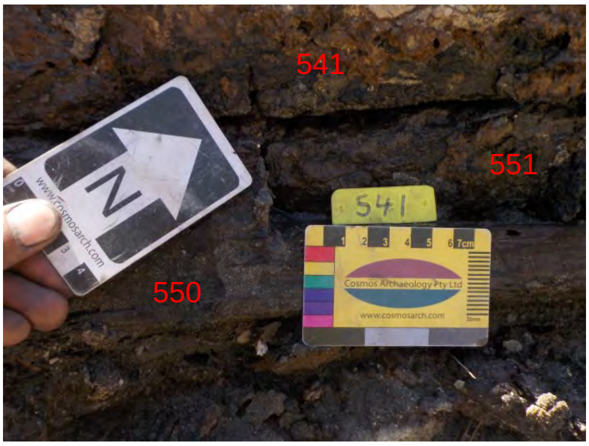

Figure 5.7: The cut (indicated by arrow) into the bottom of the filler plank [541] which lines up with the scarf cut where the two pieces comprising the aft section of the rider keel [550] and fore section [551] join.

The repairs were in response to the localised wearing away of the bearding line of the starboard rabbet on the keel. Putting aside the notion that the rabbet at this point of the keel many have been poorly cut in the first place, it is more likely that this repair was required because of activities undertaken by the vessel. What would cause the rabbet to wear away at this spot is a matter of conjecture. One can imagine weight being repetitively applied to the gunwale transferring pressure onto the garboard strake, eventually wearing away the rabbet at midships.

The sort of activity that could cause this effect could be the transferring of cargo from vessel to vessel or across a wharf. In this circumstance the cargo and/or the feet of the crew would be putting weight on the gunwale. The hauling of fishing nets across the gunwale could also eventually and potentially have an impact on the wearing away of the garboard strake rabbet. It should be noted that the port side garboard rabbet at midships also shows signs of wear but not enough apparently to warrant repairs at the time.

The wearing away of the garboard strake rabbet along the keel suggests that the vessel, while single planked, was in active use for some time. A time range for this phenomenon can only be speculated as the function of the vessel is not known. If it was used as a lighter, then the loading and unloading of the vessel would have been repeated many times a day, while if a fishing boat, the hauling of nets would take place perhaps a few times a day. In any event it would be safe to assume that this wearing away of the garboard strake rabbet would take place over a number of years, not months.

The sided faces of the rider keel – fore [551] is covered by chunam overlaid with pitch similar to the exterior of the inner planking but shows no obvious wear, while rider keel - aft [550] has no applied chunam or pitch and also does not display wear or marine borer damage (Figure 5.8 and see Figure 5.7 as well as Figure 5.9). This observation points to two separate events. Firstly, that the rider keel was not exposed to water for an appreciable length of time, and that the garboard shelf planks [539, 540, 542, and 543] for the outer planking were placed around the same time as the rider keel. This indicates that the rider keel was added to the vessel to extend the depth of the keel to accommodate the garboard shelf planks which supported the outer layer of planking.

The second event is that the aft section of the rider keel [550] is very likely a repair, scarfed onto the fore section of the rider keel [551] while still attached to the keel, as attested by the cut mark on the keel and filler plank [541] (see Figure 5.7). In this instance also there was no application of chunam and pitch on the repaired section.

Figure 5.8: View of starboard side of keel [055] and rider keel aft [550] (left of image) with rider keel [551] fore to right of image.

The addition of the rider keel resulted in the lengthening of the vessel by approximately 500 mm (see Section 4.4). This would have resulted in the restructuring of the stem assembly as the current remaining stem sits atop the rider keel – not the primary keel. This re-structure may have also resulted in the inner, original, layer of planking close to the bow being replaced with longer pieces so as to reach the rabbet along the new stem. This would seem the more durable option, rather than scarfing 500 mm long plank sections onto each strake.

The stern post [300] does not appear to have a relatively high frequency of fastener holes (See Section 4.4) which would suggest that the inner planking was not refastened when the outer planking was added.

The angled trunnel [535] was inserted into the keel sometime after the filler plank [541] was added as it passed through the piece as well as the inner starboard garboard plank [400] (Figure 5.9). There was no corresponding floor frame above the trunnel and the top of the object was rounded, suggesting that the upper part had broken off or worn away.

The function of the trunnel is unclear. If associated with a floor frame, it indicates that there was some replacement of the frames after the repair to the starboard rabbet along the keel at around midships. If so, that frame had been removed sometime later. The absence of frames in the vicinity of the trunnel could reflect the expected selected salvaging of the vessel that would have taken place after it was abandoned next to a boatyard. If the scenario of a later frame replacement is correct, it would be expected that the trunnel would have been vertical and entered the keel close towards the centre of its top side. Therefore, the trunnel's placement could be a sign of poor technique in one of the repair phases of the vessel. Alternatively, the angle of the trunnel could be the result of trying to avoid a feature running along the top of the keel, such as a now-missing mast step.

Another possibility is that the trunnel is associated with the repair works, which included the installation of the filler plank [541] to support the starboard garboard strake at midships. Perhaps the repairer was not confident in the quality of the repair, or that there was too much movement in the garboard strake after the repair was completed, and so the trunnel was inserted to pin or stabilise the strake.

Figure 5.9: Trunnel [535] entering the starboard side of the keel [055] at an angle. Fore section of rider keel [551] below.

Based on the above observations the following broad sequence of construction is proposed as follows:

<table>
<tr><td>Phase 1 - Single hull</td><td>Laying of keel with stern, stem assembly and single layer of clinker planking.</td></tr>
<tr><td colspan="2">Indeterminate period of time, perhaps a decade, in operation.</td></tr>
<tr><td rowspan="2">Phase 2 - Single hull</td><td>Repair involving restoring the garboard strake rabbet on the starboard side of the keel by fastening a plank [541] to reform the rabbet.</td></tr>
<tr><td>Angled trunnel inserted into keel either as part of the repair of the garboard strake rabbet, to avoid a feature atop of the keel such as a now missing mast step or to install, poorly, a new (and now missing) frame. The latter two scenarios could also have taken place in Phase 3.</td></tr>
<tr><td colspan="2">Indeterminate period of time in operation, possibly a number of years. The observation of an oyster having grown over the pitch of the inner planking and covered by the outer planking could indicate that the vessel may have been left temporarily abandoned.</td></tr>
<tr><td rowspan="3">Phase 3 - Double hull</td><td>Rider keel attached resulting in re-construction of the bow, including the stem assembly.</td></tr>
<tr><td>The garboard shelf planks attached to the keel and rider keel forming the rabbet for the garboard strakes of the outer planking.</td></tr>
<tr><td>Aft section of rider keel repaired by new piece being scarfed onto the fore section and keel.</td></tr>
<tr><td colspan="2">Indeterminate period of time in operation before abandoned.</td></tr>
</table>

5.2 Form

Reconstructing the form of UDHB1 from its archaeological remains combined the use of photogrammetry and on-site measurements with 3D CAD software to correct the distorted hull shape. The re-construction does include select 3D scans of individual timbers undertaken by SWF during the conservation process, which was on-going at the time of writing this report.

In summary, the final form evaluated from the remains suggest that the hull shape closely resembles a 'cutter' of the period, having a sharp bow with beamy proportions. See discussion on the vessel type in Section 5.3.

5.2.1 Sources used for reconstruction

The sources therein were used to help better understand the boat through its form, construction and function. The first source: *Working Boats of Britain: their shape and purpose*, (first published 1964) was written by Eric McKee, Commander in the Royal Navy and later Caird Research Fellow at the National Maritime Museum in Greenwich.[78] The second source: *The Boats of Men-of-War*, (first published 1974) was written by W. E. May, also a Commander in the Royal Navy, which explores the history and development of ship's boats, including many plans and scantlings from the era of early 1800s.[79] The third source: *Boatbuilding: A Complete Handbook of Wooden Boat Construction* (first published 1941) was written by esteemed American boat designer and maritime historian Howard I. Chapelle,[80] and the final source discussed in this section is *The Shipwright's Vade-mecum* first published 1805) written by shipwright David Steel. His work provides insight into cutters and scantlings for various vessels of the era.[81]

5.2.2 Hull correction and orientation

The hull had been distorted over time on the starboard side where it had been chocked with a sandstone block/ashlar (see Figure 3.3 and Figure 3.4). To correct this distortion, first, a photogrammetry model of the shell of the hull after the framing had been removed was processed into station, buttock, and waterlines to be able to adjust the lines where necessary (Figure 5.10 and Figure 5.11). Distortion is seen between Stations 2 and 3 and are most apparent in the breadth-plan in Figure 5.12. The lines were faired at this point.

Another distortion notable in the remains was that the sternpost had leant to the starboard side, and the keel had twisted. The keel components were straightened by finding the centreline through the scanned timbers in 3D CAD software, and calculating the length of the centreline.

To orientate the hull level again, the framing was used, as these held the hull in its most accurate shape. Using 3D manipulating software 'Rhino',[82] the photogrammetry model was viewed in cross section and orientated the floor frames so that the rung ends (extreme open ends of the frame), if both existed, were levelled.

---

[78] McKee, E. 1983. Working Boats of Britain: their shape and purpose

[79] May, C. W. 1974. The Boats of Men of War (2003 ed.).

[80] Chapelle, H. I. 1941. Boatbuilding: A Complete Handbook of Wooden Boat Construction (1962 ed.).

[81] Steel, D. 1805. The shipwright's vade-mecum.

[82] McNeel, R. et al, 2017. Rhinoceros 3D, Version 5.0.

Figure 5.10: Photogrammetric model of UDHB1 after removal of the frames.

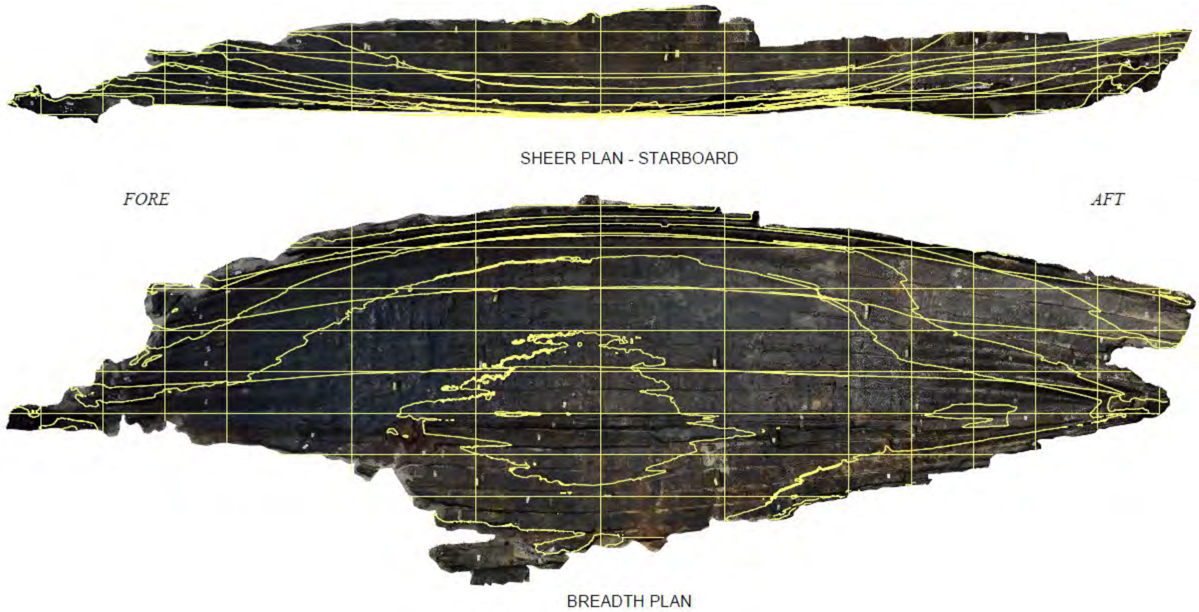

Figure 5.11: Un-faired lines on the photogrammetric model of UDHB1.

5.2.3 Reconstruction of hull shape – fairing the hull

Elements that remained in the hull provided indications to discern the most probable hull shape given the remains, such as the existing framing, and the remaining shape of the hull. The corrected lines in CAD were fitted out with the remains of components, such as the sternpost and knee from the 3D scans carried out by SWF during the conservation stage. These corrected remains were then used to project the final hull form using aids of comparison to plans of similar sized vessels of the era sourced from the National Maritime Museum, Greenwich, London, UK (see Section 5.2.5 for examples).

The stations from the photogrammetry hull model were extracted into CAD which represented the internal line of planking. The inner top edges of the planking were used to draw the hull station lines to represent the moulded, not planked, profile. This presented some challenges, as the garboard planks had shifted from the rabbet in the keel, which was corrected with a reconstruction of the keel and the plank dimensions (Figure 5.12 and Figure 5.13).

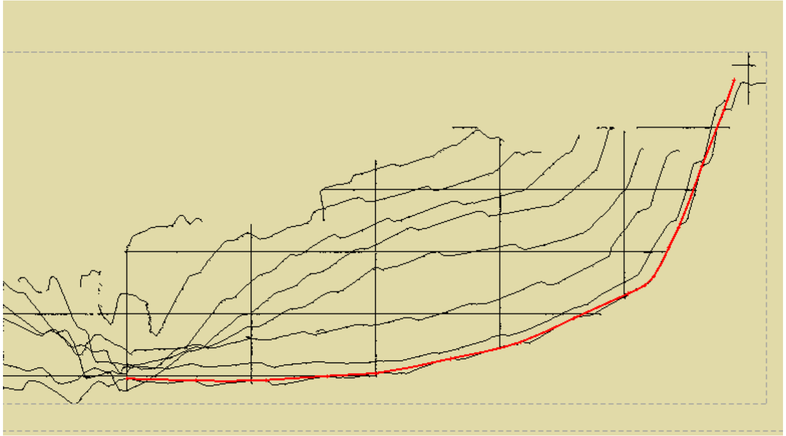

Figure 5.12: Body plan of lines of photogrammetry model of the hull looking from centre station towards the bow. Red line is the moulded profile of the centre station taken from the inside points of planking edges.

Figure 5.13: Garboard plank [437] pulled away from rabbet in keel [055]. Planks on the left of the photograph, keel on the right, looking towards the stern.

The shape of the bow was reconstructed with the curvature that remained in the stem, and where the starboard side hull planking ended. These lines were projected in 3D CAD software and Rhino in both two-dimensional and three-dimensional forms to realise the shape. However, with a small portion of the stem remaining, there is the possibility of a curved or straight stem.

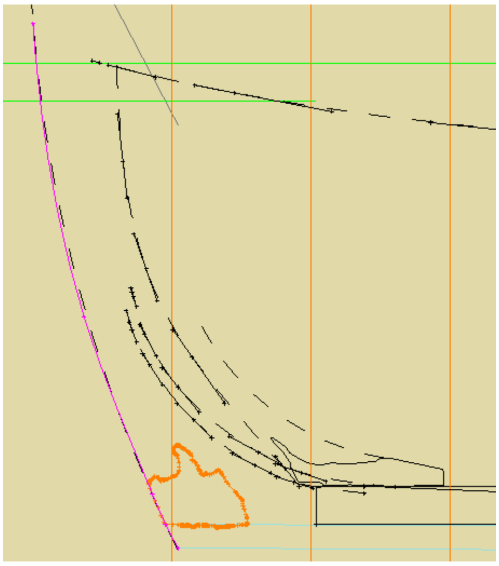

Figure 5.14: View of bow assembly from port side with projected lines of stem, apron and knee. The curvature of the stem is found using a three-point arc, then projected upwards.

Regarding the stern, there are two potential possibilities, given what remains. A straight transom could have been used. Evidence that suggests a transom is firstly that the ends of the planking line up when the rake of the sternpost is projected, and also that there were copper alloy fasteners discovered in the ends at this point, similar to the Browns Bay vessel of the same era which used copper fasteners at the transom, with iron elsewhere (see section 5.5 Comparative Analysis).[83] The ends of the planking will need further analysis to confirm signs of a transom present. The rake of the sternpost comprises of two angles; 23.75º for the sternpost and 19.45º for the backing piece [545]. This is representative of the rake of the sternpost, as well as the backing piece added below the waterline.

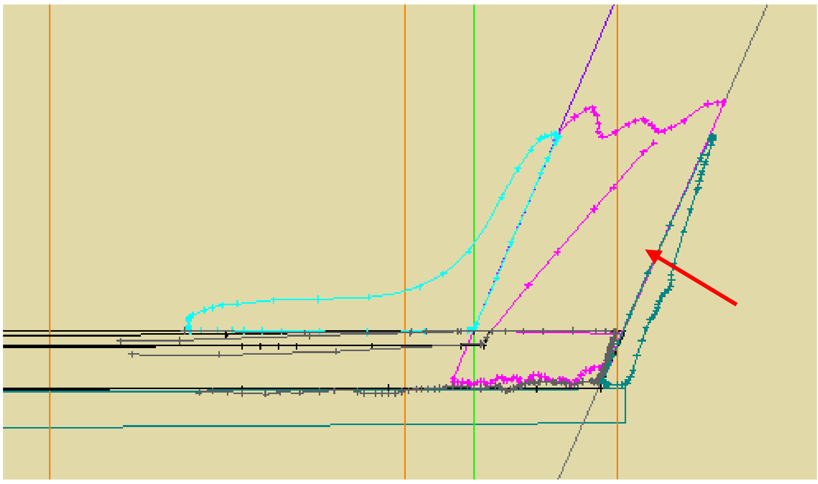

Figure 5.15: View of stern assembly from portside. Red arrow indicating backing piece [545].

The probable sheerline was determined using a combination of the previous steps taken, notably the curvature of the stem and a realistic end point in conjunction with the planking meeting it. Strakes were added above the remains equal in size, and a template of a person rowing, with the usual thwart-to-sheerline distance being accounted for, was used to suggest the probable sheerline height for the gunwale (Figure 5.16).

[83] *Amer, C.F. 1986 The Construction of the Browns Bay Vessel.*

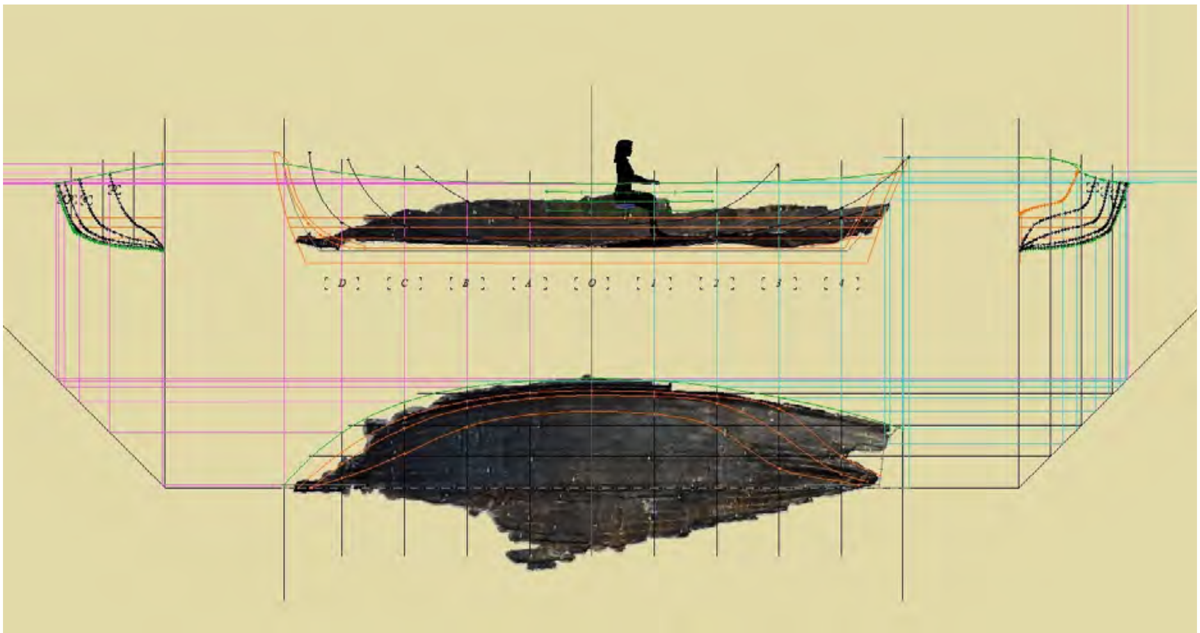

Figure 5.16: Draughting layout of sheer, breadth and body plans. Figure used to check sheer height.

5.2.4 Reconstructed lines

The reconstructed line plan presented in Figure 5.17 is the culmination of the processes described in Sections 5.2.2 to 5.2.3. A set of lines is provided in Annex B.

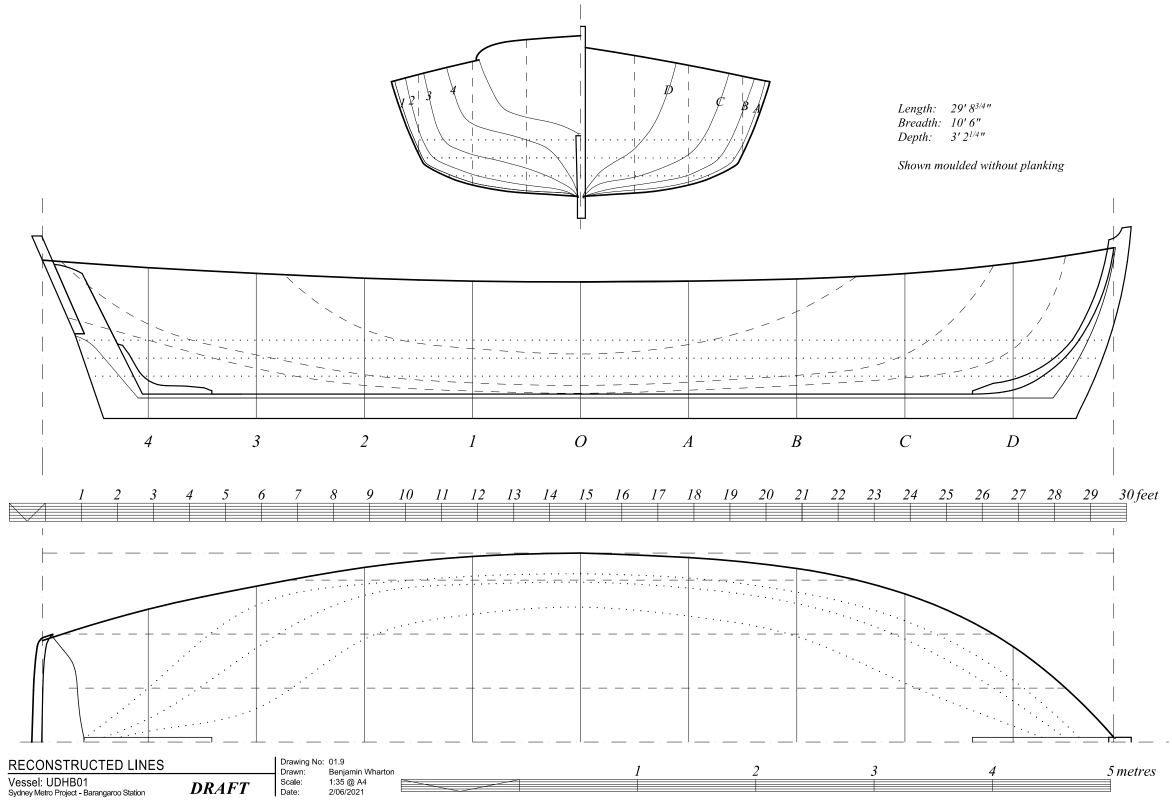

Figure 5.17: The reconstructed lines of UDHB1

5.2.5 Description

The profile of the boat can be described after McKee in two parts, first of profile, then by section[84].

Profile:

- Length overall (LOA) of the hull 29' 7" (ca. 9 m)
- Keel line is straight 27' approximated and identified as 'beam' in construction style.
- Depth (from gunnel to top of keel at midships) is 3' 2" (ca. 1 m)
- Draft fw'd approximately 1'
- Draft aft approximately 1'
- Sheerline at gunwales.
- Curved stem, though this could also have been straight.
- Stern had a transom though with no transom intact, it could have had a knuckle counterstern.

Section:

84 *McKee, E. 1983: 78-79.*

- Topside is described as having 'flam', being that the sides angle out approximately 20^{o} from the bilge.
- Bilge can be described as being hard with a radius of curvature less than $1/10^{th}$ of the beam.
- Floor is flat with approximately 4^{o} to 5^{o} deadrise.
- Width is projected to be 10' 6" (ca. 3.2 m).
- Ratio of the hull shell length to beam is 2.79 and falls within the 'normal' range but being closer to beamy than narrow. L/B of 2.6 or under being 'beamy' and over 3.75 being 'narrow'.
- Ratio of the hull shape of beam to depth is 3.3 which falls within the 'shallow' range. B/D of 2.0 or under being deep, and 3.0 or over being shallow.

Based on the projected dimensions of the vessel an estimate of its tonnage can be made. In the 19^{th} century a vessel's tonnage is often appended to a vessel's name as a way of identifying it. Tonnage was based on the volume inside the hull and below the deck, which was in effect the maximum. This was a means of assessing how much cargo a vessel could carry, which in turn facilitated the amount of port duties and other taxes that customs officers and other officials could extract from the vessels' masters. Tonnage in the first half of the 19^{th} century in Australia was calculated from a formula known as the Builder's Old Measurement (BOM).[85] The formula can be presented as follows:[86]

$$\text{Tonnage} = \frac{(\text{Length} - (\text{Beam} \times \frac{3}{5})) \times \text{Beam} \times \frac{\text{Beam}}{2}}{94}$$

With a length (from inside of stem to inside of stern post at the sheerline) of ca. 29.5' and a maximum beam of 10.5' the estimated tonnage is 13.5. As the breadth of the vessel is an estimate, for the purposes of this report the tonnage of UDHB1 will be given a range of 10 to 15 tons.

With regard to framing style, McKee's example of 'zoned discontinuous' resembles the framing layout of UDHB1 most closely (Figure 5.18).[87] He notes that '*each range of timbers is shaped and spaced to stiffen a particular zone but laps into the next one to ensure transverse continuity*.' He also describes zoned discontinuous as: '*an organised pattern of discontinuous solid or bent timbers, or mixtures of them in the various zones*.'[88]

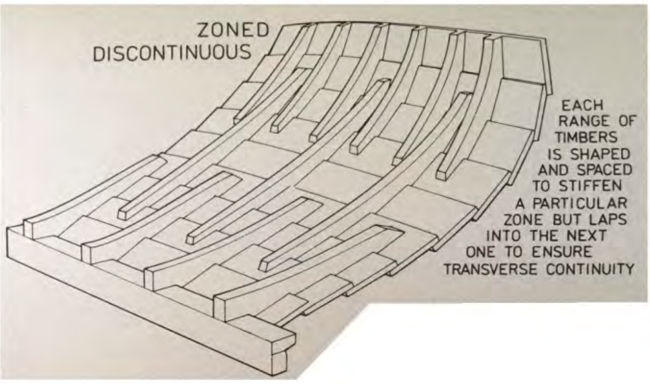

Figure 5.18: *Zoned discontinuous diagram.*

[85] ***Kemp, P. (ed) 1976 The Oxford Companion to Ships & the Sea..***
[86] ***Steel, D. 1805 : pp 249-251.***
[87] ***McKee, E. 1983 : 61.***
[88] ***McKee, E. 1983 : 60-61.***

The lines of UDHB1 now reconstructed could be compared against plans of similar sized boats. Plans held in the archive collection of the National Maritime Museum, Greenwich, England were a valuable resource to test against, given that these plans can easily be scaled correctly for 1:1 comparison. The plans also provide useful information such as vessel type and year drawn. Plans for barges, launches, pinnaces, longboats, yawls and cutters were used to compare the lines. See below some examples of plans used to compare UDHB1 (Figure 5.19 to Figure 5.21).[89]

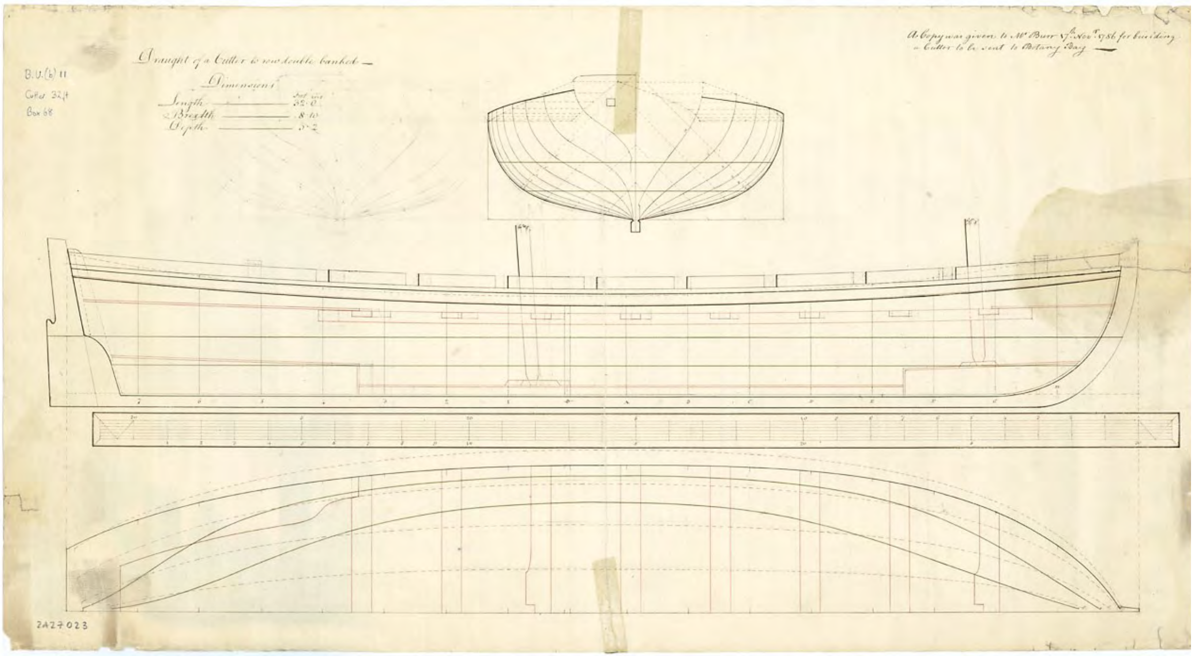

Figure 5.19: 32-foot cutter with two masts. 1786. Written in the top right corner are the words "*A copy was given to Mr Burr 17th November 1786 for building a Cutter to be sent to Botany Bay*".

[89] National Maritime Museum, Greenwich, London. Object ID: ZAZ7023, ZAZ7198.3 and ZAZ7172https://collections.rmg.co.uk/collections.html.

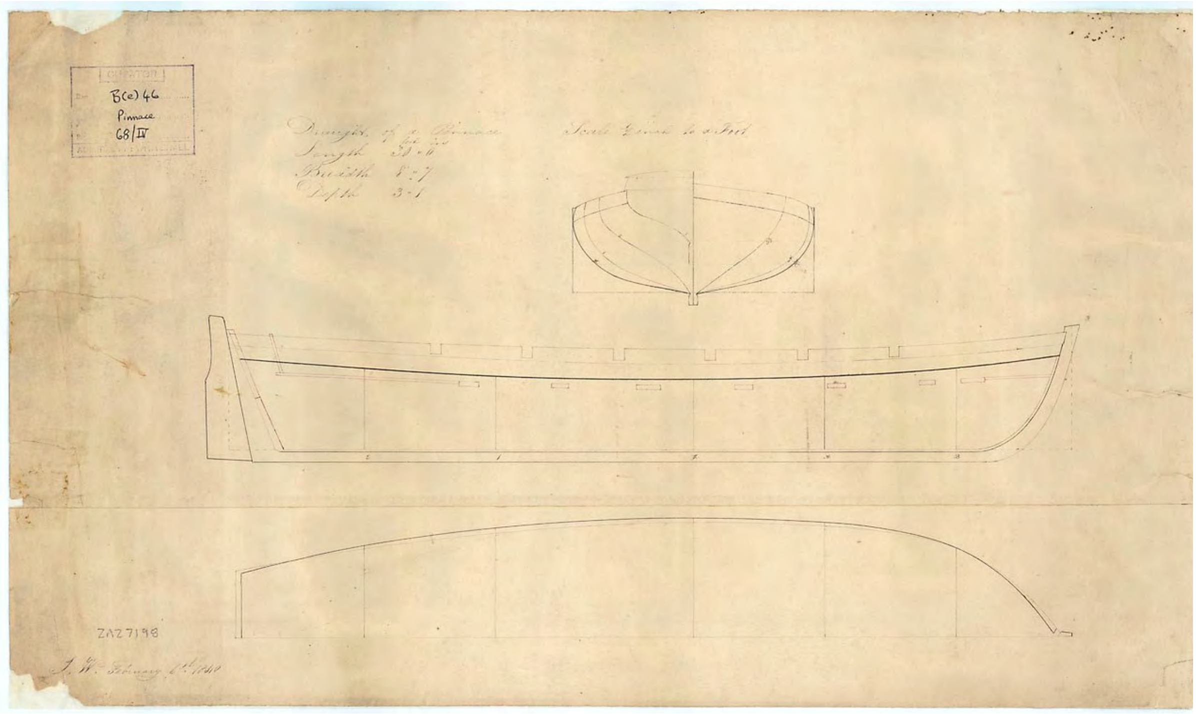

Figure 5.20: 30-foot pinnace.

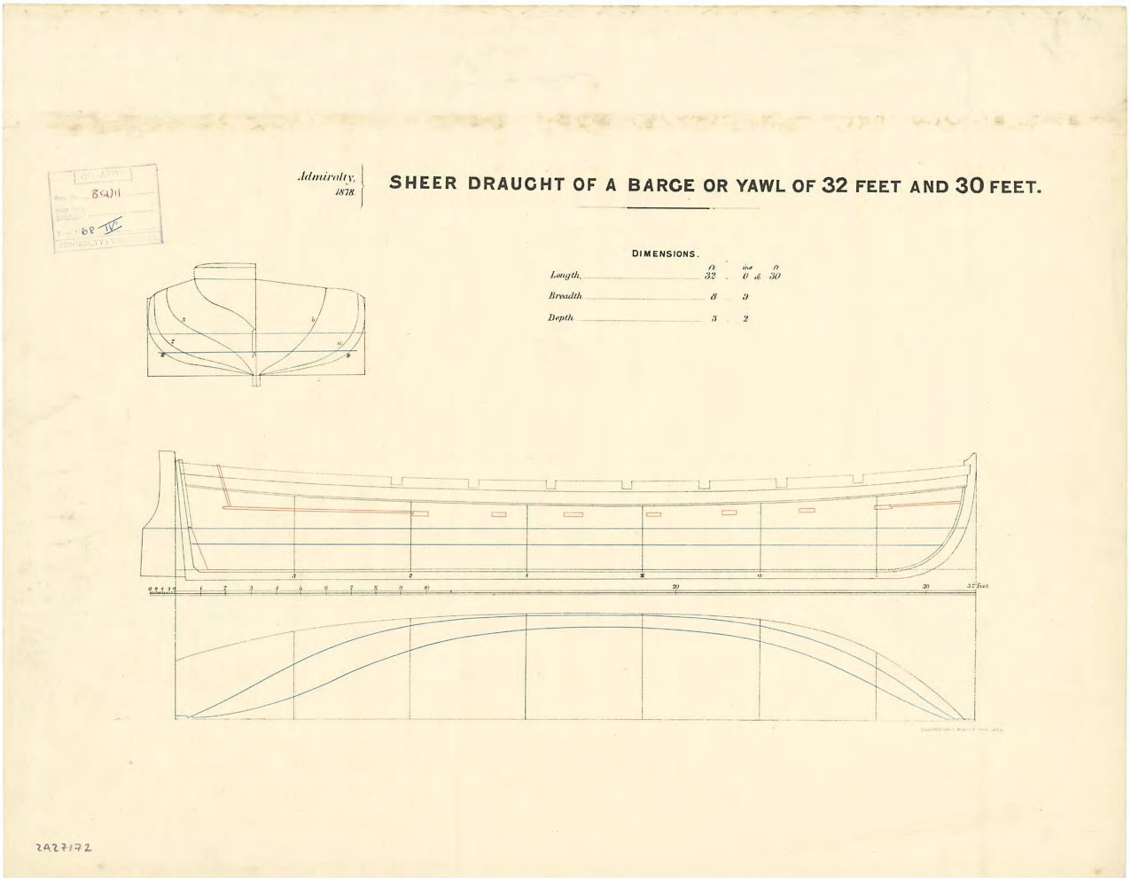

Figure 5.21: 30 and 32-foot barge or yawl. 1878.

The boat type that matched the closest were those titled as being cutters. It is important to recognise here that the term 'cutter' in this context is with regard to hull shape and design –

not the 'cutter' rig sail configuration that distinguishes this term today. Analysis of literature on the subject reveals that cutters were predominantly clinker-built, supporting the idea further; one such example below is from Chapelle. He unites the clinker-build with the cutter in an historical context:

> *The famous English Cutter of the American Revolutionary War period, and later, was clench-built. Boats used on open beaches in England were almost invariably lap-strake.*[90]

May provides an outline of the development of clinker-built cutters for use in the Royal Navy as ship's boats. Within the quotes provided below, he discusses the advantages and disadvantages of clinker-built boats, and the difficulties experienced during the early 19th century where clinker or carvel boats were to be used:

> *At the end of the seventeenth century, it was usual for the boats of men-of-war to be carvel-built, i.e., with their planking laid edge to edge; except when they were built at Deal, where the practice was for them to be clencher- (or clinker-) built with the lower edge of each plank overlapping the upper edge of the one below. Since yawls were usually built at Deal it followed that they were clinker-built.*
>
> *When the Royal yards started building yawls these were carvel-built, and both types remained in service side by side. The next departure at Deal was the building of cutters, and these also were clinker-built as were the gigs which were Deal's next introduction. When these two types began to be built in the yards this distinctive type of build was retained, though cutters were occasionally carvel-built. When building a clinker-built boat the nails should be sufficiently long to be driven right through both planks, the ends being then clenched (or bent over) to prevent the nails working out. Clinker-built boats were always lighter, more tender and more difficult to repair than carvel-built. It seems probable that the boatbuilders often economised by using nails which were too short to clench properly and that in consequence they worked out.*
>
> *The comparative frailty of clinker-built boats and the difficulty of repairing them led in 1769 to an order that yawls for foreign-going vessels should be carvel-built and that clinker-built yawls should be restricted to Channel service. In 1783 it was noted that when clinker-built boats had been allowed to go on foreign service they tended to become 'nail sick' and it was said that the trouble could be avoided if they were copper fastened instead of iron nails being used. Nevertheless in 1800 it was decided that the only cutters to be sent abroad should be jollyboats. In 1803 a Mr Boswell designed a boat with two skins for strength. The inner was to be clinker-built and the outer carvel. The Royal Navy does not appear to have shown any interest at this time.*
>
> *In 1820 the* Creole *was supplied for experiment with two quarter-boats which had carvel-built bottoms and clinker-built upperworks. Captain Alexander Mackenzie reported on them most enthusiastically, because though heavier than the usual clinker-built boats they were stronger and more easily kept in repair. In 1823 Captain Thomas Wolrige of the* Driver, *a sloop on the West Coast of Africa, reported most strongly in favour of a carvel-built yawl which had been sent to him for trial.*
>
> *It then transpired that carvel-built cutters had been constructed by mistake in 1830 and that these had been foisted upon the* Briton *by the dockyard because she did not immediately complain. Again in 1836 we find Captain Maurice Frederick Fitzhardinge Berkeley of the* Hercules *complaining that she had been supplied with carvel-built cutters as quarter-boats and that these were more than a ton heavier than were clinker-built boats*.[91]

[90] ***Chapelle, H. I. 1941 : p.442.***

[91] ***May, C. W. 1974 : pp 66-67.***

5.3 Appearance

Having the form realised to most resemble a cutter, a plausible appearance of the boat was determined to reflect that. This was carried out using indications of the internal and external remains. 3D modelling files of UDHB1 are presented in Volume 6.

5.3.1 Outer hull

The external appearance was determined by the remains of the wreck, whose outer planks were coated in pitch (Figure 5.22). Copper sheathing to protect the stem was also evident in the remains, and as such were drawn to above the probable waterline on the stem.

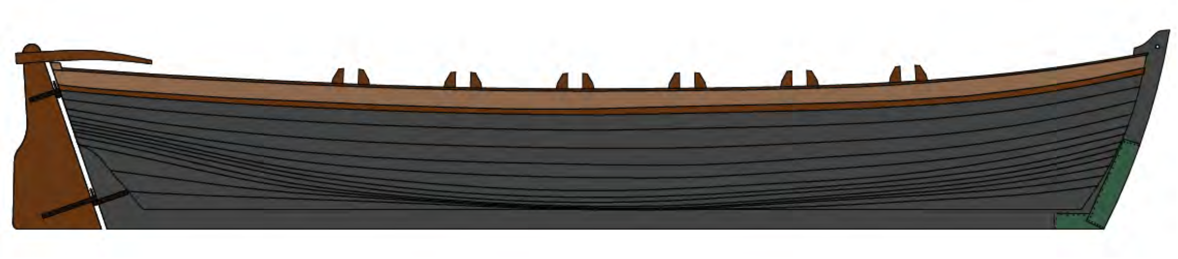

Figure 5.22: Starboard view of reconstructed vessel. Pitch coated hull with copper sheathing on stem. Sheer strake and rudder natural timber finish with oil or tar mix. (Reconstruction by Benjamin Wharton 2021).

The boat's appearance at the sheerline is at this stage unknown, as is whether or not the sheer strake continued with pitch, was painted with colour, or if the timber was sealed with tar or oil. While the majority of vessels of similar size in illustrations of the period on Sydney's waters appear to have had a sheer strake painted yellow or red, it was decided for this reconstruction to leave it natural timber oiled to avoid too much conjecture (see Section 5.3.3 for examples).

The method chosen for finishing the sheerline was to use the notes of Chapelle regarding larger lapstrake boats, combined with McKee's recording.

> *In a boat in which this [turning upside down to drain] is impractical, because of size, the sheer clamp is put in . . . Then the sheer is capped: this is done by nailing a thin strip of wood along the sheer, wide enough to reach from the outside of the sheer strake to the inside of the sheer clamp. . . The reason for the cap strip is to protect the heads of the frames from moisture and rot. Oarlock sockets are stepped in blocks between the frames, with or without the cap.* [92]

The sheer clamp (Chapelle), or inwale (Steel), was dimensioned from Steel's scantlings and the capping protruded about 1/4 inch off the sheer strake and the inner side of the sheer clamp. The seam batten shown by McKee with a filler piece within was utilised for its simplicity in construction and function and also reconciled the double planking system to finish with simplicity (Figure 5.23).[93]

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[92] ***Chapelle, H. I. 1941 : pp 457-458.***

[93] ***McKee, E. 1983 : pp 174.***

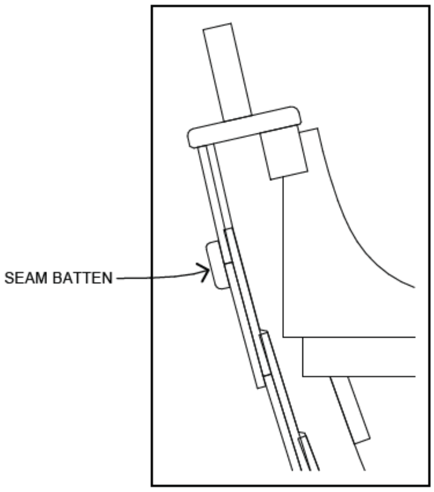

Figure 5.23: Cross-section showing planking, sheer clamp, capping, and sheer strake with seam batten.

5.3.2 Fit-out

Internally the hull planking and framing was pitched and partially covered by ceiling planks lining the inside amidships (Figure 5.24 and Figure 5.25). There were no remains high enough to gain an idea of the former existence of a riser, knees, and thwarts. Therefore these have been assumed from comparisons with similar vessels of the era sourced in illustrations, models and plans. Other parts included in the reconstruction of the vessel that have been assumed from sources include decking.

For the fitting-out of the vessel, David Steel's 1805 scantlings were used as a basis for the dimensions of components missing from the remains. The column for 'cutter' was used using the selection of 30-foot length as the basis.[94] However, in two cases, being the thwarts and rising, were increased in accordance with having a larger beam than the cutters Steel had listed in his table. The thwarts are thickened by 1/2" deep to compensate for greater span of beam in UDHB1 and the rising (also known as a stringer) was also subsequently increased with respect to the larger thwarts.

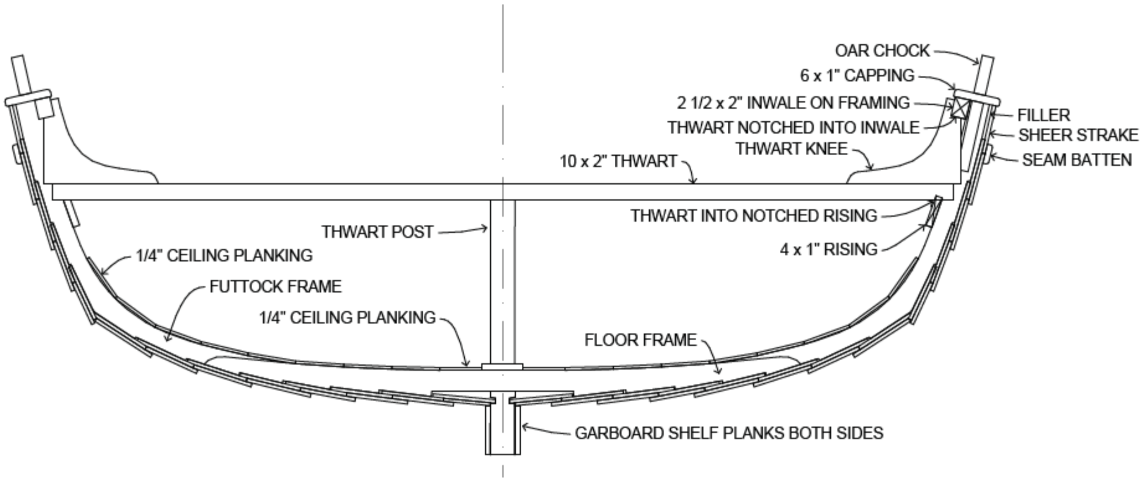

Figure 5.24: Cross section at midships. (Detail from drawing: Appearance and Cross Section No. 03.5 showing cross section at midships, Volume 6).

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[94] May, C. W. 1974 : 58-61.

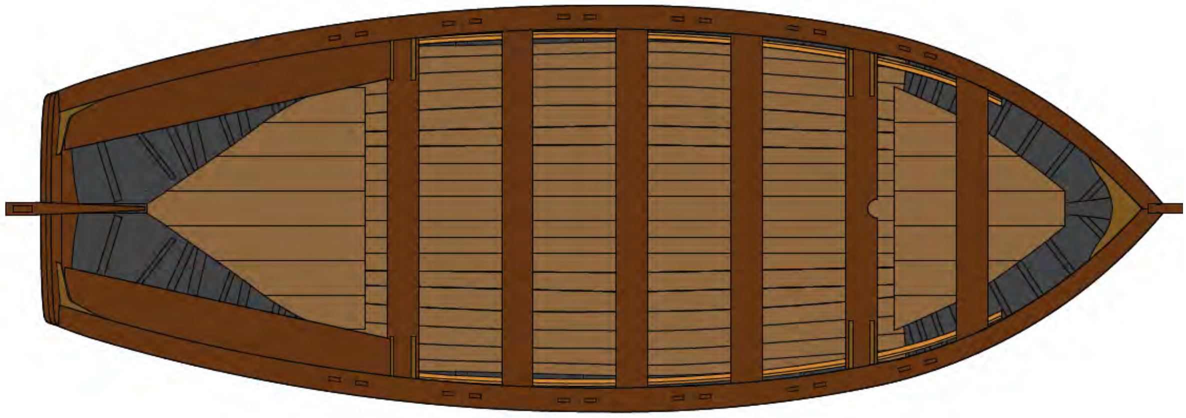

Figure 5.25: Breadth plan coloured. (Detail from drawing: 03., Volume 6).

5.3.3 Propulsion

Whether or not the vessel sailed cannot at this stage be confirmed. While there was no keelson and mast step, there was also no ceiling planking over the area of the keel where a keelson and/or a mast step could have been, nor was the bow area preserved where a mast step could have been. These factors leave the question at this stage up to speculation. A closer analysis of the fastening holes atop of the keel could contribute to any discussion as to whether UDHB1 had a mast step.

However, the cutter-style hull shape strongly suggests having been utilised for sail as well as by oar, as opposed to narrower oar-only propelled vessels. The rig of sail that could have been employed would be the gaff, lug, or sprit rig which appear for these sized vessels in the period in Port Jackson. However, the gaff rig requires more standing lines to support the mast, of which there were no recognisable remains of chain plates being fastened to the hull side, though there may have been a simple fixture not extending past the sheer strake and not preserved in the wreck. It could, however, be more likely that either lug or sprit sail were used, which do not rely on shrouds (standing lines) affixed to the hull sides. Figure 5.26 to Figure 5.28 are examples of a similar sized hull shapes with a lug mainsail.[95] Figure 5.29 demonstrates a gaff-rigged mainsail.[96]

[95] Augustus Earle, 1830. 'View of Point Piper" National Library of New Zealand. Reference : PUBL-0053-02; 'Coming to anchor off Sydney" National Gallery of Australia Assc. No. 95.342; James Glen Wilson, ca. 1859-60 'Farm Cover 'man of war roads' Sydney as Taken from Fort Denison c1859-60" State Library of NSW [a5325001 /V/198]

[96] John Eyres 1810. 'New South Wales. View of Sydney, From the East Side of the Cove. No. 2' State Library of New South Wales. XV1 / 1808 / 9 (DON: a1528168)

Figure 5.26: Detail of illustration 'View of Point Piper'. Lug mainsail with mizzen at stern.

Figure 5.27: Detail of illustration 'Coming to an Anchor off Sydney Cove'. Lugsail ketch sail configuration with two masts.

Figure 5.28: Detail of illustration 'Farm Cove "man of war roads" Sydney as taken from Fort Denison' ca. 1859-60. Lug mainsail with headsail.

Figure 5.29: Detail from illustration of Sydney Cove viewed from the east. Gaff-rigged mainsail with headsail affixed to a bowsprit. Note the standing rigging required. No evidence has been found to date of standing rigging on UDHB1.

5.4 Historical context

5.4.1 Shipping in Early Colonial New South Wales

When the New South Wales colony was established at Port Jackson (Sydney) in 1788, Governor Arthur Phillip had strict instructions to limit trade and the use of private vessels. Primarily, this was intended to protect the monopoly of the East India Company from unwanted competition, but the issue of security for what was essentially a penal settlement was also of concern. However, as early as August 1790, Governor Phillip was sending dispatches back to London stating that it was essential for the colony to have at least two schooners to maintain communications around the waterways of Port Jackson and the immediate coast to the north and south.

The establishment of farming settlements at Rose Hill (Parramatta) and along the Hawkesbury River at destinations such as Green Hills (Windsor), Richmond and Pitt Town soon became essential for supplying grain and other produce to Sydney. The only feasible way to bring these products to markets was by water transport, and government vessels such as the schooner *Francis* appear to have been regularly visited the outlying settlements to take out supplies and passengers and return cargoes to Sydney, but demand would have soon outstripped this service. The small sailing craft carrying these cargoes had to cope with many bends in the river where winds were uncertain and often contrary, obliging the crews to resort to the hard work of rowing. They also had to weather the exposed sea passage between Sydney Heads and Broken Head.

Permission to register private boats below 14 feet in length had been given by Governor Phillip in 1791, although exemptions could be granted for larger vessels. There is no firm evidence for how many non-government craft were built during this early period, although on 9 October 1797 Governor John Hunter forbade the building of any boats whatsoever for the use of private persons after a series of convict escapes by sea.[97] An incentive for the construction and ownership of more shipping came with the discovery of fur seals in the Bass Strait region following the loss of the merchant ship *Sydney Cove* in 1797. The return of the first cargo of seal skins and oil to Sydney on board the English brig *Nautilus* in March 1799 led to a surge of commercial activity in the regions of Bass Strait and the southern coast of Australia. The then governor, Phillip Gidley King, was anxious to end the colony's dependence on government funding, and private individuals were encouraged to exploit this

[97] ***Historical Records of Australia (HRA), Series I: Despatches of Governors to and from England (2): 203***

new source of income. Emancipated convicts became private entrepreneurs and a steadily increasing number of craft were locally constructed or obtained from overseas. By 1806 there were nearly twenty colonial vessels reportedly operating in Bass Strait.[98]

Larger vessels were permitted to remain in private ownership on the condition that they not go beyond the limits of the colonial territory, which precluded direct trade with Asia unless they were partnered with an 'agency house' operating under license from the East India Company. However, the colonial territory included the islands of the western Pacific, and products such as sandalwood and salted pork were soon being returned to Sydney for sale. A return of vessels '*belonging to and employed by individuals*' in New South Wales dated 28th February 1804 listed twenty-two craft ranging from the 9-ton *Argument* to the 38-ton *Governor King*, averaging 26 tons burthen. All these craft were colonial built, with seventeen constructed at Port Jackson and five at the Hawkesbury River.[99] Their areas of operation were listed as 'Bass's Straits', Hawkesbury River and 'Coal River' (later Newcastle). A similar list from August 1806 included the newly built 185-ton colonial ship *King George*, noted as being engaged in the whaling industry.[100]

The discovery of the Hunter River region in 1797, lying north of Port Jackson, had led to increasing demand for vessels to exploit the new agricultural area and its deposits of good-quality coal for the Sydney market. Over 200 cargoes of coal are recorded as coming to Sydney from the Hunter River during the period 1800 and 1821, on both private and government account. Developments of areas to the south of Port Jackson soon followed, concentrated at the 'Five Islands' (Illawarra) region and the Shoalhaven River. Early cargoes from the south included shipments of valuable cedar and other timbers useful for shipbuilding. With the establishment of new colonies in Van Diemen's Land (Tasmania) during the early 1800s, the settlements around Hobart and Launceston were sending regular shipments of grain, hides, meat and potatoes to New South Wales by 1815.

The rise of private merchant ventures in the colony resulted in developments around Sydney Cove and at the adjacent Cockle Bay (later Darling Harbour) and Woolloomooloo. Robert Campbell was the earliest of these entrepreneurs and, backed by funding from a Calcutta agency house, he constructed a warehouse and wharves on the north-western side of Sydney Cove that was far larger than any government facilities. Governor Lachlan Macquarie had the dilapidated Hospital Wharf replaced by the 'King's Wharf' during 1812 to service the government Commissariat store and the adjacent dockyard. There was also a longer jetty known as the 'Government Wharf' at the south-eastern edge of the Cove. However, because of the limited nature of these facilities and the shallow water at the head of the bay most ships appear to have discharged their cargoes while remaining at offshore anchorages, Campbell's Wharf being the exception for many years.

Shipping arrivals and departures for Sydney during 1810 show that there were almost 100 local vessel movements from the port. Ten of these voyages were to obtain seal skins and oil from locations in Bass Strait and South Australia. Colonial vessels also went to Tahiti for pork (three voyages) and New Zealand for sealing products or timber (five voyages). Sixteen voyages were to the Hunter River (Newcastle) with stores, prisoners or government personnel for the convict settlement and returning with cargoes of coal, timber or lime. The largest number of voyages by far were to and from 'the Hawkesbury' and the settlements along the river. Forty-five cargoes were received at Sydney from the region consisting primarily of wheat, maize and oats. During the year it was also noted that the 20-ton schooner *Geordy* was completed at Scotland Island, Pittwater, and the 18-ton sloop *Boyd*

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[98] Bach, J., 1976, A Maritime History of Australia : 71.

[99] Jeans, D.N., 1974, 'Shipbuilding in nineteenth-century NSW', Royal Australian Historical Society Journal and Proceedings, 60 (3):160.

[100] Cumpston, J.S., 1977, Shipping Arrivals and Departures Sydney: Volume One 1788-1825: 68.

was built from the longboat of the ship *Boyd*, which had been lost at the Bay of Islands, New Zealand, during 1809.[101]

The career of the 14-ton sloop *Raven* is a good example of the use and demise of one of these early colonial craft. *Raven* was first licensed at Sydney in October 1804 under the ownership of emancipists Thomas Reiby and Edward Mills. The vessel was primarily employed in the trade between Sydney, the Hawkesbury River and the Hunter River. *Raven* undertook two voyages to the Bass Strait sealing grounds during 1805, and departed for a third voyage in February 1806 to pick up a sealing party and their catch from an unidentified location. In early April the sloop was trying to reach Port Dalrymple (northern Tasmania) with the sealing party onboard when it disappeared during '*a perfect hurricane*', witnessed by the crew of the government schooner *Estramina*.[102]

Shipwrecks were the fate of a considerable percentage of these early colonial vessels due to their small size, lack of navigation aids and the sudden onset of bad weather on the long and exposed coastline. Even the relatively short passage between Sydney, the Hawkesbury and the Hunter River resulted in the loss of fifteen colonial craft between 1800 and 1810, including the government schooner *Francis*.[103] Commissioner John Bigges report on *Agriculture and Trade out of New South Wales*, compiled during 1819-1821, noted that there were twenty-nine vessels operating out of Sydney of which seven were 15 tons and under and the largest was 184 tons. He described them as being '*both badly equipped and badly navigated, and are little qualified to resist the heavy gales of wind with which the coast of New South Wales is visited during many seasons of the year*'.[104]

While the colonial government encouraged the construction and employment of local trading vessels, they also imposed a series of duties and regulations upon their owners. The regulations were partly economic and partly administrative in their purpose. Duties on even locally produced commodities, as well as those from foreign destinations, were intended to provide revenue for the government. There were also complex regulations designed to prevent convicts being taken from the colony by sympathetic ship-owners, or to provide security to vessels so they could not be seized by escapees. The regulation of colonial vessels also included the issuing of registrations or licenses to operate, issued directly by the Governor or Port Officer, although very few of these still exist in the documentary record. In 1826 official Registrars of British Shipping were established within the Customs Departments of Sydney and Hobart, and later Launceston. New ports of registry were also designated as the century progressed and the Australian colonies grew.

With the steady economic development of New South Wales during the 1820s and 1830s there was a commensurate increase in local shipping. One observer, writing of Sydney in 1826, noted that '*We have four vessels constantly whaling, six sealing, two employed as regular packets between Sydney and Newcastle; one between Sydney and Hobart Town (the principal traffic this way being carried on in English vessels on their way out and home); several trading constantly between Sydney and Port Dalrymple, besides irregular traders to all these places, and a number of small craft coasting the Hawkesbury, Illawarra and other points*'.[105] By 1832 the colonial fleet consisted of ninety-nine vessels, ranging from 17 to 392 tons, but still mostly trading along the New South Wales coast and as far south as Van Diemen's Land. During the 1830s the European settlement of Australia expanded with new colonies established at the Swan River/Perth (1829), Melbourne (1835), South Australia (1836), and free movement to the Moreton Bay/Brisbane area commencing in 1838.

With ports becoming better established and a greater demand for more reliable shipping services the first steamships began to appear, commencing with the launch of the paddle

[101] Cumpston, J.S., 1977: 70, 72

[102] Nash, M. & Broxam, G., 2019 : Shipwrecks in Australian Waters 1622-1850 : 29

[103] Nash, M. & Broxam, G., 2019: 20-35

[104] Bigge, J.T., 1823, Report on Agriculture and Trade in New South Wales : 55

[105] Cunningham, P., 1828, Two Years in New South Wales: 67

steamer *Surprise* at Parramatta in March 1831. The paddle steamer *Sophia Jane* arrived at Sydney from London in May 1831 to start a regular colonial service, and by 1841 there were sixteen steamships operating out of Sydney on coastal and interstate runs. Locally owned whaling vessels also appeared in increasing numbers after the gradual lessening of import duties on 'colonial' whale oil to Britain during the 1820s. In 1830 there were a reported seventeen whaling vessels based out of Sydney, and numbers rapidly increased during the decade before falling off during the late 1840s.[106] Foreign whaling vessels also used Australian colonial ports, particularly Hobart and Sydney, to resupply and trans-ship their oil and sometimes add to their crews.

One feature of the shipping movements out of Sydney and along the coast is the extent to which they relied on small craft (usually under 20 tons) that do not appear on shipping registers. The *Sydney Gazette* of 10 August 1830 compiled a list of coastal vessels whose movements were not regularly reported in the 'Shipping Intelligence' columns of the newspaper. The list notes thirty vessels, the largest being 70 tons and the smallest 10 tons, with two-thirds being under 20 tons. Trade destinations are recorded as primarily being to Newcastle (Hunter River) and the Hawkesbury/Brisbane Water, with other voyages to the Illawarra/Wollongong, Port Stephens, Manning River and 'Nola Dolla' (Ulladulla). A similar list of coastal vessel movements at Sydney between 11 April and 23 May 1831 shows seventy-eight voyages, with vessels ranging between 7 and 27 tons.[107] Cargoes included coal, flour, maize/corn, fish, beef, lime, cedar and blue-gum timbers, cut shingles and 'mangrove ashes'.

The snapshots of shipping movements published in local newspapers show a total of twenty-eight ships, brigs, schooner and cutters at Sydney Harbour on 25 January 1830.[108] A list for 24 February 1837 shows forty-eight vessels at Sydney, excluding all those craft under 100 tons.[109] In general terms shipping arrivals in Sydney peaked in 1840 after which a general economic recession caused the number of overseas and inter-colonial trading vessels to fall from over 800 in that year to less than 400 visits in 1844. This was also partly due to the cessation of convict transportation to New South Wales in 1840, the general decline in whaling, and the temporary curtailment of government sponsored immigration voyages from Britain during 1842 and 1843. However, during the same period the New South Wales coastal trade steadily increased from an estimated 1,640 voyages in 1840 to an actual figure of over 2,000 in 1844.[110]

That this consistent growth in local traffic occurred in a period of economic depression emphasises the colony's continued dependence on the sea for transport, communication and trade. Because the reduction in British, foreign and inter-colonial voyages was generally made up for by the upsurge in coastal activity, the overall number of vessels calling in at Sydney remained constant at around 2,400 arrivals per annum during the first half of the 1840s. During the month of December 1842, for example, there were a recorded 149 coastal voyages to Sydney, including forty-one steamship arrivals, for a total of 9,621 tons of shipping. The main ports of departure were Newcastle, Brisbane Water and the Hawkesbury River, with at least twenty-eight other ports listed, from Twofold Bay in the south to the Clarence River in the north.[111]

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[106] Little, B., 1969, 'Sealing and whaling in Australia before 1850', Australian Historical Review, 9 (2)

[107] Nicholson, I., 1981: Shipping Arrivals and Departures Sydney: Volume Two 1826-1840 : 63, 65

[108] Sydney Gazette 26 January 1830

[109] Sydney Gazette 25 February 1837

[110] Broxam, G. & Nicholson, I., 1988 : Shipping Arrivals and Departures Sydney: Volume Three 1841-1844 : vi-vii

[111] Broxam & Nicholson 1988 : 156

5.4.2 Shipbuilding in Early Colonial New South Wales

While there is reasonable surviving documentation about ship and boat building for government purposes at Sydney, it is much more difficult to quantify those early vessels built by private enterprise in New South Wales. Government records, particularly those contained in the *Historical Records of Australia* and the *Historical Records of New South Wales* series do contain sporadic lists of privately owned vessels in the colony, but the origins of these craft are mostly not mentioned. The first newspaper to be published, the *Sydney Gazette*, commenced in March 1803 but for some years it only appeared on a weekly basis, and did not appear at all for some months when paper supplies were unavailable. The *Sydney Gazette* and later newspapers usually contained a 'shipping news' column, which followed the movements of local vessels and occasionally had other news about building or ownership. However, as the volume of trade to and from Sydney and other ports started to increase, only the more important voyages are noted, apart from occasional lists of the smaller 'coasters' arriving and departing over specific periods. The newspapers also contain an increasing number of advertisements for vessels either available to load cargoes and passengers, or for sale or contracting out, and these provide further details about individual craft that is not picked up in the shipping registers.

As early as 1789 Governor Phillip appointed midshipman Henry Brewer as the temporary superintendent of a government boatyard at Sydney, known as the King's Slipway (Figure 5.30).[112] A ship's carpenter from HMS Supply, Robinson Reid, supervised the convict labour force at the yard, later to be replaced by master shipwright Daniel Paine from London's Deptford Yard. The first named craft to be built at Sydney was the 12-ton 'decked boat' *Rose Hill Packet*, launched in September 1789 and commissioned the following month. On 24 July 1793 the 42-ton government schooner *Francis* was launched, after being sent out in pieces from England on board the supply ship *Pitt* in 1792. Other government vessels built at Port Jackson included longboats, a whale boat for the governor's use, two lighters for unloading shipping, a 'large colonial pinnace' and 'several smaller boats for various uses'. The fleet also included 'two pinnaces of HM ship *Reliance* and *Supply* left for the use of the colony'.[113]

Figure 5.30: Sydney Cove viewed from the west by John Lancashire ca. 1803. Note the construction of two vessels at the government dockyard – one hull in frames and one almost complete.

[112] John William Lancashire, ca.1803 View of Sydney Port Jackson, New South Wales, taken from the Rocks on the western side of the Cove. State Library of New South Wales DG SV1/60
[113] Cumpston, J.S., 1977: 37

In a 'Return of Labour for 1797' Governor John Hunter reported that there were '*Sixteen shipwrights, caulkers, boat-builders, labourers, and watchmen in the dockyard*'.[114] By the end of 1801 Governor Phillip Gidley King reported '*Boat Builders – Average number of men employed 28. Built two boats – finished and launched the* Cumberland *colonial vessel of 26 tons – rebuilding old boats and doing constant repairs to the* Porpoise*,* Lady Nelson*,* Francis*,* Norfolk *and* Bee *colonial vessels*'.[115] The skill level of these 'shipwrights' and associated workers varied — commenting on the completion of the government schooner *Integrity* in 1804 Governor King noted that 'We have only two men that can be called ship's carpenters, the rest being rough house carpenters and 'prentice boys', but he also stated that the vessel was '*extremely well put together and strong, and for her first voyage is gone to Basses Straits & the Derwent*'.[116]

After 1813, when the monopoly of the East India Company on trade within the eastern seas began to be eased and colonial settlement spread, the boat and shipbuilding industry at Sydney flourished. Boats and small vessels were initially built and repaired for the Sydney Harbour and Hawkesbury trade, but as settlement extended to Newcastle and the North Coast the necessity for more and larger craft increased (Figure 5.31).[117] The early development of the sealing and whaling industries, the need for shipment of agricultural and other products to Sydney and the maintenance of trade and communications relied heavily on locally owned and built vessels. D.R. Hainsworth in his account of colonial enterprises up to 1821, *The Sydney Traders*, notes that these first shipbuilders '*showed enterprise, courage and ingenuity. They had to invest labour and capital in yards and slipways, sail lofts and sheds. There must always have been shortages of equipment and skilled labour. Even more formidable than building vessels from local materials in such conditions was the task of keeping them seaworthy year after year*'.[118]

Figure 5.31: Detail from "Walloomoolloo, The Seat of Jno Palmer Esqre Port Jackson, 1803" by John Bolger showing a vessel under construction. Note the smaller craft in the image and their clinker construction.

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[114] Historical Records of Australia (HRA), Series 1 (2): 505

[115] Historical Records of Australia (HRA), 1 (3): 439)

[116] Historical Records of Australia (HRA), 1 (4): 505)

[117] John Bolger 1803, Walloomoolloo, The Seat of Jno Palmer Esqre Port Jackson, 1803. State Library of New South Wales SV1A/WIlo/3

[118] Hainsworth, D.R., 1981, The Sydney Traders: Simeon Lord and His Contemporaries 1788-1821: 116

The first vessels constructed away from the immediate Sydney area appear to have been completed along the Hawkesbury River. Andrew Thompson was a government constable at Green Hills (Windsor), and in conjunction with a 'Mr Kelly' completed the 16-ton sloop *Hope* in 1802, the 20-ton *Nancy* in 1803 and the 18-ton *Hawkesbury* in 1804. The launching and arrival at Sydney of two new 'handsome' sloops built on the Hawkesbury was reported in the *Sydney Gazette* of 1 April 1804 — these being Thompson's *Hawkesbury* and Jonathon Griffiths' *Speedy*. Griffiths was noted as a 'boatbuilder' in official documents, and in 1808 he built the sloop *Hazard* in partnership with Samuel Thorley and the 80-ton schooner *Elizabeth & Mary* launched at Richmond in June 1810. Between 1810 and 1816 he also completed the 15-ton sloop *Betsey*, the 92-ton brig *Rosetta* and the 14-ton schooner *Nancy*. Former boatswain's mate John Grono began building vessels at Pitt Town from 1818 onwards, including the 84-ton brig *Elizabeth* launched in December 1821 and the largest ship ever constructed on the Hawkesbury, the 270-ton barque *Australian* in 1829.[119]

At Sydney Cove itself, where the government's Naval Dockyard was located, there was little private land available for shipbuilding purposes, and the adjacent bays became the centre for the Sydney industry. While shipbuilding is known to have been undertaken at locations such as Woolloomooloo and Lane Cove, the most intensive land-use for the private shipbuilding industry occurred immediately west of Sydney Cove. As the head of the bay at Darling Harbour was swampy and shallow, the shipbuilding yards and wharf space were concentrated along the northern foreshores of the bay towards Millers Point. The principal builders in the western city sector were Barclay's yard and Corcoran's yard, both located at Darling Harbour. Another yard, later to become the Phoenix Wharf, occupied the tip of Soldiers Point. These shipyards became capable of constructing large sailing ships and Thomas Chowne's yard in Johnstons Bay also built steamships up to 173 tons.

From 1850 one of the most important shipyards was that of John Cuthbert who took over Corcoran's yard. The yard was large enough to repair three vessels at one time and had its own mast house and sail loft. Other major shipyards outside this sector were Russell's yard and Charles' yard at Pyrmont, Beattie's yard at Peacock Point and Thomas Mort's Dock at Balmain, opened in February 1855, as well as a large Naval Dockyard completed by convict labourers at Cockatoo Island in 1857.[120] The concentration of shipyards west of Sydney Cove also meant that associated service industries such as boatbuilders, ironmakers, chandlers, sailmakers, block and mastmakers, were clustered around the waterfront. The largely residential area of the Rocks also accommodated a high proportion of the labour force for the shipbuilding industry.[121]

During the colonial era there was considerable competition provided by the sale of ships of all sizes and descriptions that arrived in the colony from overseas. Since the establishment of licensed trading voyages to New South Wales from India and other Asian ports from as early as 1793, some of the vessels engaged in this trade ended up being sold at Sydney for various reasons – to both government and private owners. After the end of the Napoleonic Wars in Europe in 1815 there was an oversupply of British shipping that depressed outward-bound freight rates, despite increasing trade demands. Some of the excess and cheap British vessels found their way onto the colonial market, and this is reflected in the frequency of private and public auction sales advertised in local newspapers. An overview of vessels registered in New South Wales during the period 1822-1848 shows that local shipping investors purchased almost 85% of their tonnage from overseas sources (overwhelmingly

[119] Purtell, J., 1995, The Mosquito Fleet: Hawkesbury River Trade and Traders 1794-1994: 19-27

[120] Watson, J.H., 1919, 'Early shipbuilding in Australia', Journal of the Royal Australian Historical Society, 6 (2): 96-120

[121] Proudfoot, P.R., 1983, 'Wharves and warehousing in Central Sydney 1790-1890', The Great Circle, 5 (2): 73-86

Great Britain) rather than investing in locally built vessels.[122] Some of these ships were deliberately 'dumped' on the Australian market but others were sold as they were unable to secure enough return freight or had been used as security to pay for repairs and provisions. The frequency of this occurring suggests that voyages were either under-capitalised, or did not allow for the real costs of these long journeys to Australia.

The shipbuilding industry was the loser in this as they were generally unable or unwilling to build equivalent-sized vessels for the local market, although there were notable exceptions. Generally, shipbuilders contracting to build vessels for the highly competitive steam navigation trade commanded higher prices for their hulls, although much of the machinery was still imported from Britain. There was also competition from government enterprises in colonies such as Van Diemen's Land, where large shipyards using convict labour were in operation at Macquarie Harbour (1822-1833) and Port Arthur (1834-1848). The Port Arthur establishment completed fifteen 'masted' vessels ranging from 17 to 269 tons and 140 small craft such as whaleboats, lighters, buoy-boats and tugs. The total value of the work performed over a fourteen-year period was estimated at £25,000, of which 20% was credited to repair work performed on government vessels.[123]

Another factor working against colonial shipbuilders was that the commercial shipping marketplace was competitive and changeable, and investors needed to respond quickly to circumstances. Contracting with a shipbuilder for the construction of a new vessel required a long-term investment, whereas the purchase of an existing craft could be a preferable option. The intended use of the vessel sometimes varied considerably from when building commenced and when the hull was launched and fitted out. Some shipbuilders did not rely on contracts and built vessels 'on spec', with the hope of finding a buyer upon completion but this was risky unless the builder was well capitalised. Shipwrights such as Daniel Egan at Sydney and John Griffiths at Launceston seem to have found a niche with the salvaging and repairing of wrecked craft, although this was also a fraught enterprise.

Where colonial shipbuilders did have an advantage was in the supply of smaller-tonnage shipping for the coastal and regional trades. Most of the registered commercial vessels ranged from 8 to 150 tons and were rigged as cutters or schooners and the occasional brig. There were also hundreds of unregistered vessels below 20 tons that appear regularly in the newspaper shipping columns. Their smaller size reduced capital costs involved in the construction of shipyards, hulls and rigging, and the vessel's operating costs, while cushioning the effects of any losses as most were uninsured. In addition, the size and rigging types were the most suitable for navigating difficult and shifting coastal river shoals and currents, where larger ships could not operate. An equally important consideration for investors was that smaller vessels were more efficient freight carriers, being not so reliant on procuring large quantities of cargo to break even. Shipwrights building small craft at locations away from larger towns could also utilise local timber resources, frequently at no cost other than the wages and provisions of woodcutters and sawyers. The greatest cost was usually in the need to purchase imported iron, copper sheathing, rope and canvas, usually supplied from Britain.

The pattern of the colonial shipbuilding industry followed closely the availability of suitable timber for fabrication of part or all the framework, decking, masts and spars needed in their construction, as well as locating suitable harbours or rivers from which they could be launched. From Darling Harbour and Pyrmont, Lane Cove, Pittwater and the lower Hawkesbury, and Brisbane Water, shipbuilders had progressively moved northwards along the New South Wales coast to Newcastle on the Hunter River, Port Stevens, the Williams, Macleay, Manning, Bellinger and Clarence Rivers to Moreton Bay, and southwards to the Illawarra and the Shoalhaven. Stands of red cedar, as well as flooded, Grey, Spotted, Stringy

[122] Holcomb, J., 2004, 'Opportunities and risks in the development of the NSW shipping industry 1820-1850', 262-3

[123] Nash, M., 2003, 'Convict shipbuilding in Tasmania', Tasmanian Historical Research Association Papers & Proceedings, 50 (2): 83-106.

and Blue Gum provided (to varying degrees) acceptable timber for shipbuilding. New Zealand remained as the preferred timber source for spars and masts. Shipbuilders in Sydney relied on the shipment of timber from the coastal rivers, frequently maintaining one or two vessels for the purpose, and conducting timber merchandising in conjunction with their shipbuilding and repair business.

An analysis of the Sydney shipping registers for 1844-45 shows that by the middle of the 19th century, of the 100 locally-built vessels on the registers, two-thirds came from Sydney, the Hawkesbury and Brisbane Water, the chief centres of shipbuilding since the early 1800s. The rest came from the Hunter and Williams Rivers, but a few from the Manning, Macleay and Clarence Rivers, where cedar-getters were becoming active.[124] The same pattern continued through the nineteenth century, with surges of local ship construction at the various small ports and river settlements along the New South Wales coast, but with the largest tonnages consistently produced at Sydney and Brisbane Water.

5.5 Comparative Analysis

A comparative analysis of wrecks revealed that UDHB1 shared characteristics with other vessels of its era, with regard to timber species, techniques in its construction, and methods of repair.

From this comparative analysis it is clear to see that overall, there is not a lot of archaeological data available for vessels such as this, further highlighting its significance not only to New South Wales, but in a 'British colonial boat building' sense. Further research could be carried out to find more comparable vessels and wrecks to create a larger group for understanding boat building practices in this era.

5.5.1 UHRW02 – Windsor, New South Wales

The first wreck for comparison is the boat 'UHRW02' (Unidentified Hawkesbury River Wreck 02) that was recovered from the Hawkesbury River, Windsor, New South Wales, Australia in 2019 (Figure 5.32). The wreck comprises the remains of an approximately 21' (6.4 m) long carvel-built timber sailing vessel, consisting of approximately 93% of the total length of the keel with an attached keelson and mast step. Three frames are attached to the keel/keelson, and there is one other frame attached to an individual plank. No planks were found attached to the keel structure, however, there are also approximately 26 planks and 25 frames recovered within a 30 m area from the keel.[125]

Although there are some differences in build type being a carvel-built vessel, out of all of the wrecks of comparison, the UHRW02 is the closest comparison with regard to its geographical proximity to UDHB1, timber species used, and the era in which they were built and used.

[124] Jeans, D.N., 1974 : 160.

[125] Cosmos Archaeology Pty Ltd, April 2021, Windsor Bridge Replacement Project Report on the early 19th century timber vessels and other find on the north banks of the Hawkesbury River.

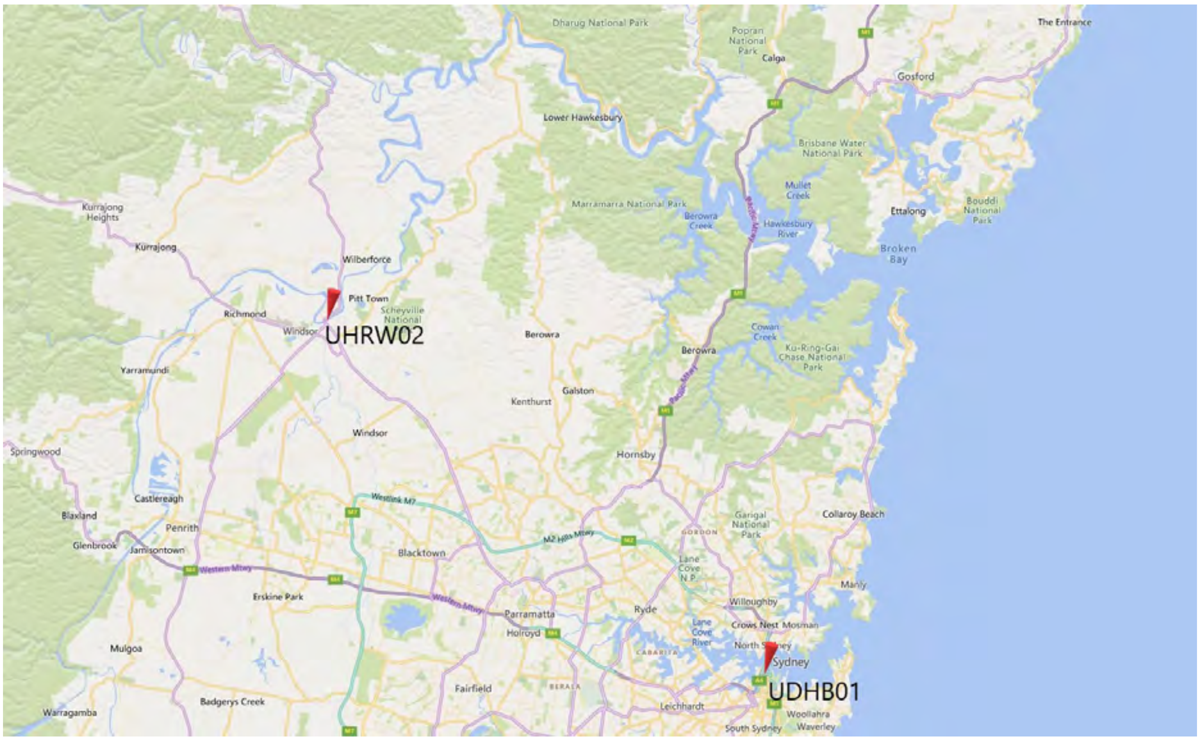

Figure 5.32: Locations of the Barangaroo wreck and the Windsor wreck. (Base image: Google Maps).

5.5.1.1 Comparison of characteristics

First and foremost, the vessels share characteristics of both being identified in era to the period of the early 1800s. Together with a closeness in geographical location, as well as Windsor and Sydney being connected by maritime trade, this collectively brings the boats together in more ways than one. This is with regard to the materials available in this time and location, technology with the tools and techniques used, and perhaps a similar originating source of ideas of boatbuilding i.e., a British working boats background. See Table 13 for comparative overview.

The size of the vessel is relatively comparable, being in the 20’ to 30’ (6.1 m to 9.1 m) range, meaning they generally could have performed similar roles, as well as required a similar number of hands to operate.

With regard to timber species being used, there are similarities. Where UDHB1 had a mix of timber types, the primary species used was Sydney Blue Gum, and UHRW02 used Sydney Blue Gum perhaps exclusively – although not all planks have been tested. The use of Spotted Gum and Stringybark are also comparative across both boats for framing.

The technology and construction methods are also comparable, namely that the planking show evidence of being pit sawn. Furthermore, the framing shapes were achieved by use of crooked branches, as opposed to the use of sawn or bent frame shapes.

How the vessels were fastened is also similar in that they both used hand-forged iron nails, however the UHRW02 used larger shank thicknesses, and had a wedge-shaped point (Table 13). These, however, were not required to be clenched over, as the nails were driven through the planking into the framing.

The hull protection, or anti-fouling for both vessels, was pitch. Whether coal or tree derived, it nonetheless achieves a similar result. The only difference known as can be derived from the remains is that the UDHB1 used copper sheathing for the stem area. This was presumably for reinforced protection for beaching, whereas the UHRW02 perhaps did not beach as part of its working duties.

Table 13: Comparative table for vessels UHWR02 and UDHB1

Vessel characteristics	UHRW02	UDHB1
Era	Early 1800s	Early 1800s
Build	Carvel	Clinker – double planked
Length	21' (6.4 m)	30' (9.1 m)
Breadth	8' 2" (2.5 m)	10' (3.05 m)
Ratio	2.6:1	3:1
Planking timber species	Sydney Blue Gum	Sydney Blue Gum; Southern Mahogany; Spotted Gum; Grey Gum.
Plank sawn method	Pit sawn	Pit sawn
Framing timber species	Spotted Gum; Stringybark; Tea Tree (knee)	Spotted Gum; Stringybark; Southern Mahogany; Grey Gum; Banksia
Framing timber manufacture type	Crooked/compass branches for frames	Crooked/compass branches for frames
Fasteners	Iron; treenails	Iron; copper tacks and nails
Hull protection	Pitch	Pitch and copper sheathing at stem

5.5.2 Browns Bay Vessel - Browns Bay on St. Lawrence River, Ontario, Canada

The next comparable wreck is the Browns Bay Vessel, a 54' (16.46 m) double-planked clinker boat which was recovered from Browns Bay, in the St. Lawrence River, Ontario, Canada.[126] This vessel was a British naval boat built for the war of 1812, and was modified sometime after 1820. Although it is larger than UDHB1, both boats possess similarities in construction methods, are both from the era of the early 1800s, and are both from a colonial British context.

5.5.2.1 Comparison of characteristics

As an overview, apart from size differences, many characteristics in construction are shared between the Browns Bay vessel and UDHB1 (Table 14). One of the main noticeable features is that the Browns Bay Vessel is also a double-planked clinker boat, however, its topsides are carvel. Both vessels are also comparative due to being fastened with iron and copper nails in the hull planking and framing, with copper used in specific areas such as planking to transom, similar to UDHB1.

[126] *Amer, C.F. 1986 The Construction of the Browns Bay Vessel.*

Table 14: Comparative table for Browns Bay Vessel and UDHB1

Vessel characteristics	Browns Bay Vessel	UDHB1
Era	Early 1800s	Early 1800s
Build	Clinker – double planked; carvel topsides	Clinker – double planked
Length	54 ft (16.46 m)	30 ft (9.1 m)
Breadth	16 ft (4.88 m)	10 ft (3.05 m)
Ratio	3.3:1	3:1
Planking timber species	White oak	Sydney Blue Gum; Southern Mahogany; Spotted Gum; Grey Gum.
Plank sawn method	Not	Pit sawn
Framing timber species	White oak; ash	Spotted Gum; Stringybark; Southern Mahogany; Grey Gum; Banksia
Framing timber manufacture type	Crooked/compass branches for frames	Crooked/compass branches for frames
Fasteners	Iron; copper nails	Iron; copper tacks and clout nails
Hull protection	Pine tar*	Pitch and some copper sheathing at stem
* This was possibly more like pitch made from pine tar. It was recorded as being 1/2" thick in places. Tar is a liquid; pitch solid.		

Interestingly, the Browns Bay Vessel also shares a unique feature of the UDHB1, in that to accommodate the second layer of planking, it too has created a second rabbet line on the sternpost by adding ¾" thick boards to each side. It does not however use garboard shelves like those found on UDHB1, and instead simply increased the rabbet in the keel.[127]

5.5.3 The Mönchgut 92 Wreck

The late Medieval period clinker-built vessel, Mönchgut 92, excavated from just south of Rügen Island, Germany, displays some characteristics with UDHB1 construction techniques and highlight their long standing and perhaps 'common' nature in boatbuilding. [128]

5.5.3.1 Wooden plugs

The first individual characteristic is the wooden plugs in nail holes (see Section 4.5.7). The repair wooden treenails used in UDHB1 to plug worn out iron nail holes are also

[127] *Amer, C.F. 1986 : 48.*

[128] *Fiedler, K., 2016, Large clinker built cargo vessels from the late medieval period in Northern and Western Europe- The Mönchgut 92 wreck in context.*

recognisable in the Mönchgut 92 wreck (Figure 5.33 and Figure 5.34). It was noted that '*In several occasions old nail holes were plugged with wooden plugs.'* [129]

Figure 5.33: Old nail hole plugged with wooden plug. (Source: Fiedler, K., 2016)

Figure 5.34: Treenail in plank [545 S-O-S3-F]. (Source: AMBS).

5.5.3.2 Scarph joint caulking textile

Another characteristic found comparative in the Mönchgut 92 wreck was the use of the textile caulking in between scarph joints (Figure 5.35). In comparison, it is coarser than that used on UDHB1 (Figure 5.36). Unfortunately, it is unknown what the Mönchgut 92 material is, as it was not conserved. However, the textile was described as:

> *. . . a 'two-shaft' or plain tabby. This means that the weave is going under and over one warp-thread at the time (Andersen, 1995:253). Both warp and weave are z-spun, there are four threads per cm in the warp and three threads per cm in the weave. The textile can be characterised as coarse and loosely woven.* [130]

Figure 5.35: Textile used as caulking on the scarph between planks in the Mönchgut 92 wreck. (Source: Fiedler, K., 2016)

Figure 5.36: Scarph joint on aft end of portside plank [346] with textile caulking. (Source: AMBS).

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[129] Fiedler, K., 2016: 42.
[130] Fiedler, K., 2016: 45.

5.6 Life and function of UDHB1

5.6.1 When was the vessel built?

It is not known when UDHB1 was built. An examination of materials and construction techniques provides some broad date ranges but no definitive dates.

Saw cut marks on timber planks

How the planks were sawn is of relevance to the dating of the initial construction of the vessel, and when its subsequent addition of a second layer was added. The relevance of whether the planks were pit sawn or cut by a circular saw is because circular saws, at least non-mechanical ones, may not have been in use in Sydney in the early 1800s. Circular saws in the United Kingdom were in use from the late 18th century, a patent being issued in 1762.[131] The first saw mill in Australia was established in Hobart in 1825, with Alexander Berry operating the first in NSW by 1829.[132] These saws were water powered, and the first steam powered circular saw started operations in Sydney in 1842. If any of the planks show evidence of circular saw marks then that would indicate they were most likely cut after the late 1820s. Where they were positioned on the hull would either give a *terminus post quem* of construction (inner planking) and/or a date of the addition of the outer planking.

The planking shows signs of saw marks that indicate that they were pit sawn. These are recognisable by prominent straight cut marks on a slight angle down the width of the plank – being the downward cutting stroke of the saw, in conjunction with faint cut marks between the prominent ones, being the up stroke. Often the up-stroke marks can vary in angle, or curve as the sawyers reset the saw and themselves for another cut.

While the majority of pit-saw marks on the planking are relatively uniform, there are some examples with anomalies, such as distinctly curved marks. It is not that these curved marks indicate the use of a circular saw, as it is important to note that these are dispersed within the prominent marks of straight pit-saw marks that are consistent across the length of the plank. They also are not characteristic of circular saw cut marks as they are not uniform in radius, and nor do the projected centres of the radii align (Figure 5.37 and Figure 5.38). Some of the curves when completed as a circle become smaller than the plank width itself, disputing any physical positioning of a circular saw blade and spindle in operation.

An explanation of these anomaly curved marks can be attributed to a few factors, historical and modern. Historically, they could be indicative of the upstroke and shifting positions of the sawyers, and when sawing, often in difficult spots of timber it is not uncommon to change the angle for a different tooth approach to the material. Another historical reasoning is that the marks could be from the holding wedges being struck in and out of wood while sawing. Another possibility is that during maintenance of plank sheathing or scraping pitch, the surface was scored with tooling. A modern explanation might also be that during excavation, when separating the planks from each other, spatulas, both steel and plastic were used, which when driven between the planks, were pushed back and forth in an arc while moving across the length of the plank in short regions. These actions were noticed during the excavation and recording stages.

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[131] Jones, W. 2006 Dictionary of Industrial Archaeology : 70

[132] Lewis, M Australian Building : A Cultural Investigation. https://www.mileslewis.net/australian-building/ : 05 Timber Frame.

Figure 5.37: Scan of Plank [542] showing curved marks on part of the plank. (3D scans supplied by SWF)

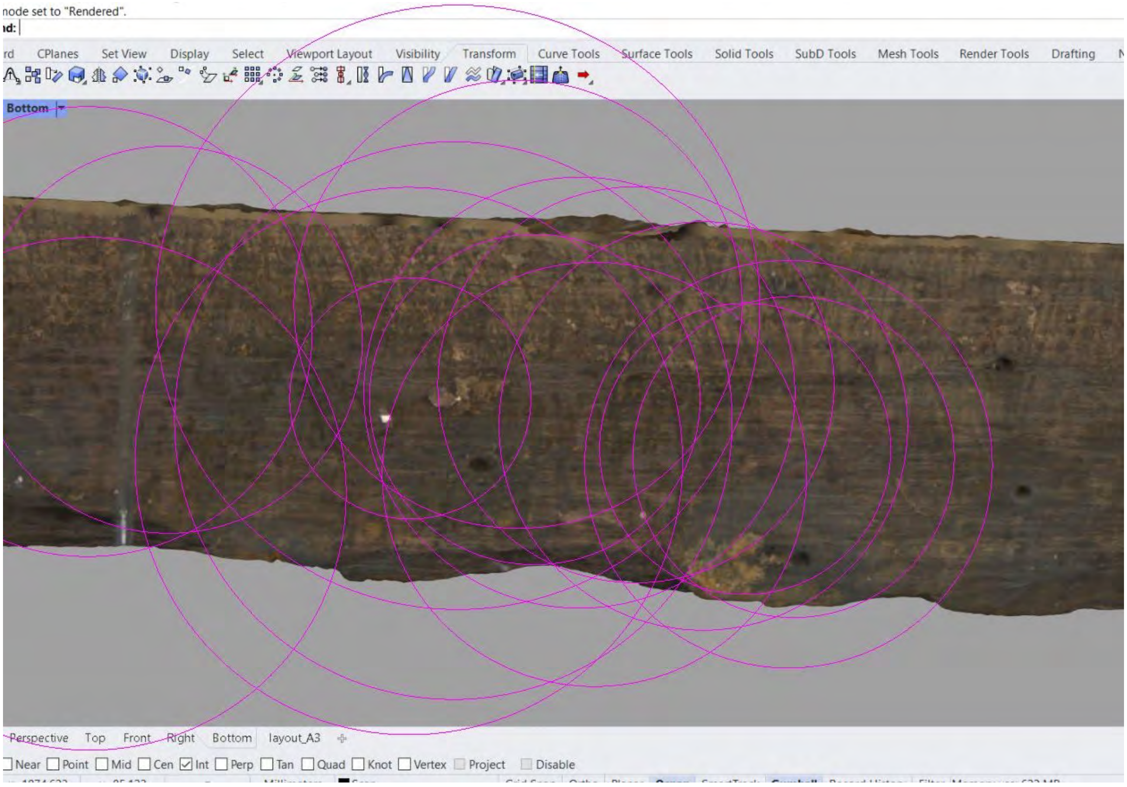

Figure 5.38: Scan of Plank [542] with curves extended to complete circles. Note inconsistency of radii and centres. (3D scans supplied by SWF)

Fastenings and sheathing

The surviving fastenings do not provide clarity on the dating of the construction of the vessel and the later addition of an outer hull. The vessel was fastened together with ferrous nails. Though none survive in their entirety, the square holes left in the planking and other timbers indicate wrought or hand forged nails. This is because cut nails, which became prevalent from the 1820s, were rectangular in shape.[133]

[133] Burke, H., Morrison, M., Smith, C. 2004. The Archaeologist's Field Handbook : pp 377 to 379

The use of hand forged or wrought iron nails in shipbuilding extends back into antiquity. In the early 19th century, the cut nail began to supplant the hand forged nail. However, it was found that the early method of manufacture of cut nails was not suitable for shipbuilding, where nails had to be clenched. This meant that hand forged nails continued to be used in shipbuilding well into the 19th century.[134] Better quality cut nails followed, by wire nails, became more readily available from the second quarter of the 19th century, however wrought iron or hand forged nails were still being used in American shipbuilding as late as the start of the 20th century.[135] In Australia the local timber reportedly required the use of wrought iron nails during the 19th century, as the timber was too hard for imported British nails.[136]

Having said this, there may be evidence of cut nail fastenings present on some of the planks, especially the outer layer which would be as a result of repairs. If the vessel operated well into the 1830s, this would be very likely.

The copper sheathing tacks which were recovered from the rider keel contain tin, zinc and lead. Fasteners are required to be harder than the sheathing itself, and the addition of some zinc, tin, and lead is consistent with sheathing tacks used in the late 18th and early 19th century (see Volume 6).

The copper sheathing that has been analysed is pure copper. Pure copper was used in European hull sheathing until 1832, when George Fredrick Muntz developed 'Muntz metal' (also known as 'yellow metal'), a 60:40 copper-zinc alloy (see Volume 6). Muntz patent sheathing was first advertised for sale in Australia in 1839 and would have been available from the 1840s onwards.[137] As the Barangaroo Boat was sheathed in the bow area with sheathing made of pure copper, it is likely that the vessel was last re-fitted or repaired prior to 1840.

Chunam

The use of a chunam (lime and oil plaster) mix between the layers of planking during the last phase of its working life can provide an indication of a time period. The earliest account for using chunam on hulls in the New South Wales newspapers is dated 1829, with the launch of the *Australian*, built by Grono in the Hawkesbury region.[138] Prior to this date, chunam is referred to in the newspapers as used in India in domestic construction for wall finishing, like stucco, and for coating ceramic wares. An 1829 article describes chunam as the process being '. . . *chunamered, or covered with a coating of oil and lime, after the manner of the Chinese Junks, and is sheathed over all*.' If this material was a relatively new introduction to the colony then it could suggest that the outer layer of planking was added sometime in the 1820s or 1830s.

Likely date range of construction

As the vessel was likely abandoned in the late 1830s/early 1840s, having had a second or outer layer of planking affixed to the original hull, it can be speculated that the vessel had a working life that spanned decades rather than years. The working life of early Australian-built vessels has been documented to have been quite brutal, with many being lost along the unlit and poorly charted eastern coastline while servicing the more exposed secondary

[134] McCarthy, M, 2005 p. 90.
[135] Desmond, C. 1919 Wooden Shipbuilding p. 207.
[136] Lewis, M., 2014. Metals: Nails and Screws : 8.06.4.
[137] The Hobart Town Courier, 8 February 1839: p.2
[138] Sydney Gazette, 'Launch of the Australian', 2 April 1829, p. 2

outports.[139] In Victoria for example, in a 10-year period from 1836 to 1846, Australian-built vessels had a working life on average of around five years.[140]

UDHB1 can be considered to have had a working life of more than five years, and its longevity could be attributed as much to good fortune as to the activities in which it was engaged, more of which will be discussed below. Based on the available information, it is thought that the vessel was originally built sometime between 10 and 20 years before it was abandoned in the late 1830s/early 1840s. This would place the date of construction of the vessel from the time of Governor Macquarie, in the 1820s.

5.6.2 Who built UDHB1?

The vessel's apparent length of service is also testament to the soundness of its construction. At present we do not know who constructed the vessel. Based on the examination of the vessel remains during the excavation, disassembly and to a limited extent during the conservation process, a number of observations can be made.

Quality of work

UDHB1 is a type of vessel not investigated previously in an Australian context. The irregular shapes and positioning of its roughly squared and grown frames gives an impression of slap dash construction. This contrasts with the precise cuts and spacing of frames in the other documented Australian built vessels constructed towards the middle of the 19th century, when steam sawn timbers were laid in adherence to drawings and rules standardised by insurers such as Lloyds. Such vessels could be considered relatively 'industrial' both in scale and production when compared to UDHB1, which was a continuation of a long tradition of hand-crafted specialised boat building that had been introduced to this continent.

> *I have talked to one boatbuilder who, while he was an apprentice in North Devon, saw a man using a taut line and a marked staff in a similar manner to that described by Arne-Emil Christensen [A history of boatbuilding in Norway]. Various types of cobles are still built without drawings, templates or moulds, strake widths and angles being used to control the shape. . . The more a builder can work without reference to drawings or other control devices, the faster and freer he can be. Where similar boats are built in quick succession the dependence of controls decreases and the work becomes habitual.[141] (p. 113)*

This seemingly chaotic patterning of the frames of UDHB1 belies an economy in the use of material and labour that could only come about by a builder at ease with their craft. The true skill of the builder(s) of UDHB1 is seen in the precision in which the planking, both inner and outer, were shaped and joined. The strength of the hull of the clinker boat is primarily provided by the planking, and the frames are added where needed to add more support.

For the builder of a clinker (or lap-strake) boat;

> *A good deal of skill is required to line off a lap-strake hull; no stealers can be used, so an error in lining off is really serious. Repairs to the planking of a lap-strake hull are difficult. Relatively thin planking must be used; while this is an advantage in some hulls it is a disadvantage in others.*[142]

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[139] Jeans, D.N. 1974 Shipbuilding in nineteenth century New South Wales. Journal of the Royal Australian Historical Society 60:156-153.

[140] Coroneos, C. 1992 A'n Investigation into the high losses of early Australian built vessels.' AIMA. Bulletin Volume 15, No. 1

[141] McKee, E. 1983. Working Boats of Britain: their shape and purpose : 442

[142] Chapelle, H. I. 1941 Boatbuilding: A Complete Handbook of Wooden Boat Construction : p441-2

In addition;

> *It is plain that the beauty of the lap-strake hull depends upon the lining-off of the strakes, and laps. In some ways, lap-strake planking is the severest test of the builder's craftmanship and sense of proportion. Tightness of a lap-strake hull depends upon the accuracy of the bevelling of the top edge of each strake as it is place, and upon skilful fastening.*[143]

That said, the relatively narrow strakes of UDHB1 may provide some clue as to the experience of the builder, although factors such as availability of stock or the proposed function of the vessel may have had some influence:

> *Narrow strakes are best for the beginner: they are easier to shape and fit, give a stronger boat, and do not require as wide stock as wide strakes. The only disadvantages are that the boat is made heavier with narrow strakes.*[144]

With regards to the clenching of nails without the use of a rove (riveting):

> *Clenching a nail is somewhat harder [than riveting] and requires practice. …There is a trick in doing this that can only be learned by experience.*[145]

Based on evidence to date it would appear that UDHB1 was built, and modified, by builders adept at their craft. The apparently long life of the vessel is testament to their skill.

Possible indicators of builder's origins

One avenue towards finding the identity of the builder of the UDHB1 is to see if the vessel had particular regional ship building traits. At present the assumption is being made that the builder of UDHB1 was of British origin, or at least well immersed in British culture. The essential elements of the construction of UDHB1 support this assumption:

> *Frames of lap-strake hulls can be either sawn or bent. The latter are used in small boats, or those in which light weight is important. Sawn frames were used in the Block Islands* [Rhode Island, USA] *boats and inmost of large European clench-built hulls.*[146]

And;

> *The straight keeled clinker-boat with a stem forward and a transom aft is the most universal type found in Britain. Her strength lies mainly in combination of the backbone with the planking, stiffened where experience had shown it essential for the work she had to do. This particular example has to work off Bucks Mills Ledge in North Devon, and this is why she has twice as many floor timbers than usual.*[147]

The above quote provides another example of double floors being used, which could be comparable to UDHB1's sister frames (Section 4.6). Furthermore, the stem-to-keel construction method shares similar characteristics to boats built in Cornwall and its neighbouring county, Devon (Figure 5.39). [148] The characteristic that corresponds the most is how the keel (when considering the keel and rider keel as a 'keel' collectively) continues forward with the stem, apron and knee on top. McKee notes, however, it is not a definitive

[143] Chapelle, H. I. 1941 : 453
[144] Chapelle, H. I. 1941 : 445
[145] Chapelle, H. I. 1941 : 453-4
[146] Chapelle, H. I. 1941 : 442
[147] McKee, E. 1983 : 109
[148] McKee, E. 1983 : 63

typology to location, he says that '*this is not to say that other methods are not also used there or that the same design is not used elsewhere'*.[149]

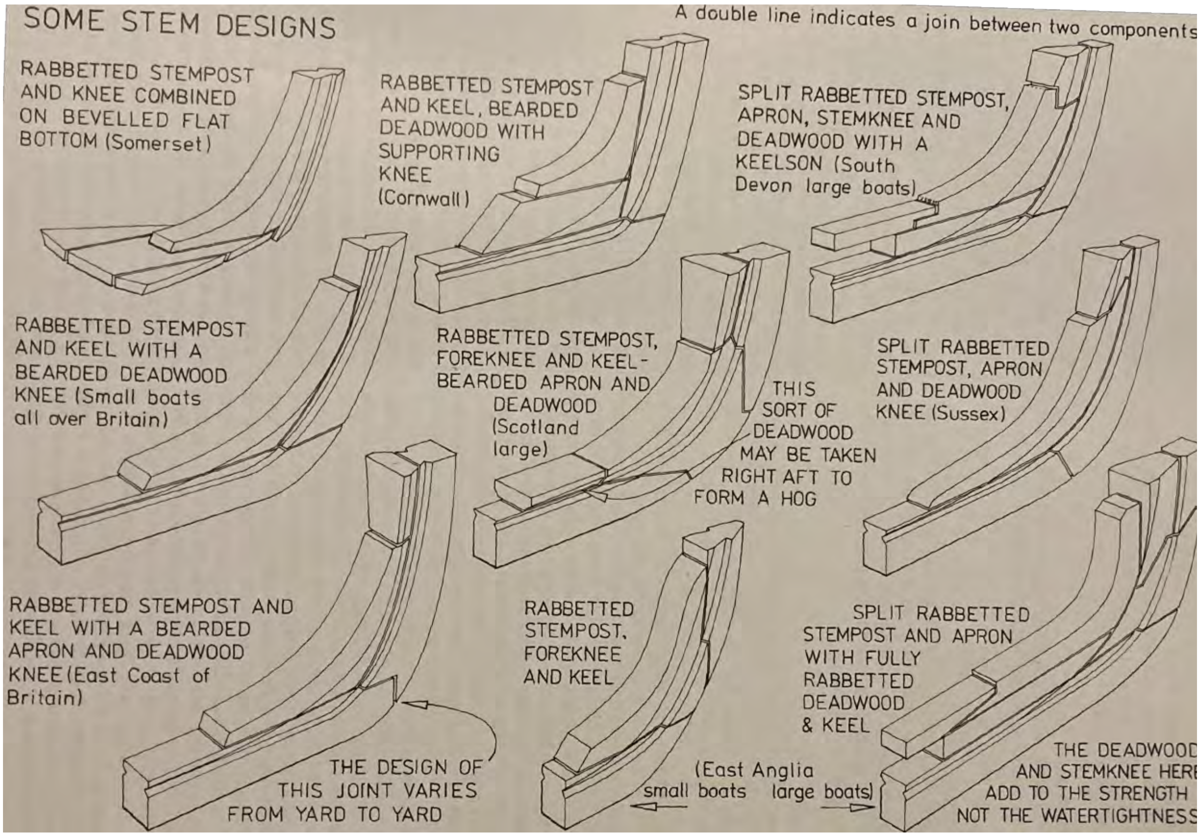


Figure 5.39: Stem designs of English boats

Based on the above discussion, there is some indication that the builder may have had some acquaintance with boat building practices from Britain's south-west region.

5.6.3 Timbers as potential indicator of where built

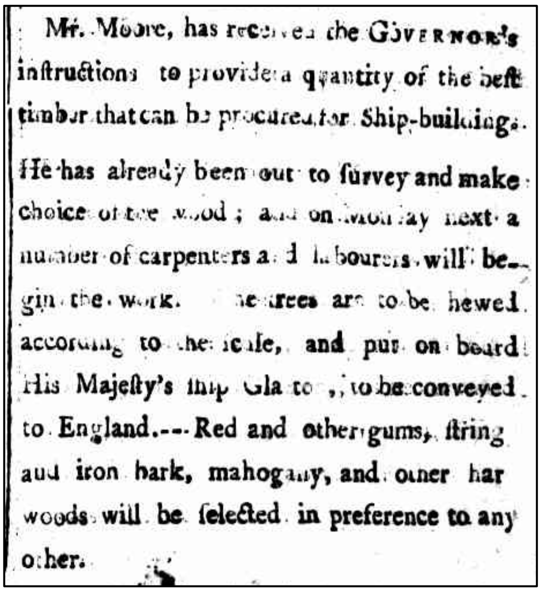
News articles from the *Sydney Gazette* dating from the early 1800s regarding the felling of timber for ship and boat building correlates with the species of timbers used in the construction of UDHB1. These articles commonly appear within the period from 1803, when the *Gazette* began publishing, to 1810. After this time, the mention of such specific activity disappears.

A brief investigation revealed that the types of timber used i.e., Blue Gum planking with Stringybark and Spotted Gum framing, were selected for shipbuilding as early as 1803 when Thomas Moore, the colony's master boat builder, was instructed to "*provide a quantity of the best timber that can be procured for ship-building"* (Figure 5.40). Articles also describe timber being procured by John Harris from Sydney's North Shore and conveyed by an 8-draught bollock timber carriage followed by a government punt across the water.[150]

The species used in UDHB1 are all accounted for in the articles, these being - Sydney Blue Gum, Southern Mahogany; Spotted Gum and Grey Gum for the planking with Spotted Gum; Stringybark, Southern Mahogany, Grey Gum and Banksia used for framing. Blue Gum was

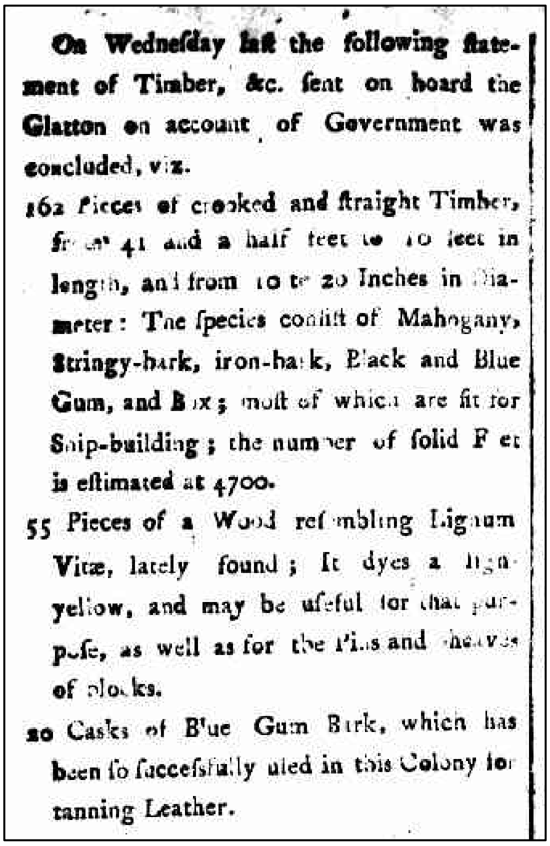
[149] McKee, E. 1983 : 63
[150] Sydney Gazette, 17 November 1805, p. 1.

used for planking and crooked timbers. As well as being used locally, these timbers were also exported to England for ship-building. Figure 5.41 to Figure 5.43 provide examples of timber cargoes from 1803 to 1820.



Mr. Moore, has received the GOVERNOR's instructions to provide a quantity of the best timber that can be procured for Ship-building. He has already been out to survey and make choice of the wood; and on Monday next a number of carpenters and labourers will begin the work. The trees are to be hewed according to the scale, and put on board His Majesty's ship Glatton, to be conveyed to England.---Red and other gums, string and iron bark, mahogany, and other hard woods will be selected in preference to any other.

Figure 5.40: 1803 article from the **Sydney Gazette** *describing instruction to the colony's master boat builder about what shipbuilding timbers to procure for shipment to England.*[151]



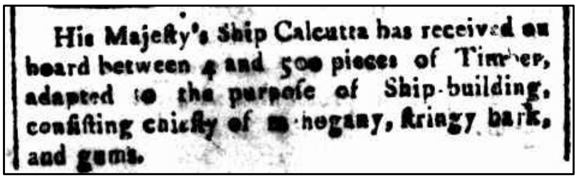
On Wednesday last the following statement of Timber, &c. sent on board the Glatton on account of Government was concluded, viz.

162 Pieces of crooked and straight Timber, from 41 and a half feet to 10 feet in length, and from 10 to 20 Inches in Diameter: The species consist of Mahogany, Stringy-bark, iron-bark, Black and Blue Gum, and Box; most of which are fit for Ship-building; the number of solid Feet is estimated at 4700.

55 Pieces of a Wood resembling Lignum Vitae, lately found; It dyes a light yellow, and may be useful for that purpose, as well as for the Pins and sheaves of blocks.

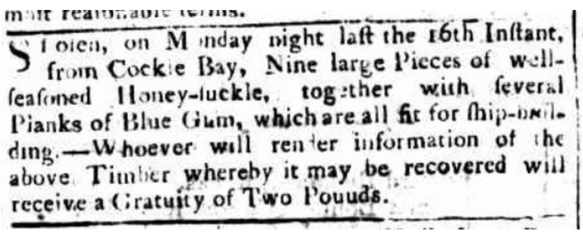
20 Casks of Blue Gum Bark, which has been so successfully used in this Colony for tanning Leather.

Figure 5.41: Example of timber cargoes in the **Sydney Gazette** *from 1803*.[152]



His Majesty's Ship Calcutta has received on board between 4 and 500 pieces of Timber, adapted to the purpose of Ship-building, consisting chiefly of mahogany, stringy bark, and gums.

Figure 5.42: Example of timber cargoes in the **Sydney Gazette** *from 1804.*[153]



most reasonable terms.

Stolen, on Monday night last the 16th Instant, from Cockle Bay, Nine large Pieces of well-seasoned Honey-suckle, together with several Planks of Blue Gum, which are all fit for ship-building.—Whoever will render information of the above Timber whereby it may be recovered will receive a Gratuity of Two Pounds.

Figure 5.43: Example of timber cargoes in the **Sydney Gazette** *from 1810.*[154]

Regarding the 'wood resembling Lignum Vitae,' this could be mangrove that grows on the Georges River. An earlier account in the *Sydney Gazette* notes that timber being found along

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[151] Sydney Gazette, 19 March 1803, p. 4
[152] Sydney Gazette, 15 May 1803, p. 3
[153] Sydney Gazette, 19 February 1804, p. 4
[154] Sydney Gazette, 21 June 1810, p. 2.

the Georges River '*bears a strong resemblance to the lignum vitae*', and later a chandlery advertisement in the *Sydney Gazette* dated 7 July 1832 lists 'Mangrove for blocks' for sale.[155]

The timber 'honeysuckle,' is an early name for Banksia – found in use in UDHB1. Tuckey, in his observations of New South Wales timbers in 1804, described this timber as: *". . . a soft wood, fitter for joiners' work than ship-building. . . its limbs are crooked, and perhaps it might be advantageously used in the upper works of ships, for knees*."[156] By the 1860s, a report on boatbuilding states that, "almost the only materials used in boat work are honeysuckle and cedar, though for the larger kind Blue Gum is occasionally employed for timbers."[157]

What is also revealed in the articles is that not all timbers for boat building were simply sourced from felled trees. As seen in Figure 5.44, branches themselves were also selected for the required angles the builder was needing in framing or for knees.

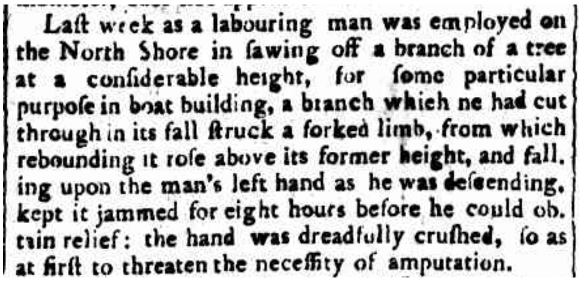
Laſt week as a labouring man was employed on the North Shore in ſawing off a branch of a tree at a conſiderable height, for ſome particular purpoſe in boat building, a branch which ne had cut through in its fall ſtruck a forked limb, from which rebounding it roſe above its former height, and fall. ing upon the man's left hand as he was deſeending, kept it jammed for eight hours before he could ob. tain relief: the hand was dreadfully cruſhed, ſo as at firſt to threaten the neceſſity of amputation.

Figure 5.44: A timber cutting accident in the **Sydney Gazette** ***in 1808***.[158]

5.6.4 Known ship and boatyards in Sydney region 1800 to 1830

The standard of construction for UDHB1 would suggest that it was built by a skilled boat builder. In early Sydney, and the Hawkesbury River, there were a number of ship/boatyards operating though not many were long-lived (see also Section 5.4.2 for general discussion on shipbuilding). Table 15 below lists those builders/yards that operated from between 1800 and 1830. Of the 23 listed, there are 11 who had stopped building by 1810. The remaining 12, including the Government Dockyard, built 37 vessels ranging from cutters to larger 3-masted schooners. The size of the vessels are not listed, but by cross checking with other sources such as Hainsworth's list of vessels trading in Sydney between 1803-21 in *The Sydney Traders* (see Volume 6) and *The Australian Register of British Ships*, the only vessel comparable in size to UDHB1 (between 10 and 15 ton), and not recorded as wrecked, is the *Betsey*.[159] The 15-ton *Betsey* is recorded as being built in 1810 by Jonathan Griffiths at Richmond, Hawkesbury River. Documentary accounts have the vessel confined to trade within the Hawkesbury River and being active from 1810 to 1815, and again from 1818 to 1822. The two distinct periods of reporting could indicate that there were two different vessels with the same name.

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[155] Sydney Gazette, 26 March 1803

[156] **Tuckey, 1804,** *The Historical Uses of Australia's Timber Resources,* Southern Peninsula Indigenous Flora &Fauna Assoc. Available at http://www.spiffa.org/early-writings-on-australian-timbers.html, accessed 15 August, 2020.

[157] Sydney Morning Herald 4 July 1868

[158] Sydney Gazette, 19 June 1808, p. 2.

[159] Hainsworth, D.R., 1981, The Sydney Traders: Simeon Lord and His Contemporaries 1788-1821: Appendix E and Parsons, R. 1983, Ships of Australia and New Zealand Before 1850 – Parts 1 and 2

Table 15: List of ship builders and boat builders in Sydney and the Hawkesbury 1800 - 1830 [160]

Builder	Location	Year start	Year end	No	Vessel types	Vessel names
Government dockyard; King's Dock Yard	East Sydney Cove then West Sydney Cove	1793	1825	9	Sloop, cutter, two mast schooner, brig, hoy	*Comet, Francis,* Government Punt, *Isabella, Isabella (Essington), Portland (Elizabeth Henrietta), Prince Regent, Rose Hill Packet, Snapper*
Underwood, James	Sydney Cove and Pyrmont, Sydney	1800	1807	6	Sloop, schooner, 3 mast schooner, brig	*Diana (Surprise), Endeavour, Governor King, Haidee, King George, Perseverance*
Moore, Thomas	West Sydney Cove	1801	1804	2	Schooner	*Cumberland, Integrity*
Egan, Brian	Sydney	1803		1	Sloop	*Fly*
Gaol Yard	Sydney	1803		1		Prisoner at large
Lord, Simon (Simeon?)	Sydney Cove	1803		1	Schooner	*Marcia*
Tadd, Stephen and Underwood	Sydney Cove	1804		1	Sloop	*Contest*
Nicholls, Isaac	Sydney	1805	1809	2	Schooner, cutter	*Fairy* (?), *Governor Hunter*
Reibie & Wills	Sydney	1807		1	Schooner	*Mercury*
Griffin, Charles	Cockle Bay, Sydney	1811		1	Sloop	*Hawkesbury Packet*
Campbell, Robert; also Campbell, Robert & Co.	Sydney Cove	1812	1813	2	Cutter, brig	*Elizabeth, Queen Charlotte*
Jenkins, J. & W.	Cockle Bay, Sydney	1814		1	Schooner	*John Palmer*
Mills, James	Sydney	1815		1	Sloop	*Jane*
Thompson, Andrew	Hawkesbury River & Scotland Is, Pittwater	1800s?	1810	2	Sloop	*Hope, Geordy*
Kelly	Green Hills, Hawkesbury	1802	1804	3	Sloop	*Hawkesbury, Hope* (?), *Nancy*
Griffiths, Jonathan	Richmond Hill,	1804	1819	10	Brig, schooner, sloop	*Anna Maria* (?), ***Betsey*** (?), *Elizabeth and Mary, Glory, Maid*

[160] Flapan, Mori, 2008, List of New South Wales Ship Builders and Boat Builders from the Register of Australian and New Zealand Vessels, accessed 11 October 2021, https://www.boatregister.net/NSW_Builders.htm.

	Hawkesbury River					*of Richmond* (?), *Nancy, Prince Leo (Mary and Elizabeth), Resolution, Rosetta (Prince Leopold, Mary and Elizabeth), Speedy*
Grono, John	Green Hills, Hawkesbury River, Pitt Town, Maitland	1807	1833	7	Brig, barque, 2 mast schooner	*Australian, Branch, Elizabeth, Governor Bligh, Governor Bourke, Industry*
Webb, John	Green Hills, Hawkesbury	1808		1	Cutter	*Unity*
Webb, James	Hawkesbury	1811	1822	2	Sloop	*James, Windson* (?)
Cunningham, R.D.	George St., Sydney	1826		1	2 m Dandy	*Emma Kemp*
Day, Thomas	Cockle Bay, Sydney	1826		1	Sloop	*Northumberland*
Egan, Daniel	Sydney	1826		1	Cutter	*Dart*
Jones, John	Sydney	1828		1	Cutter	*Fairy*

Hainsworth's list of vessels was sourced mostly from the *Sydney Gazette,* supplemented with other sources such as the returns of the Naval Officer, official correspondence, private letters and court records. This list did "...*not claim to be complete, particularly of the smaller vessels*".[161]

The Australian Register of British Ships provides details of vessels registered with customs at ports in Australia and New Zealand. The register seems to have started in the 1820s, becoming more standardised in the 1830s. Its purpose appears to have been to levy duties on vessels which were based on the tonnage of the vessel. As such, the dimensions of the vessel (length, breadth, depth) were scrupulously recorded so as to calculate tonnage. Also recorded were the physical characteristics of the vessel such as sail plan, type of stern, type of bow, so that the customs officers could recognise the watercraft. The *Register* also tracked the ownership of these vessels. It follows that, as the *Register* seems to have focused on collecting port duties, certain types of vessels may have been exempted, perhaps fishing boats or harbour lighters.

It should be noted that the vessels presented in Table 15, as well as Hainsworth's list of vessels in *Sydney Traders* (see Section 5.6.6) and the *Register of British Ships* all have masts. Evidence that UDHB1 had a mast has not been found to date but it is believed that it could have had one (see Section 5.3.3).

The list of builders and boatyards from the Sydney region presented in Table 15 is not exhaustive. Boats built by settlers on their allotments in this early period is to be expected. For example, the 1-masted, single-decked, 12.5-ton (30' x 11' x 4.8') sloop *Teviot* was built in 1821 at what was then fleetingly called Teviot River which was commonly referred to at the time as the 'second branch of the Hawkesbury' (present day Colo River).[162] The builder of the vessel was not recorded in t*he Register of British Ships*, however its owner was a settler

161 Hainsworth, D.R., 1981 : 241

162 Parsons, R. 1983b

from the area, John McDougall (see Section 5.6.6). Other examples are the *Boyd* and *Argument* mentioned in Section 5.4.1., the former being built on Scotland Island.

5.6.5 What was the vessel used for?

The characteristics of UDHB1 may provide some insight as to what it was originally designed to do. Generally speaking;

> *Clinker-built boats were always lighter, more tender and more difficult to repair than carvel-built.*[163]

Furthermore;

> *Lap-strake construction is the favorite* [sic] *method of planking boats that must be very light and strong, or that must carry heavy loads in shallow, very rough water* [and that] *Boats used on open beaches in England were almost invariably lap-strake.*[164]

According to Chapelle the;

> *…extra work of making these frames [jogged] is warranted only when the boat is used for landing on rough beaches. The extra support given the planking, between laps, by jogged frames is desirable under such conditions. Jogged frames are often used in large lap-strake hulls.*[165]

Ship's 'cutters' or boats, with which UDHB1 shares some similarities, were;

> *… used for the conveyance of seamen, or the lighter stores. They are shorter and broader in proportion to their length than the long boat, and constructed either for rowing or sailing.*[166]

UDHB1, it would appear, was initially constructed to be dragged ashore with its hard bilge and jogged frames supporting this notion (Figure 5.45).[167] The absence of teredo damage on the inner planking could be supporting evidence that UDHB1 was regularly dragged ashore. This ability would have made it a very general-purpose vessel that could have been used to convey goods and people. Such a vessel would also have made a good nearshore fishing boat. Its form and construction does not lend itself to it being a harbour work boat, such as a lighter. This is not to say, however, that it was not put into such service over its lifetime.

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[163] ***May, C. W. 1974 : 66***

[164] ***Chapelle, H. I. 1941 : 441 and 442***

[165] ***Chapelle, H. I. 1941 : 457***

[166] ***Steel, D. 1805 : 86-87***

[167] ***Robert Hunt, Blues Point, North Shore 1850s, Mitchell Library SPF/799***

Figure 5.45: Blues Point, North Shore 1850s. Note the clinker-built boats with hard chine drawn up onto the beach. UDHB1 had a similar shaped hull.

If the vessel was unmasted, it is very possible that it spent its entire working career within the confines of Port Jackson and did not undertake any voyages outside Sydney Heads. Transporting cargoes from ship to shore (lightering) provided a steady business for vessel owners before adequate wharf facilities were created (Figure 5.46).[168] Early paintings, drawings and sketches of Sydney Harbour show larger trading vessels anchored offshore and the movements of numerous smaller craft performing any number of duties (Figure 5.47).[169] As well as lightering, there were local passengers and cargo to transport between Sydney and the North Shore or to other close-by destinations. For these purposes, the use of oars alone for propulsion may have been entirely feasible, although this would have needed three to five crew. Rowed ferry boats from the period are usually of a much lighter and slender design, while naval craft of a similar size and construction (launches or cutters) could require up to twelve or fourteen sailors to propel them.

168 Jacob William Jones 1845 View Sydney Cove, N.S.W State Library of New South Wales. DGA 32 f.4

169 John Eyre 1810. New South Wales. View of Sydney, From the East Side of the Cove. No. 2 State Library of New South Wales. XV1 / 1808 / 9 (DON: a1528168)

Figure 5.46: View in Sydney Cove, NSW, by Jacob William Jones 1845. Note the number of lighters operating and the two craft at base of image showing ceiling planking does not extend above the turn of the bilge.

Figure 5.47: New South Wales, View of Sydney, From the East Side of the Cove. No. 2 by John Eyres ca. 1810. Robert Campbell's stone-built warehouse and wharves dominate the northern part of the cove (right), while the government commissariat building is further towards the head of the bay (left). Note the wide variety of small colonial craft in the bay from oared to masted. Note also on the smaller craft how far forward the mast is. This part of UDHB1 was poorly preserved and any evidence of a mast-step / stepped mast may not have survived.

Although a mast-step was not located with the hull, there are other indications that the vessel may have had a single mast (that may or may not have been removable as circumstances dictated). Single-masted vessels of the period are usually referred to as being rigged as 'cutter', 'yawl' or 'sloop' types (Figure 5.48).[170] Mast and sail propulsion would have been essential if the vessel travelled any distance, either within Port Jackson/Sydney Harbour or along the New South Wales coast, or even in Bass Strait, as demonstrated by the 14 ton sloop *Raven* (see Section 5.4.1). While the size of UDHB1 somewhere between 10 to 15 tons may seem relatively small, the coastal fleet sailing out of Sydney and along the coast did contain a number of vessels of this size as they were easier to operate where cargo loading places were difficult to approach and needed only a few crew (two or three men). They were also far nimbler in satisfying the demands of the local trade where cargoes may

170 John Eyre ca. 1807. View of Government House, Sydney Cove. State Library of New South Wales. SV/31

not have been large or needed to be transported quickly, and did not require a large financial investment to own and operate (Figure 5.49).[171]

Figure 5.48: View of Government House, Sydney Cove by John Eyre ca. 1807. Note how far forward the mast sits in the boat on the left with no standing rigging.

Figure 5.49: Sydney Harbour in the 1840s showing small craft around the foreshore. Note the square sterned boat, with rudder, its foremast bearing a square sail, smaller in size than UDHB1.

The contents of the bilge deposits, though interesting, do not appear to shed much light on the journeys and jobs that UDHB1 undertook. Within the more 'secure' contexts – 157, 158 and 159 (see Section 3 for explanation), a wide variety of artefacts were found.[172] These artefacts were small and/or sufficiently thin to pass through the gaps between the ceiling planking. Glass fragments were absent and the identifiable fragments of ceramic (7) were transfer-printed blue and white willow patterned table and tea wares. Within 159, which was located at the bow, two pins, once used for sewing, were recovered. One had an early 'upset head' (EUH), from ca.1809. The other pin was of conical shape with a later date of ca.1840 - ca.1880.

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[171] Unknown artist ca.1840s. State Library of Tasmania

[172] See Ceramic, Organic, Miscellaneous, Glass and Metal artefact reports, in Volume 3

Context 158 was considered the most intact or undisturbed context under the ceiling planks, possibly a true bilge deposit as it was in the centre of the boat. It contained nine fragments of smoking pipes, with no dates or manufacturers able to be identified from the fragments, and a piece of flint, used as a strike-a-light (Figure 5.50). Smoking is a practice that no doubt took place on the boat whilst underway, at its moorings or when dragged ashore.

A circular brass button found in 158 is the same japanned black style as buttons found in 152, 246 and 249, suggesting someone had a stash of buttons, possibly a tailor, or a whole garment had been thrown away (see Figure 5.50).

Figure 5.50: Artefacts from the mid ship area of UDHB1, below ceiling planks (l-r). Top row: pipe stems: 154/#20187 (2), 158/#20191, near whole pipe 154/#20188. Second row: pipe stems 158/#20190 (6), glazed/stained stem #158/#20192. Bottom row: pipe bowl 158/#20193, flint/strike-a-light #158/#20194, brass 4-hole button #158/#20195. 100mm scale. IMG_3834. Source: R. Workman.

Within 158, one whole turned sole with a square toe was found (Figure 5.51). Turned shoes have the upper stitched directly to the sole inside out before being turned. This technique was mainly used for indoor shoes and slippers, and was commonly used on children's shoes even after the introduction of welted manufacture. These shoes are dated until ca.1860 when new technology changed the way shoes were made. This piece is likely to have floated into the bilge when the boat was ashore and awash at the higher tides.

Figure 5.51: Outsole of turned shoe (158/#25579). 100mm scale. Img_5383. Source: R. Workman.

An unidentified piece of leather found in 158 appears to be a gasket and may have been associated with a pump (Figure 5.52). It is a flat rectangular piece of thick leather with inverted corners and two large circular holes at each end. There are wear and cut marks in the centre. This object may have formed part of a fitting on UDBH1.

Figure 5.52: Unidentified piece of leather (158/#25585). 100mm scale. Img_5387. Source: R. Workman.

The discovery of a piece of slag in 158 could hint at a cargo the vessel may have once carried. However, recovered seeds such as peach, pumpkin, hazelnut and nectarine seeds are not reliable indicators of cargo, as these durable and buoyant objects are ubiquitous within underwater and/or intertidal sites.

5.6.6 Who owned the vessel and what was its name?

Establishing the identity of UDHB1 is problematic and may never be achieved with a high degree of certainty. This is because official records from the time the vessel was built and operated are patchy, and the vessel's relatively small size may have resulted in it not being registered or being mentioned in the newspapers of the time. This would more likely be the case if the vessel was not masted, and confined to the harbour as a lighter.

An examination of the *Register of British Ships* found six vessels ranging from 27 to 31 ft that were built in the Sydney area (see Volume 6).[173] These vessels ranged from 10 ton to 14

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[173] ***Parsons, R. 1983***

ton. Another vessel, a cutter named *Sarah*, was of 14 tons, but its entry was taken from press reports and had no information on its dimension as it was apparently not registered.

Of these seven vessels, five were built in the 1830s, two of which were recorded as being wrecked in the 1840s. Interestingly, there are two entries for a cutter named *Star* registered in Sydney. The first *Star* was built at Brisbane Water in 1838. It was 27.8' in length. In 1841 a second *Star* was registered as having been built in Sydney in 1839 and had a length of 30'. It is possible that this is the same vessel, that had been lengthened and re-registered. The undated entries for both vessels state they were lost with no further information.

The other two vessels, *Sarah* and *Teviot*, were built in 1829 and 1821 respectively. The entries for both vessels do not mention what happened to them.

In his book *Sydney Traders*, Hainsworth compiled a list of 114 individual documented vessels from 1803 to 1821 (see Section 5.6.4 and Volume 6).[174] Of these vessels, 34 had no tonnage, dimensions or in most cases only sail plans recorded. Of the remaining 80, 19 vessels were between 10 and 15 ton. Four were recorded as wrecked prior to 1830. Of the remaining 15 all except for two – the *William and Henry* and *Speedy*, built in 1803 and 1804 respectively – ceased to appear in the records prior to 1830.

This should not necessarily mean that they were wrecked, as one vessel, the previously mentioned *Teviot*, ceased to appear in the records consulted by Hainsworth in 1824. However, a vessel named *Teviot* was mentioned in a notice in *The Sydney Herald* from 11th December 1841 which offered a one-pound reward for *"… a boat, painted outside black with a red streak and yellow inside, and printed on the back board "Teviot A. Burton, North Shore," which was stolen from Captain Thom's Wharf*." The notice was signed by W.M. Gritton of Pyrmont. Any of these 15 vessels listed in Table 16 plus the aforementioned *Sarah* and *Star* documented in the *Register of British Ships* could be the vessel in question, if it operated in Sydney in the first quarter of the 19th century and was masted.

Table 16: Vessels listed in* Sydney Traders *of similar tonnage not recorded as wrecked

Built	Name	Rig	Tonnage	Owner
1803	*Union*	Sl	12	(1) J. Cavenaugh (1804); (2) J. Jones (1805)
1803	*William and Mary*		12	Wm. Miller
1803	*Raven*		14	Thos. Reiby
1804	*Improvement* (1)		10	I. Jones & E. Smith
1805	*Margaret*		7	Thos. Gilberthorpe
1806	*Happy Return*	Sl	14	H
1810	*Chance*	Sc	11	G. Blaxcell
1810	*Geordy*	Sc	14	Wm. Gaudry & H. Kable Jnr
1810	*Betsy*	Sl	15	Jonathan Griffiths
1811	*Union*	Sl	12	Thos. Johnson
1811	*Revenge*	Sl	14	Geo. Dowling
1813	*Happy Return* (2)	Sl	13	(1) Thomas Ivory; (2) James Stokes
1816	*Nancy* (2)	Sc	14	(1) Jonathan Griffiths; (2)John Neal (1818)
1819	*Hawke*	Sl	9	Andrew Byrne
1821	*Tiveot (Teviot)*		12	J. McDougal

Although the list of names provides promise, it should be noted that there are also many craft noted in the *Shipping Arrivals and Departures Sydney* publications that were unregistered. The movements of these smaller vessels appear only sporadically as the *Sydney Gazette*

[174] ***Hainsworth, D.R., 1981 : Appendix E***

notes that 'the arrivals and departures occur so frequently between the Capital and the Northern Settlements that we think it unnecessary to notice events of so uninteresting a nature'.[175] Coaster voyages were not included in shipping movements published in annual almanacs, nor were such small vessels usually mentioned in Harbour Master's records. In a *Sydney Gazette* list of 'small coastal vessels' arriving and departing from Sydney during August 1830 there are 11 boats that fall within the 10 to 15-ton size range and primarily carrying cargoes to the Hawkesbury, Newcastle and the Illawarra/Wollongong area.[176] Published *Sydney Gazette* coaster lists over a four-month period from April to July 1831 identified over a hundred coastal vessel movements and include 20 craft that fall within a 10 to 15 ton size range. However, the lack of definitive information about their size, rigging and working lives means that it is impossible to suggest that any one of these could be positively identified as being UDHB1.

The occupants of the site where UDHB1 was located, brothers William and Thomas Langford, are known to have built boats at their yard from the early 1830s onwards, but the archaeological context of the find suggests that it was actually built before they occupied the site. During the period 1842-43 there are a number of advertisements for their boatyard operation, such as these from the *Sydney Herald* of 8 February 1842: '*For sale – two shell boats and one four oared gig: apply to Mr Langford, boat-builder, Clyde Street, Sydney*'; *Sydney Herald* 22 June 1842 ' *To be sold cheap, a nine-ton boat, nearly new, with masts, sails, chain, cable, anchor, complete'*; and *Sydney Morning Herald* of 15 May 1843 '*To be sold an excellent nine ton boat. Apply to Mr Langford, boat builder, Clyde Street*'. A few days before this last notice, the site was advertised to be let as '*a house with wharf attached, at the bottom of Clyde Street, well adapted for a boat builder, rental £2 5s per week. Apply to William Langford*'.[177] It is quite plausible that Langford came into possession of UDHB1 with the intention refurbishment and sale, rather than salvage, as the vessel fits well within the range of boats built and sold at the site.

A series of sketches and watercolours from the mid-1800s that incorporate Langford's boatyard give an informative glimpse into the arrangement of the waterfront at that time and the vessels associated with the establishment (see Figure 1.9 and Figure 3.8). Two images produced by Samuel Elyard provide a tantalizing possibility of the incidental depiction of UDHB1 (Figure 5.53 and Figure 5.54).[178] The sketch, dated to around 1854, shows a number of boats dragged ashore in front of and adjacent to Langford's boatyard, as well as to the west where Cuthbert's shipyard had become established by that time (Figure 5.53).

[175] Sydney Gazette 2 December 1824

[176] Nicholson, I., 1981 : 54

[177] Sydney Morning Herald 15 May 1843.

[178] Elyard, Samuel, 'Millers Point from gasworks' c1854 State Library of New South Wales 1001186 and Elyard, Samuel, 'Views of Sydney, 1862-1873' State Library of New South Wales 826108

***Figure 5.53*: View overlooking Langford's Boatyard ca. 1854.** Note the boat of similar dimensions to UDHB1 (blue arrow) dragged up in front of Langford's house.

Of interest is the small boat situated in front of Langford's house. The heel of the vessel, to starboard, and its size mimics UDHB1. However this depicted vessel is not UDHB1. This is because it sits in front of the building and there is higher, dry ground to the west of it. When this drawing was made in the 1850s, there was no reclamation or higher ground to the west of the wreck (compare Figure 3.5 and Figure 3.9). A watercolour dated a decade later but seemingly based on the aforementioned sketch, shows the boat from a slightly different angle (Figure 5.54). In this image the boat is on the same elevation as the ground entrances to Langford's building. The location of UDHB1 places it in the intertidal zone to the north west of the building on the seaward side of reclaimed land (see Figure 3.14). The base of the boat would have been around 2 m below the threshold for the ground entrance to the building.

***Figure 5.53*: View overlooking Langford's Boatyard ca. 1854.** Note the boat of similar dimensions to UDHB1 (blue arrow) dragged up in front of Langford's house.

Figure 5.54: View of Millers Point/Darling Harbour showing the Langford boatyard (right) with beaches on either side dated from 1862 to 1873 but likely based on sketch from previous decade (see Figure 5.53). The black hulled boat (red arrow) is heeled to starboard and of a similar length to UDHB1. It appears to lay in front of Langford's house at ground level.

The similarities between where the boat was discovered and a similar type of vessel sitting on reclaimed land in front of Langford's house could lead to the speculation that the vessel in the aforementioned images was in fact UDHB1, and that it was eventually moved to the intertidal zone after these images were created. If this took place after the mid-1850s, it would mean that it broke down, with the remains largely buried by marine sediments, in a relatively short period of time. This scenario is actually less plausible, because the vessel was abandoned at an establishment which regularly built vessels of a similar size. The vessel depicted in Samuel Elyard's drawing and painting from the mid-1850s is extremely likely to have been just one of the many boats built by the Langfords. However, the boats shown in these images influenced the interpretation of the appearance of UDHB1 (see Section 5.3).

6 ADDRESSING THE RESEARCH DESIGN

The following table presents an overview of the research questions relating to UDHB1 and the corresponding research design. Importantly, this section also includes additional questions that have arisen from the analysis of UDHB1, providing scope for further research.

	Question	Response	Where addressed	Recommended further investigation
When was UDHB1 built? *It was most likely built in the 1810s or 1820s*				
1	How to understand the ship/boat building industry of the late 18th and early 19th century (pre-1825) in NSW?	The earliest shipbuilding in NSW was both a Government and private enterprise. For Government-built craft the shipbuilding skills varied. The Hawkesbury River became the major shipbuilding area after Sydney. There was competition with overseas built vessels, but not for smaller craft like UDHB1. Fifty-eight vessels are documented as having been built up until 1830, however there were many occasions on which unregistered vessels below 20 tons appeared in newspaper articles.	Sections 5.4.2 and 5.6.4	a) Archival research into the functioning of the Government Dockyard and what is available for private yards. b) Focus research on boat building.
2	How to identify the vessel in the historical record?	Seventeen vessels were located in the historical record which were of a size comparable to UDHB1 with no information on whether they were wrecked. It should be noted that there were many unregistered vessels of a similar size to UDHB1 whose names have not been recorded.	Sections 5.4.2 and 5.3	a) Research the histories of the seventeen vessels through newspaper accounts to narrow the field of likely candidates.
3	How to identify techniques that provide a *terminus post quem*, such as evidence of circular saw use or dated archaeological deposits?	The only evidence to date that provides some indication on when the vessel operated was the use of pure copper sheathing which suggests that the vessel was last re-fitted and/or repaired prior to 1840. The copper alloy fastenings are consistent with those used in late 18th and early 19th centuries.	Section 5.6.1	a) Examine fastening holes on planking after completion of cleaning and scanning for evidence of the use of cut nails.
What are the time intervals, if any, between phases of construction? *Possibly one or two decades from when built and when rider keel with outer layer of planking was added.*				

	Question	Response	Where addressed	Recommended further investigation
4	Which vessel components are contemporary? For example, was the inner garboard shelf added at the same time as the rider keel to compensate for the worn rabbet on the keel?	Three phases of construction have been identified. The first phase was the initial build as a single hulled clinker boat. After a period of time, repairs were affected (2nd phase) which mainly involved repairing the starboard garboard strake. Later a rider keel was added, which extended the length of the vessel by 0.5 m, which allowed for the addition of a second layer of planking.	Section 5.1	a) Attribute each element of the wreck to the recognised phases of construction. b) On completion of cleaning and scanning examine for additional phases or sub-phases of construction.
5	Are there comparative and historical examples of a rabbet on a keel wearing to a point where a plank needs to be attached to support the hull?	No such examples have been found during the writing of this report.	Section 5.5	a) At present the answer to this question is more likely to be found in forums on historical boat restoration and the like, rather than in published archaeological studies.
6	Are there comparative and historical examples of vessels having a second or outer planking added and what were the time intervals?	The only comparable archaeological example with a double clinker hull known at present is the Brown Bay wreck from Canada. As both planking layers were rabbeted into the keel, it would appear it was built as a single hulled vessel.	Section 5.5	a) At present the answer to this question is more likely to be found in forums on historical boat restoration and the like rather than in published archaeological studies.
7	Understanding how often vessels were re-pitched, and if there is evidence of more than one application of pitch on the inner hull.	No historical accounts of re-pitching were encountered during the writing of this report. The level of analysis of the pitch for this report did not reveal multiple applications of pitch over the same areas. Lead repairs, or tingles, were more evident after the pitch had been removed, which suggests that some localised re-pitching took place.	Section 4.10.1.1	a) At present the answer to this question is more likely to be found in forums on historical boat restoration and archaeological studies outside the date range of this wreck. b) Examination of the pitch under SEM and other techniques could possibly distinguish layers of pitch if such layers existed.
8	Were there further phases of construction, including repairs? For example, are there	Based on the data collected on site and the information available at the time of writing, from the post excavation	Sections 4.5.5 and 4.6.4	a) Examination fastening holes on planks to isolate 'orphans' which

	Question	Response	Where addressed	Recommended further investigation
	remains of previous frames that do not match those of the existing frames as evidenced by fastening holes on the planks, and/or are there 'ghost frames' partially concealed by a later application of pitch?	cleaning and recording there does not appear to be evidence of earlier framing covered by pitch. There were 'ghost frames' at the bow where the cant frames were fastened. The removal of the pitch did revealed repairs.		could indicate presence of earlier frames.
What differences are there between the inner and outer hull construction?				
9	Are there differences between the timber species of the inner and outer planking?	Of the planks that were sampled (63% of total number) both layers utilised Sydney Blue Gum,Spotted Gum and Grey Gum. Southern Mahogany was only found in the outer planking.	Section 4.5.6	a) Sampling the remaining timbers could provide insights on the differences of timber species between the two layers.
10	Are there any appreciable differences in planking sizes?	The length of the planks vary according to their position on the hull, however the outer planks as a group are on average 4% longer than the inner planks. The outer planks had a slightly lower average range in thickness by 3 mm while there was no appreciable difference in the width of the plank. The scarfs appeared longer for the outer planking though not all scarfs were measured for this report. This could be because the joins could not be backed with a scarph plate and the nails could not be clenched in the joint. The scarf joints for the inner planking were sealed with a strip of fabric while this was not observed for the outer planking, though the cleaning of the timbers could reveal that this was also the case.	Sections 4.5.2, 4.5.3 and 4.5.4	b) Examine scarphs of outer planking to identify presence or absence for use of fabric to seal the joins. c) Complete measurement of scarph lengths and ratios for all planking.
11	Are there differences in fastening patterning between layers?	Differences in fastening patterns were not fully investigated for this report. The fastenings for the outer planking appear less ordered, while the fastenings pattern on the inner planking scarphs appear more regular. The secondary outer planks appear to use pairs of fasteners, perhaps in a dovetail fashion, to increase their holding power where it was not possible to use the clench method (as the nail would have to penetrate sufficiently through the inner planking to achieve this). When examining the	Section 4.5.7.2	a) Investigate fastening patterns once timber cleaning and scanning completed.

Question		Response	Where addressed	Recommended further investigation
		fastening pattern for the inner planks it should be noted that there will also be fastening holes from the outer planks, which will give a haphazard appearance. This 'blind' hammering would also make it more likely fastening holes along the grain of the inner planking leading to splitting.		
12	Are there differences in size and frequency of treenails between layers?	An inventory of treenail sizes has not been attempted for this report, but it was observed that the treenails used for the planking were either round or square shanked. The square shanked treenails seem to have been repairs that replaced ferrous fastenings. There is also the possibility of dowels being inserted as place holders before ferrous fastenings were applied.	Section 4.8.3	b) Prepare inventory of treenail styles and note if there is a difference between them.
13	Are there differences in size and frequency of ferrous fastenings between layers?	No examples have survived well enough to document. From the shapes of the fastening holes and the indentations in the wood, it has been determined that the nails were square shanked 5-7mm ($^{1}/_{4}$") at the throat and tapered down on four sides to a point. The heads ranged in size from 10-12 mm.	Section 4.8.1	a) From the 3D scans of the timbers prepare an inventory of fastener styles.
14	Are there differences between the inner and outer layer that could be attributed to the physical constraints in overlaying an existing hull with another hull?	It appears the outer layer of planking used pairs of fasteners to secure the plank to the previous plank below. The fastenings of the inner layer of planking appeared to be more regular. The outer layer scarf joints were longer, since they could not be backed with a plate and the nails could not be clenched in the joint. The fasteners in the inner planking, in contrast, are located in the middle of the join.	Section 4.5.6	
15	Are there differences in composition of pitch on the inner and outer planking?	Different textures were observed within the pitch – spongy, hard, gritty or smooth black – which suggests differing compositions and applications. The 'gritty' pitch was observed on the exterior of the outer layer of planking. The	Section 4.10.1.1	See Question 7.

	Question	Response	Where addressed	Recommended further investigation
		gritty nature could be due the presence of a substance similar to kaolin clay.		
16	Are there any differences in the cutting method, tree size and number of trees used in the planking? This could be done by examining the end grain for the inner and outer planking.	All but one of the planks where grain was visible at the time of writing showed characteristics of having been quarter sawn. The stability and straight running grain of quarter sawn timber is required when forming the wood into shape by purposeful bending and twisting achieved through steam, heat or a period of submergence in water. The one timber which was recognised as plain sawn was positioned midships, which did not require as much bending and straining, and would have been suitable for this area of the hull.	Section 4.5.6.1	a) Investigate saw patterns once timber cleaning and scanning completed.
What did the vessel look like? *Vessel is thought to have been 29' 7" long, 10' 6" wide and 3' 2" deep with a transom and a hard chine. It had the form of a late 18th / early 19th century cutter.*				
17	Is it possible to confirm that the vessel did not have a mast step or keelson?	There is currently no physical evidence that the vessel had a mast step, however the shape of the hull, that of a cutter, would suggest it was propelled by oar and/or sail with a mast which could be raised when required.	Section 5.3.3	a) A closer analysis of the fastening holes atop of the keel could contribute to the discussion as to whether UDHB01 had a mast step, and possibly a keelson.
18	Is it possible to use site measurements and photogrammetry to preparing line drawings, fit out and a 3D digital model?	The extrapolated lines of the vessel and fit out has been prepared and a 3D digital modelled constructed using site measurements and photogrammetry.	Section 5.2, 5.3 and Volumes, 4, 6 and 8	
What was the vessel's function? *General purpose boat designed to be hauled up onto beaches and propelled both by oar and sail. Most likely a coastal and riverine trader but could also have been a fishing boat and/or served as a lighter.*				
19	Is it possible to develop an understanding of what 29ft, presumably oar-propelled, open-decked vessels were used for in Sydney Harbour, and possibly beyond, in the early 19th century, through the historical record?	Such a vessel would have been engaged in short haul conveyance of goods and passengers within Sydney Harbour and Parramatta River. If outfitted with a sail it could have made coastal voyages as far as the Hawkesbury River and Newcastle. It seems too lightly	Sections 5.4.1 and 5.6.5	

Question		Response	Where addressed	Recommended further investigation
		designed to have been built as a lighter, but it is not out of the question. It may have also been a fishing boat.		
20	How to gain an understanding of activities that the vessel’s hull shape was suited for? This would include examination and comparison of similar hull shapes from the United Kingdom.	The vessel had a hard chine, which was common for boats in England that were hauled up onto beaches.	Section 5.6.5	a) Further research into British boat building traditions.
21	Is it possible to determine whether the wearing of the rabbet on the starboard side may provide an insight into how the vessel was used?	No information has been located to date, but the wear may be due to repeated actions of pressing down on the starboard gunnel. This could possibly be caused by transfer of cargo from a vessel and/or from shore. It could also be the result of hauling in fishing nets.	Section 5.1	
22	By examining the bilge deposits, is it possible to see if a record of the vessel’s voyages and cargo could be ascertained?	The bilge deposits that are thought to have been the least contaminated from post abandonment intrusions provided no insights into the vessel’s voyages and cargoes.	Volume 3 – Specialist reports.	
Additional questions arising from the writing of this report.				
23	What was the shape of the transom?			a) A closer examination of the ends of the planks at the stern may provide some insight.
24	Was the vessel re-planked (inner layer)?			a) Examine the number of fastenings at the stern post.
25	How were the inner strakes extended to meet the new stem?	Were the inner strakes lengthened by scarphing to stern strakes? (A difficult task in clinker-built vessels – and do all nail holes line up, or are some left over in the scarph?) Or is the inner planking also new at the same time as the outer planking, so as to all reach to the new stem forward of the first phase primary keel? The range of timber species carried across both inner and outer as opposed to some being in one and not the other.		

Question		Response	Where addressed	Recommended further investigation
26	What do the repairs (tingles) contribute to the understanding of the construction sequence?			a) Were they fitted during its construction or its working life? b) What were they fastened with? c) Was there any sealing mixture used on them such as oakum, fabric, pitch, channum or a combination?
27	What do the fastening patterns on the frames say about the construction sequence?			a) Were the frames fastened after the second layer of planking was attached, or are the fasteners found in the frames only from the first layer of planking? b) Are the secondary frames fastened from the inside of the hull or the outside, and if so from which layer of planking? c) Were any treenails used to fasten frames into position?
28	What was the fastening sequence for the planking - whether the scarf plate was fastened after the scarf was fastened together, or at the same time using the same fasteners?			a) Can only be done after cleaning and scanning completed.

7 THE SIGNIFICANCE OF UDHB1

The preliminary cultural heritage significance assessment of UDHB1 identified that it had values that could be considered of State significance (Section 1.3). This assessment was made prior to the recovery of the wreck. The analysis of the data collected from the field, the information that was available at the time of writing from the scanning and cleaning of the timbers during conservation and historical research has required a revaluation of the significance of the vessel.

The cultural heritage significance of UDHB1 is in an evolving state. As more data comes available during the conservation process, the cultural heritage values of the boat as presented in this section may be expanded upon and/ or change.

The cultural heritage significance of UDHB1 potentially extends beyond the cultural confines of NSW and as such in this report the values of the boat will be measured against both the State and the National cultural heritage criteria.

7.1 NSW Cultural Heritage Significance Criteria

An assessment of cultural significance or heritage significance seeks to understand and establish the importance or value that a place, site or item may have to select communities and the general community. The Australian ICOMOS *Charter for the Conservation of Places of Cultural Significance* (the *Burra Charter 1979,* most recently revised in 2013) is the standard adopted by most heritage practitioners in Australia when assessing significance.[179] It defines cultural significance as "aesthetic, historic, scientific or social value for past, present or future generations".

This value may be contained in the fabric of the item, its setting and relationship to other items, the response that the item stimulates in those who value it now, or the meaning of that item to contemporary society.

Accurate assessment of the cultural significance of sites, places and items is an essential component of the NSW heritage assessment and planning process. A clear determination of a site's significance allows informed planning decisions to be made for the place, in addition to ensuring that their heritage values are maintained, enhanced, or at least minimally affected by development.

Statements of significance are made by applying the following standard evaluation criteria provided by the NSW Office of Environment and Heritage to assess the significance:[180]

- **a.** An item is important in the **course or pattern** of NSW's **cultural or natural history** (or the cultural or natural history of the local area).
- **b.** An item has strong or special **associations with** the life or works of **a person, or group of persons, of importance in NSW' cultural or natural history** (or the cultural or natural history of the local area).
- **c.** An item is important in demonstrating **aesthetic characteristics** and/or a high degree of **creative or technical achievement** in NSW (or the local area).
- **d.** An item has strong or special **associations with a particular community or cultural group** in NSW (or the local area) for **social, cultural or spiritual reasons**.

[179] The Australia ICOMOS, 2013, Charter for the conservation of places of cultural significance.
[180] NSW Heritage Office, 2001, Assessing Heritage Significance.

e. An item has **potential to yield information** that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).

f. An item possesses **uncommon, rare or endangered** aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).

g. An item is important in **demonstrating the principal characteristics of a class of NSW's cultural or natural places**; or cultural and natural environments.

7.2 National Cultural Heritage Significance Criteria

The cultural heritage value of UDHB1 will be assessed against the criteria used to assess prospective entries on the National Heritage List.[181] The National Heritage List includes natural, historic, and indigenous places that are of outstanding national heritage value to the Australian nation. At present there are five shipwrecks or vessels on the List – HMS *Sirius*, HMVS *Cerberus*, *Batavia*, HMAS *Sydney* and HSK *Kormoran*.

The National Heritage values are assessed against the following criteria:

(a) *the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history.*

(b) *the place has outstanding heritage value to the nation because of the place's possession of uncommon, rare, or endangered aspects of Australia's natural or cultural history.*

(c) *the place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.*

(d) *the place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:*

i) a class of Australia's natural or cultural places.

ii) a class of Australia's natural or cultural environments.

(e) *the place has outstanding heritage value to the nation because of the place's importance in exhibiting a particular aesthetic characteristic valued by a community or cultural group.*

(g) *the place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.*

(h) *the place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.*

(i) *the place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.*

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[181] Department of Agriculture, Water and the Environment Australia's National Heritage List https://www.awe.gov.au/parks-heritage/heritage/places/national-heritage-list

7.3 Importance to the study of Australia's early colonies and shipbuilding efforts

Shipbuilding was one of the early maritime industries in the Australian colonies.[182] It played an important role in 'putting Australia on its feet' and was vital in bridging the great distances that separated the colonies from each other and the rest of the world.[183] Water was a connector between the first colonies, and ships and boats provided the means to transport people and provisions, as well as the trade and transport of products of its industries: whaling (oil, ambergris, baleen), pastoralism (cattle, sheep and wheat) and timber getting (lumber), as well. Despite the importance of the shipbuilding industry, little historical work on early 19th-century Australian-built vessels has been undertaken due to limited availability of archival sources detailing the local manufacturing efforts.

The archaeological sites of Australia's earliest wooden vessels thus hold answers about technological and material adaptations in colonial settings and tell the stories of the Australian colonies within its broader region.[184]

Many of the Australian-built wooden vessels were small coastal traders about which little is known, as typically they were unregistered and therefore unrecorded. Yet they were vital for the establishment and expansion of settlements throughout the newly founded colonies, and they have the potential to reveal valuable information otherwise not available.[185]

At least 2,786 Australian-built ships are known to have wrecked on the Australian coastline, and yet only 271 (10%) have been located and a mere 16 (0.6%) have been subjected to preliminary archaeological survey or excavation with results published.[186] The absence of comprehensive shipwreck studies has created a critical gap in our knowledge of Australian shipbuilding. In 1995, the Commonwealth Department of Environment and Heritage commissioned the *Historic Shipwrecks National Research Plan*, which identified Australian shipbuilding as a research theme of national importance. It recommended that within the overall theme of 'developing an Australian economy linked to world markets', the sub-theme of Australian shipbuilding should be given priority.[187]

Work on the 16 shipwrecks of Australian-built vessels that have been investigated to date has been preliminary and partial in nature, often with only small portions of the hulls recorded

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[182] Alexander, A. (ed.), 2005, The Companion to Tasmanian History, Hudspeth, A., and L. Scripps, 1990, Battery Point Historical Research

[183] Colwell, M. 1969, Whaling around Australia, Blainey, G., 2001, The Tyranny of Distance: How Distance Shaped Australia's History

[184] Richards, N., 2006, Thematic studies in Australian maritime archaeology. In M. Staniforth and M. Nash (eds), Maritime Archaeology: Australian Approaches, pp. 48–50, Nash, M. 2004. 'The Australian-built schooner Alert (1846–1854).' AIMA Bulletin 28:89–96, Orme, Z.K. 1988. 'Shipbuilding in Northern Tasmania.' AIMA Bulletin 12(2):27–32.

[185] Staniforth, M., and D. Shefi. 2014. Shipbuilding in the Australian colonies before 1850. In C. Dagneau and K. Gauvin (eds), ACUA Underwater Archaeology Proceedings 2014, pp. 335–344

[186] Nash, M. 2004, Burgess, G. 2020. Shipwreck of Tasmanian-built schooner Barbara gives archaeologists new insights into colonial boatbuilding, ABC News https://www.abc.net.au/news/2020-04-05/shipwreck-at-rye-confirmed-as-tasmanian-ship-barbara/ 12103294, van Duivenvoorde, W., L. Davison, M.E. Polzer, M. de Ruyter, K. Bennett, D. Nutley, and P. Waterson. 2022a, in press. Identification of disarticulated context- free shipwreck remains: a case study from the Gold Coast in Queensland, Australia.' Historical Archaeology; and van Duivenvoorde, W., P. Taylor, P. Harvey, M. Polzer, M. McAllister, K. Edwards, K. Jerbic, and L. Phillips. 2022b, forthcoming, 'Shipwreck of Colonial making: The Tasmanian built schooner 'Barbara' in Rye, Victoria, Australia.' International Journal of Nautical Archaeology.

[187] Edmonds, L., S. Kenderdine, G. Nayton and M. Staniforth. 1995. Historic Shipwrecks National Research Plan May 1995.

and typically with little sampling of timber or metal for identification.[188] Further, maritime archaeological research in Australia has tended towards site-specific and particular studies.[189] Attempts have been made to examine Australian shipbuilding using what Richards (2006) calls theme-based research or thematic case studies, but these have been limited to one degree or another by insufficient or inappropriate data.[190] While these studies have recognised the need for a comparative analysis of shipbuilding, they have lacked the rigorous fieldwork and analytical methodology capable of generating the data necessary to address research questions.

The UDHB1 boat already has broken away from the preliminary nature of Australian colonial shipbuilding studies as its excavation saw for the first time every timber recorded in detail. Furthermore, a substantial amount of wood samples was taken for the most comprehensive tree species identification of any Australian-built vessel to date, as well as the study of its waterproofing materials, sheathing, and fasteners. More importantly, the UDHB1 boat will be conserved and then accessioned into a museum collection, allowing researchers to revisit aspects of its current study in the future, where they may be able to verify research outcomes or undertake new investigations using techniques not yet available.

For the first time, the UDHB1 boat allows for an in-depth and comprehensive examination of the nature of early colonial shipbuilding in NSW and assess the transfer of technology to the colonial setting. It will explore the translation of shipbuilding skills in new social and environmental conditions. This is significant in a national setting as we know very little of Australia's colonial shipbuilding efforts, but also internationally as other colonial shipbuilding knowledge in, for example, the Americas or India, cannot be placed into a meaningful global context with Australia's story missing for comparative study.

Additionally, the UDHB1 boat was found within reclamation fills associated with part of a larger archaeological site - a boatyard. This provides a greater understanding of how boatyards utilised older vessels - past their prime - for parts and contributes to our understanding of the likelihood that many other similar vessels (potentially unregistered/ unrecorded) may have experienced this fate.

7.4 Significance of archaeological ships in museums

The UDHB1 is significant as it represents only the second archaeological plank-built watercraft in Australia that was raised in its entirety from its *in situ* location. The other example is that of the well-known Dutch East India Company ship *Batavia* – which is on the National Heritage List. The remains of *Batavia*'s stern were raised from the seabed over three excavation campaigns in the early 1970s under the auspices of the Western Australian Museum. The ship ran aground on its maiden voyage from the Netherlands to Indonesia on Morning Reef, in the Houtman Abrolhos Archipelago in Western Australia, on the 4th June 1629. Like UDHB1, the *Batavia* ship was constructed with a double layer of hull planking.

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[188] Bullers, R., 2006, Quality Assured: Shipbuilding in Colonial South Australia and Tasmania., Bullers, R. 2007. Zephyr: a short-lived Australian-built schooner., Bullers, R. 2018. Timber selection in Tasmanian colonial shipbuilding: A preliminary predictive model. AJMA 42:3–23, Harvey, P. 1989. Excavation of the shipwreck Clarence, Nash, M. 2004, Orme, Z.K. 1988. 'Shipbuilding in Northern Tasmania.' AIMA Bulletin 12(2):27–32

[189] Nash, M. 2006. 'Individual shipwreck site case studies.' In M. Staniforth and M. Nash (eds), Maritime Archaeology: Australian Approaches, pp. 55–67., Veth, P., and M. McCarthy. 1999. Types of explanation in maritime archaeology: the case of the SS Xantho. Australian Archaeology 48:12–15

[190] Richards, N., 2006,, Bullers, R. 2018., Coroneos, C. 1991. 'One interpretation for the short working lives of early Australian wooden sailing vessels in Victorian waters.' AIMA Bulletin 15(2):7–1, Jeffery, W. 1989. 'Research into Australian-built coastal vessels wrecked in South Australia, 1840–1900.' AIMA Bulletin 13(2):51–56 and O'Reilly, R. 2007. Australian Built Wooden Sailing Vessels of the South Australian Intrastate Trade.

Batavia's surviving stern section, now in Fremantle's Western Australian Shipwrecks Museum, is the only portion of any early 17th-century Dutch East India ship raised from the seabed and preserved. The ship's remains have demonstrated clearly since the 1970s the importance of the recovery of archaeological vessels. Studies of the remaining *Batavia* ship have led to new discoveries on Dutch shipbuilding, timber trade and procurement, European trade networks, and technological advancements, none of which could be found or extracted from historical archival sources.[191]

The most recent study of the *Batavia* ship timbers published in PLoS ONE now ranks within the top 10% of most viewed archaeological articles ever published in PLoS One.[192] This shows the significance of such studies and the impact ships in museum settings can have, especially when considering this work competes with studies related to human origins, dispersal, and Neanderthals.

For the most recent *Batavia* study, researchers were able to study the tree rings of its timbers. They found that the oak for the hull planking was sourced from two separate forests (in northern Germany and the Baltic region); with wood for the framing elements coming predominantly from the forests of Lower Saxony. The timber was processed shortly after the trees were felled (in 1625 or later) and was still green when the shipbuilders cut and bent the planks into shape. This study has led to a much better understanding of the Dutch success in world trade of how they managed to build such large ocean-going vessels, and so many of them.

This study was only possible because *Batavia's* hull was raised in its entirety. Waterlogged, *in situ* wood is mushy, so extracting samples from the timbers while still on site is always challenging. It also would have required cutting out large sections of the ship to access all the different elements.

The recovery and planned conservation of the UDHB1 boat will also allow researchers to access the hull for ongoing studies in ship construction, timber procurement in the Sydney region and our understanding of Australia's early colonies. The boat provides unique archaeological datasets to inform us of Australia's early colonial history, the environment in which it was build, timber procurement and trade in the Australian colonies, as well as the colonies' early maritime industries, Indigenous agency, and how colonists and shipbuilders adapted to a new environment. The UDHB1 boat, as the only surviving vessel of its type (clinker built) in existence that was built and lost in early colonial Sydney, has the potential to unlock much further research and generate important ongoing public interest stories.

7.5 Double planking in shipbuilding

The double planking of ship's hulls goes back to the ancient Mediterranean, and the earliest archaeological example is that of a large Roman merchant ship that sank off Madrague de Giens in France in the second or first century B.C. This ship measured about 40 m in length,

[191] Daly A., M. Domínguez-Delmás and W. van Duivenvoorde. 2021. 'Batavia shipwreck timbers reveal a key to Dutch success in 17th-century world trade.' PLoS ONE 16(10):e0259391. On-line: https://doi.org/10.1371/journal.pone.0259391, van Duivenvoorde W., A. Daly and M. Domínguez-Delmás. 2021. We studied the tree rings of the Batavia shipwreck timbers – they told us much about global seafaring history. The Conversation, 25 November. On-line: https://theconversation.com/we-studied-the-tree-rings-of-the-batavia-shipwreck-timbers-they-told-us-much-about-global-seafaring-history-171495, van Duivenvoorde, W. 2015. Dutch East India Company (VOC) Shipbuilding: The Archaeological Study of Batavia and other Seventeenth-Century VOC Ships, College Station: Texas A&M University Press. Ed Rachal Series in Nautical Archaeology. ISBN-10: 1623491797, ISBN-13: 978-1623491796. On-line: https://www.amazon.com/Dutch-India-Company-Shipbuilding-Seventeenth-Century/dp/1623491797

[192] Daly et al. 2021

9 m in beam, and it was constructed in a shell-based construction method with two layers of hull planking.[193]

Shell-based or shell-first construction is described by J. Richard Steffy as a:

> '[…] *term used to describe the process by which all or part of the outer hull planking was erected before frames were attached to it. In pure shell-built hulls, outer planking was self-supporting and formed the primary structure; the framework fastened to it formed the secondary, or stiffening, structure.*'[194]

The first evidence for the use of multiple layers of hull planking in northern Europe comes from the large medieval naval ships built for the English crown (for example Henry V's ship *Grace Dieu*, launched in 1418). These large warships were also constructed in a shell-based construction method with lapstrake or clinker planking.

Nearly two centuries later, when the Dutch started sailing to Southeast Asia for the first time in the 1590s, they had an immediate need to construct very large, ocean-going vessels. Their solution to the additional strength requirements of large hulls was the construction of double hull planking and, thereby was focused primarily on the extra layer of the outer shell (i.e. planking). It was the most obvious answer for the construction of large ships using the shell-based construction method. They used a similar solution as the ancient Mediterranean shipwrights, or those on the royal dockyards in Medieval England.

When the *Verenigde Oostindische Compagnie* (VOC, or Dutch East India Company) was founded in 1602, double-planked ships were the standard in the first decades when shipwrights had to create vessels that could withstand the longest and most distant voyaging and, in the process, protect cargoes, lives, and investments.[195] VOC shipwrights were still constructing in a shell-based method, in which its ships relied predominantly on a sturdy shell of planking. The Company mandated, via its shipbuilding instructions, that the ships were constructed with two thick layers of oak hull planking.[196] These two thick layers created not only a stronger hull, but it also facilitated the bending of heavy oak planks in the shipyard and were easier to keep in place than one double-thick plank. Two 'thinner' layers of hull planking were probably also more resilient than one very thick layer, and easier to repair.[197] The 1629 *Batavia* ship that ran aground on Morning Reef in the Abrolhos Islands off Western Australia is a typical example of such a double-planked ship. It is through its excavation, and the raising of its hull remains, that we have learned of such practices and have been able to re-interpret historic archives on shipbuilding.[198]

This type of double-planked construction is perhaps best known from whaling ships, but the earliest historical references for reinforcing Dutch whaling ships with an additional layer of oak planking date more than 50 years after the early Dutch voyages to Southeast Asia had required such methods of construction for its India ships. Double planking in whalers commenced around 1660, coinciding with the beginning of Dutch fishing and whaling in the icy waters around Spitsbergen.[199]

Since *Batavia*'s excavation in the 1970s, other Dutch East India Company ships with double planking have been identified in an archaeological context,[200] as well as similar type ships with double planking from other European nations, i.e. Denmark (Christianshavn B&W 1 and

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[193] Steffy, J. 1994 Wooden Ship Building and the Interpretation of Shipwrecks.: 262 and van Duivenvoorde, W. 2015.: 189

[194] Steffy, J. 1994: 279

[195] van Duivenvoorde, W. 2015: 186-193, Daly et al. 2021

[196] van Duivenvoorde, W. 2015: Appendix A, 244

[197] van Duivenvoorde, W. 2015

[198] van Duivenvoorde, W. 2015

[199] van Duivenvoorde, W. 2015: 349-361

[200] van Duivenvoorde, W. 2015: Chapter 5

2 ships) and England (1619 *Warwick*).[201] The practice has become known as 'Double Dutch'[202] but recent archaeological studies have revealed that merchant ships dating from the late 16th to the 18th centuries saw other nations double plank their large sailing ships as well.[203] Perhaps a relatively short-lived tradition in the early modern period, this method of planking up ships led to a transfer of technology—whether to or by the Dutch—and can be considered a particular feature in the construction of specific types of large ocean-going vessels.

The aforementioned vessels were large ships, predominantly built with a shell-based method in which double-planking was a solution to the construction of large vessels strong enough to sail long distances and carry heavy loads. Other reasons for the double planking of ships and boats may be –

1) increased water tightness (especially when specific cargoes require dryness);

2) the strengthening or stiffening of ships' hulls to improve sailing speed;

3) after the lengthening of a vessel to maintain hull integrity, or;

4) to prolong the life of a vessel after repairs.

The two other examples of double-planked hulls known from Australia are both Australian-built, early colonial vessels: the UDHB1 boat and the schooner *Barbara* that was wrecked off the Rye jetty in 1853. *Barbara* was built in Tasmania in 1841, probably around the time the UDHB1 was abandoned. Both the UDHB1 and *Barbara* were vessels much smaller in size than ships like *Batavia*. Unlike UDHB1, *Barbara* had carvel planking rather than clinker planking.[204] It was a 16-ton schooner, that measured only 12 meters in length and had a beam of 3.3 metres.[205] The vessel's hull had a deep draft (its keel had a moulded depth of 23 cm, and its false keel had a moulded depth of 21.5 cm around amidships) and it was planked up with two layers of thick Jarrah hull planking, each layer measuring 4 cm in thickness.[206] The vessel must have been quite rigid with excellent sailing properties. More importantly, it operated in the Port Phillip lime trade, carrying cargoes of calcined lime which had to be kept separate from water due to the potential fire hazard if the two materials reacted.[207] There are examples of at least 12 ships that operated in the Port Phillip lime trade that were set on fire due to this exothermic reaction of lime and water.[208] The double planking of *Barbara* may not only have provided excellent sailing properties, but also may have been a direct result of the

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[201] Lemee, C.P.P. 2006. The Renaissance Shipwrecks from Christianshavn: An Archaeological and Architectural Study of Large Carvel Vessels in Danish Waters, 1580–1640 and Bojakowski, P., and K. Custer‐Bojakowski. 2017. Warwick: report on the excavation of an early 17th‐century English shipwreck in Castle Harbour, Bermuda. International Journal of Nautical Archaeology 46(2):284-302.

[202] Maarleveld, T.J. 1994. Double Dutch solutions in flush-planked shipbuilding: continuity and adaptations at the start of modern history. In Crossroads in Ancient Shipbuilding: Proceedings of the Sixth International Symposium on Boat and Ship Archaeology, Roskilde 1991, edited by Christer Westerdahl, pp. 153–163.

[203] Beltrame, C., S. Gelichi and I. Miholjek. 2014. Sveti Pavao shipwreck: a 16th century Venetian merchantman from Mljet, Croatia. And Zwick, D. 2021. A late 17th-century 'Double Dutch' construction in the North Frisian Wadden Sea: the case of the Hörnum Odde wreck on the island of Sylt, Germany. In: Open Sea, Closed Sea: Local and Inter-Regional Traditions in Shipbuilding: Proceedings of the Fifteenth International Symposium on Boat and Ship Archaeology. G. Boetta, P. Pomey, and P. Poveda (eds.). Paris: CNRS Editions, pp. 203-209 (Archaeonautica; vol. 21).

[204] van Duivenvoorde, W., P. Taylor, P. Harvey, M. Polzer, M. McAllister, K. Edwards, K. Jerbic, and L. Phillips. 2022b

[205] Taylor, P. 2017. The Port Phillip Lime Economy: the Vessels, the Industry and Their Decline. MA Thesis (by Research), Federation University Australia.

[206] van Duivenvoorde, W., et al 2022b

[207] Taylor, P. 2017: 8

[208] Taylor, P. 2017: 83-84

conditions prescribed by the lime trade and the ensuring of a watertight hold to reduce the risk of the ignition.[209]

Further study of UDHB1 will, in the future, hopefully provide a better understanding of why it was double-planked. The second layer of planking was added after a refit or repair of the hull. It is presently unknown whether this repair was the result of a change in the purpose for which the vessel was used that required a second layer of hull planking, or whether it was a simple measure to prolong its life. The UDHB1 is a unique archaeological find in that it is an early colonial-built boat with two layers of clinker planking, and the answer(s) as to why it was double planked may tell us much about Sydney's early days and the newly founded colony's dependence on its watercraft.

[209] ***van Duivenvoorde, W., et al 2022b***

7.6 Assessment of Significance

	Historical value
State	*a) An item is important in the course or pattern of NSW's cultural or natural history (or the cultural or natural history of the local area).*
National	*(a) The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history.*

UDHB1 was constructed at a time in NSW history where locally made small timber sailing vessels were an integral and essential component of the nascent Australian economy. As a consequence, Australian shipbuilding was one of the nation's first major industries.

With great loss, including of lives, these vessels navigated uncharted waters, negotiated river bars and rose over heavy swells to maintain vital links between Sydney (and later Hobart, Brisbane and Melbourne) and small coastal and river settlements along the southeast coast of Australia. The reliance on such craft diminished with the commencement of the Gold Rush, which saw the introduction of a great number of steam ships and steam trains.

UDHB1 when assessed against this criterion contributed to the course of NSW's cultural history, and as such can be considered of **State** significance to NSW.

	Association with a well-known person or persons
State	*b) An item has strong or special associations with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).*
National	*h) The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.*

The identity of UDHB1 is currently not known, and therefore its association with a person or persons is not known. Its location within William Langford's Darling Harbour boatyard would suggest Langford was in possession of the boat during its abandonment and prior to its burial. William Langford and his descendants operated boatyards and were associated with maritime activities of Sydney's development since the 1830s into the 1860s.

Based on the available information UDHB1, when assessed against this criterion, has some association with notable figures in boat building in Sydney from the mid 19th century, and as such can be considered to be of **Local** significance to NSW.

	Aesthetic, creative and/or technical values
State	*c) An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).*
National	*e) The place has outstanding heritage value to the nation because of the place's importance in exhibiting a particular aesthetic characteristic valued by a community or cultural group.*

UDHB1 as a wreck site has aesthetic appeal arising from the varying rich red-brown hues of the timber and the irregularity of its construction. As opposed to other timber wrecks found in Australia, where the frames are finely squared and regularly spaced, this wreck has an idiosyncratic personal signature where frames have been roughly shaped with an adze, or selected based on their natural curves. It has a vernacular and personal touch with a pre-industrial feel. The apparent longevity of the vessel is testament to the skills of those who built and modified it.

While displaying technical aspects that would be idiosyncratic to individual builders, it does not appear to have any characteristics that are outside what is known about European boat building at the time. Having said this, the imprinting of a European boat building tradition onto an Australian context, especially with respect to the use of local timbers, is a technical achievement in itself and possibly the earliest known example found in Australia to date.

The lengthening of the vessel and the addition of a second layer of planking during its working life talks to the high levels of technical craftsmanship of boat builders operating in the Sydney region in the early to mid-19th century.

Based on available information UDHB1, when assessed against this criterion, makes an outstanding contribution to the understanding of technology transfer and adaptation from Europe to Australia in the early 19th century and as such can be considered of **State** significance to NSW and also commensurate with **National** cultural heritage values..

Association with a particular community	
State	*d) An item has strong or special associations with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.*
National	*g) The place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.*

No further specific public consultation has been undertaken to assess the social significance of these potential remains, but generally the maritime and industrial archaeology and heritage of NSW have strong community interest and support.

The discovery of the vessel, because of its age and provenance, resonates with nautical elements of the NSW and Australian community. This was reflected by media coverage and community interest during the excavations, particularly with the discovery of the UDHB1, strongly suggesting that these remains have social significance to a range of community groups (local and professional) who have an interest in heritage. Further the interest of the Australian National Maritime Museum in UDHB1 and the surrounding buried maritime landscape and preparation for future displays indicates their strong social values.

Ability to yield information	
State	*e) An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).*
National	*c) The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.*

Until the discovery of UDHB1 our knowledge of early Australian built vessels in NSW was based on depictions in contemporary artwork (often in the background and incidental) or what could be gleaned from scraps of material excavated on early shipbuilding sites. The early shipbuilders left few written records and even less in the way of the lines and plans of ships. Some idea of the shape of these vessels can be deduced from the *Australian Register of British Ships* but this is done *in lieu* of physical examples of such craft. UDHB1 not only provides the opportunity to study the materials used and the manner of construction of the vessel, but also its form. Such historical information is rare, even for a non-Australian built vessel.

The examination of the wreck can contribute greatly to our understanding of the workhorse of the early Colonial economy. Was this vessel typical of its type – especially with its second layer planking added during its working life? Was it poorly or cheaply built?[210] What can it tell us about the quality of craftsmanship of Australian shipbuilding in the early 19th century, and the availability of materials?

The UDHB1 boat was found within intertidal deposits associated with an 1830s-1850s boatyard together they provides a greater understanding of how boatyards reused components from vessels past their prime and contributes to our understanding of the likelihood that many other similar vessels (potentially unregistered/ unrecorded) may have experienced this fate and were abandoned along early foreshores.

UDHB1, when assessed against this criterion, can yield important information to the understanding of NSW's cultural history and could therefore be considered of **State** significance while also making an outstanding contribution to the knowledge of early Australian shipbuilding thereby making it commensurate with **National** cultural heritage values

Uncommon, rare or endangered values	
State	*f) An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).*
National	*b) The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare, or endangered aspects of Australia's natural or cultural history.*

Hundreds of vessels such as these were constructed in shipyards from Augusta, Western Australia to Williamstown, Victoria before 1850. Hundreds were also lost sailing along a poorly charted coastline. In NSW such vessels in the early 19th century would have been a common – and often welcome – sight. No such vessels survive today, and their survivability as wrecks is hindered by their relatively lightweight construction. UDHB1 is an outstanding rare surviving example of an early Australian built vessel.

Furthermore UDHB1 is a unique archaeological find in that it is an early colonial-built boat with two layers of clinker planking, and understanding why it was double planked tells us much about Sydney's early days and the newly founded colony's dependence on its watercraft.

When assessed against this criterion, UDHB1 can be considered of **State** significance and also commensurate with **National** cultural heritage values.

Demonstrating principal characteristics	
State	*g) An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural and natural environments.*

[210] Bullers, R. (2006) Quality Assured: Shipbuilding in Colonial South Australia and Tasmania. Flinders University Monograph Series Number 8 and Coroneos, C., (1991). 'One interpretation for the short working lives of early Australian wooden sailing vessels in Victorian waters.' The Bulletin of the Australian Institute for Maritime Archaeology, 15(2): 7-14.

National	*d) The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:* *i) a class of Australia's natural or cultural places.* *ii) a class of Australia's natural or cultural environments.*

UDHB1 is currently the best preserved and possibly earliest example of an early Australian built vessel. Such craft were an integral part of the development of the Australian economy and its reliance of maritime transportation. Its standard of preservation allows for understanding the technical and archaeological maritime data of UDHB1 s such that it will be the subject of research and analysis for decades to come, and its principal characteristics will serve as the baseline for studies into early Australian boat and ship building. It can also be argued that as the vessel was composed of two hulls constructed over an interval of years or even decades, UDHB1 provides a glimpse of early Australian shipbuilding across most of the first half of the 19th century.

UDHB1, when assessed against this criterion, is an outstanding example of a class of Australia's material cultural behaviour, and can be considered of **State** significance and is also commensurate with **National** cultural heritage values.

7.7 Statement of Significance

Colonial Australia's first shipbuilders

> '…*showed enterprise, courage and ingenuity. They had to invest labour and capital in yards and slipways, sail lofts and sheds. There must always have been shortages of equipment and skilled labour. Even more formidable than building vessels from local materials in such conditions was the task of keeping them seaworthy year after year*'.[211]

Australian shipbuilding was one of the nation's first major industries - at the time of the UDHB1s construction, in the 1810s/ 1820s, locally made small timber sailing vessels were an integral and essential component of the emerging Australian economy, carrying goods and people. Vessels such as UDHB1 navigated uncharted waters, negotiated river bars and rose over heavy swells to maintain vital links between Sydney and small coastal and river settlements along the southeast coast of Australia (and later Hobart, Brisbane and Melbourne), with reliance only diminishing with the introduction of greater numbers of steam ships and steam trains at the beginning of the Gold Rush in the 1850s.

Both the National and State significance of UDHB1 lies in its historical, technical and rarity values, and its ability to yield information about the form, method of construction and materials used in the making of a critical component of the early Colonial economy, and what can be learned about this frontier industry of Australian shipbuilding. In this instance, the imprinting of a European boat building tradition onto an Australian context, and especially the use of local timbers such as Sydney Blue Gum, is a technical achievement in itself and possibly the earliest known example in Australia to date. Such information can currently only be obtained from the archaeological record. The relatively good state of preservation of UDHB1 makes it an outstanding example of early Australian shipbuilding.

UDHB1 has aesthetic appeal arising from the varying rich red-brown hues of the timber and the irregularity of its construction. UDHB1 has an idiosyncratic personal signature where frames have been roughly shaped with an adze, or selected based on their natural curves (as opposed to other timber wrecks found in Australia, where the frames are finely squared

[211] Hainsworth, D.R., 1981, The Sydney Traders: Simeon Lord and His Contemporaries 1788-1821: 116

and regularly spaced). UDHB1 is the result of vernacular craftsmanship, demonstrating an individual and personal touch - a pre-industrial feel, with the apparent longevity of the vessel a testament to the skills of those who built and modified it.

With hundreds of vessels constructed in shipyards from Augusta, Western Australia to Clarence River, NSW before 1850, many were lost sailing along an uncharted coastline. While such vessels would have been a common sight in NSW in the early 19th century, no such vessels survive today, and their survivability (as wrecks) is hindered by their relatively light construction. As such the UDHB1 is an outstanding rare surviving example of an early (possibly the earliest) Australian-built vessel. Its standard of preservation is such that it will be the subject of ongoing research and analysis for decades to come, and its principal characteristics will serve as the baseline for studies into early Australian boat and ship building. Additionally the context in which UDHB1 was found – under reclamation fill and adjacent to a mid-19th century boatyard - allows for a greater understanding of how boatyards utilised older vessels - past their prime - for parts and contributes to our understanding of the likelihood that many other similar vessels (potentially unregistered/ unrecorded) may have experienced this fate.

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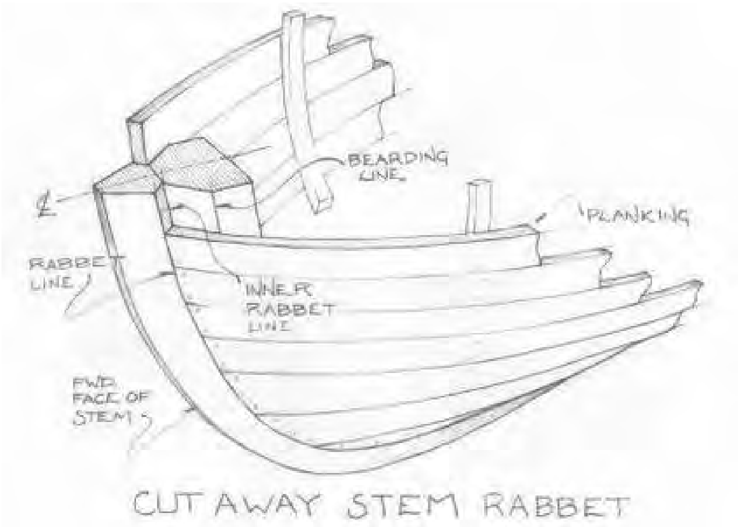
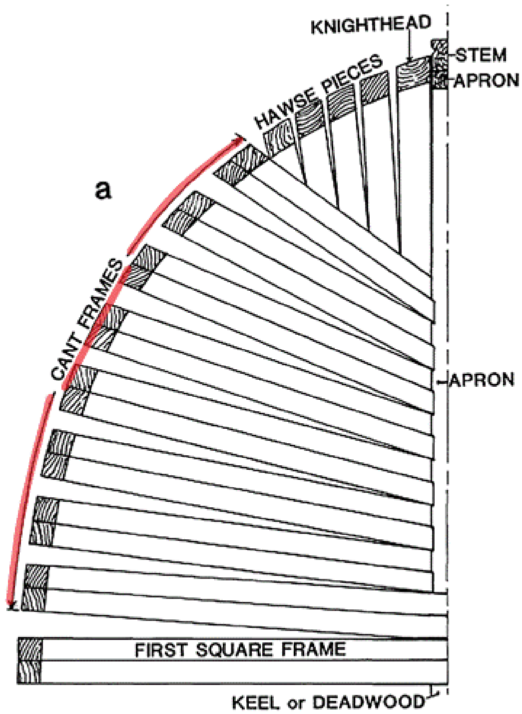
Illustrated Glossary

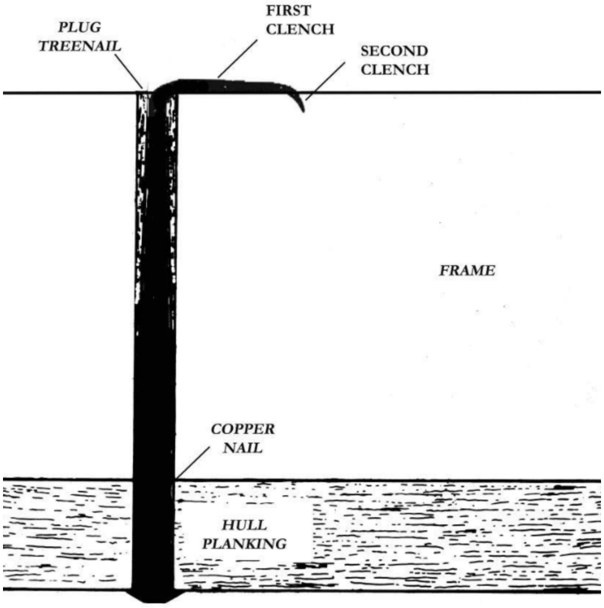
<table>
<tr><td>After cant</td><td>Framing members at the stern of a vessel mounted obliquely to the keel centreline (see cant).</td></tr>
<tr><td>Buttock</td><td>A curved line or vertical section of a vessel's bow and the under-surface part of a ship forward of the stern.</td></tr>
<tr><td>Bearding line</td><td>The line developed by the inner edge of the planking surface against the forward and after deadwood, stem, keel and sternpost.



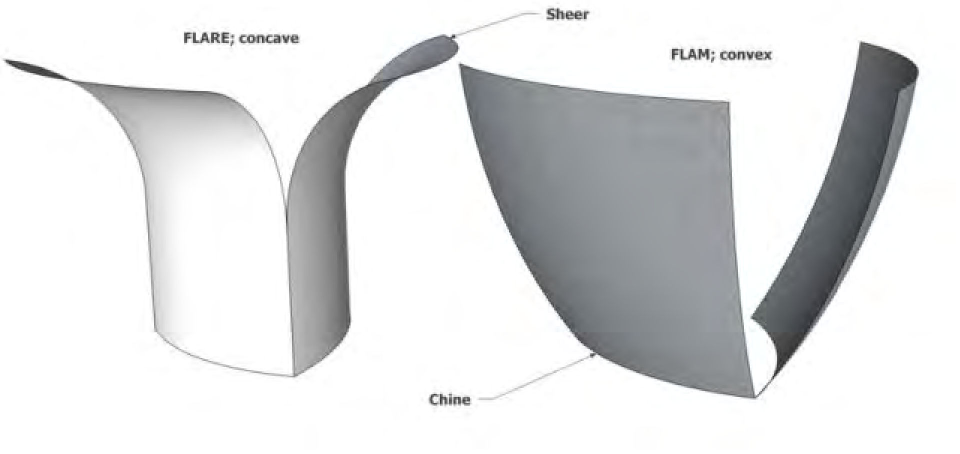
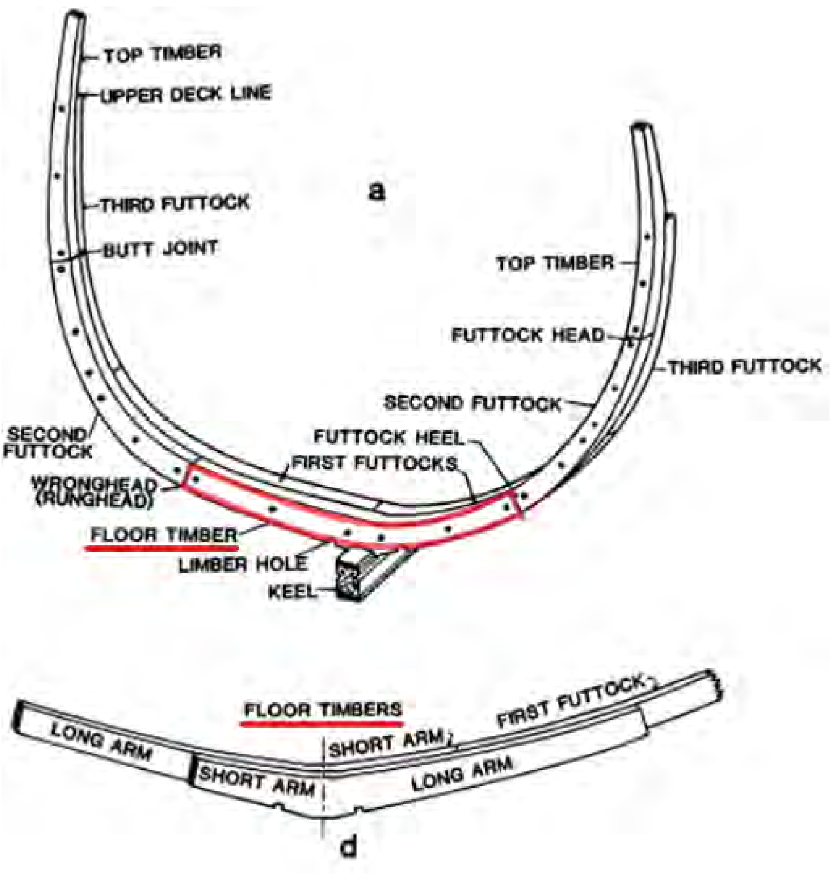
</td></tr>
<tr><td>Bilge</td><td>The rounded part of the hull between the side and bottom, either inside or outside of the hull.</td></tr>
<tr><td>Cant</td><td>Frames usually located in the bow and the stern (after-cant frames) which diagonally brace the bow and stern planking.

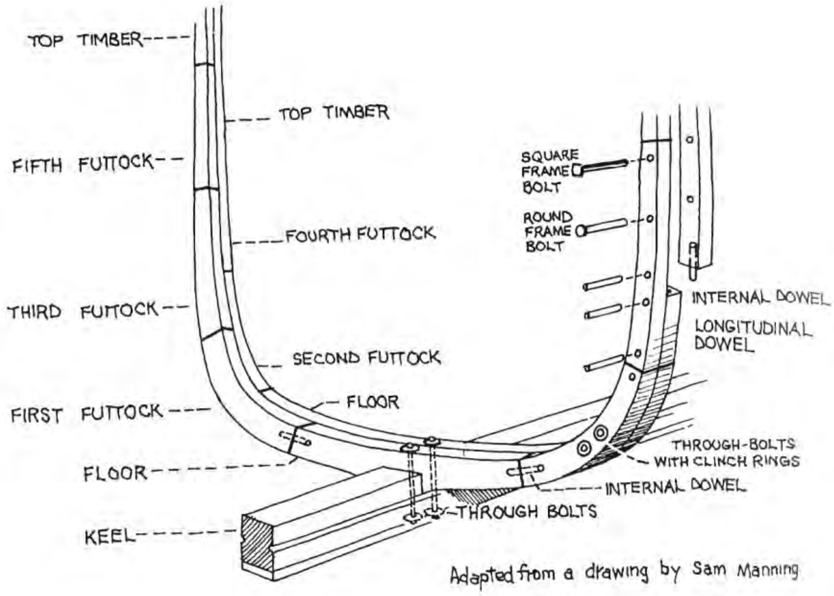
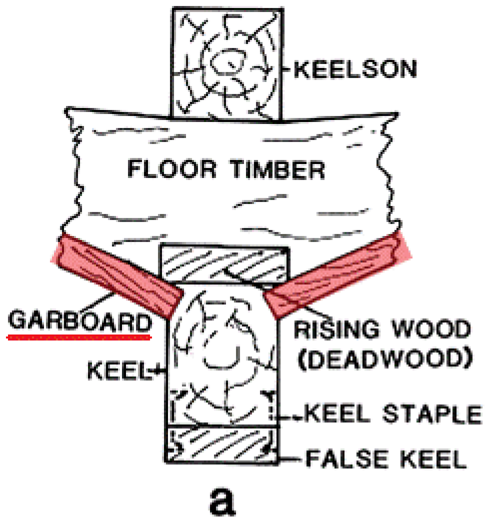


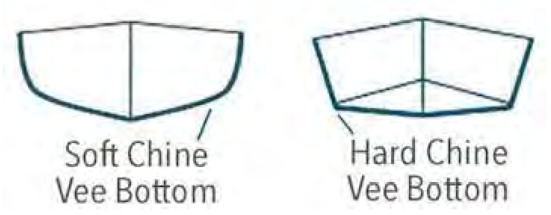
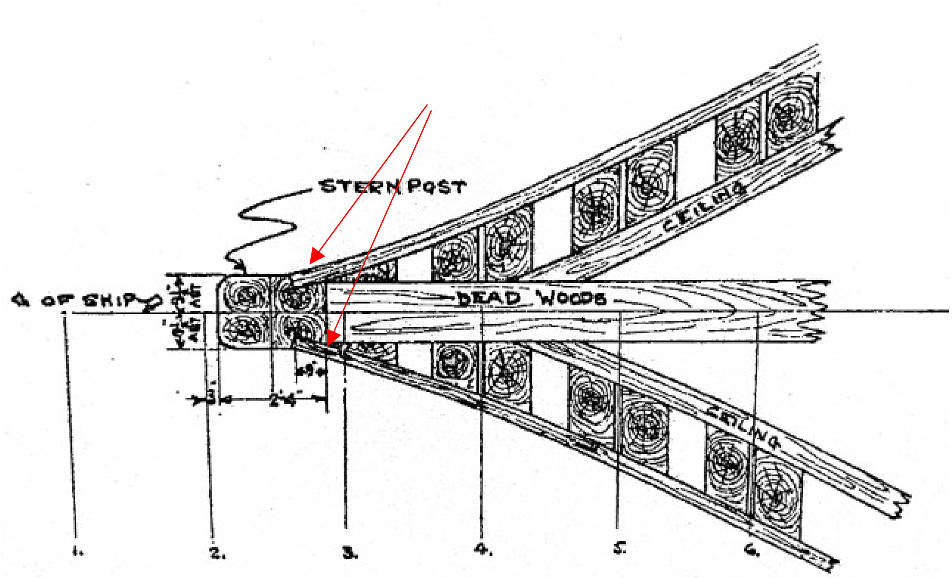
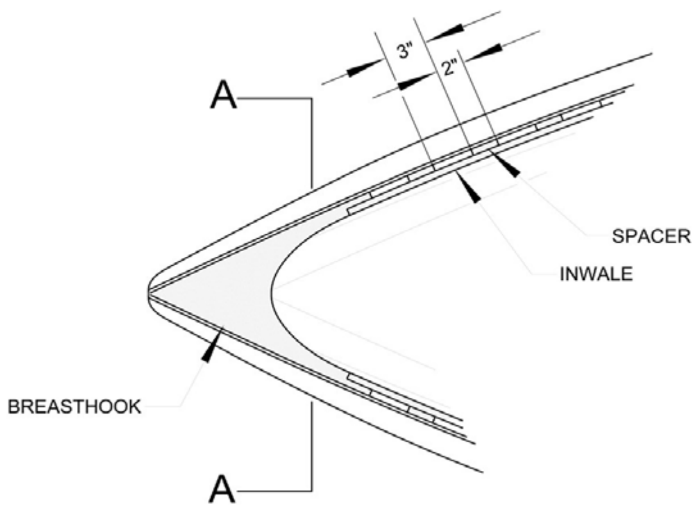
</td></tr>
</table>

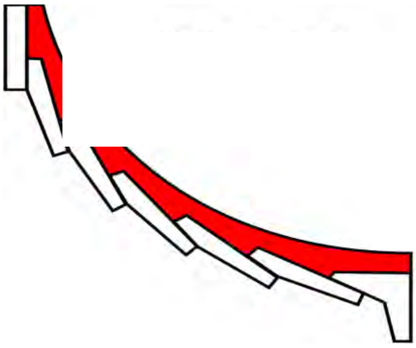
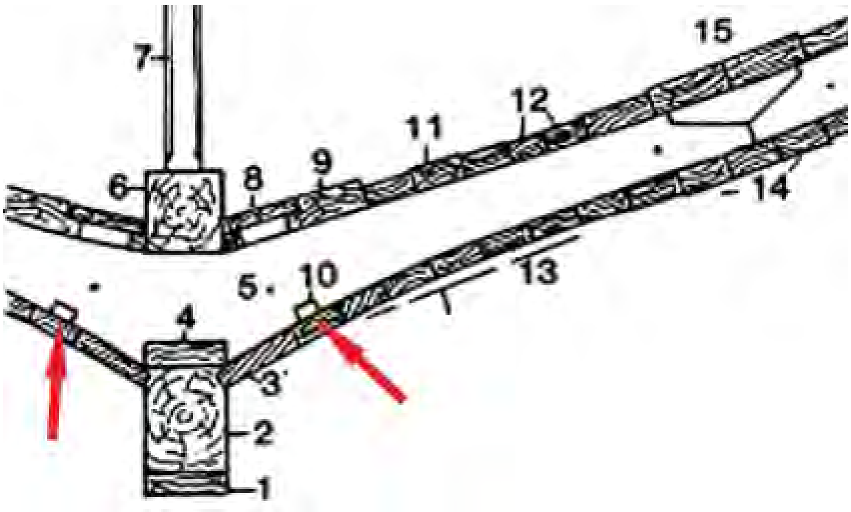
Carvel	A method of planking a vessel's hull such that the planks lie edge to edge and do not overlap along the seams or butts, fastened to the frames to form a smooth exterior.
Chock	An angular block or wedge used to fill out areas between timbers or to separate them, frequently used to fill out deadwoods and head knees, or separate frames and futtocks.
Chunam	Also referred to as *schannam* or *white stuff*. A mixture of oil and lime used as a protective coating against marine borers. Chunam could be a mixture of several coats including a lime putty, pitch, tallow, resin or tar, although the first coat was generally an oil and lime putty.[212]
Clench	To secure a nail or bolt by bending or flattening its projecting end over the surface it last penetrated. 
Clinker	A method of ship construction where the outer planking overlaps, and is fastened to, the plank immediately below it. In the context of northern European shipbuilding specialists, clinker-built refers only to those vessels whose overlapping planks are secured by closely spaced rivets.
Cockpit	Place in a boat where steering is located. In the case of UDHB1 this is at the stern where the tiller was positioned.
Dump	A nail used in fastening planking to a timber frame, as distinguished from a bolt.
Dutchman	A piece of wood fitted into a perfectly made seam; a shim.
Element	For this report, refers to individual components that make up UDHB1. The majority of observable elements are composed of timber, with copper, ferrous and leather objects. There may also be caulking (hessian and tar) present.
f'd	Forward or fore part of a vessel (the bow) or element.

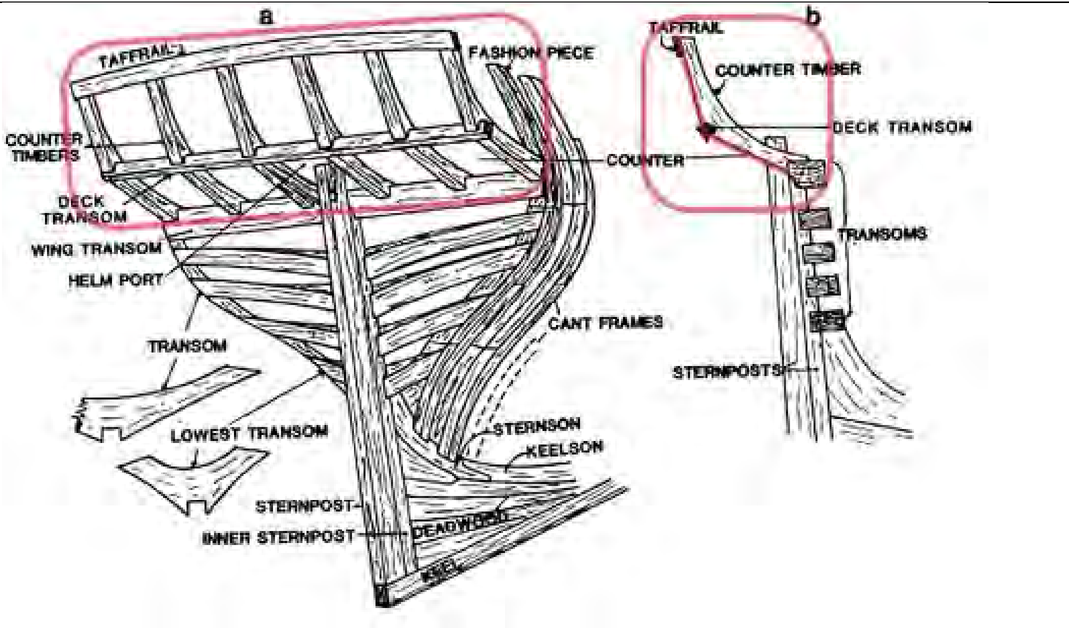
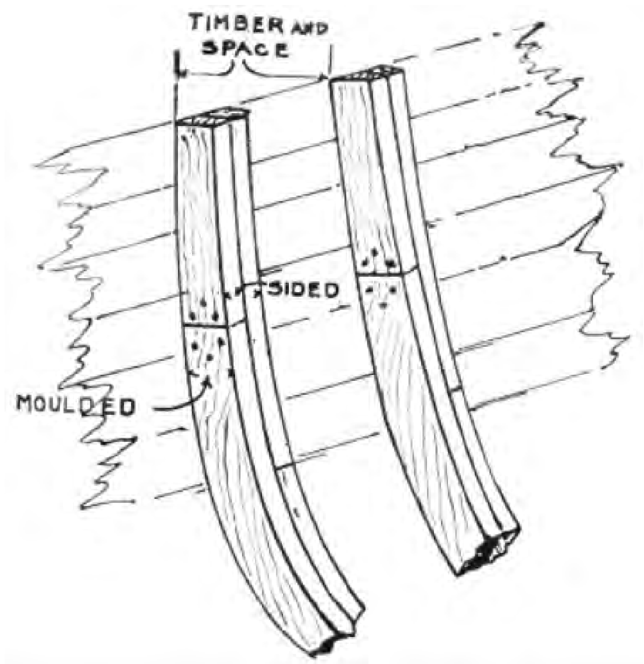
[212] Hobbs, R., 2017, A Shipwright in the Colonies: John Cuthbert 1815-1874. Nautical Association of Australia, Inc., Melbourne, p.132.

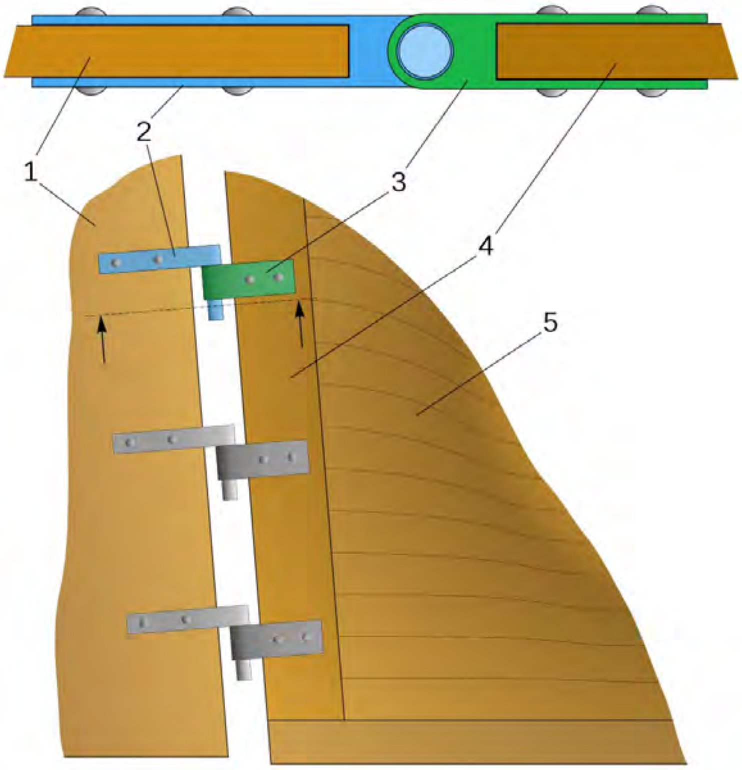
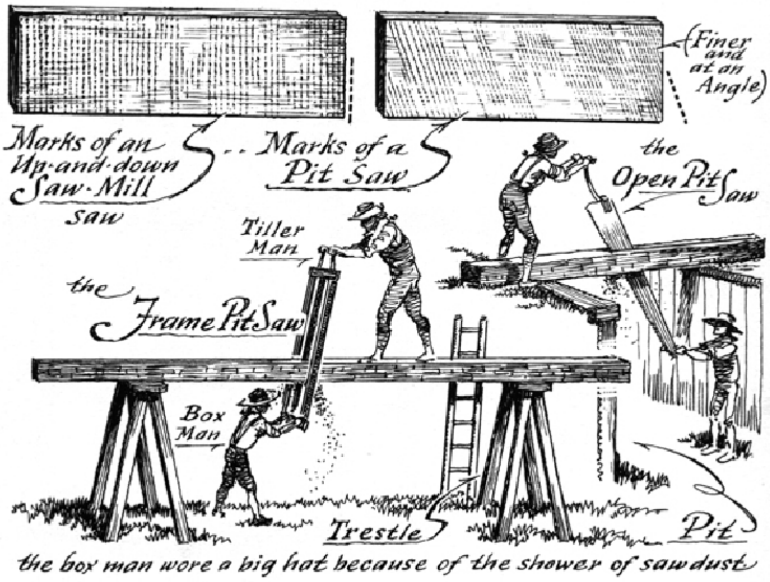
Fairing	Making ship lines even and smooth with a uniform curve without hollows or bumps.
Flam	Similar to flare or flair, the sides of the bow of a vessel curving gradually outward from the base. If the curve is concave, the vessel is said to "flare", if it is convex, the vessel is said to "flam". 
Floors	Frames on the bottom planking up to the eighth strake at the bilge before the upturn to the topside planking. They were spread from port to starboard sides evenly over the keel. 
Futtock	Frames braced the bottom planking and topside planking covering the three zones of the hull: bottom, bilge and topside.

<table>
<tr><td></td><td>
</td></tr>
<tr><td>Garboard</td><td>The planking next to the keel. Most commonly, "garboard strake", the heavy wood planking next to the keel.

</td></tr>
<tr><td>Gerald rabbet</td><td>Also, jerrold, chase, or gain; a rabbet cut into the top edge of the forward hood of a clinker planked vessel to enable the hemming plank above it to sit flush. See UDHB1 timber id: 341 (picture of Gerald below).
</td></tr>
<tr><td>Geotextile</td><td>A permeable fabric used to separate, filter, drain, protect or reinforce soil. Also referred to as Geofabric.</td></tr>
</table>

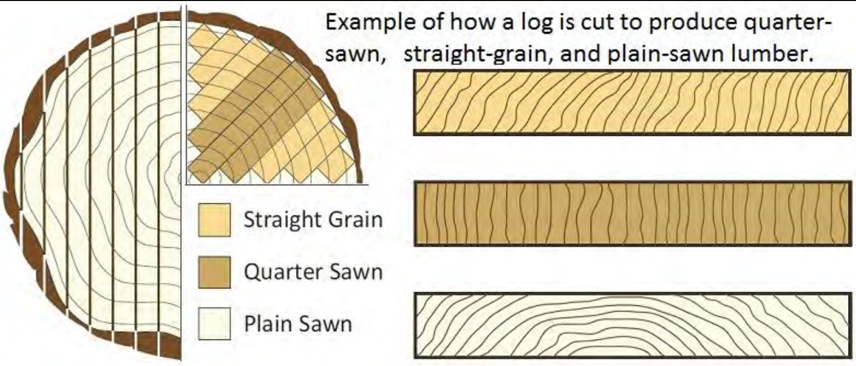
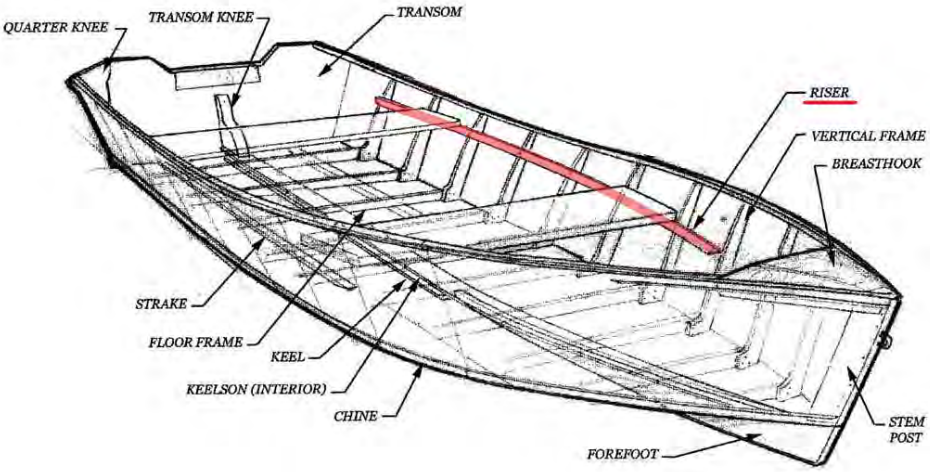
Grown	Timber which is either part of a trunk where a branch grew; or a branch with the required angle bend in it. Other terms used are *crooked* or *compass*.
Hard bilge	Also referred to as a hard chine. Where the bottom part of the hull (bilge) meets the upper hull. If the meeting point is more angular than round, it is called a hard bilge. 
Hood end	Also hood or hooded ends; the length of the ends of the skin planks that lay against the apron or inner stem or sternpost.  Fig. 34—Sectional plan view of stern showing planking rabbeted into stern-post and deadwood; also cant frames and ceiling.
Inwale	A longitudinal secondary main structural timber fitted inside the heads of the frames or timbers and under the capping to form the vessel's gunwale. 

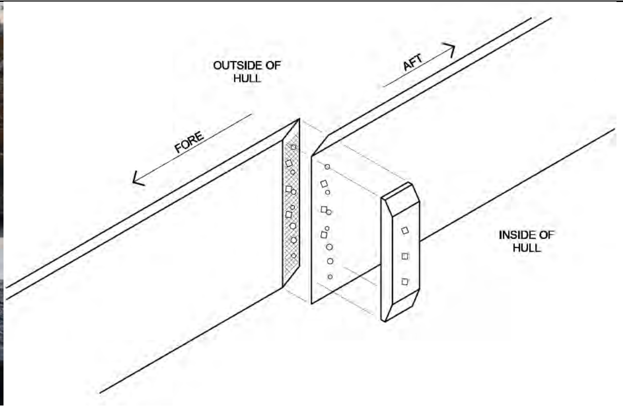
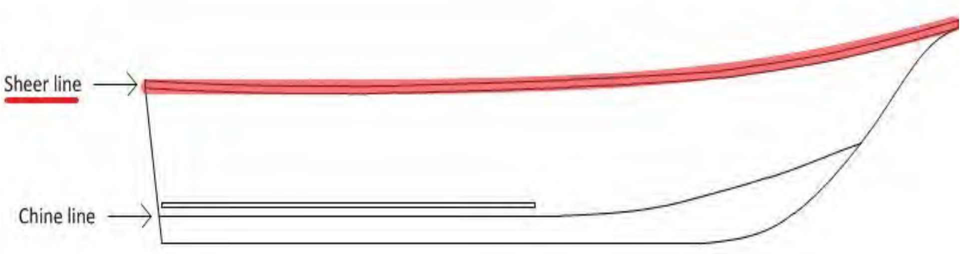
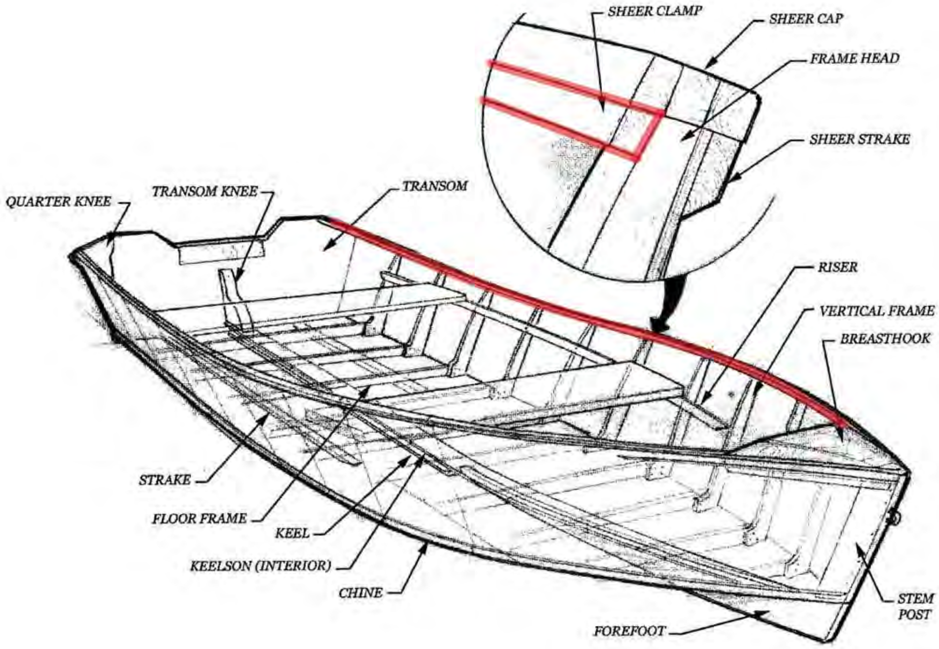
Joggle	The process of notching a timber to fit over an obstruction or another timber; also used in a general sense when anything is notched to fit over another thing. 
Knee	An angular piece of timber, usually a natural crook, used to strengthen corners.
Land	The overlap where two strakes meet. Particular to clinker hulls.
Lapstrake	Another term used for clinker method construction. In the context of northern European shipbuilding specialists, lapstrake refers only to those vessels whose overlapping planks are secured by clenched nails.
Limber hole	A hole a few inches in diameter, cut in the floor frame near the bottom to allow the bilge water to drain from one compartment space to another or to the pump well. 
Knuckle counter stern	A *knuckle* is an angle in some of the timbers of a vessel, often seen around the stern. A *counter* is the transverse area of the stern of a vessel between the top of the sternpost and the rail. A *knuckle counter stern* therefore is a specific shape of counter at the stern of a vessel, shaped with a distinct angle.

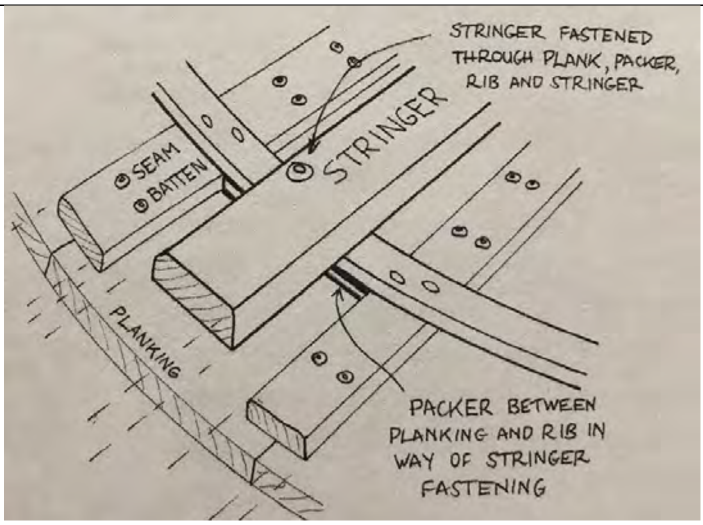
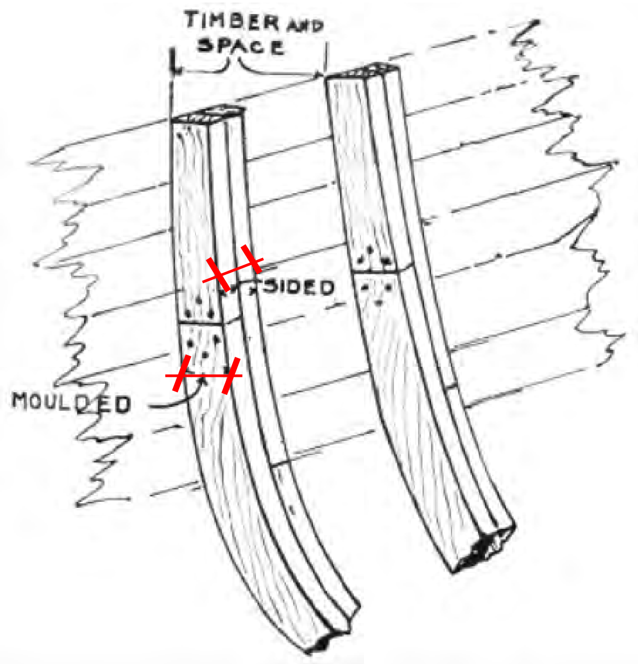
	
Moulded	The various dimensions of timbers as seen from the sheer and body views of construction plans. The vertical surfaces (sides) of keels, the fore-and-aft sides of the posts, the vertical or athwartships surfaces of frames. 
Pintle	A metal pin secured to the forward side of the rudder by a strap. The pintle is fitted into a gudgeon, which is secured to the rudder-post. The pintle and gudgeon

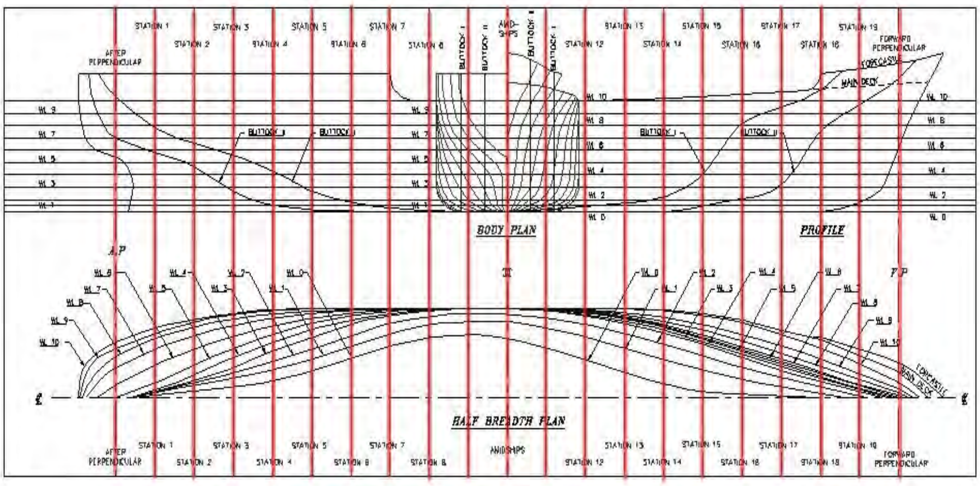
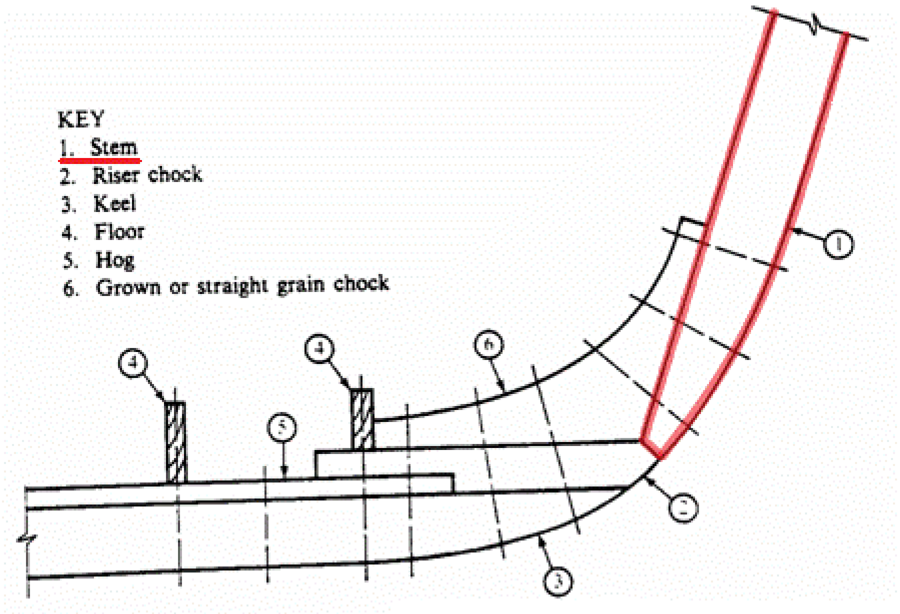
	together form the hinge on which the rudder swings. 
Pit sawn	Manually cut timbers either in a pit or above ground frame. The frame saw was used more commonly by sawyers from continental Europe, while the open pit saw was British.[213] 
Port	Left-hand side of a vessel when facing towards the bow from the stern.
Quarter sawn	Planks where the annular growth rings intersect the face of the board at a 60 to 90-degree angle. This produces a more stable plank at the cost of greater wastage at the milling stage.

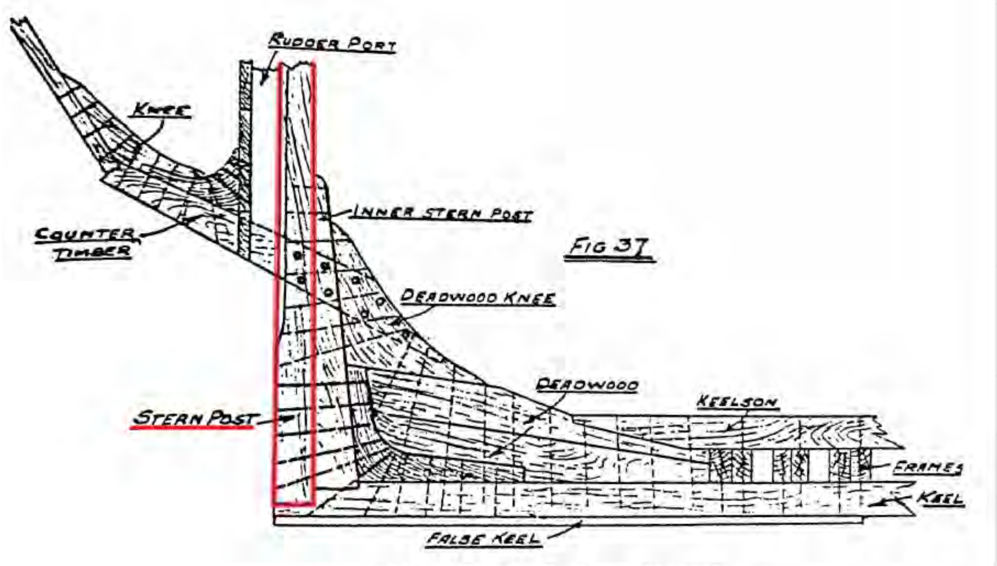
[213] Sloane**, E., 1964**, *A museum of early American tools / by Eric Sloane.*, New York: W. Funk, p. 70.

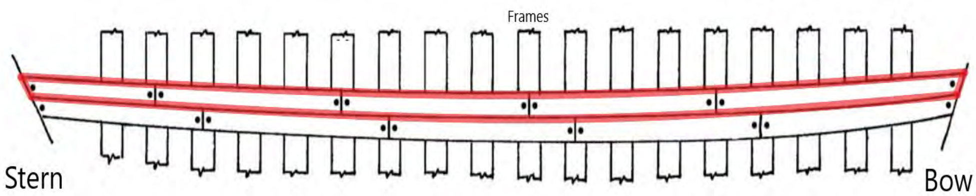
	
Rabbet	A depression or channel in a piece of timber cut for the purpose of receiving and securing the edge and hood ends of bottom and side planking, for example, the rabbet of the keel and deadwood to receive the garboard strake.
Rider Keel	One or more additional keels bolted to the bottom of the main keel to increase its strength. In the circumstance of UDHB1 the rider keel was added to support the outer layer of planking. It should not be confused with a false keel, whose primary purpose was to protect the keel's lower surface.
Ripped or rip cut	A ripped frame is a bent frame partly sawn longitudinally to make it easier to bend.
Riser	Also rising, riser timber or rising timber. A horizontal longitudinal non-structural timber on the inside of the side frames or timbers of a wooden hull to form a ledge for thwarts. 
Rung head	Also rung end, wrunghead or wringhead. The outer ends of the floor timbers.
Scarph plate	A piece of timber used specifically to cover a scarf joint.

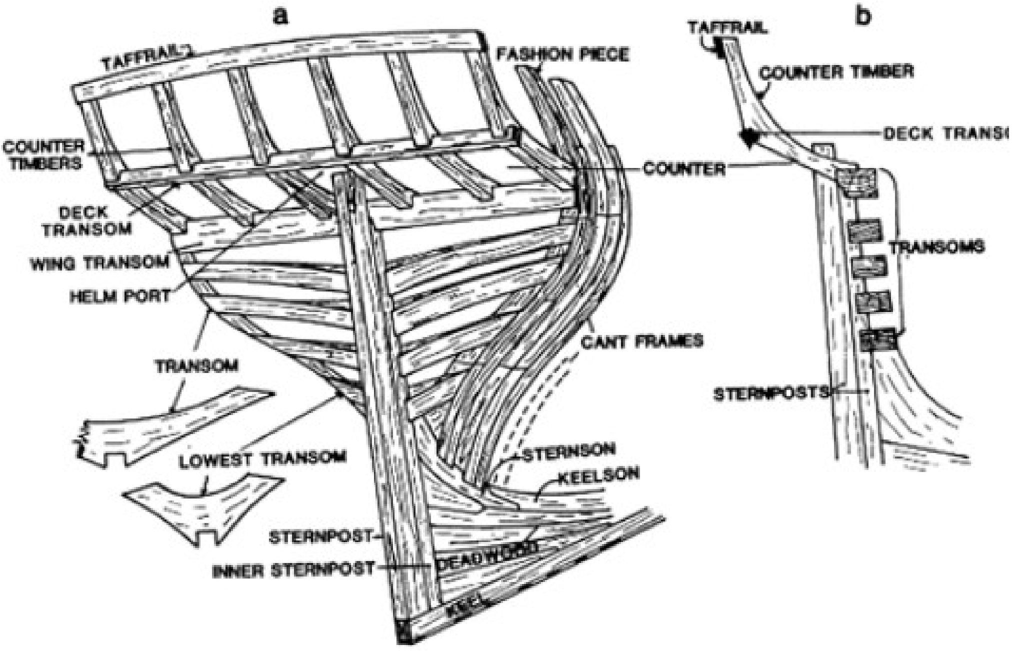
	 
Sheerline	The longitudinal curvature of the upper or main deck. 
Sheer clamp	Longitudinal member that runs the length of the boat at the sheerline and ties together the hull frames. 
Seam batten	A strip of wood or metal fastened over a flush joint or seam to prevent leakage or for strengthening purposes; also known as a *welt.* In the context of planking, a longitudinal member that reinforces the join between rows of planking, placed between the frames and the planking.

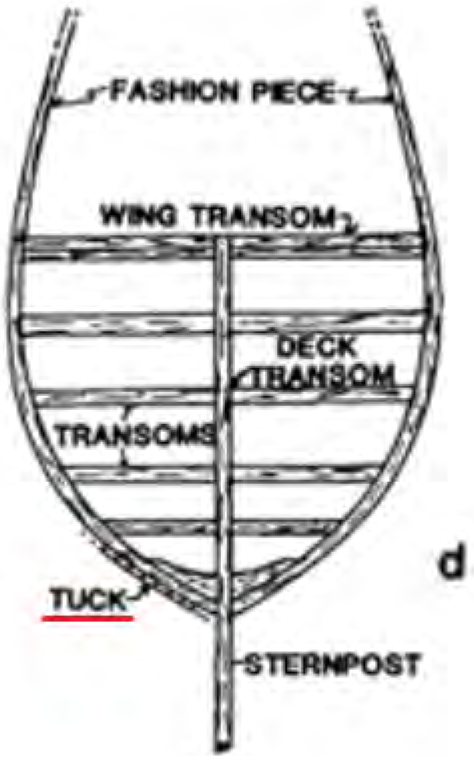
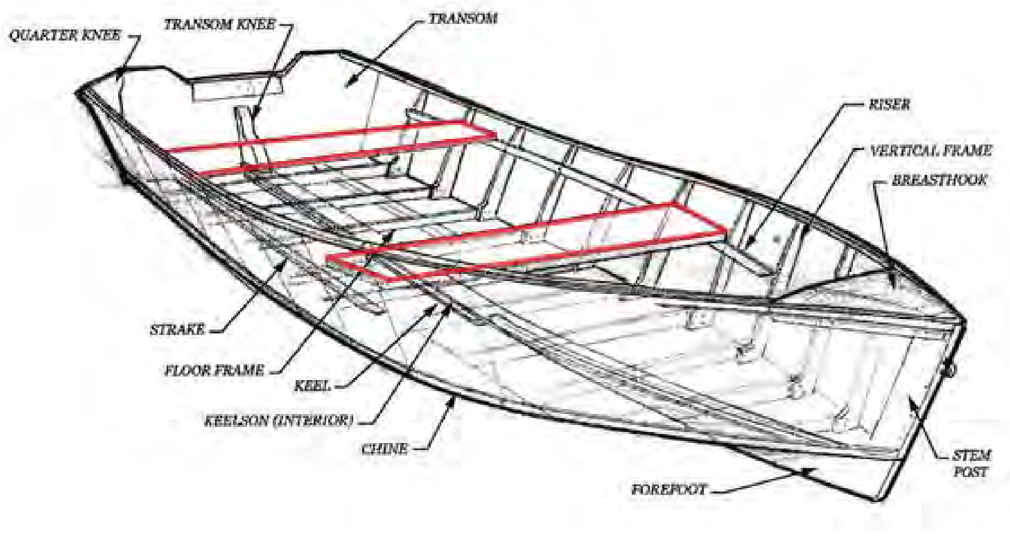
	
Sided	The dimension of an unmoulded surface; the distance across an outer frame surface, the forward or after surface of a stem or sternpost, or the upper surface of a keel or keelson. 
Starboard	Right hand side of a vessel facing towards the bow from the stern.

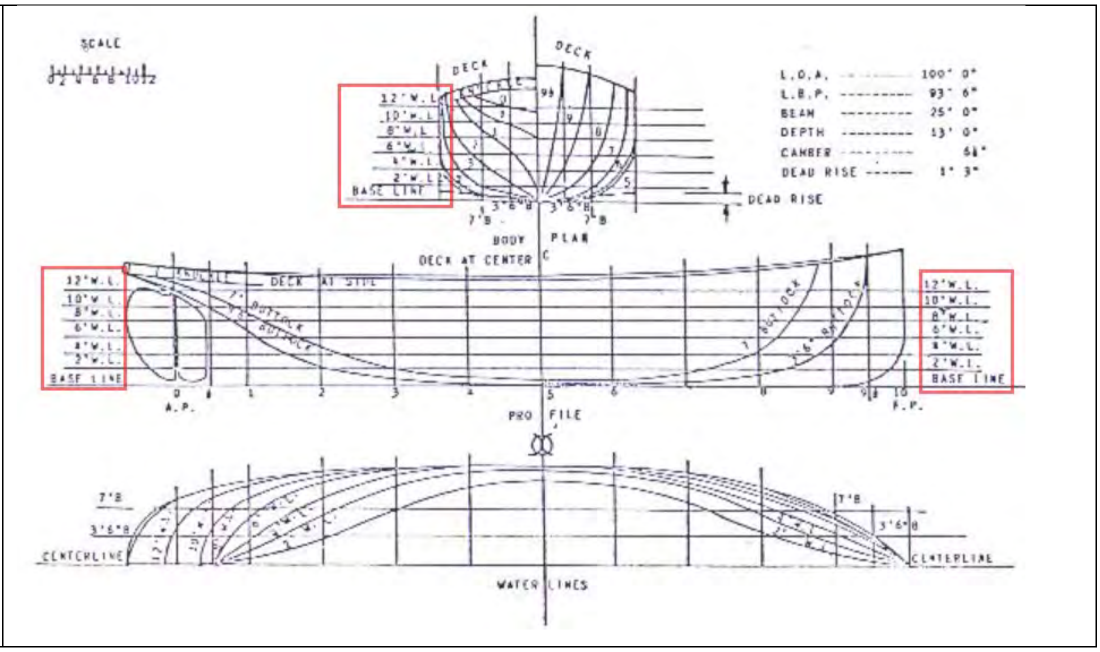
Station	One of a series of equally spaced transverse cross-section slices of the hull as shown in the lines drawing. 
Stem	A heavy timber forming the extreme bow of the ship extending from the keel to the forecastle deck. The forehood planking terminates at the rabbet and is firmly fastened to the stem. 
Sternpost	A wooden piece secured at its lower end to the aft end of a keel, the upper end supporting the transom. The sternpost is fitted with knees, deadwood, deckbeams, etc., and has a rabbet in which the aft planking terminates.

<table>
<tr><td></td><td>

Stern-Post, Sailing Vessel</td></tr>
<tr><td>Strake</td><td>A continuous breadth of planking generally running from stempost to sternpost on the outside of the ship's frame. A single strake may be made up of multiple planks scarphed end to end.

</td></tr>
<tr><td>Tingle</td><td>A piece of light metal nailed over a defect in a small vessel's planking as a temporary repair to prevent leaking and/or further deterioration.
</td></tr>
<tr><td>Transom</td><td>A flat area forming the square after end of a vessel. It may be rounded and slope forward or aft depending on the vessel's design; also, one of the athwartship</td></tr>
</table>

<table>
<tr><td></td><td>members, fixed to the sternpost, that shapes and strengthens the stern; also transom refers specifically to one of the athwartship members, fixed to the sternpost that shape and strengthen the stern.

</td></tr>
<tr><td>Tree nail</td><td>Timber dowell used to fasten timbers in lieu of metallic nails. Also called treenail and trunnel.
</td></tr>
<tr><td>Tuck</td><td>The place where the ends of the bottom planks terminate under the stern or counter.</td></tr>
</table>

	
Thwart	A transverse plank in a boat or galley; used to seat rowers, support masts, or provide lateral stiffness. 
Waterlines	Lines on a hull drawing representing the horizontal sections of the hull. These are horizontal lines intended to represent the surface line of the water on the sides of a ship.


SCALE
DECK
L.O.A. 100' 0"
L.B.P. 93' 6"
BEAM 25' 0"
DEPTH 13' 0"
CAMBER
DEAD RISE 1' 3"
DEAD RISE
BODY PLAN
DECK AT CENTER
12'W.L.
10'W.L.
8'W.L.
6'W.L.
4'W.L.
2'W.L.
BASE LINE
DECK AT SIDE
BUTTOCK
A.P.
F.P.
PRO FILE
CENTERLINE
WATER LINES