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Locating HM Bark *Endeavour*

Archaeological identification of shipwreck site RI 2394 in Newport Harbor, Rhode Island, USA

Kieran Hosty

James Hunter

www.sea.museum/en/maritime-archaeology/endeavour-report

The hull of a ship is probably the largest and most complex artefact that can be found on a wrecksite. Centuries of technological evolution and cultural processes are reflected in the remains of a sunken ship (Murray, et al. 2004: 111).

Kieran Hosty and James Hunter, *Locating HM Bark* Endeavour*: Archaeological Identification of Shipwreck Site RI 2394 in Newport Harbor, Rhode Island, USA*

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Dedicated to Paul Hundley (1955–2023), who started it all, and Dr Nigel Erskine, who finished it.

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Cover image: 2019-2021 archaeological plan of shipwreck site RI 2394 superimposed over the lower deck plan of HMB *Endeavour* generated from the British Admiralty's 1768 survey of the vessel.
Image: Royal Museums Greenwich; James Hunter/ANMM.

Contents

Executive summary 6

Historical background 8

Significance assessment for HMB *Endeavour* 16

Site location characteristics 18

Environmental considerations 18

Study area 18

Physiography 18

Climate 19

Tides and underwater visibility 19

Water temperature and salinity 19

Biota 19

Cultural processes 19

Archaeological context 21

Legal status 23

Archival and archaeological research overview 24

Identification criteria 29

Historical sources 29

Construction materials 29

Scantlings 29

Iron ballast analysis 30

Stone ballast analysis 30

Coal analysis 30

Silt and sediment analysis 31

Hair and timber treatment analysis 31

Material culture analysis 31

Historical analysis 31

Candidate shipwrecks 31

Earl of Orford 31

Mayflower 33

Yowart 33

Peggy 33

Lord Sandwich 34

Candidate shipwreck sites 35

Original Study Area 36
RI 2125 ('Naval Hospital Cannon' site) 36
RI 2119 ('Gamma' site) 37
'Site 9' 38
RI 2579 38
RI 2580 38
RI 2595 39
Inter-site surveys 39
Limited Study Area 39
RI 2393 ('Rod' site) 39
RI 2396/RI 2397 ('Greg' site) 39
RI 2578 ('Kathy' site) 39
RI 2794 ('Caroline' site) 40
RI 2394 ('Kerry' site) 40
September 2019 fieldwork 40
January 2020 fieldwork 41
Pump well structure 42
Dunnage/quoins 43
September–October 2020 fieldwork 43
Conclusions from September–October 2020 fieldwork 47
September 2021 fieldwork 47
Search for additional bilge pump suction tubes 49
Improvements to baseline placement and site plan 55
Search for the site's northern preserved extent 55
Comparing RI 2394's keel-stem scarph with archival plans 55
Investigative methodology 56
Photogrammetric recording and reconstruction 55
Timber samples 56
Artefact analysis 61
Cannons 61
Description and analysis of RI 2394's hull remains 62
Description of RI 2394's hull remains 63
Centreline timbers 63
Keel 66
Keelson 66
Frames 67
Floors 67
First futtocks 68

Planking 69
Garboard strakes 70
Ceiling 70
Limber boards/strakes 72
Pump well 73
Bilge pump tube 73
Pump well structure 75
Dunnage/quoins 76
Archaeological site plan 76
Surviving hull features compared with plans of HM Bark *Endeavour* 77
Scantling data 79
British- and North American-built shipwrecks: an archaeological comparison by date 80
The case for identifying RI 2394 as *Lord Sandwich* (ex HMB *Endeavour*) 93
Evaluation criteria 93
Exclusion of sites RI 2119, RI 2125, RI 2579, RI 2580, RI 2595 and 'Site 9' 93
Sites within the Limited Study Area: RI 2393, RI 2394, RI 2396/RI 2397, RI 2578 and RI 2794 94
Timber scantlings 94
Keelson 94
Length of keel 95
Additional structural features 95
Modification to ship's structure 97
Timber analysis 97
Material culture 97
Archaeological evidence suggesting RI 2394's use as a prison ship 98
Dearth of small finds and other artefacts 98
Conclusion 100
Further research 101
Conclusion 102
Acknowledgements 104
Bibliography 106
Primary sources 106
Unpublished reports 107
Secondary sources 108
Appendices 114
Appendix 1. Construction details from *The Voyage of* Endeavour, *1768–1771* 114
Appendix 2. Glossary 119

Executive summary

His Majesty's Bark (HMB) *Endeavour* is a significant vessel in Australian maritime history and one that elicits mixed opinions. For some, the Pacific voyage led by James Cook between 1768 and 1771 embodies the spirit of Europe's Age of Enlightenment, while for others it symbolises the onset of colonisation and the subjugation of First Nations Peoples. Less well understood in Australia is *Endeavour's* afterlife as a British troop transport and prison ship caught up in the American War of Independence. It was in this capacity – and renamed *Lord Sandwich* – that the vessel was deliberately sunk in Rhode Island in 1778.

This report outlines the archival and archaeological evidence that confirms the identification of the shipwreck site of *Lord Sandwich*, formerly HMB *Endeavour*. The site, officially known by its Rhode Island state archaeological site number RI 2394, is in Newport Harbor, in the state of Rhode Island and Providence Plantations, USA. As the culmination of a 26-year program of archival and archaeological research, the identification of RI 2394 as *Lord Sandwich* (ex-HMB *Endeavour*) was based on a 'preponderance of evidence' approach.

When *Endeavour* returned to England in 1771, it largely passed out of public view. The vessel was instead used as a naval transport before being sold to private owners, who renamed the bark *Lord Sandwich* and used it to carry troops to the American colonies in support of British campaigns. In 1778, the vessel was in poor condition and relegated to gaoling American prisoners of war in Newport Harbor. When American and French forces besieged the British-held town, *Lord Sandwich* was one of thirteen vessels scuttled (deliberately sunk) to act as a submerged blockade. It was never salvaged and remained where it sank.

In 1998, two Australian historians, Mike Connell and Des Liddy, determined *Endeavour's* fate via archival research (Connell and Liddy 1997). Dr Kathy Abbass of the Rhode Island Marine Archaeology Project (RIMAP) built upon their work, and consequently in 1999 the state of Rhode Island laid claim to the wrecks of all ships scuttled in Newport Harbor in 1778. This claim was upheld by the District Court of the US Federal Government, leaving the Rhode Island Historical Preservation and Heritage Commission (RIHPHC) responsible for protecting and licensing any archaeological work on these shipwrecks, including *Lord Sandwich* (ex-HMB *Endeavour*).

The Australian National Maritime Museum (ANMM) commenced working with RIMAP in 1999 to locate the shipwreck site of *Lord Sandwich*. This relationship led to a series of archaeological expeditions in Newport Harbor in 1999, 2000, 2001, 2002 and 2004. These projects undertook remote sensing of the seafloor, underwater survey by divers, and analysis of samples of stone, coal, timber, and sediment raised from a range of shipwreck sites of 18th-century vintage. None of the candidate sites proved to share sufficient characteristics to be identified as the wreck site of *Lord Sandwich*.

The RIMAP-ANMM project resumed in 2015, and further diving expeditions continued to survey a large area of Newport Harbor. In 2016, new research by ANMM's Dr Nigel Erskine located archival evidence that substantially narrowed the location within the harbour in which *Lord Sandwich* was scuttled (Erskine 2017). This Limited Study Area (LSA), just to the north of Goat Island, encompassed five of the 13 transports sunk in 1778, of which *Lord Sandwich* was the largest by a substantial margin (Abbass 2016: 2–4). Between 2017 and 2021, the project team investigated the remains of five shipwrecks located within the LSA: RI 2396, RI 2397, RI 2578, RI 2393, and RI 2394 (Abbass 2016, 2017, 2021; Abbass and Lynch 2019 Lynch and Abbass 2020; Broadwater 2020; Broadwater and Daniel 2021).

The two largest shipwreck sites, RI 2578 and RI 2394, were considered the most likely candidates for the remains of *Lord Sandwich*. Archaeological survey of RI 2578 has revealed a 14.0 metre x 8.2 metre site comprised of a linear stone ballast pile mixed with iron kentledge (ballast blocks). The site also includes eroded ship's timbers that are thought to be associated with the ballast pile (Abbass 2016 and 2017; Hosty 2016 and 2017). Although a substantial iron anchor and a small iron cannon are also present, RI 2578 does not feature sufficient characteristics to be identified as *Lord Sandwich*.

RI 2394 is substantially larger than RI 2578, with visible remains covering an area 18.2 metres long x 7.3 metres wide (Abbass 2016: 52). It comprises a linear stone ballast pile with a line of exposed, articulated timber frames (ribs) of substantial size along its eastern periphery. Four iron cannons are also visible on the site, along with a lead scupper. Analyses have been undertaken on the site's hull timbers, ballast, and artefacts.

Excavation permits granted by RIHPHC between 2019 and 2021 allowed more detailed investigation of RI 2394, including exposure of hull architecture and diagnostic features such as the bilge pump well, the keel and keelson, and, in 2021, the bow assembly. The dimensions of a range of structural timbers – collectively referred to as 'scantlings'

– compare favourably with measurements taken when *Endeavour* was surveyed by the Royal Navy in 1768. Timber samples have also been taken on three occasions, with the most recent batch collected in September 2021. Analysis of the most recent samples, while not containing evidence of exotic species (e.g., non-European timbers that may have been used to repair *Endeavour* in Australia and/or Indonesia in 1770), do seem to indicate the bow section of RI 2394 underwent significant repairs that utilised European timbers later in its life (Ilic 2022: 1). This evidence correlates well with the history of HMB *Endeavour*, which underwent significant repairs in 1776, shortly after being sold out of naval service. Site measurements and probing of the seafloor have also confirmed the extent of RI 2394's surviving hull (from bilge pump to bow) is very close to that of *Endeavour* between those same locations. RI 2394 shares other similarities with *Endeavour*, including the placement of paired and tripled floor timbers that correspond exactly with the locations of *Endeavour*'s main and fore masts, and the presence of a very unusual joint or scarph that connected the stempost and forward end of the keel.

In 1999 and again in 2019, RIMAP and ANMM agreed on a set of criteria that, if satisfied, would permit identification of RI 2394 as *Lord Sandwich* (see Abbass 1999; RIMAP and ANMM 2019). Based on the agreed preponderance of evidence approach, enough of these criteria have now been met for the ANMM to positively identify RI 2394 as the remnants of *Lord Sandwich*, formerly James Cook's HMB *Endeavour*.

Given *Endeavour's* historical and cultural significance to Australia, Aotearoa New Zealand, England, the United States of America and First Nations peoples throughout the Pacific Ocean, positive identification of its shipwreck site requires securing the highest possible level of legislative and physical protection for RI 2394.

Historical background

Construction, repair and modification of *Earl of Pembroke/Endeavour/Lord Sandwich*

In 1767, the British Admiralty and Royal Society made the decision to conduct an expedition to observe the transit of Venus in Tahiti. The Navy Board – the Royal Navy department responsible for selection of naval vessels – initiated a search for a suitable vessel to undertake the voyage to the South Pacific. Several vessels, including the colliers *Valentine, Earl of Pembroke* and *Ann and Elizabeth*, were surveyed on 27 March 1768. Shortly thereafter, the Navy Board decided to acquire the cat-rigged bark *Earl of Pembroke* for £2,307. This vessel had been constructed in 1764 by Thomas Fishburn at Whitby in Yorkshire, on England's north-eastern coast.[1] When first registered in June 1764 it was rated at 366 49/94 tons burthen (Beaglehole 2015: 606–7; Moore 2018: 98–102).

'Cat-built' (also known as 'Scandinavian-built') barks were robust, wooden-hulled vessels with three masts and very bluff (broad and flat) bows. They also featured a square stern, vertical stempost, and long, boxlike body with nearly vertical sides. This gave the vessel a large, deep hold that was ideal for carrying coal and other bulk cargoes, but equally suited to store many months of provisions for a large crew. Cat-built colliers also had very flat floors (giving the hull a wide, flat bottom) and a wide beam, which made them slow but steady sailors. An additional advantage exhibited by the type was its ability to 'take the ground' (rest directly on the seabed at low tide) without suffering any structural damage (Macarthur 1997: 19–45).

When the Royal Navy considered purchasing *Earl of Pembroke* in 1768, marine surveyors at Deptford conducted an extensive survey of the vessel. The survey also provided detailed drawings of the vessel and an extensive list of scantlings, concluding that *Earl of Pembroke* was:

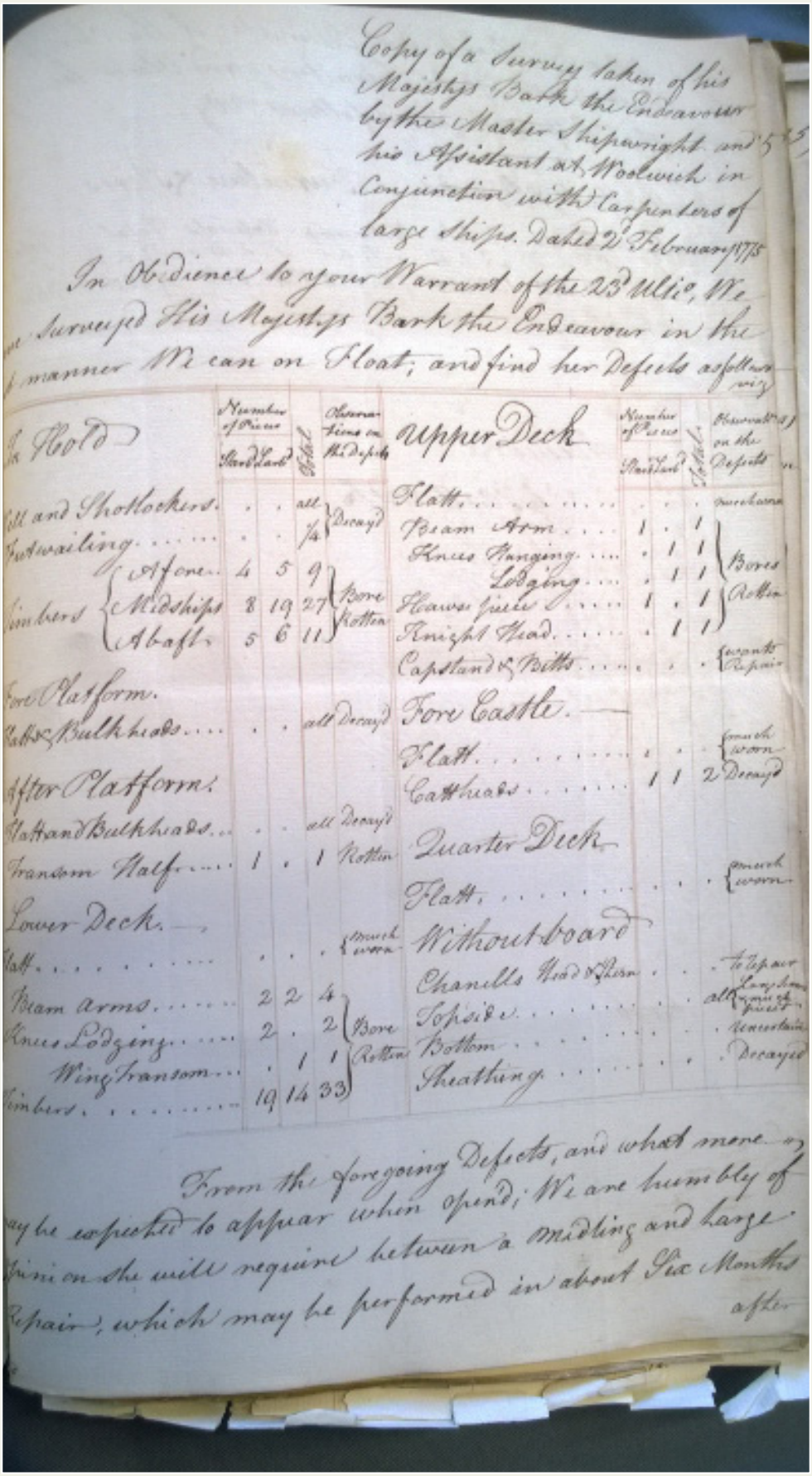
> built at Whitby, her Age 3 years, 9 mon., Square Stern Bark, Single Bottom full Built and comes nearest to the Tonnage mentioned in your Warrant, and not so OLD, by 14 Months, is a promising Ship for Sailing of this kind, and fit to Store Provisions and Stores as may be put on Board her (ADM 196/3315, Public Records Office, Deptford Yard Copy Book, 198, cited in Abbass 1999: 5; 2001: 5).

Once *Earl of Pembroke* was accepted for naval service it was renamed *Endeavour* and underwent a complete refit at the Admiralty dockyard at Deptford. Another series of plans was produced that detailed the fit-out and additional modifications made to the vessel. These included a new internal deck that ran the full length of the ship. Additional small platform decks (called 'lazarettes') – along with a powder magazine, bread and fish rooms, steward's room and captain's storeroom – were also installed in the hold at the bow and stern. Other additions included cabins to house Royal Society scientists. Cook ordered 12 tons of permanent pig iron ballast ('kentledge') loaded aboard to help trim the vessel, and armament was added in the form of ten 4-pound carriage guns and twelve ½-pound swivel guns (Knight 1933: 298–9).

Because *Endeavour* would be operating in the warm, tropical waters of the Pacific Ocean and prone to attack from wood-boring teredo worms (*Teredo navalis*), the Royal Navy also modified its hull beneath the waterline. While at Deptford, the vessel's hull was thoroughly scraped of marine growth, re-caulked, and covered with thick layers of paper rags coated in a mixture of horsehair and tar. Atop this layer of antifouling was placed an additional layer of wooden planking, heavily fastened with broad-headed iron nails (Moore 2018: 109). It was then coated with 'White Stuff', a mixture of 'trans oil' (whale and fish oil), rosin, turpentine, and brimstone (Macarthur 1997: 19–45). Further additions and modifications were made to *Endeavour* at Plymouth prior to its departure from England. These included construction of an additional deck above the tiller arm – part of the vessel's steering mechanism – at the stern of the ship.

At the conclusion of Cook's scientific voyage, which lasted from 26 August 1768 to 13 July 1771, *Endeavour* arrived at the Downs in south-eastern England (Erskine 2017: 57). It subsequently sailed to Woolwich, where it was re-sheathed and quickly refitted for additional naval service. The vessel made three voyages to the Falkland Islands – in November 1771, December 1772, and January 1774 – and finally arrived back in England in September 1774 (Erskine 2017: 58). *Endeavour* was now ten years old, and after sailing some 70,000 miles and suffering several groundings, it was showing its age. A survey conducted at Woolwich on 2 February 1775 (Figure 1) found 47 of the

1 Fishburn ultimately built three of Cook's four vessels of exploration: *Earl of Pembroke* (HMB *Endeavour*); *Marquis of Granby* (HMS *Resolution*) and *Marquis of Rockingham*, later HMS *Raleigh* (HMS *Adventure*) (McGowan 1979: 109). Both *Endeavour* and *Adventure* share the same unusual joint/scarph at the junction of the stem and forward end of the keel, suggesting this may have been a specific design attribute of Fishburn-built colliers.



Copy of a Survey taken of his Majestys Bark the Endeavour by the Master Shipwright and his Assistant at Woolwich in Conjunction with Carpenters of large Ships. Dated 2d February 1775

In Obedience to your Warrant of the 23d Ulto, We have Surveyed His Majestys Bark the Endeavour in the best manner We can on Float; and find her Defects as follows viz

In Hold	Number of Pieces Starboard	Larboard	Total	Observations on the Defects
Sill and Shotlockers	.	.	all	Decayd
Footwailing	.	.	1/4	
Timbers Afore	4	5	9	Bore Rotten
Timbers Midships	8	19	27	
Timbers Abaft	5	6	11	
Fore Platform.				
Platt & Bulkheads	.	.	all	Decayd
After Platform.				
Platt and Bulkheads	.	.	all	Decayd
Transom Half	1	.	1	Rotten
Lower Deck.				
Platt	.	.	.	Much worn
Beam arms	2	2	4	Bore Rotten
Knees Lodging	2	.	2	
Wing Transom	.	1	1	
Timbers	19	14	33	

Upper Deck	Number of Pieces Starboard	Larboard	Total	Observations on the Defects
Platt	.	.	.	Much worn
Beam Arm	1	.	1	Bore Rotten
Knees Hanging	.	1	1	
Lodging	.	1	1	
Hawse piece	1	.	1	
Knight Head	.	1	1	
Capstand & Bitts	.	.	.	Wants Repair
Fore Castle.				
Platt	.	.	.	Much worn
Catthead	1	1	2	Decayd
Quarter Deck				
Platt	.	.	.	Much worn
Without board				
Chanells Head & Rism	.	.	.	To Repair
Topside	.	.	.	All Very bad in point of piece
Bottom	.	.	.	Uncertain
Sheathing	.	.	.	Decayed

From the foregoing Defects, and what more may be expected to appear when opend; We are humbly of Opinion she will require between a Midling and large Repair, which may be performed in about Six Months after

Figure 1. Report to the Admiralty noting significant repairs required in 1775 to keep *Endeavour* operational and seaworthy (ADM 354/189/330 Navy Board: Bound Out-Letters: Woolwich; National Archives, Kew). Photograph: Nigel Erskine/ ANMM

ship's frames and 33 of the transom (stern) timbers were rotten, could not be repaired, and needed to be replaced.[2] All decks were described as 'much worn', the sheathing 'decayed', and the state of the ship's lower hull 'uncertain' (Erskine 2017: 61).

The master shipwright at Woolwich stated *Endeavour* required 'large repairs' that would take around six months to complete and cost approximately £3,420. Upon receiving the report, the Navy Board recommended the vessel be sold out of service, and in March 1775 master mariner George Brodrick purchased it for £645 (Erskine 2017: 59–61; Knight 1933: 299–300). The 1776 edition of *Lloyds Register* states *Endeavour*, a ship-rigged vessel of 350 tons built at Whitby in 1764, is 'Now the *Lord Sandwich;* owner James Mather; Blanchard – Master, sailed from Archangel (Russia) for London' (Erskine 2017: 61–3).

Scuttling and abandonment of *Lord Sandwich* in Newport Harbor

In the 1770s, the political situation in the North American colonies deteriorated to the point of open rebellion against British rule, culminating with the outbreak of the American War of Independence on 19 April 1775 (Moore 2018: 292). Consequently, the British Government decided to send additional troops to the colonies. *Endeavour* – now under civilian ownership and renamed *Lord Sandwich* – was offered to the Transport Service in response to this need (Abbass 1999; Erskine 2017: 61). On 6 December 1775, Deptford Yard reported to the Navy Board that *Lord Sandwich* failed survey:

> Honbl Sirs:
> In Obedience to your directions of Yesterday's date, We have Surveyed the Endeavour Bark, tendered for the Transport Service, and find her to be the same that was lately Sold from Woolwich Ordny, the Officers of which yard have apprehended, prior to her being sold, reported her defects such as to render her unfit for His Majesty's Service, and it appearing to us, that no Material Repairs has been given her since, We cannot under those circumstances recommend her as a proper ship, to be employed as a Transport (ADM 106/3402, Public Records Office, Deptford Yard Billing Book, 337, Cited in Abbass 2001: 4).

Although at first refused for service, 'material repairs' were made to *Lord Sandwich* to improve the vessel's prospects of being accepted as a transport. Following a second survey, *Lord Sandwich* was accepted for use by the Transport Service on 5 February 1776. This document notes the vessel had been recently repaired and its 'Bottom Sheathed, her riser to her Quarter Deck and Forecastle, is roomly [sic] and has good accommodation, her lower decks laid' (ADM 106/3402, Public Records Office, Deptford Yard Billing Book, 424, cited in Abbass 2001: 4). The same survey report lists several attributes that correlate exactly to *Endeavour*, including its age (10 years), tonnage (368 $^{71}/_{94}$ tons) and between-deck measurements (Abbass 1999; Erskine 2017: 63).

Erskine (2017: 64) notes *Lord Sandwich's* first voyage in the employ of the Transport Service was as part of a 74-ship convoy sent from the Thames in March 1776 to the River Weser (Bremerhaven, Germany). The vessel picked up a contingent of Hessians – German soldiers who served as auxiliaries to the British Army during the American War of Independence – and transported them first to Spithead, and then North America. Around 23 November 1776, *Lord Sandwich* departed New York with 574 soldiers of the *Larsborg du Corps* Hessian Brigade. They were part of a combined force of 7,000 British and Hessian troops under the command of General Henry Clinton and tasked with establishing a British garrison at Newport, in the colony of Rhode Island, in early December 1776 (Abbass 2001; Erskine 2017: 65).

After *Lord Sandwich* arrived in Newport, it was converted into a prison ship (Newport Historical Society, Document A, 'A List of persons taken from the town of Newport ... Vault A, Box 123, Folio 21). Following ratification of the French-American Treaty in the spring of 1778, France sent 4,000 troops and a fleet of 11 ships of the line to North America to support the American efforts. When this fleet arrived off Narragansett Bay on 29 July, Captain John Brisbane, the senior British naval commander in Newport, worried the town might be overwhelmed by the combined French and American assault. He consequently ordered several British warships to be stripped and sunk to prevent them falling into enemy hands (Erskine 2017: 65). The galleys *Alarm* and *Spitfire*, sloop-of-war *Kingfisher*, and frigates *Juno, Cerberus, Orpheus, Lark, Flora* and *Falcon* were subsequently burned and sunk (Abbass 2016: 10).

On 3 August 1778, Brisbane ordered Lieutenant Knowles, the Agent for Transports in Newport, to scuttle several of the transports and deny the French fleet access to the harbour. Transports were sunk to the north and west of Goat Island, and off Breton Point in the town's outer harbour. This tactic was intended to prevent the French ships from coming too close to shore, where they might cannonade the town, its protective artillery batteries and British garrisons (Abbass 2016: 11; Erskine 2017: 66). The vessels listed in the margins of Brisbane's orders were *Lord Sandwich, Earl of Orford*, *Yowart*, *Peggy*, *Mayflower*, *Esther*,

2 ADM 354/189/330 notes the following timbers were rotten and needed to be replaced: In the bow, four timbers (frames) on the starboard side and nine timbers on the larboard (port) side; at midships, eight timbers on the starboard side and 19 timbers on the larboard side; and at the stern, five timbers on the starboard side and six timbers on the larboard side. This constituted 47 timbers in total, or around 36% of the lower hull.

Name	Tonnage	Where Built	Master
Betty	234 5/94	Not known	Thos. Long
Britannia	374 82/97	America	J. Trousdale
Earl of Orford	231 71/94	America	Jas. Johnson
Good Intent (or *Intent*)	241 17/94	Scarborough, England	Jn. Harrison
Grand Duke of Russia	671 84/94	East Indiaman; possibly England	Jn. Holman
Lord Sandwich	368 71/94	Whitby, England	Jn. Blanchard
Malaga	205 91/94	America	Wm. Chien
Rachel and Mary	320 7/94	Hull, England	Fran. Rowbotham
Susanna	254 20/95	Bristol, England	Thos. Spencer
Union	261 66/94	America	Bryson

Table 1. British transports scuttled in Newport Harbor in August 1778 (compiled from ADM 106/3404 and ADM 49/127).

Bristol, *Malaga*, *Good Intent*, *Rachel and Mary*, *Susannah*, *Union* and *Lucy*. On 3 August 1778 he reported:

> This morning I caused five Transports to be sunk in the passage between Goat Island and the Blue Rocks, to prevent the Approach of the Enemy too near the North Battery, so as to attack it with Advantage. And Five more Transports are proceeding out, in order to be sunk between Goat Island and Rose Island for the same Purpose (ADM 1/488, Public Records Office, Correspondence of Admiral Howe, 1777–78, 328).

The five scuttled transports to the north of Goat Island were *Earl of Orford*, *Mayflower*, *Peggy*, *Yowart* and *Lord Sandwich* (Erskine 2017: 66–8). Additional evidence for these transports being scuttled is found in a report written by Major General Sir Robert Pigot, who was in overall command of British forces at Newport:

> The French fleet ... kept up a warm fire on Brenton's Point, Goat Island and the North Batteries ... The last of these works [North Batteries] had been previously strengthened and some transports sunk in its front as an effectual measure to block up the passage between it and Rose Island (CO 5/1089 Correspondence General – Secretary of State – Report of Major General Sir Robert Pigot to General Clinton, cited in Erskine 2017: 67).

A journal belonging to Newport patriot Fleet Greene also records the scuttling of the transports on 3 August: 'Six ships were Sunk from the North End of Goat Island to the Town to Obstruct the Entrance in the Harbour. Three Others are in Readiness to Obstruct the South Entrance'. Greene also notes additional transports were scuttled on 5 August: 'Four transports [were] sunk this morning on the West Side of Goat Island at the South Entrance of the Harbour ... & Two transports that lay at Anchor were likewise burnt' (Abbass 2001: 9).

When the French fleet attacked Newport on 8 August, the transport *Grand Duke of Russia* was burned, and the frigate *Flora* and sloop-of-war *Falcon* were sunk to protect the entrance to Newport's inner harbour (Abbass 2016: 12). Twelve or thirteen submerged transports – with their masts projecting above the waters of Newport Harbor – now protected the western shoreline and battery on Goat Island, as well as the northern entrance to Newport Harbor and the North Battery (now called Fort Greene). Pierre Ozanne, a French artist assigned to Admiral d'Estaing's staff, made a series of wash drawings of the French fleet and Newport from the weather deck of the French warship *Revolution*. One of these drawings clearly shows the sunken transports to the north of Goat Island.

When news arrived in England that the transports had been scuttled, their owners expected to be reimbursed for their loss. Such a request was understandable because the transports were chartered to, and not owned by, the British government. In response to a request from the various transport owners, Deptford Yard sent the Navy Board the names of ten transports scuttled at Newport (Table 1). Valuations were also included for their hulls, masts, yards, furniture, and stores. According to this list in the *Deptford Yard Copy Book*, '*Lord Sandwich*, of 368 71/94 tons, that entered paid service on February 7, 1776', had been abandoned along with nine other vessels, including *Grand Duke of Russia* and *Rachel and Mary*. Interestingly, this list did not include the 190-ton armed snow *Mayflower*, built at Whitehaven in 1757 (ADM 106/3404, Public Records Office, *Deptford Yard Copy Book*; Erskine 2017: 71).

The British attempted to salvage several of the warships, including the frigate *Flora* and sloop-of-war *Falcon*, as well as the transport *Grand Duke of Russia*. However, many of the scuttled vessels remained visible above the surface of Newport Harbor for some time and many appear to not have been salvaged at all. A 1779 chart by Edward Fage, an engineer on General Clinton's staff, shows three scuttled frigates north of Newport and 13 transports sunk in Newport Harbor. The chart also depicts a line of four transports sunk parallel to the western shore of Goat Island, seven between the northern tip of Goat Island and southern tip of Coasters Harbor, and two in the channel between Blue Rocks (now called Gull Rock) and Coasters Harbor (Figure 2). Fage appears to have estimated the distance between the line of scuttled vessels north of Goat Island and the North Battery, as the words '800 yards' are written in faint pencil to the right of the blockships. This distance correlates closely to the actual span between the North Battery and transport shipwreck sites, which is approximately 760 yards (695 metres).

As the American Revolution turned in favour of the Continental Army and its French allies, the British abandoned Newport. In late 1779, the city and its harbour became the base for the French Navy under the command of Admiral Charles-Henri-Louis d'Arsac de Ternay. During their occupation, the French also drafted charts of the harbour, one of which – prepared in 1780 – depicts a line of scuttled ships north of Goat Island and south of Coaster's Harbor (Figure 3).

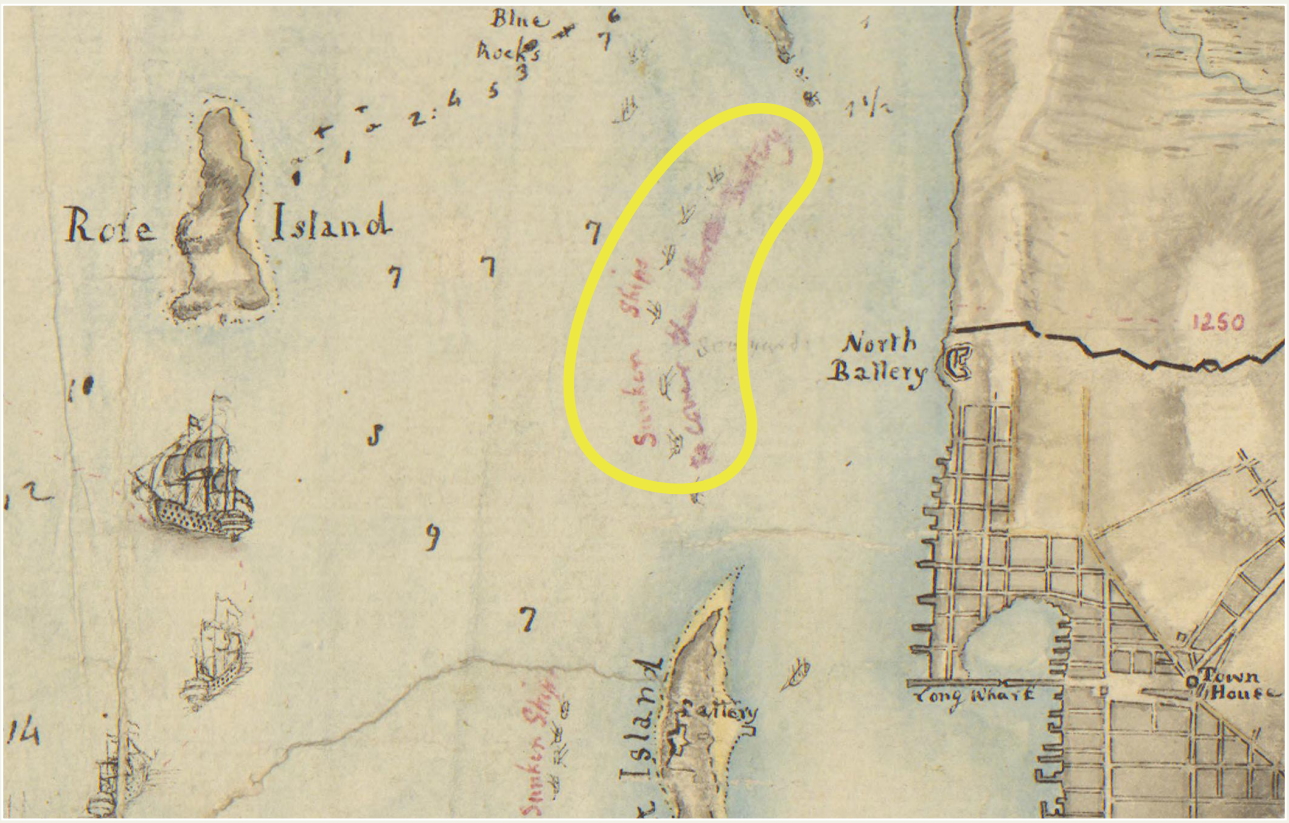


Figure 2. Edward Fage, *[Newport and its environs, ca. 1778]*, William L. Clements Library, University of Michigan, 8380. Note 'Sunken Ships' indicated due west of North Battery (circled).

More specific information about the locations and identities of the vessels scuttled by the British in Newport Harbor is contained in a letter written by Lieutenant John Knowles to the Navy Board on 12 September 1778:

> In consequence of an order from Captain Brisbane, Senior Officer of His Majesty's ships at Newport – the under mentioned Transports and Victualling vessels were scuttled and sunk, the stores etc. which were saved belonging to them, will as soon as collected be delivered to the Commanding officer to be disposed of for the benefit of the Crown.

Most of the ships not sunk and those not bodily immersed received a number of heavy shot through their hulls as the French squadron passed and repassed the batteries.

Those ships sunk off the different batteries in the channels cannot possibly be weighed [raised], from the depth of the water and a very heavy gale of wind coming on a few days after they were sunk and the age of the vessels most of them being very weak (ADM 354/198/21 Navy Board: Bound Out-Letters: Copy of Letter from Lieutenant John Knowles, Agent for Transports at Newport, Rhode Island 12 September 1778, cited in Erskine 2017: 69).

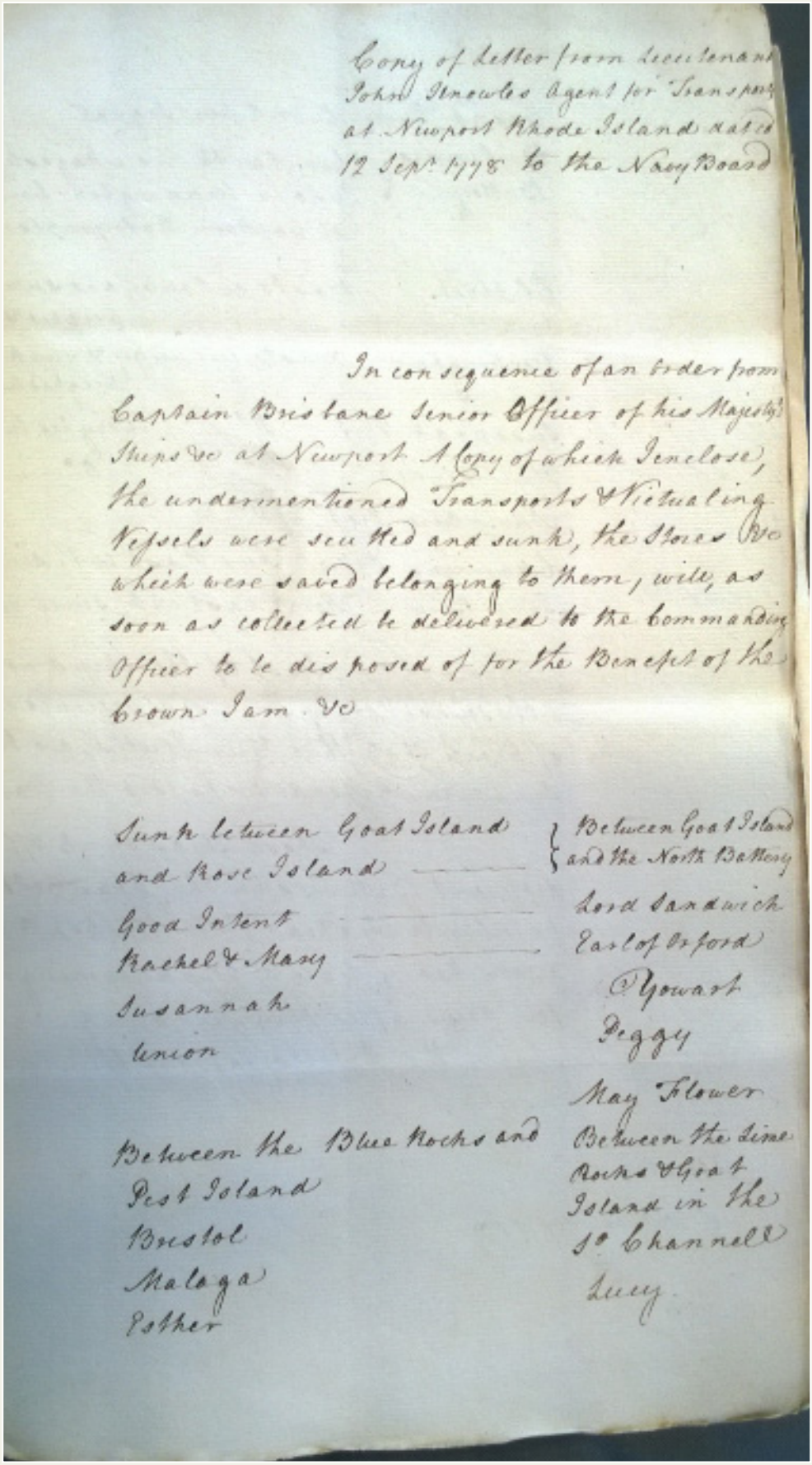
Figure 3. *Plan de la position de l'armée françoise autour de Newport et du mouillage de l'escadre dans la rade de cette ville*. Rochambeau Map Collection, 1780, Library of Congress, G3774.N4S3 1780 .P53. Note the three circled items numbered '57', which the key on the map indicates are 'Carcasses de Batisseux' – the remains of the ships sunk by the British in 1778.

Location	Transports
Sunk between Goat Island and Rose Island	*Good Intent* *Rachel and Mary* *Susannah* *Union*
Between Goat Island and the North Battery	*Lord Sandwich* *Earl of Orford* *Yowart* *Peggy* *Mayflower*
Between Blue Rocks and Pest Island	*Bristol* *Malaga* *Esther*
Between the Lime Rocks and Goat Island in the South Channel	*Lucy* *Grand Duke* [*of Russia*] – burnt *Britannia and Betsy* – burnt with *Juno* in Coddington Cove *Clibborn* – sunk – since weighed [salvaged] and masted *Rockingham* – sunk – since weighed and masted *Susannah* (Victualler) – sunk – since weighed but not masted *Olive Branch* – sunk – since weighed but not masted *Adventure* (Victualler) – sunk – since weighed but not masted *Charming Polly* – foremast cut away – since fished *Jane* brig – foremast cut away, since repaired

Table 2. List of locations and names of vessels sunk by British forces in Newport Harbor in August 1778.

Knowles' letter specified the location of *Lord Sandwich* and other transports scuttled ahead of the battle (Figure 4 and Table 2). It also indicated seven additional vessels had been sunk, scuttled or burnt, and revealed that some scuttled vessels were later re-floated. Finally, the letter stated that some vessels, including *Lord Sandwich*, were not re-floated due to the depth of water where they were scuttled, their age and/or the poor condition of their hull. This letter confirms that *Lord Sandwich* was scuttled alongside the transports *Earl of Orford*, *Yowart*, *Peggy* and *Mayflower* in an area immediately north of Goat Island (Erskine: 2017).

Following Erskine's work (Erskine 2017: 66–8) which was later verified by Abbass (2016: 4–6) in 2017, this area was designated by RIMAP as the Limited Study Area and would be the focus of all future search and survey activities.



Copy of Letter from Lieutenant John Knowles Agent for Transports at Newport Rhode Island dated 12 Sept. 1778 to the Navy Board

In consequence of an Order from Captain Bristane Senior Officer of his Majesty's Ships &c at Newport A Copy of which I enclose, the undermentioned Transports & Victualing Vessels were scuttled and sunk, the Stores &c which were saved belonging to them, will, as soon as collected be delivered to the Commanding Officer to be disposed of for the Benefit of the Crown I am &c

Sunk between Goat Island and Rose Island	Between Goat Island and the North Battery
Good Intent	Lord Sandwich
Rachel & Mary	Earl of Oxford
Susannah	Howard
Union	Peggy
	May Flower
Between the Blue Rocks and Pest Island	Between the Line Rocks & Goat Island in the So Channel
Bristol	Lucy
Malaga	
Esther	

Figure 4 List of transports scuttled in Newport Harbor in 1778. *Lord Sandwich* is listed on the centre-right of the page, beneath the annotation 'Between Goat Island and the North Battery' (ADM 354/198/21 Navy Board: *Bound Out-Letters: Copy of Letter from Lieutenant John Knowles, Agent for Transports at Newport, Rhode Island 12 September 1778;* National Archives, Kew). Image: Nigel Erskine/ANMM.

Significance assessment for HMB *Endeavour*

Lieutenant James Cook and his vessel HMB *Endeavour* have played a highly significant role in the history of Australia.

Endeavour's voyage of exploration and scientific discovery across the Pacific eventually led to the charting of the entire east coast of Australia and subsequent claim of ownership by the British Crown. The favourable reports of Cook – and especially Sir Joseph Banks and James Matra – contributed to the European occupation of the Australian continent from 1788.

Under the *Underwater Cultural Heritage Act 2018* (Cwlth) and influenced by the ICOMOS Burra Charter, the Commonwealth of Australia has developed a series of evaluation criteria that allow archaeologists to assess the archaeological and historical significance of shipwrecks.

The wreck of *Lord Sandwich*, formerly HMB *Endeavour*, fulfils these criteria in several key respects.

Criterion One: Historic

Significant in the evolution and pattern of history. Important in relation to a figure, event, phase, or activity of historic influence.

No single western navigator holds greater historical significance to Australia than James Cook (1728–79). His First Voyage to the Pacific Ocean (1768–71) both charted and claimed the eastern coast of New Holland (later named Australia) for King George III of Great Britain. Despite its erroneous claim under the precept of *terra nullius*, Cook's gambit and the information provided by his First Voyage substantially contributed to the British colonisation of the continent, including its devastating impacts on Aboriginal and Torres Strait Islander peoples. Cook's Second and Third Voyages altered the science, geopolitics and First Nations destinies in Aotearoa New Zealand and across the Pacific.

HMB *Endeavour* is an exceptionally significant vessel in Australia's history. The vessel is associated with several key protagonists in the European occupation and understanding of Australia, including Captain James Cook, Sir Joseph Banks, Daniel Solander and James Mario Matra.

Criterion Two: Technical

Significant in possessing or contributing to technical or creative accomplishments. Important in demonstrating a high degree of technical or creative achievement for the period in question.

HMB *Endeavour* was specifically chosen by the Royal Navy as the ideal vessel to undertake an 18th-century voyage of scientific exploration and discovery to a remote part of the world. The vessel was chosen to sail alone and hence required a robust structure to withstand diverse environmental hazards, from shipworm to coral reefs. Both the hardiness and the vulnerability of this single vessel were pointed out by Cook on his return, ensuring that future expeditions of a similar nature entailed at least two vessels.

The vessel is associated with the 1769 observation of the Transit of Venus and the scientific work of Sir Joseph Banks; naturalists Daniel Carl Solander and Herman Diedrich Spöring; astronomer Charles Green; and natural history artists Sydney Parkinson and Alexander Buchan.

These scientists not only recorded some of the earliest European encounters with Aboriginal and Torres Strait Islander peoples of Australia, but also prepared the first written descriptions and hand-drawn illustrations of the continent's unique flora and fauna.

Criterion Three: Social

Significant through association with a community or communities in Australia today for social, cultural or spiritual reasons. Important as a cultural items or places highly valued for reasons of social, cultural, religious, spiritual, aesthetic or educational associations by a community today.

Captain James Cook and the crew of HMB *Endeavour* have reached an almost iconic significance in Australia. The voyage of Cook and *Endeavour* is taught at primary school level in most Australian States and Territories and their names appear on maps of Australia's hinterland, as well as charts of the coast.

In 1970, a 50-cent piece and a series of stamps were minted to commemorate Cook's 1770 voyage along the Australian east coast. Between 1987 and 1994, an $18 million reconstruction of the vessel was built in Western Australia. The voyage of Cook and HMB *Endeavour* feature in museums as far apart as Kurnell in New South Wales, Cooktown in Queensland, and Cook's birthplace in Marton-in-Cleveland, North Yorkshire, England.

Equally, Cook and the arrival of HMB *Endeavour* are regarded as harbingers of European colonisation of Australia and its profound and destructive impact on First Nations cultures. For many Aboriginal and Torres Strait Islander peoples, *Endeavour* represents a moment of rupture, leading to dispossession and destruction.

Criterion Four: Archaeological

Significant for the potential to yield information contributing to an understanding of history, technological accomplishments and social developments. Important for its potential to yield information contributing to a wider understanding of the history of human activity.

Although HMB *Endeavour* was extensively surveyed prior to its purchase by the Royal Navy, it underwent several modifications prior to and during its voyage of exploration. Plans generated from the Admiralty's 1768 survey of the vessel provide detailed information about its design and construction; however, no framing plan is known to exist. As the shipwreck site's surviving fabric comprises much of the lower hull's architecture – including framing – it can better inform our understanding of the vessel's overall design and construction.

Many of these modifications were carried out to make the vessel more efficient, or the crew more comfortable. However, further modifications were carried out at Endeavour River in June–July 1770 to repair damage incurred by the vessel after it grounded on what is now known as Endeavour Reef. Australian timbers were very likely used in these repairs. Carried out thousands of miles from *Endeavour's* home port, these repairs represent a major technological achievement.

Criterion Five: Scientific

Significant in the potential to yield information about the composition and history of cultural remains and associated natural phenomena, particular the biota, through examination of physical, chemical and biological processes. Important in the testing of hypotheses concerning biological processes, the composition of cultural remains, the effects of original use and the effects of other environmental factors.

The research conducted in pursuit of *Endeavour's* wreck site has led to the development of several innovative underwater testing processes that are interdisciplinary in scope. To assist researchers in maritime archaeology and materials science, this single shipwreck investigation has assembled the work of scientists in the fields of sedimentology and environmental science, forestry, geology, archaeobotany and palynology, forensic science and nuclear science.

The site still has substantial research potential, including palynology, coal dust and timber analysis. Any material culture not removed from the vessel's final role as a prison ship is likely to have been concentrated in the bilge, which is precisely the portion that remains at the shipwreck site. The creation of a replica *Endeavour* in the 1990s combined historical research with reconstructions of 18th-century shipbuilding, that can be tested and compared against the shipwreck of the original vessel.

Criterion Six: Rare

Significant in possessing rare, endangered or uncommon aspects of history. Important in demonstrating a distinctive way of life, custom, process, waterway use, function or design, which is no longer, practise, is in danger of being lost or is of exceptional interest to the community.

HMB *Endeavour* is significant for its potential to enhance our understanding of the various uses adopted for a mid-18th century British vessel, including as a ship of exploration, troop transport, and prison hulk. The shipwreck, along with its associated artefacts, can provide exceptionally rare and valuable insight into 18th-century ship construction, as well as the lives of the many crewmen, passengers and prisoners who lived within the vessel's wooden walls over the course of its 14-year life.

Site location characteristics

Environmental considerations

Study area

The study area for this report is located within Newport Harbor in the state of Rhode Island and Providence Plantations, United States of America. Based on historical documentation, the wrecks of the British transports sunk in August 1778 lie within an area bounded by Dyer Point (also known as Battery Point) to the east, Coasters Harbor Island to the North, Rose Island to the west and Goat Island to the south (Figure 5).

Physiography

The dominant physiographic feature of the State of Rhode Island and Providence Plantations is the Narragansett Basin, a shallow lowland area of carboniferous sediments that are partly submerged as Narragansett Bay is an ancient drowned glacial river valley (Raposa and Schwartz 2009: 25). An arm of the Atlantic Ocean, this bay is 30 miles (48 kilometres) long and between 3 and 12 miles (5 and 19 kilometres) wide. Its many inlets provided harbours that were advantageous to colonial trade, and later, to holiday resort development. At the head of the bay is

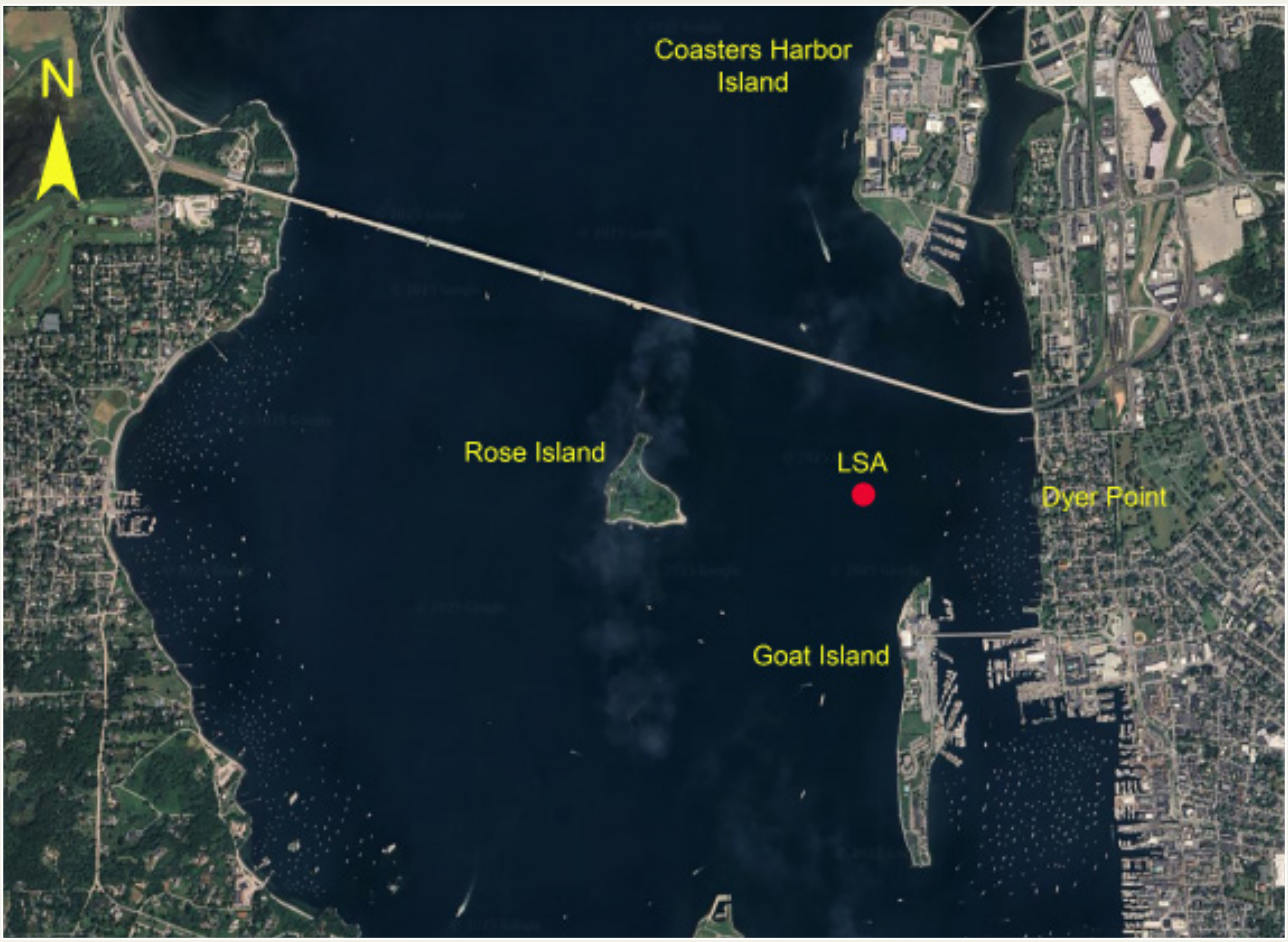


Figure 5. The area of Newport Harbor in which British vessels, including *Lord Sandwich*, were scuttled in August 1778. 'LSA' indicates the approximate centre of the Limited Study Area in which the wreck of *Lord Sandwich* is located. Image: James Hunter/ANMM; map data: ©2024 Google, Airbus.

Providence, the State's capital. At the south- eastern corner of the northern bay portion is Newport. Newport Harbor is sheltered from the south and east by Newport Neck, from the north by Rhode Island and Coasters Harbor, and from the west by Rose Island, Goat Island and Fort Adams.

The Rhode Island shoreline is presently undergoing a steady process of erosion. It is submerging because of the slow rise in sea level relative to land, at a rate of approximately 0.33 metres per 100 years (Hale 1998). Based on tidal records, the depth of water in Newport Harbor has increased approximately 0.80 metres since the loss of the British transports in 1778. Narragansett Bay is generally quite shallow, with the bottom tapering gradually from Rhode Island Sound in the south to the head of the bay. Average water depth is approximately 24.5 feet (7.5 metres) at mean low water in both the West Passage and Sakonnet River (Hale 1998; Raposa and Schwartz 2009: 77–80).

Climate

The prevailing winds of Narragansett Bay blow from the northwest in winter and from the southwest in summer (Raposa and Schwartz 2009: 27). Sudden summer storms can unleash rain squalls and 40–50 knot winds that move opposite to the prevailing wind conditions. Usually, these squalls tend to last no more than a few minutes, but they can make all boating and diving operations uncomfortable, and in some cases dangerous.

Although hurricanes are uncommon, they can strike with incredible force, as the bay acts as a giant funnel that constricts and mounds up associated storm surge. Between 1635 and 1938, nine severe tropical systems struck the Narragansett Bay region. One hurricane in 1815 increased the depth of the bay at Providence by 12–14 feet (3.7–4.3 metres) beyond normal level.

Tides and underwater visibility

Tidal movement in Narragansett Bay is minimal with an average range of 3.6 feet (1.1 metres) at the mouth of the Bay and 4.5 feet (1.4 metres) at the head (Raposa and Schwartz 2009: 83). While water movement is slow, twice-daily tides create powerful currents within the constricted channels between islands (Hale 1998). The bottom of much of the bay is silty, resulting in turbid, low-light waters in Newport Harbor. There is very minor site scouring caused by tidal flow and some silt deposition. As this area also hosts significant zooplankton and phytoplankton, plus algae blooms during the summer months, underwater visibility during this time of year is often less than 3 feet (1.0 metres) (Raposa and Schwartz 2009: 113).

Water temperature and salinity

Summer water surface temperatures at the mouth of Narragansett Bay range from 64° to 74°F (17° to 23° C). Bottom temperatures are cooler and in winter the water temperature may reach a low of 32.9°F (0.5°C; Raposa and Schwartz 2009: 86). At the bay's three entrances and for a considerable distance northward, the water has an average salt content of between 30 and 32 parts per thousand. Bottom waters are generally saltier than the water at the surface. The East Passage, which includes Newport Harbor, has the highest concentrations of salt in the entire Narragansett Bay region.

Biota

Because of the bay's location it contains both northern, cold-water species and southern species of marine life. Native marine life includes various types of lobster, crabs, winter flounder (blackback), summer flounder (fluke), tautog (blackfish), sea bass, cunners, bluefish, menhaden, mackerel, herring, hake, butterfish, striped bass, sand shark, dusky shark, smooth and spiny dogfish, and the gray squeteague (saltwater trout). Various shellfish, including quahaugs (which thrive in sand, mud, clay, shell, and small rocks found on the floor of the bay), razor clam, ribbed and blue mussels, mud snails, oyster drills, oysters, bay scallops, and limpets, are also found in the silt and sediment of the bay (Hale 1998; Raposa and Schwartz 2009: 93–4, 125–36).

Cultural processes

The English colony of Rhode Island was established in 1639 by settlers fleeing religious restrictions imposed by the Massachusetts Bay Colony (Abbass 1998: 9). The town of Newport flourished from shipbuilding and trade with the middle and southern colonies, the West Indies and Europe. Initially engaged in trade in wool and food, Newport merchants later traded in molasses, rum, and slaves. By the 1750s, Newport rivalled Boston, Philadelphia and New York as one of the chief commercial and cultural centres on the eastern seaboard of what is now the United States and was one of the five leading ports in North America (Neimeyer 2010: 30; Thompson 1959: 365–6).

By the mid-1700s, relations between the Rhode Island Assembly and British Crown began to sour (Kinkel 2014: 4; Thompson 1959: 374). What was probably the first American act of open rebellion against the British Crown occurred at Newport on 9 July 1764, when the crew of the British-flagged schooner *St. John* attempted to capture an alleged deserter. The townspeople forcibly resisted, took the opportunity to capture Fort George and then fired upon HMS *Squirrel*, which was anchored in the harbour at the time (Leslie 1952: 233–6; Kinkel 2014: 4). Further acts of rebellion followed, including the burning of HMS *Liberty* in 1769 and the British customs schooner *Gaspee* in 1772 (Abbass 2016: 7; Kinkel 2014: 24–6; Messer 2015: 582–91; Thompson 1959: 274–5).

In June 1775, the Assembly of the Crown Colony of Rhode Island created the first independent navy in the North American colonies (McBurney 2011: 10; Metz 1987: 200).

The Rhode Island Navy consisted of two armed vessels, the 12-gun sloop *Katy* and six-gun galley *Washington*. It was created with the intention of either sinking or driving away Royal Navy vessels operating in Narragansett Bay. Rhode Island's delegates to the Continental Congress next moved to create a federal navy to oppose the Royal Navy and unfavourable British trade policy. The 'Rhode Island Plan', which called for the construction of 13 frigates for what would become the Continental Navy, was enacted in December 1775. This was followed by the *Rhode Island Renunciation of Allegiance to King George III* in May 1776 (McBurney 2011: 9–10; Metz 1987: 200).

Occupied by the British – and later the French – during the American War of Independence, Newport's commercial influence declined until the American Civil War in the 1860s. During this period, the US Naval Academy was evacuated from Annapolis, Maryland to Newport. A Naval Torpedo Station was established at Goat Island in 1869 and the Naval Training Station (Naval Education and Training Center) was built at Coasters Harbor in 1883 (Nicolosi 1984: 117–18; Snyder 2004: 2–4). This was followed by construction of the Naval War College and Naval Hospital at Newport in 1884 and 1886, respectively. During the torpedo station's period of operation, Newport's outer harbour west of Goat Island became the primary testing area for the US Navy's torpedo research and development, whilst the island was used for the manufacturing and testing of main charge explosives, primers and detonators (Jolie 1978: 25). The navy built a large coaling station at Melville on Aquidneck Island in 1901 and the Naval Torpedo Factory at Goat Island in 1906, which by 1945 employed more than 13,000 people and proof fired more than 100 torpedoes a day (Jolie 1978: 10; Mather and Jensen 2010: 27; Nicolosi 1984: 118–19, 126–9). These were followed by the Quonset Point Naval Air Station, Davisville Naval Base, Officer Indoctrination School, Chaplin School, Surface Warfare Officer School and Naval Undersea Warfare Center (NUWC).

The US Navy's activities have had a direct impact on the waters west and northwest of Goat Island and, judging by the condition of shipwreck sites in these areas, have also affected the scuttled transports. Cultural activities that have disturbed these sites include the placement of anchors and moorings, dredging of channels, underwater diving operations and explosives testing (Corps of Engineers 1955: 2; Harbor Commissioners 1878: 9, 32–3).

The establishment of large naval stations at Coasters Harbor and Goat Island meant that the stretch of water off Dyer Point (North Battery), which would later become the Limited Study Area in 2017, became the major anchoring area for the United States Navy in Newport.

The presence and ongoing development of maritime, naval and civic infrastructure has led to pronounced modification of the underwater cultural heritage sites in Newport Harbor. For instance, photographic evidence shows two large U.S. Navy frigates anchored directly offshore from the North Battery and directly over the top of shipwreck sites with Rhode Island identification numbers RI 2394, RI 2578 and RI 2396 in 1894. Direct evidence of this mooring activity can also be seen on the site of RI 2396 where a 4.5 metre-long 19th century iron Admiralty Pattern anchor lies only a few metres north of the site (Hosty, 2016: 65).

Given that photographs indicate that these naval vessels were moored using a single-point mooring system that swung freely under the influence of wind and tide, all three shipwreck sites were regularly swept by the catenary of the mooring chains. This levelled or removed structural timbers above the sea floor and scattered ballast stones across the site. The dispersal of material can be seen on RI 2394 and RI 2578 in the form of ballast stones that are distributed randomly around the site rather than forming discrete ballast mounds such as those found on RI 2125 and RI 2119. The latter sites lie 700 metres to the north of the mooring field, on the other side of the Claiborne Pell Bridge. The mooring chain may also be responsible for the almost surgical removal of the keelson and mast-steps from RI 2394 where the shadow of these hull features can still be seen in the form of iron concretions (Hosty and Hunter, 2022a).

The Naval Torpedo Station at Goat Island, along with Gould Island and Coasters Harbor, were also the destination for numerous electrical cables, water and sewer pipelines that connected them with Newport (Naval Undersea Warfare Center 2019: 5). The first cable was laid in 1877, and by 1937 the *Report of the Board of Engineers for Rivers and Harbors – Newport Harbor* reported there were six submarine cables, three water pipelines and a sewer outfall connecting Goat Island with the mainland (War Department, Washington, 1937: 1–25). Some of these cables and pipelines were in the process of being lowered due to extensive dredge operations then occurring on the eastern and northern sides of Goat Island.

Evidence of these activities can be seen on RI 2578, where a 200 mm (8-inch) electrical cable has been laid directly across the site from north-west to south-west, and on RI 2394, where a separate 200 mm (8-inch) electrical cable has been laid from east to west directly across the site. In both cases the cables appear to have sliced across the sites, redistributing ballast stones. In the case of RI 2394, the cable may also have removed structural features such as the keelson (Hosty, 2016: 84-86).

The reason for the keelson's absence on RI 2394 is unclear. However, archival research raises the distinct possibility that it – along with the rider/deadwood keelson (with an approximate combined height of 900 mm or 34.5 inches) and its fore- and mainmast step mortises – may have been removed by the cable's placement. It may also have been removed by diving/dredging activities to lower the cable to sea floor during extensive harbour dredging and

electrical cable laying in the 1930s. These activities were carried out as part of an expansion of the Naval Torpedo Station on Goat Island (Abbass, 2016: 18; Naval Undersea Warfare Center, 2019: 5; War Department, 1937:1–25)

Numerous torpedo and underwater explosives tests were conducted in Newport Harbor as part of the station's research and these activities no doubt impacted the Revolutionary War shipwrecks in the area (Souza 1999, cited in Abbass 2001: 200). Abbass (2016: 18) also states that during the late 19th and early 20th centuries, United States Navy divers training at Goat Island found several shipwrecks nearby, retrieved artefacts from them and used the wrecks for demolition practice.

These activities are substantiated by an article in *The New York Times* (2 August 1891, p.17) which stated:

> Newport's old wreck: Interesting discoveries by divers of the Torpedo Station ... The old wreck recently discovered by the diving class of the torpedo station promises to become an especial object of interest. It lies completely buried in mud and stone on the west side of the torpedo station, within a couple of hundred feet of the [Goat] island.

On Saturday July 23, 1892, the *Providence Journal* reported:

> the old wreck lying on the west side of the Torpedo Station [Goat Island] was blown up yesterday afternoon by torpedoes, to facilitate the work of the divers connected with the station, who have been examining it with the double purpose of practice and to secure information as to the vessel's identity.

Taylor (2017: 107) supports the premise that other wrecks were being actively removed from Newport Harbor in the 19th century by naval personnel based at the Torpedo Station. In her book *Images of America: Rhode Island Shipwrecks* (2017: 107), she quotes a letter sent to Commander Goodrich from William Underwood, which states 'there are two old hulks upon the shore of Mr. E.D. Morgan's place at Brenton Cove which he is very desirous of having removed ... Would it be possible to make any arrangement whereby you could, in your torpedo experiments, blow these wrecks to pieces?'. Taylor (2017: 107) goes on to state this was 'a common fate of old vessels in late 19th century Narragansett Bay, which was the torpedo testing ground of the U.S. Navy'.

With the advent of SCUBA equipment in the early 1950s, Rhode Island, with its thousands of accessible shipwrecks, became a popular destination for divers seeking artefacts. Marlene and Don Snyder, two of Rhode Island's best-known recreational divers who pioneered the sport in the late 1950s and early 1960s, state in *Rhode Island Adventure Diving* that 'dozens of shipwrecks found in the area [Narragansett Bay and Newport Harbor] have yielded everything from brass [sic] deck spikes and portholes to perfectly preserved wooden pulleys and revolutionary war-era cannons and cannonballs' (Snyder and Snyder 1998: 80).

The Snyders go on to state in their second book, *Rhode Island Adventure Diving II*, that recreational divers located several of the 18th-century scuttled transport ships in Newport Harbor (Snyder and Snyder 1999: 6–7). Notably, one of those sites, RI 2125, had artefacts removed from it, including a swivel gun and ballast stones. While the Snyders do not provide the locations of the transport sites in Newport Harbor, archaeological survey work carried out between 1999 and 2003 on RI 2119 and RI 2125 indicates both had been subjected to significant past disturbance. The most obvious disturbance included trenching across the ballast mounds of both sites, which exposed hull timbers and artefact deposits (Abbass, 2000: 14, 25a).

The Rhode Island Harbor Commissioners were also actively involved in the removal of submerged wrecks and abandoned watercraft from the 1870s onwards and were engaged in extensive dredging and rock removal operations (Harbor Commissioners 1878: 9–12; 1900: 51–3). This included construction of a shipping channel between 150–750 feet (46–228 metres) wide around the southern, northern and eastern sides of Goat Island, which involved the removal of more than 827,000 cubic yards (632,286 cubic metres) of mud, silt and debris between 1881 and 1896 (Harbor Commissioners 1897: 21–5; U.S. Army Corps of Engineers 1955: 2–3). Additional dredging works on the southern and eastern sides of Goat Island between 1901 and 1907 involved the removal of an additional 623,486 cubic yards (476,689 cubic metres) of sand, mud, and clay, plus 92,382 cubic yards (70,631 cubic metres) of rock (Harbor Commissioners 1907: 21–5).

In addition to channel dredging for large military and civilian vessels, intrusive modern development has included construction of the Claiborne Pell Bridge in 1969. The bridge connects Conanicut Island with Aquidneck Island, where Newport is situated. Its eastern edge bisects the area north of Goat Island. Dredging, construction spill and altered water flows from the bridge may all contribute to underwater features and site formation processes within the study area.

Archaeological context

According to Mather and Jensen (2010: 355), data regarding shipwreck losses in Rhode Island comes in multiple forms, with the most reliable database of shipwrecks maintained by RIHPHC, who hold the official state database. As of 2010, this database listed 1,041 shipwrecks in Rhode Island state waters, with most of the information provided by RIMAP. Two additional databases complement that of the State. One is the Northern Shipwreck Database, which states more than 1,200 shipwrecks are recorded in Rhode Island waters. The

other database is the Automated Wreck and Obstruction Information System (AWOIS), which is maintained by the National Oceanographic and Atmospheric Administration Office of Coast Surveys. It records 850 shipwrecks and obstructions from Long Island Sound to Cape Cod and includes Rhode Island waters.

As part of the 2010 *Rhode Island Ocean Special Area Management Plan* (RIOSAMP), the University of Rhode Island (URI) developed three additional underwater cultural heritage databases for Rhode Island (Mather and Jensen 2010). These include the URI Working Archaeological Database (which contains 618 shipwreck sites), a geophysical database containing acoustic imagery of 30 shipwrecks and the URI Supplementary Historic Database, which contains listings for 584 wrecking events in Rhode Island prior to 1908. URI recorded at least 1,200 maritime accidents and disasters between 1650 and the present day. More than half were recorded in the vicinity of Block Island and the remainder off Point Judith, Watch Hill, Beavertail and in Newport Harbor (Figure 6).

Further analysis of the shipwreck data contained in RIOSAMP indicates there was a noticeable spike in the number of Rhode Island shipwrecks during the American War of Independence from 1775–83, and another during the first two decades of the 19th century. The report also states there was a significant rise in the number of shipwrecks that occurred in Rhode Island waters starting during the 1860s and reaching a peak in the 1880s. This rise coincided with the most rapid period of industrial development in the United States (Mather and Jensen

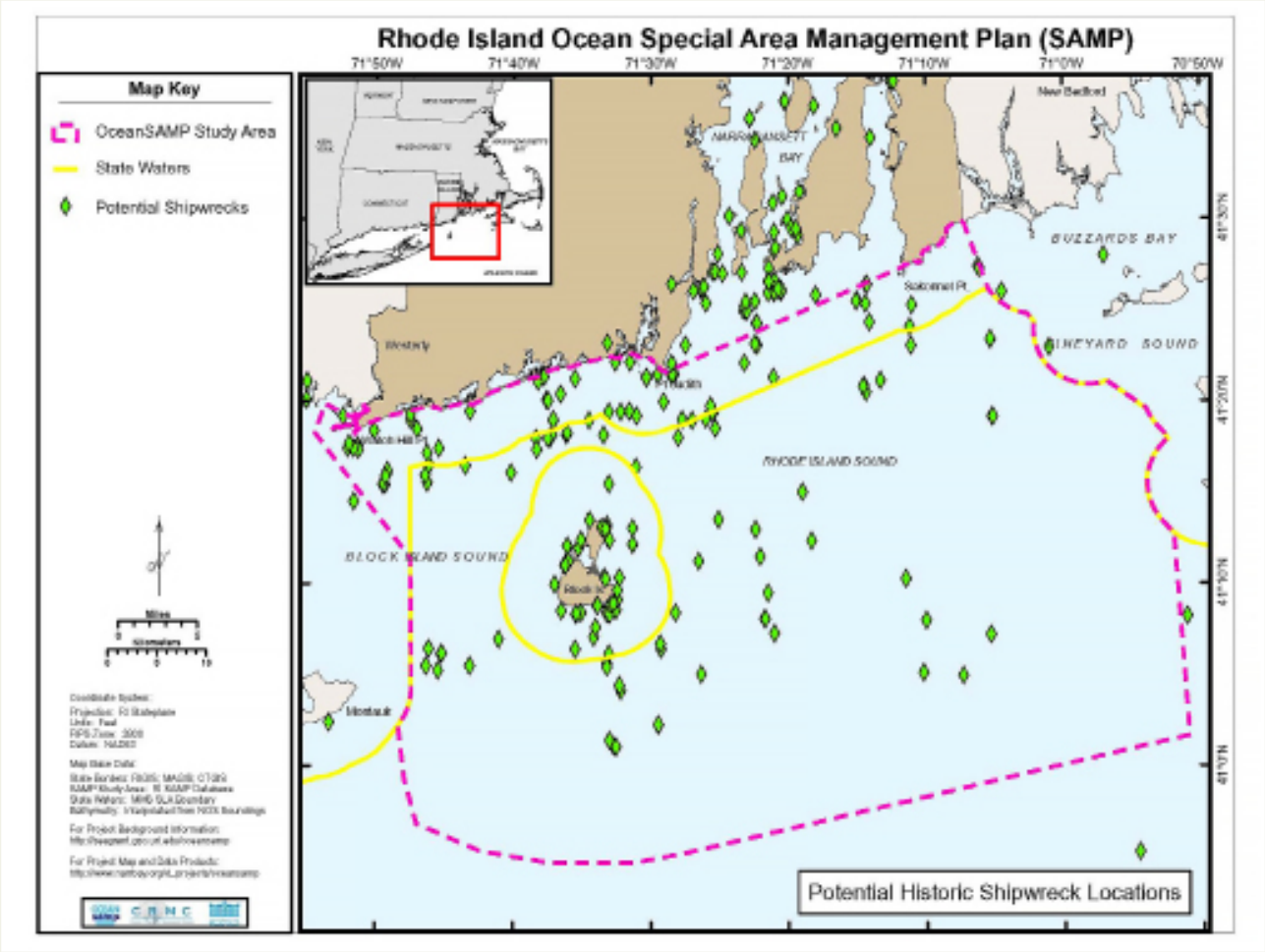


Figure 6. Potential Historic Shipwreck Locations in Rhode Island. From Rhode Island Ocean Special Area Management Plan (Mather and Jensen 2010: 380, University of Rhode Island, Figure 4.2).

2010: 383–8). Further information regarding shipwrecks within the Newport Harbor Original Study Area (the area protected by the United States District Court in 1999 that awarded custody of all sunken non-motorised wooden vessels in Newport Harbor to Rhode Island and its agent, RIHPHC) and the Limited Study Area can be found in the 'Candidate shipwreck sites' section of this report (Abbass 2001: 19–20).

Legal status

The United States *Abandoned Shipwreck Act 1987* (*ASA*) establishes federal government control over most historic shipwrecks located in the waters of the United States of America and its Territories. *ASA* affirms the authority of state governments, such as that of Rhode Island, to claim and manage abandoned historic shipwrecks and asserts they are multi-use resources (Delgado 1998).

Under *ASA*, the US Government asserts title to three classes of abandoned shipwrecks located within 3 nautical miles of the United States' coastline and within the nation's internal navigable waters, such as Newport Harbor. *ASA* applies to abandoned shipwrecks that are embedded in submerged lands or embedded in coralline formations protected by a state, as well as those located on submerged lands and included in, or determined eligible for, inclusion on the US National Register of Historic Places (Bleichner 2019: 20–1). Upon establishing title to these shipwrecks, the US Government transfers ownership to the government entity that owns the submerged lands in which they are embedded (Bleichner 2019: 214–15). The term *embedded* means firmly affixed in submerged lands or coralline formations such that excavation tools are required to move bottom sediments to gain access to the site. As a result, state governments, such as that of Rhode Island, have title to shipwrecks located on their submerged lands (Bleichner 2019: 214–15).

However, under provisions of the *Sunken Military Craft Act 1990* (*SMCA*), the US Government holds perpetual title to all sunken US military ships and aircraft, and protects all foreign sunken military craft that are entitled to sovereign immunity from unauthorised disturbance (Bleichner 2019: 217). *SMCA* applies to all sunken military craft that lie within US territorial waters (including internal waters such as Narragansett Bay). According to Bederman (2006: 653), under the Act, sunken military craft are defined as:

All or any portion of:

(a) Any sunken warship, naval auxiliary, or other vessel that was owned or operated by a government on military non-commercial service when it sank;

(b) Any sunken military aircraft or military spacecraft that was owned or operated by a government when it sank; and

(c) The associated contents of a craft referred to in (A) or (B).

Further, *SMCA* ceases to apply *only* when the vessel has been expressly abandoned by the sovereign nation it belongs to (Bederman 2006).

One of *ASA's* most important provisions specifies that the laws of salvage and finds do not apply to abandoned shipwrecks claimed by the government under the Act. As required under *ASA*, the National Park Service (within the US Department of the Interior) has prepared guidelines to assist State and Federal agencies in carrying out their responsibilities under the Act. These guidelines provide advice for establishing and funding historic shipwreck management programs and technical guidance for surveying, identifying, documenting and evaluating shipwreck sites (Delgado 1998).

In Rhode Island, historic shipwrecks are administered through the State Historic Preservation Office (SHPO) at RIHPHC. All archaeological work conducted on non-military historic shipwrecks in Rhode Island must abide by the *Abandoned Shipwreck Act*, the National Park Service's *Guidelines*, and the *Antiquities Act of Rhode Island 2013*.

Due to the considerable historical and archaeological potential of the scuttled British transport fleet, in April 1999 the State of Rhode Island took steps to protect these shipwreck sites. Rhode Island's Attorney General used the State's preservation laws, *ASA*, the law of finds, and the law of salvage to ask the United States District Court to award custody of all sunken non-motorised wooden vessels in Newport Harbor to Rhode Island and its agent, RIHPHC. This claim was not challenged, either by the US Government (under *SMCA*) or other interested parties, such as the United Kingdom or the Royal Navy (Abbass 2001: 19– 20).[3]

On 1 December 2000, the federal judge in the case awarded title to the state of Rhode Island, thereby extinguishing any other claims of ownership to the shipwrecked Revolutionary War transports. RIMAP was awarded exclusive title to conduct archaeological work on the transport sites, via a Memorandum of Agreement (MOA) with RIHPHC (Abbass 2001). However, in May 2019 RIHPHC, acting under advice of the Rhode Island Attorney General, terminated the MOA and ended the exclusive arrangement between the State and RIMAP (Belmore 2019a, 2019c; Loether 2019):

3 Since 2000, it has been assumed the State of Rhode Island is the legitimate owner of all transport shipwrecks (including RI 2394) in Newport Harbor. However, the *SMCA* could cast doubt on Rhode Island's ownership, given the Act's emphasis on the need for 'expressed abandonment' by a foreign power. In the absence of a formalised declaration, the British government may have a legitimate claim to shipwreck site RI 2394.

> In accordance with the provisions of the MOA noted above, the Commission is hereby providing RIMAP with notice of termination of the MOA, effective 10 days from the date of this notice ...
>
> The Commission has concluded that it is not currently in the best interests of the State of Rhode Island to enter into or maintain any agreements that, on an open-ended basis, designate any private or public entity as an exclusive investigator for any state-owned historic property in Rhode Island (Loether 2019).

RIHPHC also granted site access to all individuals and organisations that satisfied the necessary conditions to conduct archaeological survey work within Rhode Island:

> While the termination of the MOU will allow other companies interested to now apply for or receive state archaeological permits to investigate *Endeavour* specifically or the transport fleet in general on a project-by-project basis, it will also allow RIMAP to apply once again [for a yearly permit], as long as the application for the project satisfies all permit requirements (Belmore 2019b).

Additional protection to the sunken transport fleets was granted in 2016 by the Rhode Island Coastal Resources Management Council, who authorised the creation of a restricted zone (Assent No. 2006-10-075) in the southern area of Newport's outer harbour (Abbass, 2019: 2).

Archival and archaeological research overview

RIMAP was founded as a not-for-profit organisation in 1992, with the principal aim of documenting vessels wrecked in the waters of the State of Rhode Island (Abbass 1998: 2). Among the shipwreck sites investigated by RIMAP since the 1990s are the British transports and Royal Navy vessels deliberately scuttled in Newport Harbor during the Battle of Rhode Island in August 1778.

Except for David Syrett's pioneering work (1970), little had been written about the British transport system during the American War of Independence. According to Abbass (2001: 1), this is because transports were not Royal Navy vessels, but instead privately owned and chartered by the British government to transport troops and supplies to North America. Using local historical sources and editions of the *Newport Historical Magazine*, Abbass (2001: 1) identified the names of several the transports assigned to Newport during the conflict, including *Grand Duke of Russia*, *Rachel and Mary*, and *Lord Sandwich*.

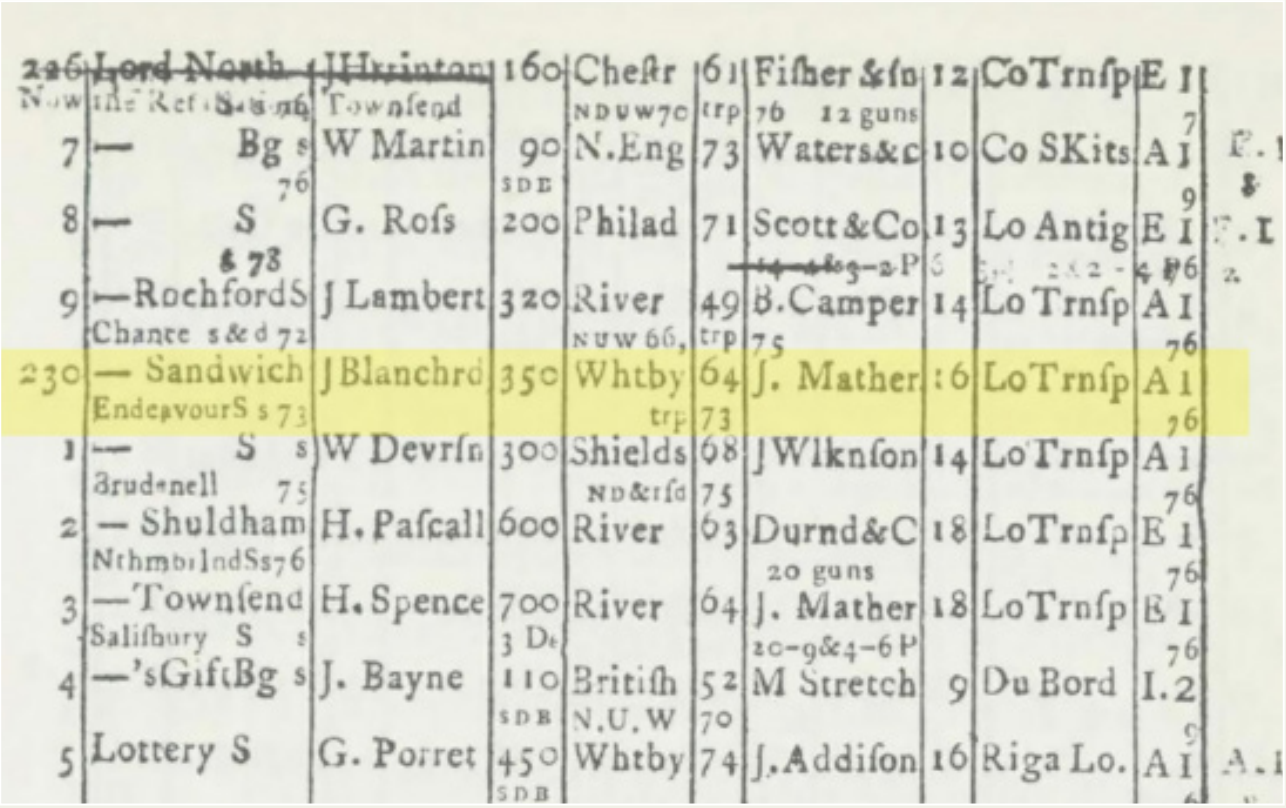
Abbass is RIMAP's founder and principal archaeological investigator. In January 1999 she announced that she had uncovered archival information at the British Public Records Office (PRO) that suggested the remains of HMB *Endeavour* lay in waters off Newport (Mellefont 1999). Abbass made the discovery while investigating several British naval vessels and chartered transport vessels – including *Lord Sandwich* – that were deliberately sunk off Newport in August 1778. Abbass travelled to England on advice from Antonia Macarthur, a London-based maritime historian and historic vessel restoration specialist. Her travel was also encouraged by John Longley, the then-Chief Executive Officer of the HM Bark Endeavour Foundation in Fremantle, Western Australia. Abbass was following a lead published by Sydney-based maritime historians Mike Connell and Des Liddy (1997: 40–9), who had identified entries in *Lloyd's Register* for 1776 and 1777 that suggested *Endeavour* had been sold out of service and renamed *Lord Sandwich* (Figure 7; Erskine 2017: 61).

Abbass located records in the PRO that proved *Lord Sandwich* was Cook's *Endeavour* and had served as a troop transport to North America. Additionally, her research revealed the vessel had served as a prison ship in Newport Harbor and was subsequently scuttled there in August 1778 (Abbass 2001: 5–7; Mellefont 1999).

Given Australia's national interest in Cook and *Endeavour*, the Australian National Maritime Museum (ANMM) closely followed Abbass' work. In 1999, Paul Hundley, an ANMM maritime archaeologist, met with Abbass and RIMAP's Board of Directors to discuss their ongoing research and how ANMM might assist the project. In May 1999, Abbass, RIMAP's Board of Directors, Rhode Island state-appointed archaeologists and Hundley developed a strategic approach to guide future archaeological investigation of wooden, non-motorised historic shipwreck sites in Newport Harbor:

> RIMAP expanded its earlier research design to include questions that would allow the identification of *Lord Sandwich* ex HMB *Endeavour* from among the transports that still exist. The amended research design is a complex matrix that includes the size of each vessel and its tonnage, overall dimensions and measurements of major timbers, construction details, wood identification and dendrochronology, pollen and sediment studies, flora and fauna evidence, ballast stone analysis, evidence of burning, and artefact identification (especially the presence of material that will confirm regiments or individuals known to have been on board). Based on what is known of *Lord Sandwich* ex HMB *Endeavour*'s history and RIMAP's knowledge of local conditions, we can predict what her archaeological site should look like (Abbass 2001: 15).

The aim of this 'preponderance of evidence' approach was to positively identify one of the 18th-century vessels sunk during the Battle of Rhode Island as *Lord Sandwich* (Hosty and Hunter 2022b). The approach would involve not only additional historical research, but also archaeological surveys and possible partial excavation of selected shipwreck sites considered high-priority candidates



226	Lord North	J Hrrinton	160	Chestr	61	Fisher & sn	12	Co Trnsp	E I	
Now	the Ref	Townsend		NDUW 70	trp	76 12 guns			7	
7	— Bg s	W Martin	90	N.Eng	73	Waters & c	10	Co SKits	A I	
	76		SDB						9	
8	— S	G. Ross	200	Philad	71	Scott & Co	13	Lo Antig	E I	
	& 78									
9	— Rochford S	J Lambert	320	River	49	B. Camper	14	Lo Trnsp	A I	
	Chance s & d 72			NUW 66,	trp	75			76	
230	— Sandwich	J Blanchrd	350	Whtby	64	J. Mather	16	Lo Trnsp	A I	
	Endeavour S s 73			trp	73				76	
1	— S s	W Devrsn	300	Shields	68	J Wlknson	14	Lo Trnsp	A I	
	Brudenell 75			ND & rsd	75				76	
2	— Shuldham	H. Pascall	600	River	63	Durnd & C	18	Lo Trnsp	E I	
	Nthmbrlnd S s 76					20 guns			76	
3	— Townsend	H. Spence	700	River	64	J. Mather	18	Lo Trnsp	E I	
	Salisbury S s		3 Ds			20-9 & 4-6 P			76	
4	— 's Gift Bg s	J. Bayne	110	British	52	M Stretch	9	Du Bord	I. 2	
			SDB	N.U.W	70				9	
5	Lottery S	G. Porret	450	Whtby	74	J. Addison	16	Riga Lo.	A I	
			SDB							

Figure 7. Extract from *Lloyd's Register of Shipping* (1778), showing HMB *Endeavour* renamed as *Lord Sandwich*. Yellow highlighted area added. Image: Lloyd's Register Foundation Heritage & Education Centre/Internet Archive.

for *Lord Sandwich* (Abbass 1998: 16). The project team developed a set of criteria that would be used to identify the scuttled transport vessels. These criteria were subsequently modified in 2017 (ANMM and RIMAP 2019: 3), and again in 2019 (ANMM and RIMAP 2019: 3), as additional archaeological surveys and archival research narrowed down the search area and number of potential transport sites of interest (see 'Description and analysis of RI 2394's hull remains', below).

The team carried out excavation work on a shipwreck located in shallows off Newport's Navy Hospital Pier. Officially designated RI 2125, the site was also known as the 'Hospital Cannon Site'. Although the team previously discounted this site as *Endeavour*, further work was carried out in the bow and stern areas to confirm the vessel's overall length, assess the site's level of preservation and archaeological significance, and backfill eroded areas (Bassett, et al. 2000a). Using a water-induction dredge, the team excavated two small trenches at the southern and northern ends of the ballast mound, providing an opportunity to examine the vessel's confusing construction and establish its actual length of keel (Bassett, et al. 2000a).

Once work was completed on RI 2125, the team commenced a remote sensing survey of Newport Harbor. This expanded previous survey work conducted by RIMAP and the US National Oceanic and Atmospheric Administration (NOAA), which had recorded five shipwreck sites and obstructions in the area. None of these sites were revisited during the 2000 field season (Bassett, et al. 2000a).

In mid-August 2000, the team commenced investigation of two shipwrecks lying adjacent to one another in 12–13 metres of water immediately north of the Jamestown Bridge. This site was given site number RI 2119 by RIHPHC and nicknamed 'Gamma' by RIMAP. It consisted of a small

20th-century timber and iron barge lying on a north-south axis. A much earlier stone ballast mound, with associated anchor, was lying beneath part of the barge on an east-west orientation (Bassett, et al. 2000a; Hosty and Hundley 2001).

The 2001 program included additional excavation work at RI 2119. A four-point mooring system was installed on the site in early August 2001, as were trail lines that extended around its periphery. A simple grid system was established around the proposed excavation areas in the wreck site's bow and stern sections (Hosty and Hundley 2001). The team suspended excavation at RI 2119 to take advantage of the availability of staff and sonar equipment from the US Naval Undersea Warfare Center (NUWC) in Newport (Hosty and Hundley 2001). It was hoped NUWC would be able to identify and confirm sub-surface anomalies detected during previous remote sensing surveys of Newport Harbor and Narragansett Bay. The first site investigated was RI 2119. NUWC's dual-frequency EG&G sub-bottom profiler (SBP) detected a significant depositional layer at the site, as well as a substantial anomaly just to the north of RI 2119. The prevailing theory was that this anomaly could represent the shipwreck site of another scuttled British transport.

The team then moved to RI 2125 and repeated the process. The system failed to detect the small stone ballast mound, but this may have been due to the site's relatively shallow water depth. The final SBP survey was conducted at Coddington Cove, where the Royal Navy frigate *Juno* was burned and abandoned during the Battle of Newport. The device detected a significant anomaly below the bottom of the cove – possibly the remains of *Juno* or another wrecked vessel.

The primary objective of the 2002 field investigations was to conduct further excavation of RI 2119 to locate the wreck site's stern, ascertain the surviving hull's overall length, confirm the material composition of the rudder fittings and collect timber samples from the keel. Where excavated, hull timbers were measured for their scantlings and photographed, while timber, ballast and sediment samples were collected for analysis. Data recovered during the 2002 investigations indicated RI 2119 represented the remains of an 18th-century vessel of similar size and construction to *Lord Sandwich* (Bassett, et al. 2000a; Hosty and Hundley 2001, 2002).

In August 2004, a team from ANMM returned to Newport to continue work on RI 2119 with RIMAP and Dr Rod Mather from the University of Rhode Island (URI). Fieldwork commenced with a side-scan sonar survey of Rhode Island's Sekonnet River to locate HMS *Kingsfisher*, a 300-ton *Swan*-class sloop built at Chatham Dockyard in 1770. The team also searched for *Spitfire*, an American galley captured by the British. Both vessels were scuttled during the Battle of Rhode Island (Erskine 2004: 5–12). The search for both wreck sites proved unsuccessful, and attention turned to investigation of RI 2119.

At the conclusion of the 2004 investigations, the collaborative program between ANMM and RIMAP went into hiatus until 2015. Following the signing of a Memorandum of Understanding/Funding Agreement between ANMM and RIMAP and acting under a Permit (#15-14) issued to RIMAP by the RIHPHC, ANMM representatives returned to Newport between 9 and 14 September 2015 and investigated a series of sonar anomalies off the western shoreline of Goat Island (ANMM and RIMAP 2015). First located during the 2001 and 2002 surveys, the anomalies were in an area directly west of the 1778 Goat Island Battery and where both the historic Fage Chart and Knowles report indicated several transports were scuttled before the Battle of Rhode Island (Hosty 2015: 56–63).

As identification of *Lord Sandwich*'s wreck site was proving elusive, in 2016 Dr Nigel Erskine (then Head of Research at ANMM) commenced a review of all archival material related to HMB *Endeavour* and *Lord Sandwich*. The project sought relevant archival documents housed at the PRO, UK National Archives, Caird Library at Royal Museums Greenwich, British Library and ANMM's Vaughan Evans Library. A scholarly article written by Erskine in *The Great Circle* (2017) proved beyond reasonable doubt that *Lord Sandwich* was one of five transports scuttled during the Battle of Rhode Island in an area immediately north of Goat Island. The new information led the team to focus on the Limited Study Area (LSA) north of Goat Island. Four historic shipwrecks were located within the boundaries of the LSA and designated with site numbers RI 2393, RI 2394, RI 2396/RI 2397, and RI 2578 (Abbass 2016: 7; Abbass 2019: 3). A fifth potential shipwreck site, RI 2794, was located in 2017 but, following extensive site investigation, was determined not to comprise the shipwreck of a scuttled transport.

Following three years of remote sensing and non-disturbance site surveys, the ANMM/RIMAP team conducted additional archaeological investigations within the LSA in September 2018, including non-intrusive metal detector surveys. Efforts concentrated on an area of seabed 250–800 metres north of Goat Island, with particular emphasis placed on a site dubbed 'Caroline' by RIMAP, as well as RI 2578, RI 2393, and RI 2394 (Hosty 2018: 144–59). At the conclusion of this round of fieldwork, the project partners agreed that RI 2394 appeared to be the largest shipwreck site (in terms of both surface and sub-surface deposits) of the four within the LSA and therefore the most likely candidate for *Lord Sandwich* (Abbass 2019: 4–6).

In 2019, a limited-impact Phase II study of RI 2394 commenced. Proposed tasks included controlled excavation of the wreck site to expose two or three narrow test trenches, and between six and eight small test pits at specific locations along the hull. Newly exposed timbers would be documented and sampled, representative

ballast and silt samples collected, and selected artefacts recovered for analysis. Non-disturbance investigations were also conducted at shipwreck sites RI 2578, RI 2794 and RI 2393, as all had the potential to provide comparative data to support RI 2394's identity as *Lord Sandwich* (Hosty 2019: 1–11). RIHPHC granted permission to excavate a small area of RI 2394 to expose deeply buried and better-preserved sections of articulated hull structure (Abbass 2019; Hunter, et al. 2019: 19–22).

The team also wished to determine whether the wreck site exhibited remnants of a 'rider' or 'deadwood' keelson. The keel is the primary structural component of a wooden sailing vessel and extends longitudinally along the bottom centreline of the hull, while the keelson is a corresponding timber that lies atop the floors and locks them against the keel, reinforcing the overall lower hull structure. Whitby shipbuilder Thomas Fishburn was known for constructing sturdy, solid-floored colliers designed to be run ashore in shallow tidal estuaries and harbours. To prevent the vessel breaking its back when 'taking the ground', Fishburn incorporated a second rider or deadwood keelson into the hull design of several of his vessels, including *Earl of Pembroke* (later HMB *Endeavour*) and *Marquis of Rockingham* (later HMS *Adventure*). This timber was installed atop the vessel's regular keelson, substantially increasing its overall height to 34.5 inches (0.9 metres) (Hosty, 2019: 1–11; Hunter, et al. 2019: 22).

The 2019 excavations also focused on locating evidence of the damaged areas of *Endeavour*'s hull created when the vessel ran aground on Australia's Great Barrier Reef in 1770. Specific fieldwork tasks included excavation of at least two narrow (2–3 foot wide) transverse trenches from the eastern edge of the visible frames to the centreline, identification of the keel/keelson assembly, and detailed documentation of all exposed floor timbers, futtocks, ceiling and exterior planking (Hosty, 2019: 1–11; Hunter, et al. 2019: 20). Once the wreck site's centreline was located and identified, a narrow trench was excavated along the keel/keelson assembly to locate each timber's preserved ends and determine their respective overall lengths. Another sought-out feature was the unique 'step' between the keelson and rider/deadwood keelson that is a specific construction feature visible on the hull plans of *Earl of Pembroke*/HMB *Endeavour* (Hosty, 2019: 1–11; Hunter, et al. 2019: 20).

Timber, ballast and sediment samples were collected from areas where they might be most diagnostic, such as the keel/keelson assembly, along transverse trenches, and where indicated by timbers exposed in specific excavation units and test pits. Particular focus was placed on RI 2394's keel, keelson and end posts, while special care was taken to identify evidence of repairs in areas where *Endeavour*'s hull was known to have been damaged (Hosty, 2019: 1–11). As with previous investigations, all timber samples were large enough to be divided into four pieces for testing: one for RIMAP's chosen specialist, one for ANMM's chosen specialist, one for a third-party expert opinion in case the first two disagreed, and one for the site's permanent data archive (Hunter, et al. 2019: 22).

A round of winter fieldwork was undertaken in January 2020 to take advantage of better water clarity in Newport Harbor that occurs when plankton and algae blooms die off. The project aimed to establish a north-south centreline on RI 2394, and to this end the team excavated a series of test pits northwards from the September 2019 excavation units, following the line of the keel to locate the northern extent of the site (Hosty, 2020: 13–21). Investigations also aimed to locate the keelson/rider keelson complex, assess the condition of four cannons exposed or partially exposed above the seabed, and commence *in situ* conservation treatment of two of these cannons on the site's western periphery. Finally, efforts that had commenced in 2019 to conduct a photogrammetric 3D reconstruction (P3DR) survey of the site continued (Hosty, 2020: 13–21).

During September–October 2020, Dr John Broadwater joined the project team to act as a 'surrogate' for ANMM's maritime archaeologists, who were unable to travel to the United States due to the Covid-19 pandemic. A former Director of NOAA's Maritime Heritage Program, Broadwater was selected because of his archaeological experience and expertise with 18th-century shipwreck material culture and hull construction (see Broadwater 1980, 1995; Broadwater et al., 1985). Activities undertaken in October 2020 were a continuation of previous site investigations at RI 2394, including the effort to locate the northernmost preserved end of the hull with probing, metal detecting and limited excavation (Broadwater, 2020: 18). Probing was conducted along the site's centreline to the end of recognisable hull structure at the 120-foot (36-metre) mark.

Simultaneously, a metal detector was used to follow the line of keel bolts from the wreck site's midship section, where their concretions were visible, out to the end of the centreline. At the conclusion of these non-disturbance surveys, the team commenced excavation of a test pit at 100 feet (30.5 metres) north of the southern end of the site, and east of the new centreline (see Broadwater, 2020: 18–20).

After consolidating the results of both 2020 expeditions, additional investigations commenced at RI 2394 between 10 and 25 September 2021. Due to ongoing Covid-19 travel restrictions, Broadwater again served as a surrogate for the Australian team, and was joined by Joshua Daniel, another American maritime archaeologist with relevant knowledge and experience (see Broadwater and Daniel, 2021: 9). Coordinated by RIMAP, the principal objective of this round of fieldwork was to collect additional data to test the hypothesis that RI 2394 comprised the shipwreck

of *Lord Sandwich*. The primary goals of the investigation were to:

1. follow up previous efforts to locate the southern end of the site's preserved hull remains;
2. locate a second starboard suction (bilge) pump tube that would confirm the hull was fitted with four bilge pumps (instead of the more common practice of installing two bilge pumps);
3. recover wood samples from frames at the southern end of the preserved hull; and
4. time permitting, search for the northern end of the site to determine the hull's overall preserved length.

All tasks were intended to collect as many details of the vessel's design and construction as possible so they could be rendered in a detailed archaeological site plan (featured on the gatefold rear cover of this report) and compared with details of HMB *Endeavour*'s build in archival sources. This 'preponderance of evidence' approach reflected a list of criteria agreed to by ANMM and RIMAP in 2019 (see 'Identification criteria' below).

The 2021 expedition revealed the PVC baseline installed on RI 2394 prior to commencement of the October 2020 investigations was out of alignment with the orientation of the articulated hull's centreline (Broadwater and Daniel 2021: 14). To maximize the chances of finding the southern end of the site, and to improve overall accuracy of the site plan, the 2021 team allocated several dives to installation of baselines accurately aligned with the centreline. Because the PVC baseline was not properly aligned with the keel, two corrective actions were taken. First, the PVC baseline was tightened and realigned by attaching an anchor to each end of the baseline approximately 10 feet (3.0 metres) beyond its ends. The anchors were then used to stretch and straighten the baseline. The team then established a new centreline baseline by aligning it with a series of keel bolt concretions – many of which were uncovered during the 2021 investigations – and exposed portions of the keel at the site's southern end (see Broadwater and Daniel 2021: 14–15). Preliminary results of the 2021 field season were detailed in a report generated by Broadwater and Daniel in November of that year (see Broadwater and Daniel 2021). Specific details of the methodologies employed on shipwreck sites within the LSA, and the data recovered from them, are outlined in subsequent sections of this report.

Identification criteria

The agreed identification criteria for the shipwreck site of *Lord Sandwich* (ex-HMB *Endeavour*) were developed jointly by representatives of ANMM, RIMAP and RIHPHC (ANMM and RIMAP 2018: 4; 2019: 3). These criteria have undergone several iterations, based upon new archival and archaeological evidence uncovered since 1999. The empirical basis for the development of these criteria is outlined here. The current criteria can be found in the section below entitled 'Description and analysis of RI 2394's hull remains'.

Historical sources

Prior to its purchase by the Royal Navy in 1768, HMB *Endeavour* was called *Earl of Pembroke*. There exists both in Australia and in the United Kingdom an extensive archive of documents and ship's plans associated with *Earl of Pembroke*, as well as its transition to HMB *Endeavour* and subsequent voyage of exploration to Australia. This corpus of evidence exists owing to the following factors.

- Detailed surveys carried out on *Earl of Pembroke's* hull prior to its purchase by the Royal Navy in 1768.
- Detailed surveys carried out at Deptford prior to *Lord Sandwich* (ex-HMB *Endeavour*) being accepted by the Board of Transport in 1776.
- The meticulous records of the Navy Board.
- Journals kept by those aboard *Endeavour* during its voyage of exploration, including James Cook, Joseph Banks, Sydney Parkinson, Jonathon Monkhouse and Robert Molyneux (see Appendix 1. Construction details from *The Voyage of* Endeavour *1768–1771*).
- Research related to the design and construction of the HMB *Endeavour* replica built in Fremantle, Western Australia, and launched in 1993.
- Continuing historical and cultural interest in the voyages of Cook and *Endeavour*.

Construction materials

Historical sources such as Burney (1815: 133, 322), Falconer (1769), Sutherland (1711) and Partington (1826: 98, 141) imply that British-built ships such as *Earl of Pembroke/ Endeavour* were constructed predominantly of English white oak (*Quercus robur*) for floors and futtocks, as well as ceiling and hull planking, English or Dutch elm (for the keel, stem post and possibly the keelson), Baltic pine (for all masts) and possibly fir (for the upper deck). Jones (1982: 236) notes that from 1790 onwards shipbuilders in Whitby were importing increasing amounts of elm and oak from Europe (Geneva) as suitable timber became harder to find in England. These historical sources are supported by comparative archaeological surveys of 18th-century shipwrecks in North American waters and more contemporary accounts of shipbuilding in England during the 1700s (Jones 1982: 34–6; Krivor 1994: 124–7; Mitchell 1994: 11–15, 60–8; Steffy 2004: 256–9; VanHorn 2004: 15–18, 227–33; Wilson 2015: 94–6).

Earl of Pembroke was timber sheathed, assembled with iron and timber (treenail) fasteners, and fitted with iron gudgeons and pintles (hinges that attached the rudder to the vessel's stern). No copper-alloy bolts, fasteners or sheathing were used in the construction or refit of either *Earl of Pembroke* or *Endeavour*. It is also possible that Australian timber species were employed to repair the vessel at Endeavour River during June and July of 1770, or that Southeast Asian timber was incorporated into the more extensive overhaul undertaken in Batavia (now Jakarta in Indonesia) in October 1770.

By contrast, 18th-century vessels built in North America tended to use hard maple (*Acer nigrum*), American white oak (*Quercus alba*), yellow pine (*Pinus jeffreyi* or *Pinus ponderosa*), southern hard pine (*Pinus taeda, Pinus echinata, Pinus elliottii* or *Pinus pallustris*) or live oak (*Quercus virginiana*) for their keels. Floors, futtocks and planking typically comprised a mixture of live oak (*Quercus virginiana*), American white oak (*Quercus alba*), chestnut oak (*Quercus prinus*), southern hard pine (*Pinus taeda, Pinus echinata, Pinus elliottii* or *Pinus pallustris*), red cedar (*Juniperus virginiana*) and red oak (*Quercus rubra*) (Carter and Kenchington 1985: 13–26; Dunning 2004: 187–213; Reiss 1987: 20–2; Steffy 2004: 256–9 and VanHorn 2004: 15–18, 227–33). Consequently, data recovery protocols for all sites investigated in Newport Harbor called for thorough hull recording, as well as sampling of timbers and fasteners recovered from a variety of strategic structural components, such as the keel, keelson and framing elements.

Scantlings

By the 1700s, shipwrights had developed a series of unwritten codes relating to the size of structural timbers used in ship construction. Some of these codes were later formalised in Sutherland's *The Ship-builders Assistant* (1711), Blanckley's *A Naval Expositer* (1750), *The Shipbuilder's Repository* (Anon, 1788) and, later, *Lloyd's Rules and*

Regulations for the Construction and Classification of Ships. The latter was used by Lloyd's surveyors from the 1760s onwards and specified that vessels of a particular tonnage must be constructed with timbers of a certain size. The *Rules and Regulations* also specified the minimum dimensions of specific structural components, such as the keel, keelson, floors and futtocks. Known collectively as 'scantlings', these dimensions can be used to calculate the tonnage of 18th-century shipwreck sites.

The initial non-disturbance surveys of RI 2394 established that natural processes have damaged the original surfaces of exposed timber sections, calling into question the accuracy of their respective scantling measurements (Hunter, et al. 2018: 21). For this reason, excavated, undamaged timbers were targeted, as their preserved scantlings were more likely to provide an accurate indication of the wrecked hull's original dimensions and tonnage.

Iron ballast analysis

When *Endeavour* grounded on Endeavour Reef in 1770, the crew jettisoned over 50 tons of material from the vessel. This included iron guns, gun carriages, water casks, provisions and some of the stone and iron ballast that had been stored in the bark's Bread Room. In the late 1960s, several artefacts associated with *Endeavour's* grounding, including six cannons, one anchor, and most of the jettisoned stone and iron ballast were recovered from the stranding site. In accordance with *The Navigation Act 1912*, these items were handed over to Australia's Commonwealth Department of Transport (Pearson 1972). While the anchor and six cannons were sent to various institutions and museums in Australia and internationally (Greenwich, Philadelphia, Auckland, Canberra, Cooktown and Kurnell), the Department passed custodianship of the remainder of the recovered material to ANMM in 1986.

It is likely that *Endeavour's* iron ballast, which was considered a 'permanent' fixture and usually chained or fastened to the hull, was included when the vessel was sold out of Royal Navy service in 1775. Comparison between iron ballast found on any of the Newport shipwrecks with examples held by ANMM and known to have originated from *Endeavour* could be used as a means of site identification. Suitable techniques could include X-ray fluorescence (XRF), metallurgical sampling or dimensional comparisons.

Element	Ballast iron %
Total carbon	3.01%
Silicon	0.01%
Manganese	0.25%
Sulphur	0.03%
Phosphorus	1.17%
Titanium	0.005%
Copper	0.02%
Vanadium	0.007%

Table 3. Metallurgical composition of kentledge from HMB *Endeavour*, recovered from Endeavour Reef in 1969.

In the 18th century, Royal Navy ballast or 'kentledge' was manufactured to a specific size (3 feet x 6 inches x 6 inches (0.90 metres x 0.15 metres x 0.15 metres) and weight (320 pounds or 145 kilograms). It was also typically marked with the 'Broad Arrow', indicating British government ownership (Lavery 1987: 186). Pearson (1972: 74) notes that kentledge recovered from Endeavour Reef had a specific metallurgical composition (Table 3).

This result is typical of high-phosphorus white-cast iron but demonstrates an unusually low silicon content – probably a product of the smelting process (Pearson 1972: 74). The foundry that produced *Endeavour's* kentledge appears to have chosen cheap and readily available iron ore that was easy to smelt and cast in a charcoal-fed blast furnace. The result was an iron composition that was brittle, but ideal for ballast. At least one of *Endeavour's* ballast blocks in the collection of the Silentworld Foundation was revealed to contain iron shot, which suggests recycled material of this type was also used (Hundley and Malliaros 2021: 2).

Stone ballast analysis

It is possible that examples of stone ballast that Cook and his crew obtained during their voyage to the Pacific may be found atop the ceiling planking and between frames on the *Lord Sandwich* wreck site. Only one of the other 13 transports scuttled in Newport Harbor – the much larger 671-ton East Indiaman *Grand Duke of Russia* – journeyed to the South Pacific during its sailing career.

Careful sampling of stone ballast, in particular whole stones or fragments found between frames and/or immediately atop ceiling planking, might reveal exotic types identical to those found in the South Pacific. Of particular interest would be stone originating from New Zealand and Tahiti, where *Endeavour's* crew is known to have obtained additional ballast (see Appendix 1. Construction details from *The Voyage of* Endeavour *1768–1771*). Ballast stone recovered from scuttled transport sites in Newport Harbor could also be compared with *Endeavour* ballast recovered from Endeavour Reef in 1969 and now held in ANMM's collections (Pearson 1972: 105).

Coal analysis

Prior to its conversion to *Endeavour* in 1768, *Earl of Pembroke* operated as a collier (coal carrier) out of Whitby, England. Abbass (1999) has also reported that

Lord Sandwich carried coal from England to Newport via New York in 1776. A comparison of coal recovered from shipwreck sites within the LSA with known coal sources in England could assist in narrowing the field of candidates to only those that shipped British coal.

In 2000 and 2001 Professor Claus Diessel from the University of Newcastle (Australia) carried out analysis of coal recovered from RI 2125 (Hospital Cannon Site) and RI 2119 (Gamma Site). on behalf of the ANMM/RIMAP team. In both instances, Diessel identified the coals as coming from British sources (Diessel 2000, 2001).

Silt and sediment analysis

Endeavour's voyage to the South Pacific, as well as its period of repairs in both Australia and Indonesia, may have created an opportunity for marine organisms, plant fragments and pollen spores unique to these regions to be trapped within bilge sediments. Analysis of these sediments could reveal region-specific organisms that would provide compelling evidence towards identifying a particular wreck site as *Lord Sandwich*. Further, analytical techniques such as Lead-210 accumulation could be used to accurately date shipwreck bilge sediments.

Hair and timber treatment analysis

Beginning in the mid-1500s, maritime nations treated, coated and sheathed the hulls of their ships with various mixtures, concoctions and substances, to preserve and protect them from marine borers and prevent fouling. During its overhaul for Royal Navy service, *Endeavour's* timbers were re-caulked and covered with thick layers of paper rags coated in a mixture of horsehair and tar. An additional layer of wooden planking was then coated with 'White Stuff' comprising 'trans oil' (whale and fish oil), rosin, turpentine and brimstone. The protective sheathing was then 'filled' with broad-headed iron nails in a process called hob-nailing (Moore 2018: 109). Careful sampling and analysis of the wreck site's hull planking may isolate protective coatings, allowing them to be compared to those known to have been used on HMB *Endeavour*. These samples could also aid in dating the shipwreck.

Material culture analysis

It is highly unlikely that artefacts associated with Cook's voyage to Australia remain within the shipwreck's surviving hull. However, it may be possible to identify the site through analysis of artefacts associated with *Lord Sandwich's* use as a troop transport and prison ship. Material culture associated with Hessian troops transported to the American colonies aboard *Lord Sandwich* in 1777, or any of the prisoners known to have been incarcerated on the ship prior to it being sunk as a blockship, would provide strong evidence of the site's identity. The prospect of finding such diagnostic material culture is slim as Knowles reported that the British transports were stripped of fixtures and fittings (and indeed anything that could be recycled or reused) prior to being scuttled in 1778 (Abbass 2016: 26). However, Abbass (2016: 26) also states that at least two of the 18th century Newport Harbor shipwreck sites studies by the RIMAP/ANMM team include cannon – notably The Hospital Cannon Site (RI 2125) and RI 2394.

Historical analysis

In 2016, Dr Erskine received financial assistance from the Australian Research Council to commence a review of all archival material relating to HMB *Endeavour* and *Lord Sandwich*. This included material held in the collections of the Public Records Office and National Archives at Kew, England, Caird Library (Royal Museums Greenwich), British Library and the Vaughan Evans Library at ANMM. Erskine's research was published in *The Great Circle*, the same Australian academic journal that published the initial article connecting *Endeavour* to *Lord Sandwich* (Erskine 2017). This research proved beyond reasonable doubt that *Endeavour* and *Lord Sandwich* were the same vessel. It also confirmed that *Lord Sandwich*, along with four other transports, was scuttled directly to the north of Goat Island in August 1778.

Of the five transports sunk north of Goat Island, only *Lord Sandwich* has been extensively researched. The remaining four vessels (Table 4) became the subject of a more exhaustive archival study conducted by Erskine in 2017–18, Dr James Hunter, ANMM's Curator of Naval Heritage and Archaeology, in 2020–22 (see below) and RIMAP (Abbass and Lynch 2024) .

Although the 1778 report by Lieutenant Knowles indicates five British transports were scuttled within the LSA (historically, the area between the northern end of Goat Island and the North Battery), to date only four 18th-century shipwreck sites have been positively identified within the same location. Indeed, multi-beam echo sounder imagery obtained by NOAA within the boundaries of the LSA reveals a relatively featureless seabed between the north end of Goat Island and the former location of the North Battery, save for the four sites (RI 2396/2397, RI 2578, RI 2394 and RI 2393) already located.

Erskine (2017: 68, 79–80) notes a handful of scuttled transports may have been refloated after the Battle of Rhode Island and that one of these vessels, *Earl of Orford*, was among those intentionally sunk within the LSA.

Candidate shipwrecks

Earl of Orford

Earl of Orford was an American-built ship surveyed by the Transport Service on 7 October 1775. Some discrepancy exists between the information recorded during this survey and what is listed for the vessel in *Lloyd's Register*

Name	Tonnage	Type	Year built	Origin	Notes
Mayflower	160	Snow	1759	Whitehaven, England	Survey 197 tons
Earl of Orford	200	Ship	1769	Maryland, North America	Survey 231 7/94 tons
Peggy	200	Ship	1766	North America	Most likely vessel from five candidates
Yowart	250	Ship	1764	Whitehaven, England	Survey 272 tons
Lord Sandwich	350	Bark	1764	Whitby, England	Survey 368 71/94 tons

Table 4. Key characteristics of the five transports scuttled north of Goat Island in August 1778. Tonnage is that listed in *Lloyd's Register* for 1776–78, while the surveyed tonnage is that recorded by the British Transport Service upon commissioning.

of Shipping. According to the survey, *Earl of Orford* was launched in 1771, had a carrying capacity of 231 7/94 tons, and its master was James Johnson (Erskine 2017: 70; Syrett 2015: 114). It was a full-bodied ship, with its bottom sheathed in timber. It was flush-decked fore and aft, roomy, and featured good accommodation with a proper (full-length) lower deck. Its height between decks was 5 feet 9 inches (1.72 metres) forward, 5 feet 7 inches (1.69 metres) midships and 6 feet 2 inches (1.88 metres) aft. By contrast, the ship's first entry in *Lloyd's Register* lists its year of construction as 1769, a carrying capacity of 200 tons and T. Twyman as master (Society for the Registry of Shipping: 1776). Additional details of note include that it was built in Maryland, had a draught of 14 feet (4.3 metres), and was owned by J. Jenkins. It is also recorded as a 'London Transport' and, as only one vessel with the name *Earl of Orford* was listed in the employ of the Transport Service during the American War of Independence, both sets of records almost certainly refer to the same ship.

The ship's details in *Lloyd's Register* remain consistent for the tenure of its listing, although curiously, the name is recorded as *Earl of* ***Oxford*** in most entries (Society for the Registry of Shipping: 1778, 1781–84). However, as the other details remain the same, it can be surmised the name *Earl of Oxford* is a transcription error that was accidentally repeated. The vessel scuttled at Newport in 1778 is listed in archival correspondence as *Earl of* ***Orford***, and as there is no record of a transport named *Earl of Oxford* in these sources, it stands to reason this was the ship's true name (Knowles 1778). Furthermore, the British peerage title Earl of Oxford became dormant in 1703, whereas the Earl of Orford was established in 1697, lay dormant between 1727 and 1742, but was again bestowed over 1742–97. When the vessel was launched in 1771, the title was held by the 3rd Earl of Orford, George Walpole, a British army officer during the Seven Years' War (1756–63). Additional support for this argument includes *Earl of Orford* (of 231 tons) listed among transports that accompanied the expeditionary fleet assembled by Commodore Sir Peter Parker to assault Newport in November 1776 (Morgan 1976: 260). Additionally, an 'Earl of Oxford' is included among a list of transports moored in the Downs on 5 December 1775, but 'Twyman' is recorded as the vessel's master (Clark 1968: 407).

Erskine's contention that *Earl of Orford* may have been refloated is based on his observation that the vessel appears in *Lloyd's Register* until 1781 – an aspect that mirrors a handful of other transports, such as the brigs *Good Intent* and *Malaga*, and snow *Esther* (Erskine 2017: 79). By contrast, the entries for all other transports – except for those specifically identified by Knowles as having been 'weighed' (refloated) – end in 1779 (Knowles 1778). Erskine (2017: 79) states the appearance of these latter vessels in the 1779 edition of *Lloyd's Register* is not surprising, as it 'seems likely that it took several months for vessel losses to filter through to Lloyd's, and that the continuing listing of the scuttled and burnt vessels ... should be regarded as a short-term aberration'.

Building on Erskine's research, additional review of *Lloyd's Register* has revealed *Earl of Orford* is listed *beyond* 1781 (as *Earl of Oxford*) and does not disappear from the register entirely until 1784. Although Knowles (1778) observed that 'ships sunk off the different batteries in the channells [sic] [could not] possibly be weighed' due to a variety of factors, including their age and water depth where they were scuttled, it is possible some exceptions were made. This could account for *Earl of Orford* still being listed in *Lloyd's Register* six years after the Battle of Rhode Island.

Alternatively, *Earl of Orford's* persistent presence in the register may indeed have been erroneous. It may have been the result of information about the vessel's fate only gradually reaching the Society for the Registry of Shipping (renamed *Lloyd's Register of British and Foreign Shipping* after 1833). There is also the possibility that the missing shipwreck site in the LSA may have been removed or otherwise destroyed by subsequent development activities in Newport Harbor, including channel dredging, placement of subsurface infrastructure such as moorings

and cables, and efforts to reduce or eliminate hazards to navigation. To date, a fifth wreck site remains unaccounted for and would fill the apparent gap between the otherwise evenly spaced cluster of three sites close to the north end of Goat Island (RI 2578, RI 2394 and RI 2393) and the fourth site (RI 2396/2397) nearer the North Battery and northern approach to Newport's inner harbour. This proposed gap may indicate that one of the transports may have ultimately been refloated. This supposition is in turn supported by *Earl of Orford's* listing in *Lloyd's Register* until 1784 (Hunter 2022).

Mayflower

Mayflower was approved for the Transport Service and granted a license to carry goods to North America on 13 March 1776. Recorded as having a carrying capacity of 197 tons, the vessel made at least two trips to North America, carrying troops and equipment, before ending up in Newport in 1778. The vessel is recorded in the 1776 edition of *Lloyd's Register* as a two-masted snow of 160 tons, built at Whitehaven in England in 1759. It had a draught of 13 feet (4.0 metres), a single deck and was listed in the 1778 *Muster of Transports in America* as armed with two 6-pounder and four 4-pounder cannons (Erskine 2017: 71).

Yowart

The 250-ton ship *Yowart* (or *Youart*) was recorded in the 1776 edition of *Lloyd's Register* as having been built in Whitehaven, England in 1764. It had a draught of 14 feet (4.3 metres) and was rated A1. *Yowart* was accepted into the Transport Service in May 1776 as a victualler to His Majesty's ships to North America. In that capacity it made two voyages to the North American colonies before ending up in Newport Harbor in 1778 (Erskine 2017: 72).

Peggy

Erskine (2017: 76–7) identified three potential candidates for a vessel named *Peggy*, reportedly scuttled alongside four other transports in waters north of Goat Island prior to the Battle of Rhode Island in September 1778. While one was a ship of 360 tons and comparable in size to *Lord Sandwich/Endeavour* (368 tons), the other two had significantly smaller tonnages (234 and 209 tons, respectively) and the likelihood is that their smaller size was reflected in their construction. What is unclear is the specific origin and tonnage of the scuttled *Peggy*, a common name for British- and American-built vessels in the 18th century. Abbass and Lynch (2024: 123–36) have reviewed several candidate vessels, including a 90-ton Rhode Island-built vessel, concluding that it was highly unlikely to have been scuttled in Newport in 1778. Building on Erskine's research, a comprehensive review of *Lloyd's Register of Shipping* was undertaken, with particular emphasis on editions published proximate to the 1778 Battle of Rhode Island.

A single-decked brig of 180 tons named *Peggy* first appears in the 1776 edition of *Lloyd's Register*. It was built in Dundee, Scotland in 1773, owned by Sheriff & Co., and its first master was John Scougal. It was operating as an armed transport by 1778, under the command and ownership of J. Rankin. The brig's complement of defensive artillery comprised six 3-pounders and remained with the vessel until at least 1784, when armament is no longer noted in the register. *Peggy's* length was extended in 1778, which resulted in an increase in the brig's carrying capacity to 230 tons. Following the end of the American War of Independence, the vessel was primarily engaged in colonial trade between London and Jamaica. It underwent some repairs in 1784, but also had its rating downgraded to E1 the same year. Three years later, *Peggy's* entry in *Lloyd's Register* was crossed out and the vessel listed as 'lost' while on a voyage from London to Honduras under the command of R. Spence.

A 200-ton single-decked ship named *Peggy* first appears in *Lloyd's Register* in 1776. Its place of build is listed as 'America' and it was launched in 1766. By 1776, the vessel was rated E1, owned by Stevenson & Co., and its master was C. Campbell. While not listed as a transport, *Peggy* was operating in the American colonies at the time the Battle of Rhode Island occurred. It disappears from the register after 1778, which suggests it could be a candidate for the *Peggy* scuttled at Newport.

The name *Peggy* was also given to a brig of 170 tons that was built in the American colony of Virginia in 1774. It was initially owned by John Ingram and its first master was Jacques Fox. In 1778, the vessel's hull was lengthened and carrying capacity increased to 400 tons. It was also armed with two 4-pounder and four 3-pounder cannons. Now under the ownership of Leighton & Co., it operated between London and the Russian port city of St. Petersburg until 1781, when it was listed as a transport. *Peggy* operated in this capacity until 1784, when it disappears from *Lloyd's Register*. Although not officially listed as a transport at the time the Battle of Rhode Island occurred, *Peggy* was armed and could have been requisitioned for transport duty. However, given that it disappears from the register after 1784, this vessel could not have been scuttled at Newport in 1778 – unless it was subsequently re-floated.

In 1767, the 250-ton single-decked ship *Peggy* was launched in the American colonies. It had a draught of 14 feet (4.3 metres) and was owned and captained by R. Aukland. The vessel is only listed in the 1776 edition of *Lloyd's Register*, at which time it was rated A2 and operating between Leith and St. Petersburg. It is identified by Erskine (2017: 77) as a possible candidate for the *Peggy* scuttled in Newport Harbor during the Battle of Rhode Island. However, given that it is not listed in the register after 1776, this seems unlikely but cannot be entirely ruled out.

Of the three *Peggy* candidates identified by Erskine, the largest and closest in size to *Lord Sandwich/Endeavour* is a single-decked ship of 360 tons built at Hull in 1760. It appears in the 1764 edition of Lloyd's Register with a larger carrying capacity (480 tons) that was reduced to 360 tons by the 1768 edition. In 1774, *Peggy* underwent thorough repairs and refit, including installation of new upperworks. Two years later, its hull was sheathed, it was placed under the command of J.B. Wilson and identified as a transport for the first time. By 1778, the ship was armed with six 4-pounders, but this was upgraded to '14 guns' of unidentified calibre the following year. *Peggy* was listed as a transport until 1780, when it began operating between London and New York. It underwent repairs in 1780 and 1783, the latter of which included re-sheathing of the hull.

In 1789, *Peggy's* listed carrying capacity was reduced a second time to 352 tons. Command transferred from J.B. Wilson to a Mr Edington in 1793, and the vessel commenced operating between London and Norway. Its hull was almost completely rebuilt and re-sheathed two years later, at the same time the vessel commenced operating out of the English port of Hull. Curiously, its capacity was increased to 362 tons in 1793. In 1798, *Peggy* was re-armed with six 6-pounders, possibly due to the Irish uprising that began the same year. Its complement of artillery was downgraded to six 4-pounders two years later, and no armament is listed for the ship between 1801 and 1813, when it was re-armed with four 9-pounders. The 1813 re-arming of the vessel was almost certainly a consequence of the Napoleonic Wars, as no armament is listed after 1815, the year Napoleon was defeated at Waterloo and exiled to St. Helena.

Peggy was in the possession of M. Middleton from its launch in 1760 until 1816, when ownership passed to merchants Michael Henley and Son, and J. Taylor assumed command. Some repairs were made to the ship the same year, and in 1818 *Lloyd's Register* notes the hull was fitted with iron knees and part of its keel was replaced. *Peggy's* last entry in the register is in 1821, the year after ownership transferred to R. Seaton and P. Davis was put in command. Despite being 61 years old, the ship was operating on the North Atlantic run between Bristol and Quebec – a route notorious for foul weather and heavy seas, particularly during the winter months. Although its fate is unknown, the fact this *Peggy* is listed in *Lloyd's Register* until 1821 means it could not have been lost at Newport – unless it was scuttled and subsequently re-floated.

Therefore, of the *Peggy* candidates registered around 1778, only the 360-ton ship built at Hull in 1760 is of comparable size to *Lord Sandwich/Endeavour*. It would therefore likely share specific hull features, such as scantlings and British timber species, with shipwreck site RI 2394. The 180-ton, 200-ton and 250-ton vessels named *Peggy* would likely have been constructed with timber scantlings smaller than those listed for HMB *Endeavour* in its 1768 Admiralty survey report.

Furthermore, the latter two vessels were built in the American colonies and almost certainly would have featured North American timber in their construction. While the 170-ton brig *Peggy* was later rebuilt to a size (400 tons) that more closely approximates that of *Lord Sandwich/Endeavour*, that vessel too was built in the American colonies and very likely comprised hull elements hewn from indigenous wood species.

Apart from the 200-ton *Peggy* built in the American colonies, all the candidates either disappeared from *Lloyd's Register* before the Battle of Rhode Island or continued to be listed for several years afterwards. The most notable example is the 360-ton ship built in Hull, which remained in operation until 1821 and underwent over four decades of documented repairs, refits and ownership changes following the naval engagement in Newport Harbor. If this vessel was the *Peggy* scuttled at Newport – a scenario that is highly unlikely – it must have been re-floated and therefore cannot be RI 2394.

In summary, if the shipwreck of the *Peggy* scuttled in 1778 remains within the Limited Search Area, it is almost certainly the 200-ton *Peggy* built in the American colonies in 1766. However, its smaller scantlings and North American timber composition would clearly distinguish it from the larger scantlings and British timber construction attributed to *Lord Sandwich/Endeavour*.

Lord Sandwich

As noted in Figure 7 above, *Lord Sandwich*, formerly HMB *Endeavour*, was listed as a 350-ton ship in the 1778 edition of *Lloyd's Register*. Allowing for the uncertainty regarding the identity of the *Peggy* scuttled at Newport in 1778, *Lord Sandwich* was 100 tons larger than any of the other four transports scuttled within the Limited Study Area. The respective tonnages of the five sunken transports should be reflected in the relative size of each shipwreck and the scantlings of its surviving hull timbers (Hunter 2021).

Candidate shipwreck sites

Between 1999 and 2021, maritime archaeologists from RIMAP and ANMM conducted remote sensing, mapping and photogrammetric surveys of myriad underwater archaeological sites and features in Newport Harbor (See Hosty 1999, 2000, 2001, 2015 and 2019). In addition to systematically ensuring no potential shipwreck sites remained un-surveyed, these investigations also eliminated many natural features and non-shipwreck sites from consideration. The sites that have been investigated as potential candidates for *Lord Sandwich* (ex-HMB *Endeavour*) are located within the bounded area of Newport Harbor depicted in Figure 8. For definitions of nautical and maritime archaeology terms, see Appendix 2.

Figure 8. Dotted yellow line indicates the Limited Study Area established in 2017, indicating the approximate location of underwater archaeological sites in Newport Harbor considered to be possible locations of vessels scuttled in 1778. Image: James Hunter/ANMM; map data: ©2024 Google, Airbus.

More detailed evaluation of these candidate sites is presented below. The discussion of shipwrecks within the original study area (RI 2119, RI 2125, RI 2579, RI 2595 and RI 2580) is relatively brief as archival research in 2016 confirmed *Lord Sandwich's* wreck site is located within the much smaller Limited Study Area (Abbass 2016: 10–17; Erskine 2017).

Original Study Area

Archival research conducted by Abbass (1999) suggested the general location of scuttled British transports to be anywhere within Newport Harbor indicated by 18th-century maps and illustrations such as the Fage Chart (see Figure 2). For this reason, fieldwork conducted between 1999 and 2017 encompassed many potential 18th-century shipwreck sites across numerous locations in the vicinity of Newport and Goat Island. It was only after Erskine's 2016 archival research revealed the specific location within Newport Harbor where *Lord Sandwich* was scuttled that archaeological investigations focused on the Limited Study Area outlined in Figure 8 (Abbass 2016: 6).

RI 2125 ('Naval Hospital Cannon' site)

The first joint ANMM-RIMAP archaeological project in August 1999 involved limited excavation of a shipwreck site colloquially known as 'Primary Target A' or the 'Naval Hospital Cannon Site'. Also known by its RIHPHC site number RI 2125, the wreck site had been the subject of previous non-disturbance archaeological surveys and was at the time the most likely contender for *Lord Sandwich* (Abbass 1998: 14; Bassett, et al. 2000a).

RI 2125 is in 16–18 feet (5–6 metres) of water, 165 feet (50 metres) west of a concrete and stone pier that is associated with the former US Naval Hospital at Naval Station Newport. The site consists of a stone ballast mound approximately 50 feet (15 metres) long by 33 feet (10 metres) wide that rises to a height of 3 feet (1 metre) above the surrounding seabed. Other visible elements include two iron cannons, scattered hull timbers and two small piles of bricks. The latter feature may be associated with the vessel's galley or kitchen. Articulated lower hull, covered in layers of thick silt and shell, is buried beneath the ballast mound for much of its length (Bassett, et al. 2000b).

The team worked within a 10 foot x 10 foot (3 x 3 metre) grid and uncovered additional ballast stones and pebbles, as well as more hull timbers. Artefacts uncovered in the north-western quadrant of the excavation area included a series of articulated wooden barrel staves and the head of a small wooden cask. These items were recorded *in situ,* photographed, and recovered for further recording and conservation. Other artefacts recovered from the site included small fragments of glass, stone and coal, more barrel staves, ceramic sherds (including fragments of a figurine of possible South-East Asian origin), three wooden handles, the wooden base and spindles of a sand glass, lead pellets, cloth and hair from the ship's caulking, and metal and wooden buttons (Bassett, et al. 2000b). Ten small samples were also recovered from some of the hull's structural timbers and areas where repairs were evident. These samples were analysed by timber specialists in the United States and Australia (Table 5).

The geographic origin of the oak timbers sampled on RI 2125 could not be sourced to an area more specific than the northern hemisphere, but the pine sacrificial planking appears to be of European origin. Although all identified timber species were available in both North America and Europe during the 18th century, the absence of an elm keel suggests a non-English origin for the vessel (VanHorn 2004: 15–18, 227–33).

Structural feature	Timber type
Keelson	Baltic Pine (*Pinus sylvestris*)
Keel	White Oak Group (*Quercus* sp.)
Floor	White Oak Group (*Quercus* sp.)
Outer hull plank	White Oak Group (*Quercus* sp.)
Futtock 1	White Oak Group (*Quercus* sp.)
Repair to futtock	White Oak Group (*Quercus* sp.)
Keelson scarph	White Oak Group (*Quercus* sp.)
Treenail / trunnel	White Oak Group (*Quercus* sp.)
Sacrificial planking	Baltic Pine (*Pinus sylvestris*)

Table 5. Timber sample analysis from RI 2125, conducted by CSIRO Forestry and Forest Products Section.

Hull elements revealed during excavation included a massive keelson complete with scarph joints, a series of first and second futtocks, paired frames, hull planking, ceiling planking and the top of the vessel's keel. All were carefully recorded, and the vessel's lines (shape of the hull) were generated from these data. Subsequent measurements suggested the hull's total keel length exceeded 79 feet (24 metres). Allowing for a physical break in the contiguous articulated hull and twisting of the surviving structure, the keel's original total length was likely in the region of between 80 feet and 82 feet (24.3 to 24.9 metres). A square hole was located directly below the break in the keelson between two of the vessel's floors. It had been deliberately cut or punched through the outer hull planking, indicating the ship's carpenters made a breach in the ship's hull to scuttle it (Bassett, et al. 2000a).

The team noticed major differences between RI 2125 and archival information pertaining to the design and construction of *Lord Sandwich* (ex-HMB *Endeavour*). All floors uncovered in the 10 x 10 foot grid were far too short to match the dimensions listed for *Lord Sandwich* (Bassett, et al. 2000a, 2000b). Several construction features differed from those shown in the *Endeavour* plans. None of the frames were paired, the floors rose too sharply, and every second frame was not attached to the keel by a floor and instead consisted of only the first futtock with no corresponding second futtock. These structural features were identical to those found on the North American-built *Boscawen* but absent from British-built vessels (Cohn 1985: 337). Moreover, the hull was more wedge-shaped and had finer lines than *Endeavour*. RI 2125's surviving hull had all the features of a lightly built sloop or schooner with a fine entry, rather than a square-bodied, bluff-bowed merchant ship (Bassett, et al. 2000a, 2000b). In addition, very few iron fastenings were noted – certainly less than would be expected for a vessel as robustly built as *Lord Sandwich*.

The scantlings recorded for the excavated timbers suggest that RI 2125 was a vessel of around 300 tons. However, the size of the stern post and deadwood was more suitable for a much smaller vessel – possibly one of only 150 to 200 tons. A comparison of the wreck site's scantlings with those obtained from *Endeavour*'s 1768 survey report revealed the average sided dimension of the floors was too narrow (11 inches, as opposed to 12 inches), a larger room-and-space was present between frames (12–18 inches, as opposed to 6 inches), and the keel's depth was too shallow (approximately 15 inches compared to 21 inches). The keel also comprised one piece of contiguous timber rather than two distinct sections joined to one another. RI 2125's hull planking was thinner than that recorded for *Endeavour*, measuring 2 inches thick rather than 3–4 inches (Bassett, et al. 2000a, 2000b).

Enough differences exist between the hull architecture of RI 2125 and *Endeavour* to authoritatively state they are not the same vessel. Post-excavation analysis of stone ballast, coal and sediment samples, as well as the site's artefact assemblage, indicated that while RI 2125 likely represents one of the British transports scuttled in 1778, it was probably an American-built vessel of between 150 and 250 tons that spent some time in European waters before returning to North America (Bassett, et al. 2000a).

RI 2119 ('Gamma' site)

In 2000, the RIMAP-ANMM team commenced investigation of two shipwrecks lying adjacent to one another in 39–42 feet (12–13 metres) of water immediately north of the Jamestown Bridge. The site was designated RI 2119 by RIHPHC and nicknamed 'Gamma'. It comprised a small 20th-century timber and iron barge oriented on a north-south axis. A much earlier stone ballast mound with associated anchor was partly covered by the barge and positioned on an east-west axis. The ballast mound was more than 40 feet (12 metres) long, 16.4 feet (5 metres) across and 3 feet (1.0 metre) high and consisted of numerous dark river-rounded rocks that were possibly basalt or granite (Bassett, et al. 2000a; Hosty and Hundley 2001).

Prominent site features included a large 18th-century Admiralty Pattern anchor located at the eastern end of the ballast pile and a cluster of 18th-century bottle bases on its northern side. A small trench was excavated from north to

Construction feature	Timber type	Likely origin
Floors	White Oak group (*Quercus* sp)	USA or Europe
Futtocks	White Oak group (*Quercus* sp)	USA or Europe
Hull planking (parallel plank)	White Oak group (*Quercus* sp)	USA or Europe
Internal plank (longitudinal timber)	White Oak group (*Quercus* sp)	USA or Europe
Keelson (bow)	White Oak group (*Quercus* sp)	USA or Europe
Keel (stern)	Inconclusive	

Table 6. Timber sample analysis from RI 2119, conducted by CSIRO Forestry and Forest Products Section.

south across the ballast mound, permitting the removal of undisturbed timber, silt, coal and stone samples, as well as collection of scantling measurements (Bassett, et al. 2000a). Substantial frames and ceiling planking were uncovered, and their orientation indicated the hull was heeled steeply on its southern side. Analysis of timber samples revealed the vessel was constructed primarily of oak (Table 6). Unfortunately, it was not possible to isolate the origin of the oak species to a locale more specific than the northern hemisphere (Ilic 2000).

Some similarities were noted between RI 2119 and archival information relating to *Earl of Pembroke/Endeavour*. Although badly degraded, the surviving futtocks appeared similar in size and spacing to those recorded for *Endeavour*. Recovered data suggested RI 2119 represented the remains of a vessel between 300 and 400 tons, a size that encompasses the listed tonnage for *Lord Sandwich* (Bassett, et al. 2000a). The anchor was a wooden-stocked Old Pattern Long-Shanked Admiralty variant that dated to the late 18th century. Its dimensions – 12.1 feet (3.7 metres) long, 1.6 feet (0.5 metres) span between flukes and 2.4 feet (0.75 metres) fluke length – are compatible with the best bower anchor of a vessel between 350 and 400 tons (Curryer 1999). Further, the shipwreck's structural features bore some similarity to construction methods noted in *Endeavour*'s 1768 survey report. RI 2119's scantlings were also close to those recorded for *Endeavour* (Table 7). The team furthermore noted the ceiling thickness (from the floorheads to the keel), as well as the sided dimension of the lower futtocks, was the same as that listed for *Endeavour* (Bassett, et al. 2000b).

The absence of softwood among RI 2119's timber samples and the documented preference of 18th-century English shipwrights to only use hardwoods in vessel construction supports the premise that RI 2119 is an English- or European-built vessel (as opposed to an American-built vessel) (Steffy 1994: 256–9; VanHorn 2004: 15–18, 227–33).

Analyses of the site's ballast, coal, slag and artefacts was largely inconclusive, but favour a British origin or cultural affiliation. Given its estimated tonnage and suspected British nationality, RI 2119 may be the American-built *Britannia* of 374 tons but is more likely the British-built 320-ton ship *Rachel and Mary*. Although the wreck site's archaeological characteristics bore many similarities to those of *Lord Sandwich*, it was ultimately eliminated as a candidate based on subsequent archival research that confirmed *Lord Sandwich* was scuttled within the Limited Study Area (Bassett, et al. 2000a; Hosty and Hundley 2001).

'Site 9'

One sonar anomaly to the west of Goat Island was identified as a relatively small wooden shipwreck comprising hull timbers buried beneath a scattered, flat stone ballast mound and silt. The shipwreck was nicknamed 'Site 9' by RIMAP. Following inspection and initial assessment of the site, project team members established a temporary surveying grid measuring 65.9 feet (20.1 metres) north-to-south by 42.0 feet (12.8 metres) east-to-west. Survey lines were strung every 3 feet (0.91 metres) across the site and all exposed features – including hull timbers, stone ballast, artefacts, natural geological formations, and intrusive items such as lobster traps – were documented *in situ* (Hosty, 2015:64). Owing to its small dimensions, this shipwreck site was readily eliminated as a possible candidate for *Lord Sandwich* (ex-HMB *Endeavour*).

RI 2579

This site did not possess any archaeological features suggestive of a shipwreck and consequently was not subject to further investigation.

RI 2580

Archaeological investigation of this site indicated it was likely a shipwreck, but analysis of associated artefacts and features indicated its date of origin and period of use was probably later than the 18th century. Consequently, it was not subject to further investigation.

	RI 2119	*Endeavour*	*Shipbuilders Repository* 1788
Keel (sided)	12.5″	12.5″	9.0–9.5″
Keelson (sided)	12.5″	12.5″	12–13″
Stem (moulded)	15″	–	16″
Floor (sided)	10–11″	14″	11–13″
Floor and space	24″	29″	20–23″
Lower futtock (sided)	11″	11″	10–12″
Ceilings	10″ x 3″	3″	3.5–4.0″

Table 7. Scantlings measured from shipwreck site RI 2119, the 1768 survey of HMB *Endeavour*, and as listed in *The Shipbuilder's Repository* (Anon 1788).

RI 2595

This site was briefly surveyed and tentatively identified as a scuttled transport shipwreck site. However, because it is located outside the Limited Study Area, the wreck has not yet undergone additional archaeological investigation.

Inter-site surveys

In 2000, the RIMAP-ANMM team conducted a series of remote-sensing surveys of Newport Harbor using a Klein 2000 side-scan sonar with integrated Global Positioning System (GPS). The three areas chosen for examination were located along the west coast of Goat Island, between Fort Greene and Rose Island, and in an area to the east of Gull Rocks bounded by Coasters Harbor Island and the Naval Hospital. Nine sonar anomalies were discounted as 'false echoes' caused by naturally occurring geology, shelving sand or silt, or recently deposited material such as bridge debris. However, four substantial anomalies that represented possible ballast mounds were located immediately south of the Claiborne Pell Newport Bridge. Their locations were recorded with GPS, Loran C, and shore transits, and were later investigated by divers and discounted as shipwreck sites (Bassett et al. 2000b: 18–25).

In 2001 the RIMAP-ANMM team paired with the US Naval Undersea Warfare Center (NUWC) to undertake an extensive remote sensing survey of Newport Harbor. This sub-bottom profiling study also included Coddington Cove, where the Royal Navy frigate HMS *Juno* was abandoned and burnt during the Battle of Rhode Island in August 1778. Here the sub-bottom profiler was able to detect a significant anomaly below the sediment of the cove, which may represent the remains of a vessel. The system was also tested on the sites of three other Royal Navy frigates – HM Ships *Cerberus*, *Orpheus* and *Lark* – that were abandoned and burnt at the same time as *Juno*. Here the sub-bottom profile system proved very successful in detecting the remains of the three frigates and respective stone ballast mounds (Hosty and Hundley 2001).

Limited Study Area

Erskine's 2016 discovery of archival evidence that *Lord Sandwich* was scuttled north of Goat Island led the project team to focus fieldwork on the Limited Study Area. From 2017 onwards, all underwater surveys were undertaken within the LSA. In addition to four historic shipwrecks (RI 2393, RI 2578, RI 2394 and RI 2396/RI 2397), survey activities within the LSA investigated the surrounding seafloor to locate and identify previously unknown sites. The project team had already commenced searching un-surveyed areas within the LSA in 2015 and 2016. Survey areas were divided into 100 x 100 foot (91 x 91 metre) grids that included installation of physical baselines (x) and transects (y). Each grid was then surveyed by divers using swim lines. Despite relatively poor visibility, six grids were thoroughly searched; however, no additional shipwrecks or 18th-century material culture was located (Abbass 2016: 55; Hosty 2016: 88–93).

RI 2393 ('Rod' site)

RI 2393 is located approximately 246 feet (75 metres) south of RI 2394. Known to the project team by its RIMAP nickname, the 'Rod' site, it consists of a compact stone ballast pile measuring 29.5 feet (9.0 metres) north-to-south, and 29.5 feet (9.0 metres) east-to-west. Only the ballast pile is visible above the seabed, and no associated hull timbers, artefacts or other features were noted. Based on a non-disturbance survey of the ballast mound, RI 2393 appears to represent the remnants of one of the scuttled 1778 transports. Two small lead pipes – possibly scuppers – were observed along the eastern periphery of the ballast pile, but no hull timbers, artefacts or other cultural material were noted. A metal detector survey undertaken in 2018 found that the site was magnetically 'quiet', with no anomalies recorded (Hosty 2018: 159–60). While RI 2393's ballast mound appears to represent remnants of one of the scuttled transports, its size – approximately one-third the size of RI 2394 and half the size of RI 2578 – indicates it is unlikely that of *Lord Sandwich*, which was the largest of the five transports scuttled north of Goat Island.

RI 2396/RI 2397 ('Greg' site)

Shipwreck site RI 2396/RI 2397 is also known by its RIMAP nickname, the 'Greg' site. It is located approximately 820 feet (250 metres) north of RI 2578 and appears quite small when compared with RI 2578 and RI 2394. Visible remains cover an area 24 feet (7.3 metres) north-to-south by 11.8 feet (3.6 metres) east-to-west. The site comprises a linear, compact stone ballast pile, the south-eastern periphery of which features several exposed articulated hull timbers. These timbers, tentatively identified as floors, have sided dimensions ranging between 8.6 and 9.4 inches (22 and 24 centimetres). A large 19th-century iron anchor is located 69 feet (21 metres) north of the site. It was fitted with a shackle rather than a ring, which indicates it was used – if not manufactured – after 1818, when anchor chain shackles were first invented. Given the anchor's age and distance from RI 2396/RI 2397, it is unlikely to be associated with the shipwreck site (Hosty 2016: 95). Given its small dimensions, this composite archaeological site has been excluded as a candidate for the shipwreck of *Lord Sandwich* (ex-HMB *Endeavour*).

RI 2578 ('Kathy' site)

The first shipwreck site investigated in 2016 was RI 2578 (also known by its RIMAP nickname, the 'Kathy' site). Measuring 45 feet (14 metres) north-to-south by 27 feet (8.2 metres) east-to-west, it comprises a linear stone ballast pile interspersed with blocks of iron kentledge measuring 3.2 feet (1.0 metres) long by 6 inches (0.15 metres) thick. Isolated (and by all appearances disarticulated) eroded

ship's timbers were observed on the site but obscured by silt and sediment. A substantial iron anchor and small iron cannon are located within the north-west corner of the site. What appears to be a metal power or telegraph cable originates in the site's north-west corner and traverses it from north to southwest (Hosty 2016: 84–6).

Based on the results of non-disturbance surveys, RI 2578 appears to be the second-largest transport shipwreck within the LSA. A second visual survey of the site was carried out in 2018 to confirm the absence of concealed archaeological deposits. This was followed by a metal detector survey, which identified additional areas within the ballast field that likely contain more buried kentledge. Although additional cultural material was located, it did not extend the site's overall extent. Although Abbass and Lynch consider that it should remain within consideration (2024: 204), its smaller overall size compared to RI 2394 effectively rules it out as a candidate for *Lord Sandwich* (ex-HMB *Endeavour*) (Hosty 2018: 151,157),

RI 2794 ('Caroline' site)

A possible archaeological site, nicknamed 'Caroline' (later designated RI 2794), is located in the LSA's south-western corner (Abbass 2016: 55). When surveyed in 2017 it consisted of a thin scatter of brick, ballast stone, glass and ceramic fragments that covered an area approximately 59.7 feet (18.2 metres) north-to-south by 59.7 feet (18.2 metres) east-to-west. The site also featured geological 'erratics', naturally occurring stone exposed above the seabed. Following an initial assessment, the team established a temporary survey grid measuring 79.7 feet (24.3 metres) by 79.7 feet (24.3 metres) around the entire site. Although extensively surveyed, the site revealed very little with which to positively identify it as a shipwreck. Aside from the scatter of artefacts listed above, no hull components or features associated with a ship, such as hardware and/or fittings, were noted. A second survey of the site in 2018 found that no further material had become exposed in the intervening 12 months (Hosty 2018: 147–9).

Results derived from the survey and assessment of the 'Caroline' site indicate it is not a shipwreck, but instead either a ballast ground (an area used for dumping excess ballast) or scatter of artefacts that have drifted down current from sites further to the north such as RI 2394 and RI 2578 (Hosty 2018: 147–9). These artefacts then became ensnared among the area's geological erratics. Given the site is not a shipwreck, it was excluded from consideration as one of the scuttled 1778 transports.

RI 2394 ('Kerry' site)

RI 2394, also known by its RIMAP nickname the 'Kerry' site, is located approximately 50 metres south of RI 2578. Visible remains cover an area 59.7 feet (18.2 metres) north-to-south by 24 feet (7.3 metres) east-to-west, making it approximately three times larger than RI 2396/RI 2397 and 1.5 times larger than RI 2578. Based on data collected during the 2021 field season, the site's elevation slopes gently downward from north to south. Water depth is approximately 39 feet (11.9 metres) at the northern end of the site and increases to 43.0 feet (13.1 metres) at its southern extremity (Hosty 2016: 86–7; 2018:142–6). Although not confirmed with measurements, the site's elevation also appears to gradually slope downwards from east to west, in the direction of Newport Harbor's shipping channel (Broadwater and Daniel 2021).

Surveys of RI 2394 prior to 2019 confirmed it is largely buried beneath the seabed. Its visible features include a linear stone ballast pile, the eastern periphery of which features a line of partially exposed frame ends that are closely spaced and of substantial size. Four iron cannons are also present on the site. Two are largely exposed above the seabed and lie immediately adjacent to one another on the western side of the site. Their overall lengths are 5.5 feet (1.67 metres) and 5.0 feet (1.5 metres) respectively (Hosty 2020: 13–16). The third cannon's muzzle is partially exposed at the southern end of the site, while the breech of the fourth is just visible above the seabed on the eastern periphery of the site's approximate midsection. A lead scupper was found lying atop the seabed between the exposed cannons and line of frame ends. As with RI 2587, a metal power or telegraph cable crosses the site's north-west corner and transits from north to south-west (Hosty 2016: 86–7, 94). Among the exposed hull timbers at the site are a line of frames made up of floors and futtocks, as well as a stanchion (vertical post that usually supported deck beams) and sections of hull (external) and ceiling (internal) planking (Hosty 2018: 144–6; Hunter, et al. 2018: 16). By 2019, careful surface investigation of all shipwrecks located within the Limited Study Area determined RI 2394 was the most likely candidate for *Lord Sandwich* (ex-HMB *Endeavour*) (Abbass 2019: 7).

September 2019 fieldwork

In 2019 an area encompassing three consecutive frames in the approximate centre of the RI 2394 site was chosen for excavation. These elements of hull structure were relocated and a steel excavation grid measuring 2.99 feet (0.91 metres) wide by 8.98 feet (2.74 metres) long was installed over the frames, and oriented with its longer dimension athwartship (across the breadth of the hull). The grid was sub-divided into three separate 3-foot (0.91-metre) square sections known as 'cells', which were excavated individually in layers or 'spits'. Alternating 1-foot (0.3-metre) yellow and black intervals were marked along the grid's periphery (corresponding to the 'X' and 'Y' axes). These markers provided visual references during site mapping and artefact recording while a measuring tape suspended from the frame provided vertical ('Z' axis) depth information (Hosty 2019: 192–208).

A water-induction dredge was used by the team to excavate sediment from the wreck site and expose hull

remains, artefacts and other archaeological features. A mesh bag was attached to the outfall/discharge end of the dredge to catch small finds, such as miniscule ceramic or glass fragments. Failure to observe such small artefacts remains a risk during excavation, given Newport Harbor's poor underwater visibility.

Excavation in 2019 revealed extensive articulated hull structure, including well-preserved floors and first-futtocks, ceiling planking, both garboard strakes (large exterior hull planks positioned to either side of the keel), a limber channel (to aid in draining the vessel's lower hull) and the upper surface of the keel (Hosty 2019: 204). However, the keelson and rider/deadwood keelson assembly were completely absent from the site, although the keelson's outline was still present in the form of rectangular iron concretions on the upper sided surfaces of the exposed floors. It is unclear why the keelson is missing. One likely theory is that it remained exposed above the seabed and fell victim to either human interference, biological action and/or other natural processes (Abbass 2016: 18).

The team observed a large oval-shaped, jagged-edged hole in one of the garboard strakes, and are certain it was created with the intention of scuttling the vessel. The hole bears the hallmarks of having been executed in haste with a heavy striking or cutting implement, such as a crowbar, axe or adze. These hallmarks include its crude overall form and the presence of impact marks around its edges. These marks can be observed both on the interior face of the garboard and the upper-sided face of the adjacent keel. Heavy blows to the garboard appear to have worked the wood grain apart, opening a long fissure that is located a short distance outboard of the scuttling hole. A similar feature was located on RI 2119 and the appearance of a scuttling hole on RI 2394 strongly indicates that it is one of the British transports intentionally sunk in August 1778 (Hosty and Hundley 2002; Hunter, et al. 2019: 25).

The surfaces of the buried timbers were pristine and provided excellent scantling data (Table 8). The scantling data collected from RI 2394 in 2019 compares favourably with the scantlings listed for *Earl of Pembroke* when the vessel was first surveyed in 1768 (PRO ADM 106 1335, Folio 197–198).

January 2020 fieldwork

When excavation of RI 2394 resumed in 2020, five test pits were placed along the hull's centreline at 6.5-to-13.1-foot (2–4 metre) intervals. They were excavated to a depth between 10 and 50 centimetres and covered an area ranging from 80 to 150 square centimetres. Ship's structure, including floors, futtocks and ceiling planking, was encountered in all test pits. Among the 18th-century artefacts observed were clay bricks, olive jar fragments, flint nodules, barrel staves, wooden sheaves and ship's fastenings. Some of these artefacts were recovered for analysis (Hosty 2020: 14) and have subsequently been catalogued (Abbass and Lynch 2024: 45–53, 275–81). Another hull feature uncovered during the January 2020 investigations proved to be the base of one of the ship's bilge pump shafts. As the bilge pumps fitted to 18th-century ships were normally positioned around

Structural feature	RI 2394	*Endeavour*
Keel (sided)	13″	12.5″
Keel (moulded, below rabbet)	11″	11″
Keelson (sided)	12″ (estimate)	12.5″
Keelson (moulded)	–	–
Floors (sided)	12–16″	–
Floors (moulded)	13.5–17″	14″
First futtocks (sided)	5.5–11.5″	11″
First futtocks (moulded)	11–20″	–
Spacing between frames	1–2″	–
Room and space	24–32″	–
Lower hull planking (thickness)	3″ (garboard)	–
Lower hull planking (width)	–	–
Ceiling planking (thickness)	3–4″	3″
Ceiling planking (width)	6–14″	–
Treenails (diameter)	1.5″ (average)	–

Table 8. Scantlings collected from shipwreck site RI 2394 and the 1768 survey of HMB *Endeavour*.

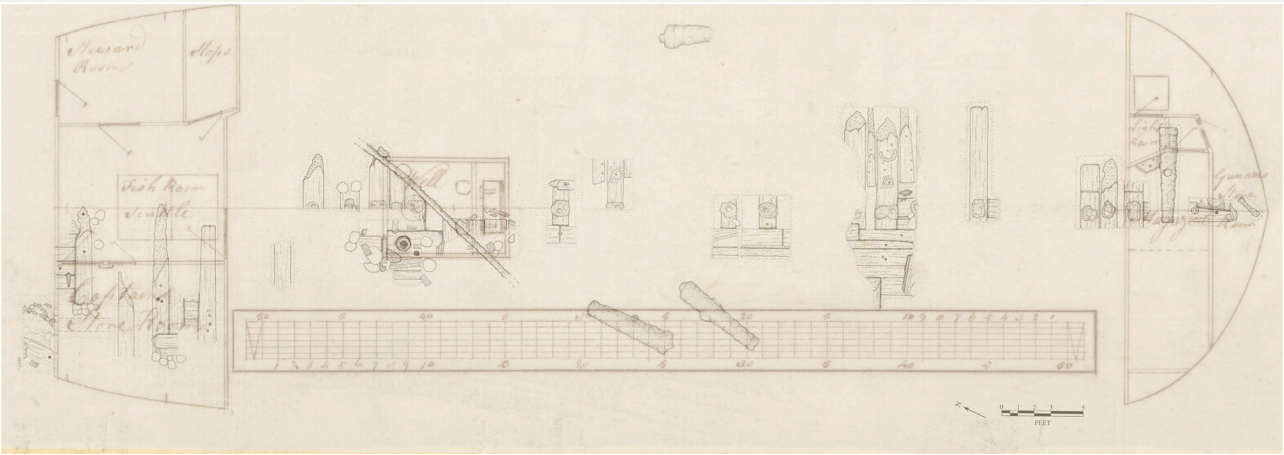


Figure 9. 2019–21 site plan overlaid with *Endeavour*'s 1768 survey draught, showing relative positions of site features such as the pump well compared with those on the archival plan. Image: Royal Museums Greenwich; James Hunter/ANMM.

the mainmast in the hull's midships section, the positive identification of the shaft stump provided a reference for position fixing within the vessel's surviving hull. An archaeological site plan generated from hull recording during the 2019 and 2020 investigations was scaled to the same size and superimposed with the 1768 Admiralty plan of *Endeavour* (Figure 9). The positions of the surviving bilge pump shaft, pump well bulkheads, and centreline keel bolts correlate exactly to the positions of these features on the 1768 plan of *Endeavour*'s lower hold (ADM 3814b, March 1768; Marquardt 2010: 40–1).

Pump well structure

Architectural elements associated with RI 2394's pump well, some of which remain *in situ*, were documented during the 2020 investigations (see Figure 9). These include the apron that formed the floor of the well, two fragmented partitions that formed one of the well's corners and an associated corner post. Two disarticulated stanchions that supported the partitions were observed lying on, or immediately adjacent to, the apron. A single mortise is located on the upper surface of the apron near the pump tube stump and likely accommodated one of these support stanchions.

The apron (PW1) is the pump well's largest recorded structural component. It is a substantial plank-like timber that extends eastward from the interior edge of the longitudinal pump well partition (PW2) for 2 feet, 2 inches (75.1 centimetres) before terminating 19 inches (48.3 centimetres) from the vessel's centreline. It is very likely that the void between the line of keel bolts and the apron's edge would have once accommodated the now-absent keelson, and possibly part – if not all – of the vessel's mainmast step. PW1's northern edge abuts the lateral pump well partition (PW3), and extends southward for 2 feet, 1 inch (0.73 metres) before disappearing into TP4's southern wall. Where exposed, the apron's edge was 3 inches (7.6 centimetres) thick. The mortise observed on PW1's upper surface is located immediately adjacent to the pump tube stump. It is roughly square-shaped, measures 3 inches (7.6 centimetres) per side and is 2 inches (5.1 centimetres) deep.

PW2 once formed part of the pump well's western wall and was arranged parallel to the run of the hull. Now dislodged, it is no longer connected to PW3 and canted slightly towards the vessel's centreline. It is 2.3 inches (5.7 centimetres) thick and extends southward from PW3 for 23.5 inches (59.7 centimetres) before disappearing into the south wall of TP4. Where PW2 and PW3 intersect forms an approximate 90° angle and would have once comprised one of the pump well's corners. PW3 forms part of the pump well's northern wall and extends east from the corner for 20 inches (50.8 centimetres) before terminating in an eroded end. It is 3 inches (7.6 centimetres) thick and stands 18 inches (45.7 centimetres) above the apron. A square-hewn stanchion (PW4) measuring 6.5 inches (16.5 centimetres) in width per side is positioned vertically within the pump well at the intersection of PW2 and PW3. Although heavily eroded and worm-eaten on its upper end, the timber is otherwise well preserved and extends downwards for 12 inches (30.5 centimetres) before disappearing beneath PW3. Based on its location, orientation and size, PW4 functioned as one of the well's corner posts, but has undergone partial disarticulation and collapse (Hunter and Hosty 2020).

Two smaller stanchions (PW5 and PW6) were also uncovered within the pump well's footprint and once served as internal vertical supports for the well's partitions. PW5 is located just east of PW1's eastern edge and positioned perpendicular to the shipwreck's centreline. It is a square-hewn timber, each side of which measures 3.8 inches (9.5 centimetres) wide. Approximately 10 inches (25.4 centimetres) of its overall length was exposed during the January 2020 excavations; the remainder is buried beneath sediment between F8 and F9. PW6 was uncovered on the opposite (western) side of PW1, lying directly atop the apron and next to the 3-inch square mortise let into its upper surface. The stanchion is 14 inches (35.6 centimetres) long and square-hewn, each of the sides at its best-preserved end measuring 3 inches (7.6 centimetres) wide. Given their proximity and matching dimensions, the base of PW6 was almost certainly once positioned within the mortise.

Dunnage/quoins

Two small timbers were uncovered in Excavation Unit 2-West (EU2-W) in direct association with RI 2394's hull but appear to be packing material such as dunnage. Steffy (1994: 270) defines dunnage as 'brushwood, scrapwood, or other loose material laid in the hold to protect cargo from water damage or prevent it from shifting, or to protect the ceiling [planking] from abrasion'. Both examples from RI 2394 (D1 and D2) were hewn from narrow logs that were bisected longitudinally (presumably with an axe) and cut into shorter sections with bevelled ends. In terms of overall appearance, both timbers share many traits in common and appear to have been manufactured from the same timber species. The flat, cut sides of both D1 and D2 face downwards and rest directly against the ceiling planks beneath them, while their upward facing surfaces follow the natural curve of the logs from which they were hewn and are roughly semi-circular in cross-section.

D1 is 1 foot, 11 inches (58.4 centimetres) long and 4 inches (10.2 centimetres) in diameter. It appears to have been stripped of its bark and is positioned at an approximate right angle (athwartships) to the ceiling plank (C5) beneath it. The timber's western end forms an approximate right angle with the southern extremity of D2, which is oriented parallel to the run of the hull. Approximately 15 inches (38.1 centimetres) of D2's overall length was exposed during excavation; the remainder is buried in sediment and could not be measured. It measures 6 inches (15.2 centimetres) in diameter and – like D1 – appears to have been stripped of its bark.

The arrangement of D1 and D2 at approximate right angles to one another appears to be intentional. In addition to their orientation, both timbers were immovable and may have been affixed to the hull, although fasteners (or their remnants) were not observed in association with either timber. In most cases, dunnage found in association with shipwreck sites comprises logs, branches and/or twigs arranged horizontally along the vessel's long axis (see Nash 2009: 40–1). However, dunnage could also be arranged laterally. In his treatise *The Rights of Seamen*, Isaac Ridler Butts included 'Rules for Dunnaging' that advised for dunnage to be placed athwartships to permit water to 'run ... more readily to the waterways, and into the scuppers' (Butts 1848: 105).

'Bedding and quoining', in which successive layers of dunnage and cargo were chocked in place with wedges and blocks, was a common method of securing items in a vessel's hold during the age of sail. Indeed, 'quoining' was frequently used to pack 'the first tier' of casks and barrels in place and involved 'driving several wedges under each side' of a staved container (Taylor 1920: 72). Wooden wedges or 'quoins' were used to prevent gross movement of cask cargo, whereas dunnage was used to prevent staved containers from abrading each other or the vessel's ceiling planking. The 90° arrangement of D1 and D2 could represent the bedding and quoining technique, particularly given the remnants of a large wooden barrel were found immediately adjacent to both timbers. It is worth noting that a 'rough-cut log, flat on one side with a curved section cut out of the upper surface' was observed in the lower hold of the wrecked merchant vessel *William Salthouse* (1841) and identified as a 'quoin' (Staniforth 1987: 27). In terms of appearance, this timber closely resembles both D1 and D2, and suggests the latter examples may have been quoins rather than dunnage.

September–October 2020 fieldwork

Fieldwork conducted during September and October 2020 revealed a significant number of large- and medium-sized ballast stones, numerous iron concretions and a few small finds (Broadwater 2020). Two frames were uncovered at the northern extremity of the site, initially identified as floors, and designated Frames A and B North. No evidence of the keelson was encountered within the test pit excavated closest to the frames (Test Pit 6 North, or TP6N). While originally assumed to be floors, evidence of an associated keel could not be confirmed, and it is possible that one or both frames could be first futtocks. The field season concluded before either frame could be excavated in its entirety, so their identity remains unconfirmed.

Several planks run fore and aft through TP6N on a roughly north-south orientation and are located at a depth of approximately 1 foot (0.3 metres) below grade. Those encountered beneath Frame A North were identified as runs of hull planking that had become disarticulated from the frame. Additional planks were encountered in TP6N, and some are believed to be contiguous with the hull planking beneath Frame A North. All are approximately 1 foot (0.3 metres) below grade. Their relatively shallow burial depth, as well as that of the two frames, suggests hull preservation is very poor in this part of the site. This

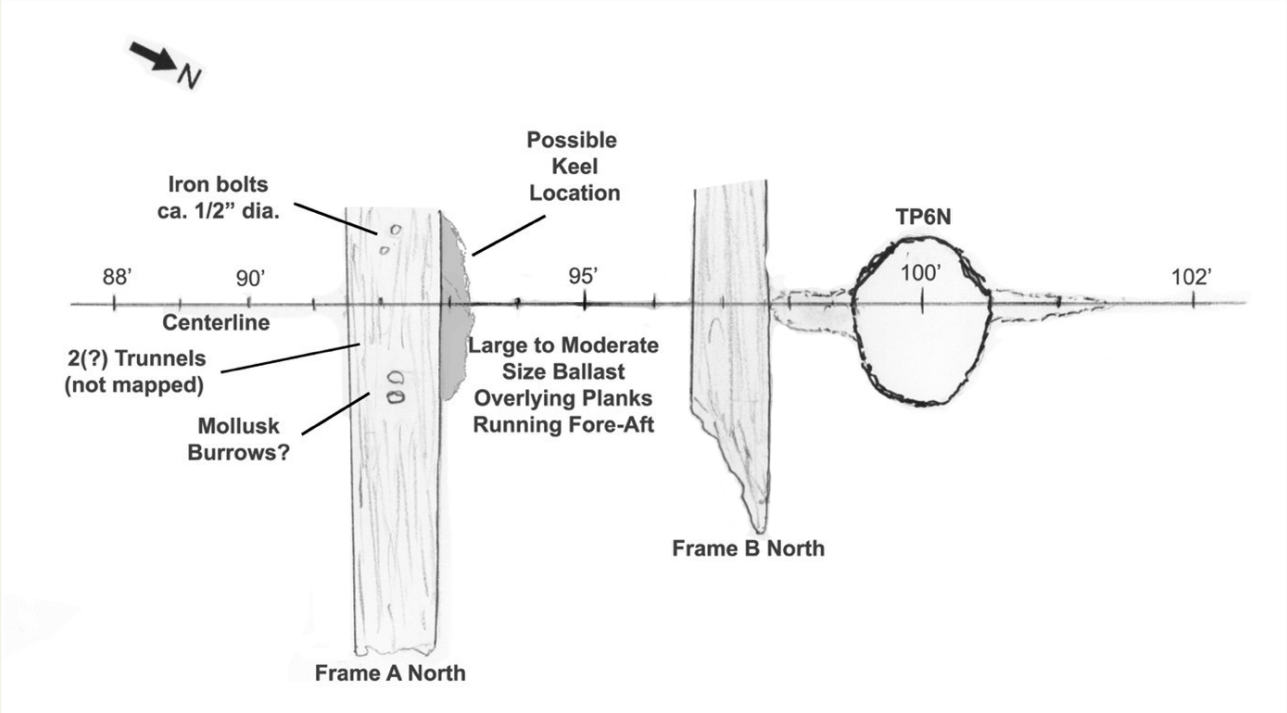


Figure 10. Area of archaeological investigation on RI 2394 during October 2020 (John D. Broadwater).

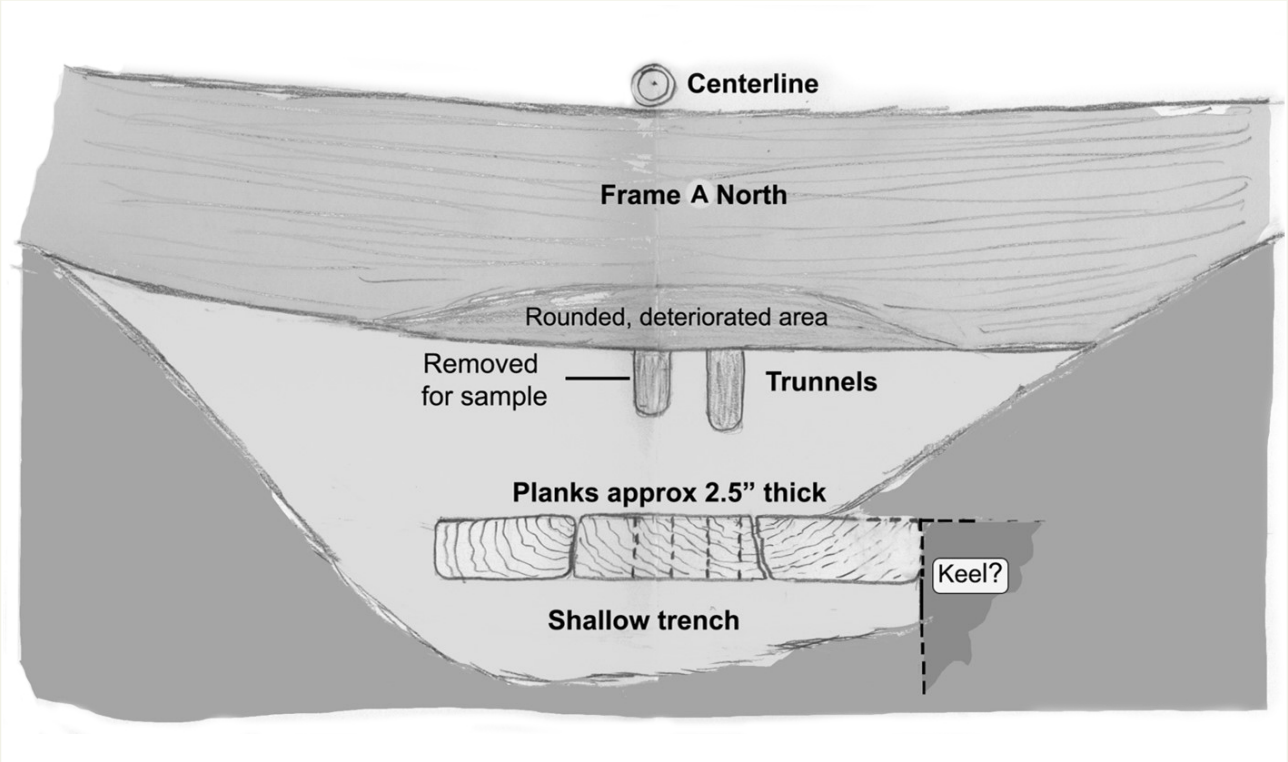


Figure 11. Cross-section through TP6N southern extension, at Frame A North (FU7), facing south, showing outer planking pulled free from Frame B North. Also shown is the possible keel, located on the last dive. Scale approximate (John D. Broadwater).

Key to labels in Figure 12.

1. Concretion 7 inches (17.8 centimetres) dbg*
2. Concretion 5 inches (12.7 centimetres) dbg
3. Concretion 5 inches (12.7 centimetres) dbg
4. Wood 8 inches (20.3 centimetres) dbg, 6 inches (15.2 centimetres) east of centreline, 2 inches (5.1 centimetres) thick
5. Brick 5 inches (12.7 centimetres) dbg
6. Stone 7 inches (17.8 centimetres) dbg
7. Stone?
8. Stone
9. Wood plank, 6 inches (15.2 centimetres) exposed width
10. Brick
11. Wood fragment, 10 inches (25.4 centimetres) dbg
12. Wood fragment
13. Concretion
14. Wood plank
15. Bottle fragment, 7 inches (17.8 centimetres) dbg
16. Glass fragment, 12 inches (30.5 centimetres) dbg
17. Metal disk, 4 inches (10.2 centimetres) dia., 7 inches (17.8 centimetres) dbg
18. Sounding lead, "XIII", 9 inches (22.9 centimetres) dbg
19. "Dog bone" shaped concretion
20. Whitish brick with embossed "LO"
21. Large & medium size ballast stone lying over planks running parallel to centreline

* Note: dbg = depth below grade

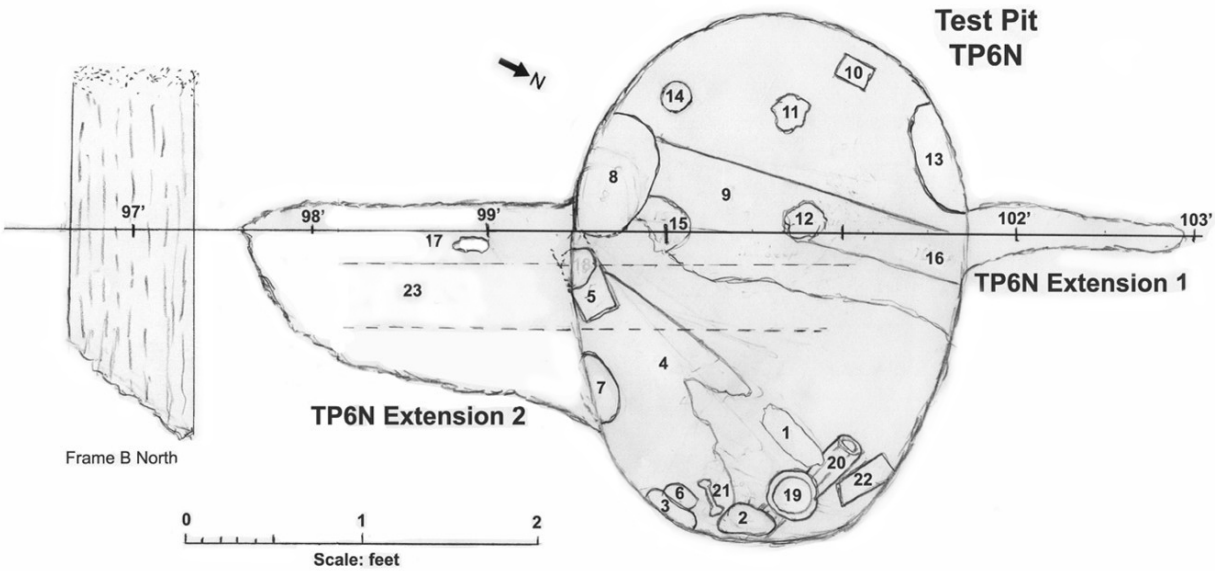


Figure 12. RI 2394: Details of test pit TP6N (John D. Broadwater).

proposal is supported by the lack of additional frames and other hull components (such as ceiling planking) that are likely to have become disarticulated from the hull and lost via a combination of natural and human processes.

Figure 10 shows the two athwartship frames relative to TP6N. The upper sided surface of Frame A North features two large holes. These were located just east of the centreline and initially thought to be empty keel bolt holes. However, closer examination revealed the holes are not quite circular, do not contain adhering ferrous concretion and were likely made by marine molluscs. To the west of the centreline, the upper sided surface of the same timber features remnants of what appear to be two small iron bolts (approximately ½-inch or 1.3-centimetre diameter). These fasteners are too small to be keel bolts and were instead likely used to affix hull or ceiling planking in conjunction with at least two treenails found protruding from the frame's lower sided face. The treenails were cut flush with the timber's upper sided face and may have been wedged. Spacing between the frames is significantly greater than that observed elsewhere on RI 2394 and suggests additional intermediate frames are missing. This in turn provides additional evidence of hull deterioration at the site's northern end. Because the team could not locate the keel in TP6N, a small exploratory test pit was excavated along the northern moulded face of Frame A North.

Figure 11 is a sectional sketch of TP6N that is roughly to scale. It reveals the hull planking is separated from the frame by approximately 5 inches (12.7 centimetres) and has exposed two treenails that protrude from the frame's lower sided face. Because it was assumed that the site's centreline baseline was aligned with the keel, the team's initial interpretation was that the floor was attached to the keel exclusively with treenails. However, this conclusion seems unlikely, given that a floor timber – even if installed as an emergency replacement – would have been affixed to the keel with more robust metal fasteners such as iron bolts.

Figure 12 illustrates the size and extent of TP6N, including the locations of several small finds. Because this test pit was excavated over the course of several days, the sketch should be considered an approximate composite drawing. Not all artefacts, timbers, ballast stones, concretions and other material culture encountered in TP6N are shown. Excavation revealed medium- and large-diameter ballast stones, iron concretions of various sizes and shapes, and a few diagnostic artefacts. The latter included plate glass and bottle-glass fragments, bricks, a possible wooden handle, a lead musket ball, a circular iron object that appears to be a weight, and a deep-sea sounding lead incised with the Roman numeral 'XIII'.

One curious feature found in TP6N is a very wide plank at the test pit's western extremity through which a 2-inch (5.1-centimetre) circular hole has been drilled (Object No. 14 in Figure 12). The hole does not retain staining or concretion residue that might be associated with a fastener that has since disappeared. In addition, the plank does not appear to be aligned with the run of the keel, although the overlay of the site plan and the

Distance on centreline	Observations
68″ 6″ (20.9 metres)	Loose plank, 1″ (30.5 cm) x 5″ (12.7 cm) x 1.5″ (3.8 cm) thick (placed ballast stone atop it)
87″ 0″ (26.5 metres)	Apparent wood, ca. 3″ below grade; also, apparent wood 1″ 10″ (55.9 cm) below grade
89″ 6″ (27.3 metres)	Exposed timber to east of CL, perpendicular to CL (size not determined)
91″ 6″ (27.9 metres)	Ditto
94″ 9″ (28.9 metres)	Stone (?) to east of CL, 1″ 6″ (45.7 cm) x 1″ 3″ (38.1 cm) x ???
100″ 0″ (30.5 metres)	Apparent wood probed 1″ 10″ (55.9 cm) below grade
103″ 0″ (31.4 metres)	Apparent hard substrate ca. 1″ (30.5 cm) below grade
105″ 0″ (32.0 metres)	Ditto*
110″ 0″ (33.5 metres)	Ditto*
115″ 0″ (35.1 metres)	Ditto*
120″ 0″ (36.6 metres)	Ditto*
125″ 0″ (38.1 metres)	Ditto*

Table 9. RI 2394 probing results from September-October 2020 fieldwork. *Note: No wood or ballast was observed in this area, just loose shell hash mixed in dark, mobile silt. The hard substrate covered a large area north of 103′ (31.4 m) on centreline and may be bedrock. Probing was conducted on a single dive, so the observations described in this table should be considered preliminary only.

1768 Admiralty plans reveals its angle correlates to the narrowing of the hull at the stern. Given its unusual size, the presence of the hole, and its proximity to the suspected location of the keel, the plank could be a limber board – a movable plank that covered bilge-water passages on each side of the keelson. Alternatively, it may be a wider hull plank in the narrowing part of the stern and the cavity a scuttling hole created with a drill.

Probing suggests the shipwreck may have settled onto a hard marl or bedrock layer that prevented the hull from sinking into a stratum of softer, more protective bottom sediments. Probing did not confirm the presence of hull remains to the north of 100 feet (30.5 metres) on the centreline baseline, but more extensive probing might produce positive results (Table 9).

Conclusions from September – October 2020 fieldwork

At the conclusion of the September–October 2020 expedition, the PVC centreline baseline installed on RI 2394 was found to be significantly out of alignment with the orientation of the articulated hull's centreline (Broadwater and Daniel 2021: 4, 13). This was disappointing, as it meant the project team were unable locate the true northern extremity of the site or confirm the location of the keel in the vicinity of TP6N. Only one feature in TP6N, the plank with the 2-inch circular hole, offered a clue to the location of the keel. It is positioned roughly parallel to the centreline and offset to its west about 1.5 feet (0.46 metres). This distance is approximately the same as that of a timber beneath Frame A North that extends deeper than the adjacent hull planks and may be the keel (see Figure 11). If the timber in question is the keel, an argument can be made that the plank with the hole is a limber board (Broadwater and Daniel 2021: 9). The hole would have provided a means for removing the plank to permit access to the vessel's bilge and check it for obstructions.

While the northern extremity of the site was not positively identified, investigation of the northernmost assemblage of articulated hull timbers indicated hull preservation in this area is extremely poor (Broadwater and Daniel 2021: 5). Only two athwartships frames were located, and the intermediate floors and/or futtocks between them appeared to be missing. Finally, no evidence of the keel or keelson was noted.

During the shipwreck's site formation, the floors, futtocks, and other missing hull components appear to have become disarticulated and scattered or destroyed. This was likely the result of a combination of natural and human manifested processes and activities (Broadwater 2020: 10). Excavation enabled the team to confirm the thickness of RI 2394's exterior planking, which proved to be between 2.5 and 3 inches (6.4 and 7.6 centimetres). These data correlate well with the documented thickness of *Earl of Pembroke*'s hull planking 'from [the floorheads] to the keel', recorded as 3 inches in the 1768 survey report (Knight 1933: 295).

Although the team encountered small finds, the quantity and variety were minimal. This is another indication that most of the wreck site's structure and contents have been removed from the site by natural and cultural extractive forces (Broadwater 2020: 10).

September 2021 fieldwork

The fieldwork strategy developed for September 2021, as authorised by the permit granted by RIHPHC (#19-14), was to relocate keel bolt concretions within or near EU1-C and establish the line of the keel based on as many bolts as possible. Once this was accomplished, a series of test pits would be excavated at intervals towards the site's southern terminus until the end of the keel was located. Ultimately, six test pits were excavated, one of which – TP6S – contained the southern end of the keel (Broadwater and Daniel 2021: 25).

Fortunately, the keel's southern end was largely preserved and retained most of the scarph that connected it to the vessel's stem. Positive identification of the keel-stem scarph confirmed RI 2394's bow faces south (Figures 13 and 14). The location of the bow end of the keel was very close to its predicted position (with a margin of error of 8 inches, or 20.3 centimetres), based on superimposition of RI 2394's 2019–20 hull plan with the 1768 Admiralty plan of *Endeavour* (Admiralty Draught No. 3814(b), 28 March 1768). The stem was absent, save for a small remnant timber fragment found lying within the scarph.

The extant forward end of the keel measures 13.0 inches (0.33 metres) sided. The 2 foot (0.60 metre) long scarph was let into the keel to a depth of 4.0 inches (0.1 metres). It measures 6.0 inches (0.15 metres) wide at its forward preserved edge and 2 inches (0.05 metres) wide aft, creating a 'wedge' shape when viewed in plan (Broadwater and Daniel 2021: 7–10) The presence of a large wooden sheave atop the approximate middle of the scarph limited the extent to which it could be excavated, so it is unclear whether the wedge shape is due to natural processes or a result of intentional manufacture (see Figures 13 and 14).

The survival of the keel-stem scarph – a highly diagnostic feature – is important for two reasons. First, it permitted the project team to obtain a key measurement from the stem end of the keel to the projected location of the mainmast, a value of approximately 49.8 feet (15.17 metres). Second, it provided details of the scarph itself, which appears to be a rare form of stem attachment known as a 'half-lap' joint (Broadwater and Daniel 2021: 7–10) (Figure 15).

The use of a half-lap scarph joint like the one observed on RI 2394 seems unusual, as it superficially does not appear to be a particularly strong method for fastening the keel to the stem. However, as the area occupied by the two timbers where they overlap is significant (more than 0.33 metres of

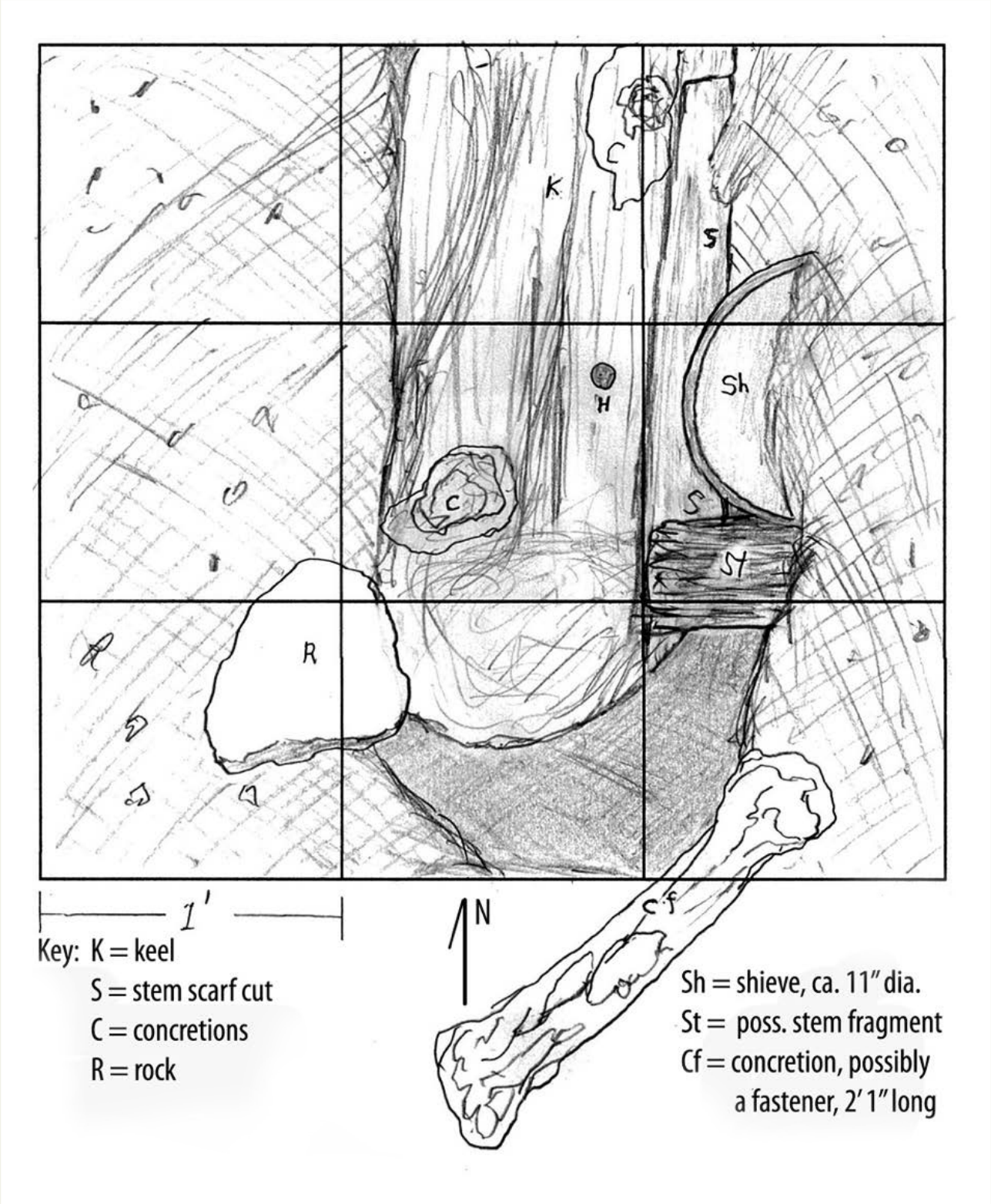


Figure 13. South end of keel, showing stem-keel scarph in plan view (John D. Broadwater).

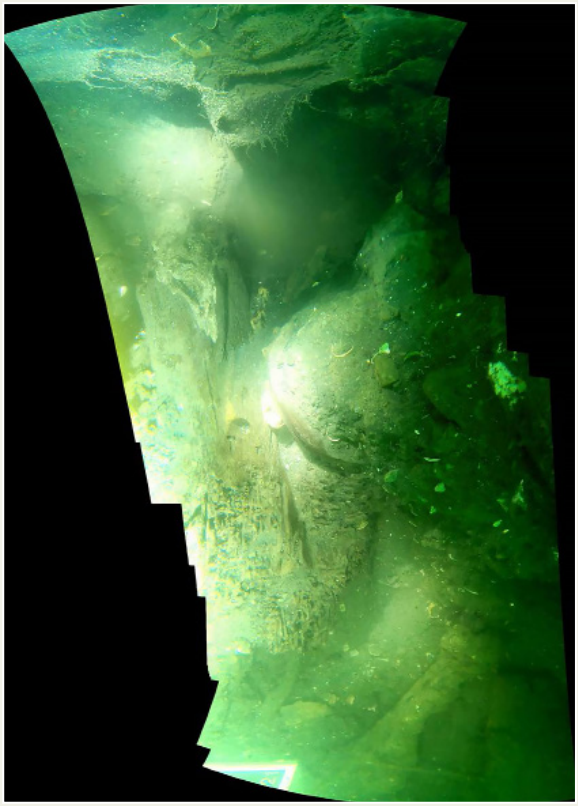


Figure 14. Photomosaic of keel's southern terminus, showing scarph for the stem (beneath wooden sheave at image centre). Note that north is up (John D. Broadwater and Joshua Daniel).

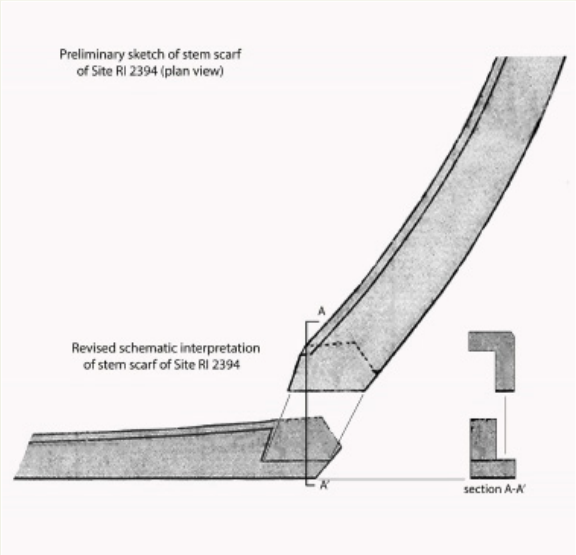


Figure 15. Reconstruction of RI 2394's keel-stem scarph (John D. Broadwater).

3.5 square feet,) it would have provided a large, flat surface for the insertion of several large connecting fasteners. It should be noted the surface area listed above does not include the upper, aft and lower surfaces of each timber, which also likely would have accommodated several large fasteners. When fayed together, the keel and stem would have formed a combined joint measuring 18 inches (0.46 metres) sided. Finally, the stem sat directly atop the keel, which would have helped to support the entire structure, as well as the bow deadwood immediately above it. It also permitted the stem to have a near-vertical rake, an absolute necessity for a vessel requiring the broad, bluff bow typical of a Whitby collier (Broadwater and Daniel 2021: 7–10).

One possible treenail hole and two iron fastener concretions were located atop the keel. While the keel's forwardmost end is worm-eaten, remnants of what appears to be the finished top edge of the keel survive. No evidence of other timbers typically used to form the bow structure – such as deadwood or an apron – survive, nor are fasteners or fastener concretions evident that corroborate their presence. Finally, the presence of a horseshoe plate, as illustrated in Marquardt (1995: 49), was not noted, nor were remnants of fasteners that might have once secured the horseshoe plate observed on the keel (Broadwater and Daniel 2021: 19).

Search for additional bilge pump suction tubes

The search for evidence of additional bilge pumps on RI 2394 was based on the location of the wreck site's starboard suction tube and the configuration of four common bilge pumps depicted on the 1768 Admiralty draughts of *Endeavour* (Admiralty Draught No. 3814(b), 28 March 1768). Using the Admiralty draughts and Marquardt (1995) as guides, the team conducted test excavations at the second starboard pump's projected location. When that effort proved unsuccessful, the team excavated the areas where the wreck site's two port pump tubes were thought to be located, again without success. RI 2394's portside hull is poorly preserved in the vicinity of the pump well, which likely accounts for the absence of the port pump tubes. Finally, the team excavated an area to the north of the pump well to provide full coverage in the event the projection was incorrect. No evidence of pump shafts was found in this area either (Broadwater and Daniel 2021: 28).

It is possible further excavation could reveal holes cut in the ceiling to accommodate the suction tubes or a pump sieve – also referred to as a 'basket' (ADM 3814b; Marquardt 1995: 71). However, further excavation of the pump well was discontinued, as exposing a larger and deeper area was thought to exceed the terms of the RIHPHC permit (Broadwater and Daniel 2021: 10). A large area within and forward of the pump well was exposed and carefully mapped (Figures 16 and 17). Scaled plan-view sketches, drawn with a 3-foot by 3-foot mapping grid, added more detail to the overall site plan and provide a starting point for future excavations in this area.

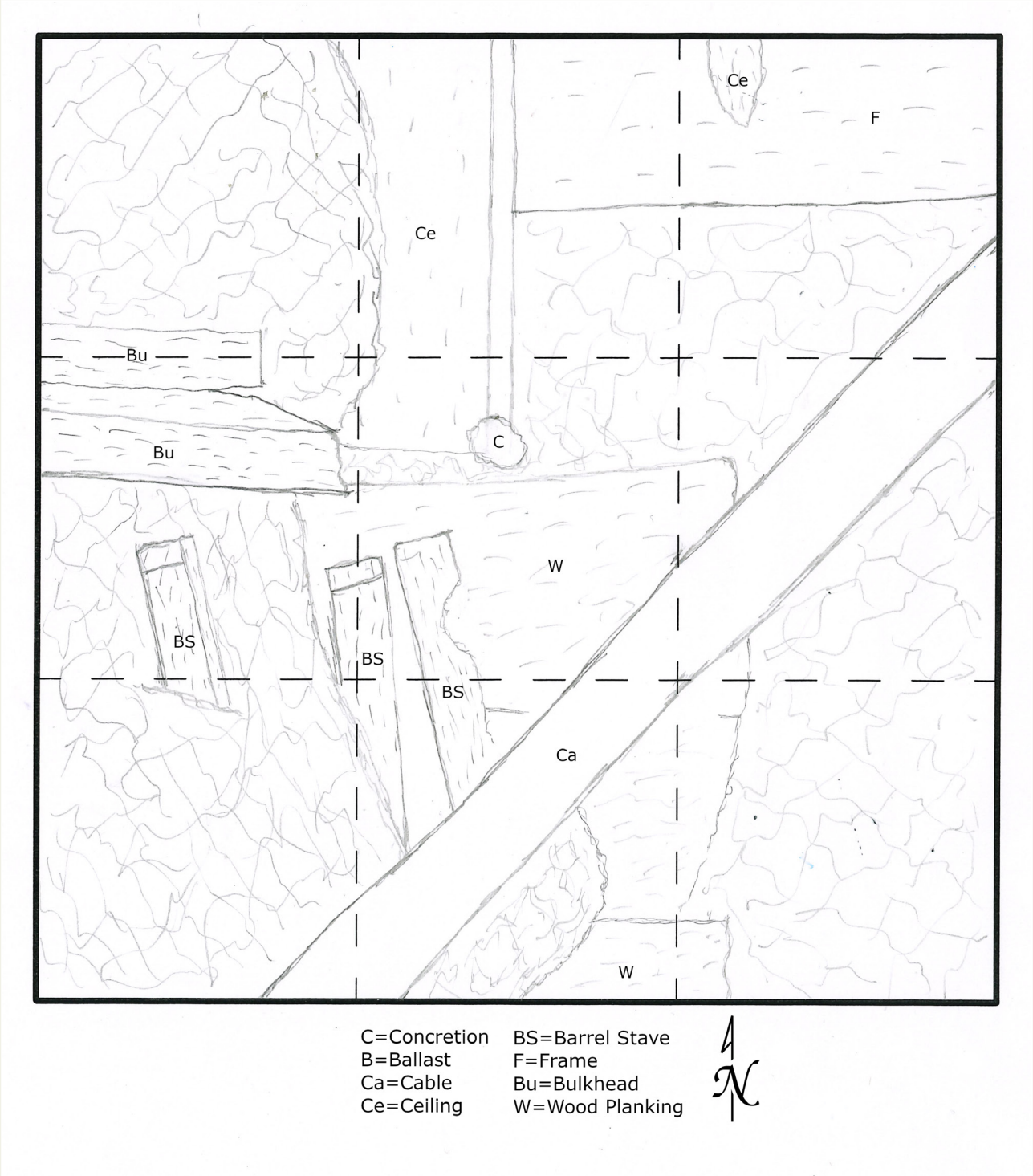


Figure 16. Pump well test pit, north section (Joshua Daniel).

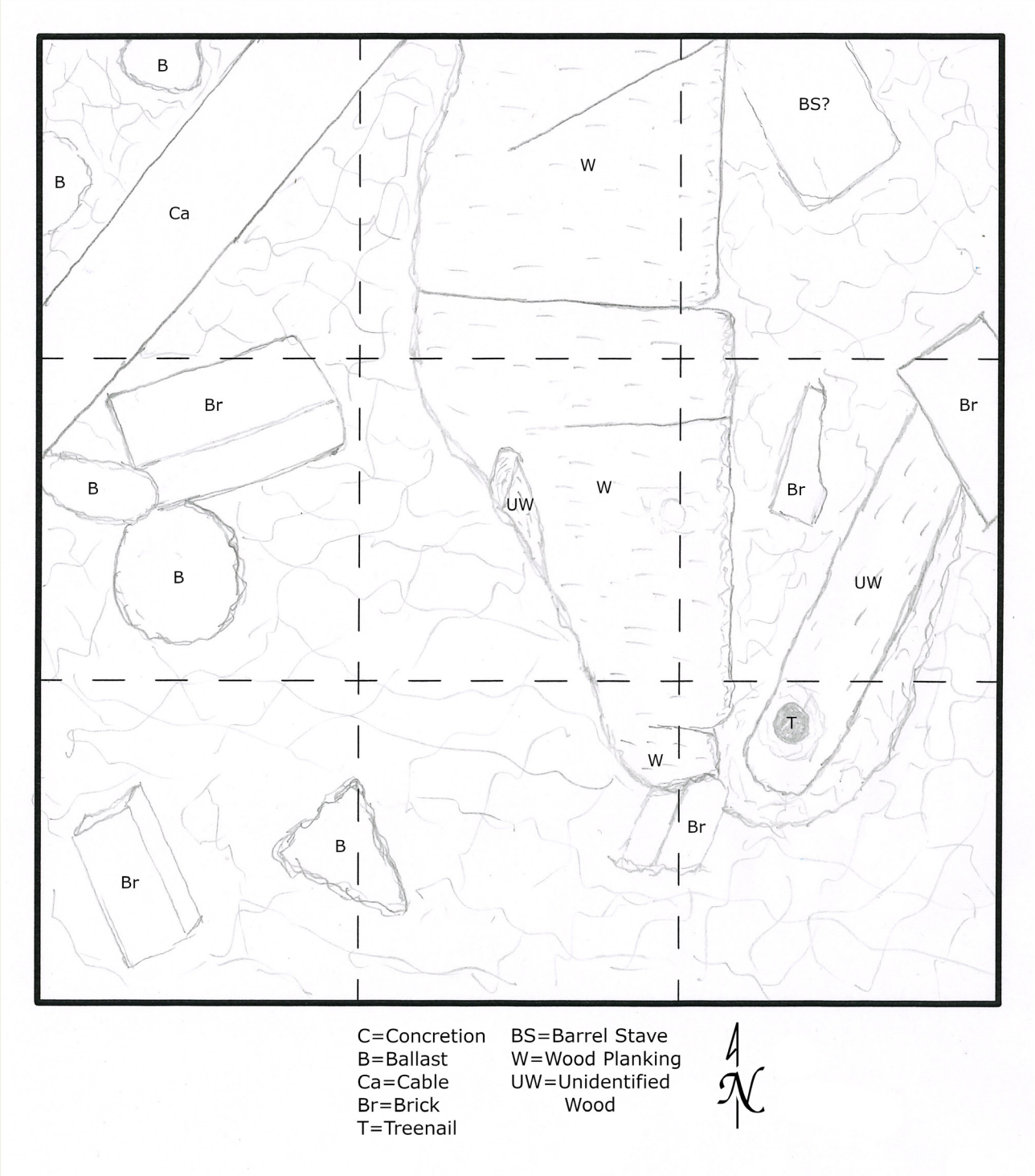


Figure 17. Pump well test pit, south section (Joshua Daniel).

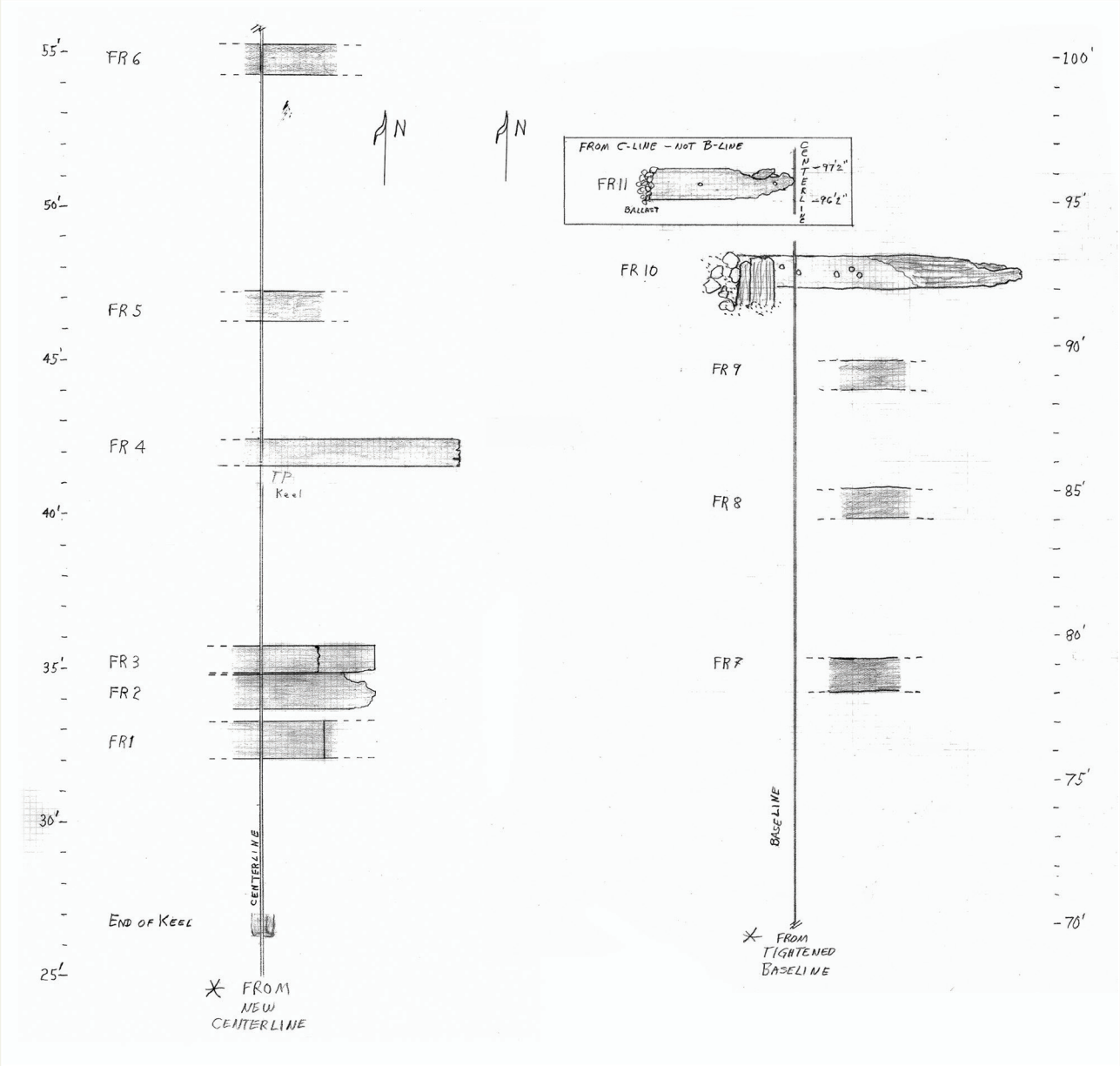


Figure 18. Locations of exposed frames in the bow section (left) and at the extent of the site's surviving stern (right) (John D. Broadwater).

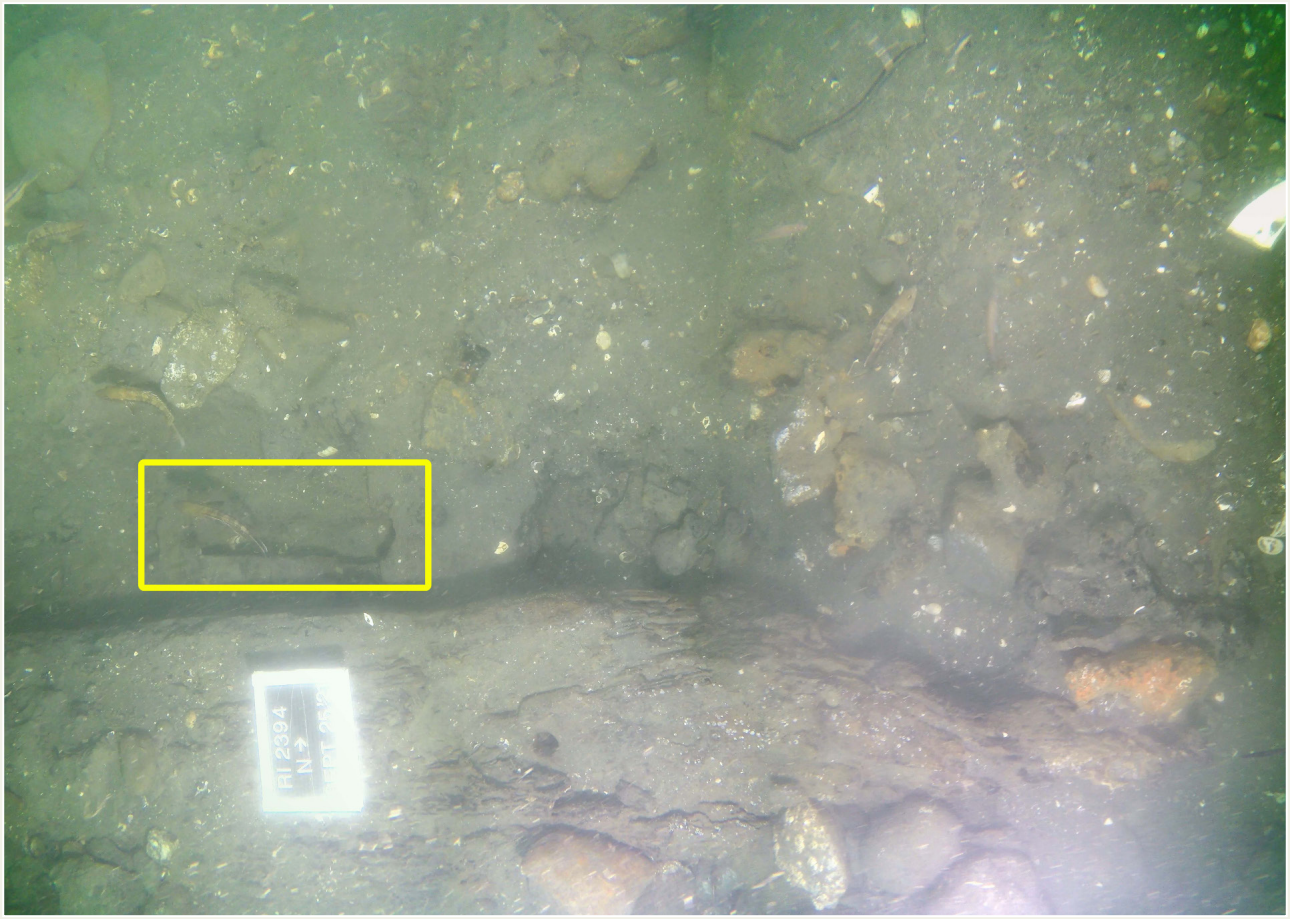


Figure 19. Mosaic showing frame and scuttling hole beneath letter board, north is at bottom of image (John D. Broadwater).

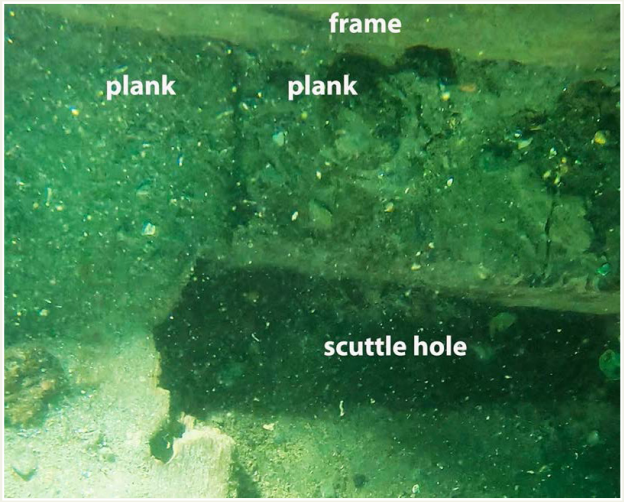


Figure 20. Close-up image of scuttling hole on the north side of the frame (John D. Broadwater).

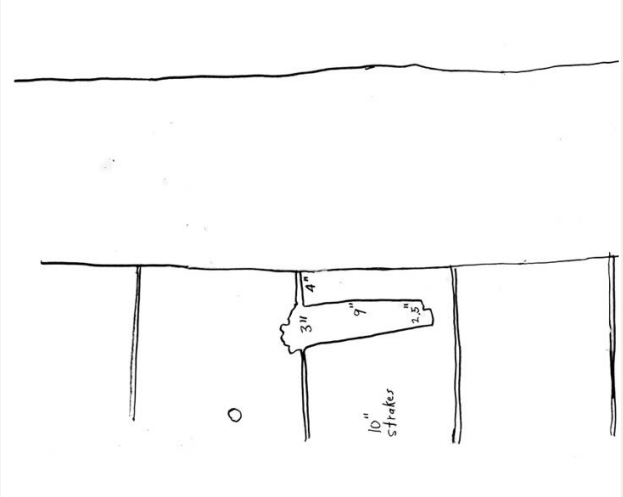


Figure 21. Sketch of scuttling hole (plan view, north is at bottom of image) (John D. Broadwater).

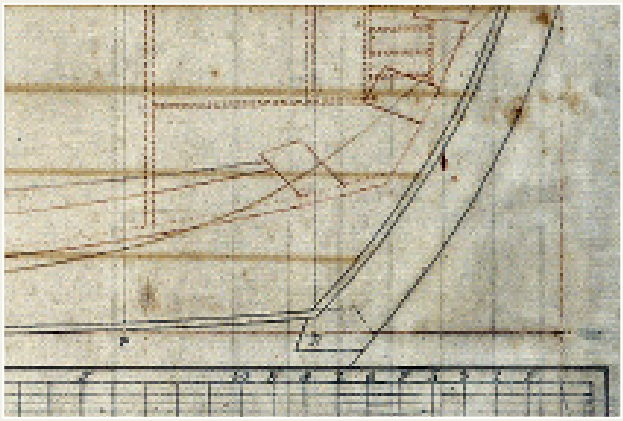


Figure 22. Detail of 1768 Admiralty draught showing *Endeavour*'s unusual keel-stem scarph. Image: Australasian Pioneers' Club collection.

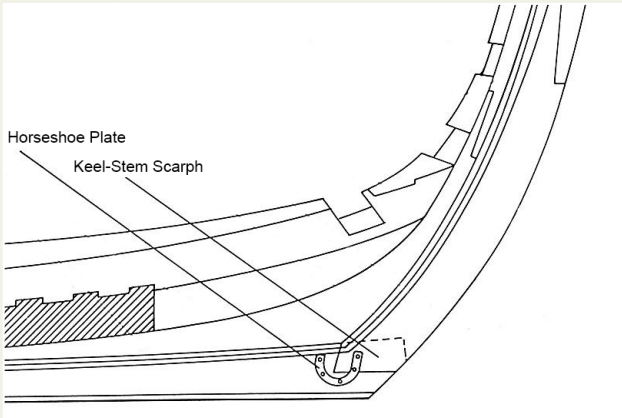


Figure 23. Detail of illustration showing *Endeavour*'s unusual keel-stem scarph braced by a horseshoe plate (adapted from Marquardt 1995: 49).

Figure 24. Keel of *Endeavour* replica showing the exposed keel-stem scarph, outlined in the dotted line (HM Bark Endeavour Foundation, Australian National Maritime Museum Collection).

Figure 25. *Endeavour* replica stem and keel after being joined, showing the scarph, bolt pattern and modified horseshoe plate (HM Bark Endeavour Foundation, Australian National Maritime Museum Collection).

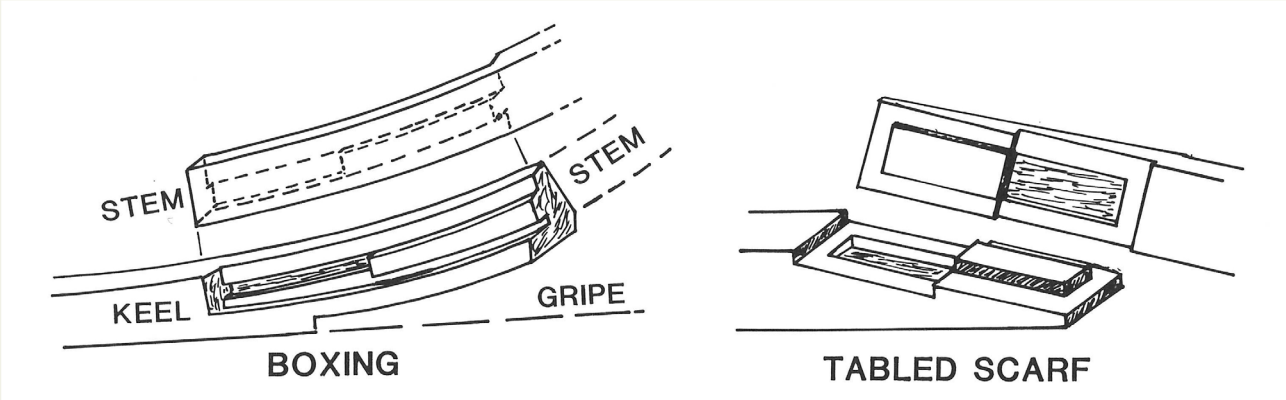


Figure 26. Typical scarphs for joining a stem and keel together (Steffy 1994: 292).

Following the 2021 excavation of the pump well, Erskine (2021: 6) provided additional archival research that revealed *Endeavour*'s four bilge pumps were removed prior to the vessel being sold out of service in 1775. Further, none had been replaced by the time George Brodrick took possession of the vessel (ADM106/1226/154). There is no known record indicating the four pumps were returned to Brodrick, but it is likely he reinstalled at least two pumps (as per normal practice on merchant ships during the 18th century) to meet survey requirements for the Board of Transport, a conclusion also reached by Abbass and Lynch (2024: 191–4). This in turn could account for the absence of a second starboard bilge pump shaft on RI 2394.

Improvements to baseline placement and site plan

The new centreline baseline installed during the 2021 field season closely follows the line of the keel. However, both the original and new baselines were used, where applicable, to define the locations of RI 2394's hull features and artefacts. When time permitted, exposed frames were mapped with the use of either the original or new centreline baseline as a guide (Broadwater and Daniel 2021: 12–14). Figure 18 shows the resulting framing plan. This plan should not be considered complete or entirely accurate, as the mapping of frames was not a primary goal of the 2021 investigations. It is included here to provide a general indication of how many of the wreck site's frames are missing or buried.

To accurately position the bilge pump suction tube on RIMAP's site plan, the team obtained direct measurements between it and three of the site's four cannons. The cannons were chosen as temporary 'datums' because it was assumed they have not moved since the site was first mapped. Unfortunately, plotting the new measurements on the existing site plan proved impossible as the overlapping arcs differed by several feet (Broadwater and Daniel 2021: 14).

Search for the site's northern preserved extent

Given the limited timetable and number of tasks that needed to be accomplished during the 2021 investigations, the team attempted to locate the northern extent of RI 2394 on the final day of the project. A test pit was excavated at the 35-metre (115-foot) mark on the new centreline baseline, as this was the location predicted for the northern (stern) end of the keel based on superimposition of ANMM's 2019–20 hull plan and 1768 ship's draught. The test pit yielded one relatively small, disjointed fragment of wood. A second test pit (Test Pit 9-North) excavated at the 33.5-metre (110-foot) mark on the centreline baseline, yielded only sediment mixed with local shell and a heavy concentration of small gravel (Broadwater and Daniel 2021: 14).

A shallow trench (Test Pit 10-North) was excavated adjacent to the northern moulded face of the frame located at 96.0 feet (29.2 metres) on the centreline baseline. While the objective was to locate the keel, the trench instead revealed at least six hull planks to the west of the baseline, two of which featured a scuttling hole (Figures 19, 20 and 21). The hole is located at the 97.0-foot (29.6-metre) mark on the centreline baseline and is offset 4 feet, 6 inches (1.4 metres)(Broadwater and Daniel 2021: 14) (Figure 19).

Comparing RI 2394's keel-stem scarph with archival plans

There is no question the bow end of RI 2394's keel has been located and identified. Although the stem is missing (save for a small fragment), the scarph that once joined it to the keel is clearly visible (see Figures 13, 14 and 15).

During the mid-to-late 18th century, British shipwrights established accepted methods for joining the keel to the stem. However, RI 2394's keel-stem scarph is markedly different from the 'table' and 'box' scarphs typically employed during this period. When RI 2394's keel-stem scarph (Figure 15) is compared with the scarph shown in the Admiralty plans of *Endeavour* (Figure 22), there is no question they match exactly in both form and dimensions. As illustrated in Figure 23, Marquardt (1995: 49) depicts the same scarph (#16) and shows it braced with a horseshoe plate (#15). A similar scarph design was also used during construction of the *Endeavour* replica during the early 1990s. This vessel is now in the ANMM collection (Figures 24 and 25). A C-shaped concretion of 5 x 5.4 inches (metres) was recovered from the bow end of the keel, which may represent a horseshoe plate, but a definitive identification has not been completed (Abbass and Lynch 2024: 30).

Figure 26 illustrates typical box and table scarphs used during the 18th century to join the stem and keel together. These forms of joinery are notably different from those used to join *Endeavour*'s keel and stem, and the keel-stem scarph noted on RI 2394.

Investigative methodology

Photogrammetric recording and reconstruction

In 2018, the project team used a relatively new technique available to maritime archaeologists called Photogrammetric 3D Reconstruction (P3DR). This is an algorithmic process in which highly detailed and visually accurate digital 3D models or digital reproductions of real-world objects can be generated from multiple digital still images. The technique is also known by a handful of other names, including 'Structure from Motion', 'Photogrammetry' or '3D Reconstruction'. The term 'photogrammetry' is widely used within the discipline of maritime archaeology to refer to P3DR; however, photogrammetry traditionally refers to the science of obtaining measurements from photographs, and although

this occurs at very high-density in P3DR, the later stages of digital 3D model development is beyond the scope of traditional photogrammetry.

Because water clarity at RI 2394 was generally poor, only 1.6 square feet (50 square centimetres) or less could typically be captured within a single photograph at a time. Consequently, a single one-hour dive could generate as many as 500 images but only document a relatively small portion of the site. While this technique worked well for hull remains and other site components with unique visual attributes, it proved insufficient for portions of the wreck that were buried beneath sediment or relatively featureless. To combat this problem, the team placed photogrammetric 'targets' throughout areas of sterile seabed. Each target comprised a small (approximately 10-centimetre square) sheet of white Mylar, upon which was printed a unique geometric pattern (Hunter, et al. 2018: 119).

When surveying buried parts of the site, team members swam overlapping transects along the site's length. Visible elements of the wreck site were systematically photographed from multiple perspectives, ensuring the necessary overlap of no less than 60% among the captured images. Care was taken to capture at least two targets in each image and that one target overlapped between successive images. Taken together, the unique pattern on each target provided the photogrammetric software with a means of visual recognition that enabled it to combine multiple images into a single digital model. The team's GoPro Hero 4 Silver cameras were pre-programmed to capture one 12-megapixel image every two seconds (Hunter, et al. 2018: 15–19).

More than 10,000 digital images were collected during the 2018 field season alone, and the sheer volume meant that generating a composite 3D model of the entire shipwreck was painstakingly slow. To help combat this, and to test whether the survey was capturing usable imagery, the team created medium-resolution models of specific site features – such as the exposed cannon – while still in the field. The test models confirmed the efficacy of P3DR in the documentation of historic shipwrecks in Newport Harbor and formed the basis of a much-higher resolution model of RI 2394 (Hunter, et al. 2018: 19).

In 2019, the team decided to use multiple light arrays with more powerful lumens capable of cutting through the gloom of Newport Harbor. The new lights proved an excellent choice, as they illuminated an even greater area of the site within the camera frame when compared to the 2018 survey. As with the 2018 investigations, the photographic team pre-programmed their cameras to capture one 12-megapixel image every two seconds, systematically photographing visible elements of the wreck site from multiple perspectives and ensuring no less than 60% overlap among captured images. The larger lighting array meant a greater area could be captured within a single photograph but poor visibility still limited coverage (Hunter, et al. 2019: 22). Nevertheless, extensive articulated hull structure with significant relief enabled the team to generate good-quality 3D models of excavated areas.

Timber samples

The major material used in ship construction during the 18th century was timber. In European shipbuilding, the vessel's keel and stern post required long, straight timbers. As they were permanently below the waterline, these structural members tended to be hewn from rot-resistant European elm (*Ulmus* sp.) Elm had the additional advantages of being a particularly tall tree and producing a wood that did not require seasoning (Mitchell 1994: 64). English shipwrights preferred English oak (*Quercus robur*) for all other parts of a ship's structure and exhibited severe prejudice against non-English 'foreign' timbers (Jones 1982: 32). Nevertheless, after 1677 British timber agents began to supply 'East Country plank' from the Baltic to supplement domestic supplies. In addition to English oak, British shipwrights typically favoured European white oak (*Quercus petraea*) or North American white oak (*Quercus alba*) for floors, futtocks, keelson, ceiling and outer planking. Masts would most likely have been constructed from European spruce (*Picea abies*) or Baltic pine (*Pinus sylvestris*) (Anon 1788; Lavery 1991: 63; Mitchell 1994: 11–15).

Structural feature	Timber type	Likely origin
Possible floor	White Oak group (*Quercus* sp.)	North America or Europe
Possible floor	White Oak group (*Quercus* sp.)	North America or Europe
Possible floor	White Oak group (*Quercus* sp.)	North America or Europe
Possible ceiling plank	White Oak group (*Quercus* sp.)	North America or Europe
Stanchion/hold pillar	White Oak group (*Quercus* sp.)	North America or Europe

Table 10. Timber sample analysis from material sourced from RI 2394 (Ilic 2018).

Sample	Scientific name	Commercial or trade name
A (Keel – K1)	*Ulmus* sp.	Elm
B (Garboard – G2)	*Quercus* sp.	White Oak group (true oak)
C (Floor – F1)	*Quercus* sp.	White Oak group (true oak)
D (Treenail from C3)	*Quercus* sp.	White Oak group (true oak)
E (First futtock – FU1)	*Quercus* sp.	White Oak group (true oak)
F (Dunnage – D1)	*Betula* sp.	Birch
G (Ceiling plank – C2)	*Quercus* sp.	White Oak group (true oak)

Table 11. Additional timber sample analysis from material sourced from RI 2394 (Ilic 2019).

The 1768 Royal Navy survey of *Earl of Pembroke* notes the vessel's frames and planking were hewn from 'English' or 'European' oak (*Quercus robur*). Use of this species of oak was widespread in British shipbuilding during the 18th century. Several different species of oak exist, including some native to North America – such as American or southern live oak (*Quercus virginiana*) – that were preferred shipbuilding timber for North American-based shipbuilders during the same period (Green 2002: 82–3; VanHorn 2004: 15–18, 227–33). Erskine (2017) notes at least one (and possibly two) of the four vessels scuttled in Newport Harbor to the north of Goat Island were American built, and almost certainly constructed from North American timber species.

Positive identification of RI 2394's structural timbers provides a vital clue in determining whether it was constructed in Great Britain or North America. If the vessel is *Lord Sandwich*, it would be expected that surviving hull structure would almost exclusively comprise English oak and English (or Dutch) elm. For this reason, all wood samples recovered from RI 2394 were large enough to be divided into four pieces for testing: one for RIMAP's nominated specialist, one for the ANMM-nominated specialist, one for a third expert opinion in case the first two experts disagreed, and one for the permanent archive (Hunter, et al. 2019: 22).

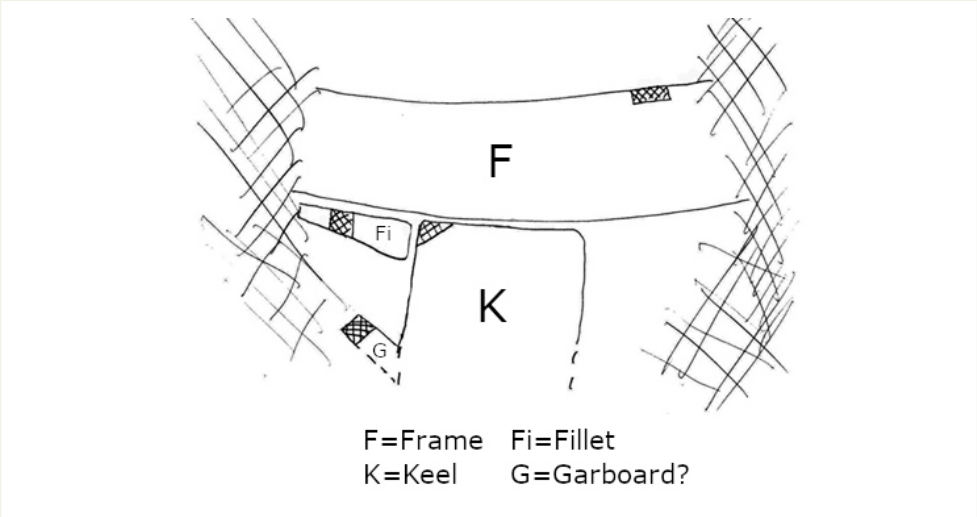
Under the terms of the RIHPHC agreement, RIMAP received permission in 2018 to collect timber samples from a selection of RI 2394's exposed (non-excavated) timbers.

Permission was granted with the proviso that the samples were small, collected from discrete locations, and that sampled areas were sealed with a suitable marine grade two-part epoxy resin to prevent additional timber degradation. Five timber samples were recovered from structural components that were tentatively identified as floors, ceiling planking and a hold pillar or stanchion (Abbass 2019: 12–13; Hosty 2018: 158).

All samples were analysed in the United States by Professor Bruce Hoadley (University of Massachusetts, Amherst) and in Australia by an expert wood scientist, Dr Jugo Ilic, of Know Your Wood, Inc. (Ilic 2018). Dr Ilic is an independent consultant and timber specialist who worked for 36 years as a Principal Research Scientist in wood science research and timber species identification at Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO). Unfortunately, as the samples had originated from exposed portions of hull timbers that had suffered damage from marine organisms and other natural processes, their overall condition was relatively poor. Degradation of each timber sample's cellular structure meant only very general conclusions could be made regarding their respective identities. Both timber specialists identified all five samples as white oak (*Quercus* sp.), which indicates the vessel was either North American- or European-built (Table 10). However, the likelihood the vessel was European built was reinforced by the absence of definitive North American timber species such as live oak (*Quercus virginiana*) or red oak (*Quercus rubra*) (Abbass 2019: 15).

Timber samples were recovered from six individual elements of RI 2394's hull structure during the 2019 field investigations. A seventh sample was taken from a timber specimen (D1) believed to be dunnage that was found atop the ceiling planking in EU2-W. The team ensured the samples were collected from timbers that were deeply buried and well preserved. One sample was obtained from each of the following hull components: the keel (K1), as well as a floor (F1), first futtock (FU1), ceiling plank (C2) and garboard (G2). One treenail in C3 was also sampled. Each sample was again divided into four separate portions: one portion each was retained by ANMM and RIMAP to be analysed by their respective timber identification specialist(s), while the remaining two portions are currently in cold storage. One portion may be analysed in future in the event there is a disagreement between results provided by ANMM's and RIMAP's

Figure 27. Locations where wood samples were recovered from TP3-S, view facing north (John D. Broadwater).



respective specialists, while the remaining specimen is to be kept in cold storage in perpetuity for 'archival' purposes.

No 2019 timber sample information from RIMAP was available to ANMM for comparative analysis. The timber samples collected by ANMM were again sent to Dr Ilic, who conducted microscopic examination of all samples and determined their respective cellular structures are consistent with the wood species outlined in Table 11 (Ilic 2019: 1).

Most of the timber samples obtained from RI 2394 were identified as White Oak (*Quercus* sp.). Prevalent use of that timber in the vessel's construction, combined with the total absence of any definitive North American timbers, reinforces the findings of the 2018 timber sampling regimen and is strongly suggestive of a European-built ship (see Krivor 1994: 145; Mitchell 1994: 64; VanHorn 2004: 15–18, 227–33). The presence of an elm (*Ulmus* sp.) keel is also indicative of a European-built vessel. American elm (*Ulmus americana*) is coarse, hard and tough, and features interlacing, contorted fibres. These make it difficult to split or chop and cause it to warp after sawing (Werthner 1935: 398). Consequently, it was not highly regarded by American shipbuilders, who preferred live oak (*Quercus virginiana*) in the manufacture of ship keels.

In her comparative archaeological study of American and British ships built during the 18th century, VanHorn (2004: 227–33) does not cite any examples of American shipbuilders employing elm but notes its use in numerous British-built vessels such as the Chub Heads Cut shipwreck in Bermuda, the Port Royal Shipwreck, *El Nuevo Constante*, HMS *Swift*, HMS *Charon* and HMS *Pandora* (Clifford 1993: 107–9; Elkin, et al. 2007: 32–58; Gesner 2000; Hawkins, et al. 2015; Krivor 1994: 126, 141; Steffy 1981).

The sample obtained from RI 2394's dunnage was identified as birch, a timber found in both North America and Europe. It was not unusual for dunnage to be sourced

Sample	Scientific name	Commercial or trade name
A (Keel – TP3-S)	*Quercus* sp.	White Oak group (true oak)
B (Keel – TP4-S)	*Quercus* sp.	White Oak group (true oak)
C (Floor – TP3-S)	*Quercus* sp.	White Oak group (true oak)
D (Fillet – TP3-S)	*Quercus* sp.	White Oak group (true oak)
(Port garboard strake – TP3-S)	*Quercus* sp.	White Oak group (true oak)

Table 12. Further timber sample analysis from material sourced from RI 2394 (Ilic 2022).

Sample	Scientific name	Commercial or trade name
A (Keel – TP3-S)	*Quercus* sp.	White Oak group (true oak)
B (Keel – TP4-S)	*Quercus* sp.	White Oak group (true oak)
C (Floor – TP3-S)	*Quercus* sp.	White Oak group (true oak)
D (Fillet – TP3-S)	*Quercus* sp.	White Oak group (true oak)
E (Garboard strake – TP3-S)	*Quercus* sp.	White Oak group (true oak)

Table 13. Timber sample analysis from material sourced from RI 2394 (Newsom 2021).

from local timber. For example, specimens recovered from the wreck of the 18th-century colonial trading vessel *Sydney Cove* included cut sections of Dryand (*Heriteria* sp.) and bamboo. Both timber species are native to India, where *Sydney Cove*'s final voyage originated (Nash 2009: 40–2). As birch was not used for any of RI 2394's structural timbers, its presence does not conflict with the hypothesis that the vessel originated in Europe.

The importance of timber sampling was elevated during the 2021 field investigations due to the discovery of the forward end of the keel and its associated stem scarph. The presence of these hull components raised the possibility that timber sampling and analysis could reveal evidence of the extensive repairs made to *Endeavour*'s bow section in Batavia (present-day Jakarta, Indonesia) following the vessel's grounding on Endeavour Reef in 1770. Identification of Australian and/or Indonesian hardwoods among RI 2394's bow timbers would provide compelling evidence for the site's identification as *Endeavour*.

In September 2021, wood samples were recovered from four hull members in Test Pit 3-South (TP3-S): the keel, a floor timber, a fillet, and possible garboard strake (Figure 27). When a possible repair in the form of an unusual keel scarph was located in TP3-S, another sample was recovered from the keel in Test Pit 4-South (TP4-S) in an effort to identify possible use of exotic timbers in repairs to the keel (Broadwater and Daniel 2021: 13).

The timber samples allocated for analysis in Australia were again assessed and identified by Dr Jugo Ilic and presented in Table 12 (2022: 1).

According to RIMAP's nominated timber specialist, Dr Lee Newsom, all recovered timber samples fell in the white oak group, as shown in Table 13.

Dr Newsom (2021: 1-2) went on to observe:

> All five specimens were assigned to the oak genus, *Quercus* sp. (Fagaceae), and all exhibit the pronounced growth increment variation typical of temperate oak species. The form and arrangement of the latewood vessels (diagnostic traits) are consistent with the American white oak anatomical group (Panshin and de Zeeuw 1980), of which *Quercus alba* L. (white oak) is a conspicuous member. However, several European oak taxa have very similar conformation of the latewood and these specimens conform quite well with comparative specimens of the European taxa, possibly more so than the American ones. If indeed European in origin, the occurrence of the large earlywood vessels in one to two rows or layers suggests that the wood may belong to the species *Q. robur* L. (pedunculate oak, also known as European oak or English oak) and/or *Quercus petraea* (Cornish oak, sessile oak, Welsh oak) (Den Outer et al. 1988). Indeed, slight variation in pore numbers and arrangement between the two keel samples possibly suggests the presence of two species, but this is highly subjective and uncertain. The comparatively abrupt transition in size from the large earlywood vessels to those of the latewood is also consistent with the European taxa. Two additional observations are 1) the very narrow growth increments associated with the Fillet sample, and 2) the inclusion of yellowish, oily extractives variously in and among the cells, especially the keel samples, which may suggest use of varnish or conditioning oils.

Although Newsom found no evidence of non-European (e.g., Australian and/or Southeast Asian) timbers among the five samples, the presence of two white oak keel samples from RI 2394's bow section does raise interesting questions. Given samples recovered from the keel in the wreck site's midships area were identified as European elm, the presence of white oak keel sections on either side of a scarph in the extreme forward end of the vessel is strongly suggestive of repair to the hull. Further, as 18th-century British shipwrights typically preferred elm over oak for keel timber, the presence of oak in the forward keel hints that its use may have been influenced by haste or cost-cutting measures (VanHorn 2004: 15–18; 227–33).

One possible explanation for the repairs is that one or more sections of keel within RI 2394's bow were replaced over the course of the vessel's career. Coincidentally, *Endeavour*'s bow section and the lower hull in the vicinity of the starboard forechains (approximately 8 feet or 2.4 metres aft of the stem) were the parts of the ship most severely affected when it grounded on the Great Barrier Reef in 1770 (Cook, 11–14 June 1770). These sections of the hull were repaired in Batavia in 1770 and again in 1775 when *Endeavour* was surveyed prior to being sold out of service (ADM 354/189/330). They were also included in repairs to the vessel noted in February 1776 when it was surveyed prior to being accepted by the Transport Service (ADM 106/3402/424).

Another suggested scenario is that extensive and undocumented repairs to *Lord Sandwich* occurred in Newport, Rhode Island prior to the Siege of Newport in August 1778. This scenario was suggested by the RIHPHC in its review of the draft version of this report in January 2022. However, given *Lord Sandwich*'s age and the location and extent of the repairs needed, sophisticated dockyard facilities would have been required, as well as access to a large stock of seasoned timbers. In addition, the vessel was in use as a prison hulk in the lead-up to the Battle of Rhode Island and slated for scuttling as a blockship once the assault on Newport commenced, which would have made extensive repairs redundant. Given the low likelihood that besieged English forces would devote time and effort performing extensive repairs to a transport they would later scuttle as a blockship, this scenario seems highly improbable.

The hypothesis that *Lord Sandwich*'s timber repairs were carried out in England rather than North America is further supported by Merwin (2003: 3–18) and Malcarne (2003: 31–40), who note that while Newport was Rhode Island's original shipbuilding centre, a severe shortage of timber on Aquidneck Island forced the city's shipyards to close and move across Narragansett Bay to Wickford, where they were active from 1790 to 1850. Both scholars also state that shipbuilding activity was dramatically interrupted by British occupation during the American Revolution and did not completely resume until after the War of 1812.

Finally, Abbass (2016: 45) and Abbass and Lynch (2020: 6) also draw attention to the possibility of using evidence of ship construction and repairs as a possible indicator of site identification:

> The life expectancy of a wooden vessel is about 20 years, and less if she [sic] has had especially hard life (such as *Endeavour*). It is not known that all ships sent to the Newport's Outer Harbor were selected because of their poor overall condition. Therefore, evidence of that poor condition may not be diagnostic, but if coupled with the sorts of repairs mentioned above, that will be consistent with what is known of the later uses of the *Lord Sandwich* ex *Endeavour* (Abbass 2016: 45).

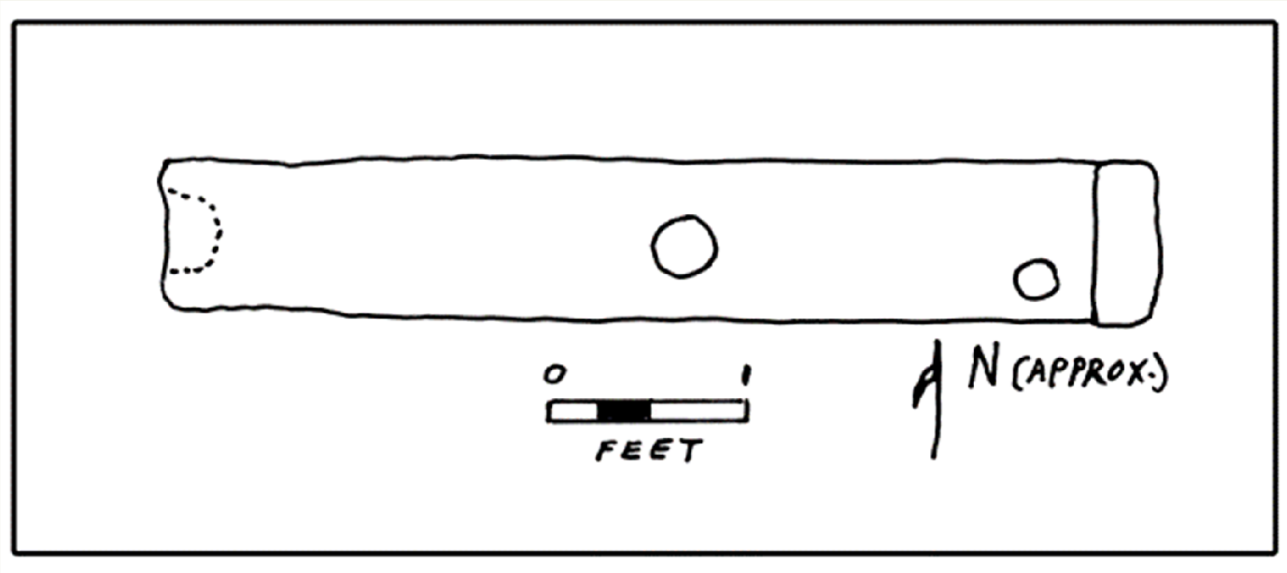


Figure 28: Sketch of Cannon 4 (John D. Broadwater).

Artefact analysis

Artefacts located and recovered from RI 2394 during the 2019–21 field seasons including glass bottle fragments (from EU1-C), a clay pipe stem, leather shoe sole (from EU2-W), decorated copper-alloy button with a wheel-engraved sunburst pattern (from EU1-W), animal bones, wooden sheaves (pulleys associated with the ship's running rigging), a lead sounding weight and a wooden barrel head (from EU2-E). Other artefacts, including an articulated barrel (from EU2-W and EU-3) were recorded and left *in situ* due to conservation concerns (Abbass and Lynch 2020: 11; Hunter, et al. 2019; Broadwater 2020: 8; Broadwater and Daniel 2021: 25).

According to Abbass and Lynch (2020: 13) the preliminary artefact identifications from all strata include small to tiny fragments of miscellaneous wood, concretions and coal fragments, coal chunks and ballast stones. These were fully documented, sampled and then repatriated to the site. Artefacts that were recovered by strata include bottle glass, animal bone, flint fragments, plastic fragments and a shoe sole from Stratigraphic Layer (Strat) 1. Strat 2 contained bottle glass, animal bone, flint fragments, concretions, brick fragments, one small gunflint fragment, animal fat, tin enamelware ceramic, nut husk fragments, worked wood, a sheave and a portion of a wooden cask. Strat 3 contained bottle glass, animal bone, flint fragments, concretions, animal fat, wire, concretions that may comprise a bolt-and-chain section, a barrel cant and one sheave. Strat 4 contained bottle glass, flint fragments, insect remains, a possible rope fragment, buttons and one kaolin pipe stem with a 4/64-inch (16-millimetre) bore that dates between 1750 and 1800. Strat 5 contained bottle glass, animal bone, flint fragments, brick fragments, worked wood and nut husks. A listing of the recovered artefacts has been tabulated by Abbass and Lynch (2024: 275–81).

Analysis of the material recovered in 2020 and 2021 by RIMAP, and by Broadwater and Daniels, is still ongoing. However, preliminary reports reveal that none of the artefacts demonstrate features that may assist in the identification of the RI 2394 shipwreck site (Abbass and Lynch 2020; Abbass 2021; Abbass and Lynch 2024: 44–53).

Cannons

Four iron cannons are visible on RI 2394. Two – Cannon 1 and Cannon 2 – are located next to one another in the approximate midships section, to starboard of the wreck site's centreline, while a third gun (Cannon 3, also in the approximate midships area) is lying on its own a short distance from the hull's surviving portside frames. All three cannons in the midships section are positioned approximately parallel to the run of RI 2394's surviving hull. The fourth cannon (Cannon 4, discussed below) is located at the extreme forward end of the hull and positioned perpendicular to the centreline, with most of its length within the port bow but its muzzle crossing the keel (Broadwater and Daniel 2021: 17). Sacrificial anodes installed on frames attached to Cannon 1 and Cannon 2 in 2020 were also inspected in September 2021 (Broadwater and Daniel 2021: 17).

During the September 2021 investigations, team members inspected Cannon 4, which is located at the 30.4-foot (9.3-metre) mark on the baseline. Hand fanning revealed the cannon is positioned in a predominantly flat and level orientation on the seabed beneath a thin layer of sediment. The field sketch below (Figure 28) shows the cannon is lying on its side with one trunnion facing upward and the muzzle facing west (towards the shipwreck site's starboard side). An unidentified flat, cylindrical metal object is concreted to the cannon near its breech. The muzzle opening is largely unobstructed, but the bore becomes progressively more choked with iron concretion towards the breech, and this precluded accurate measurement of its internal diameter.

The cannon and surrounding sediment (which has been largely encapsulated in concretion) give the impression that something flat once rested atop the cannon and had been there for some time. During the 2019 investigations, a large fragment of what appeared to be lead sheet was located immediately adjacent to Cannon 4 and its sheer size and extent precluded further excavation. Interestingly, superimposition of the archaeological site plan with the 1768 Admiralty plans of *Endeavour* places Cannon 4 beneath the location of the bark's forward lazarette deck and powder magazine. Lead or copper sheeting was often used to line the interior of powder magazines to prevent sparks and this could explain the presence of the large lead fragment and 'concreted' sediment found in association with the cannon.

The presence of such weaponry on a privately-owned ship chartered by the British government as a troop transport is not unusual. As Syrett (1970: 115) notes, for a vessel to qualify as a military transport with the British Board of Transport in 1776, it had to be armed by its owner(s) with 'at least six carriage guns of six pounders, or less bore as the Board shall think proper according to the size of the ship, and to provide twenty rounds of ammunition per gun'. This condition was modified slightly after 1779, with the Board allowing owners to fit their transports with carronades instead of long guns.

Description and analysis of RI 2394's hull remains

Originally constructed as the Whitby collier *Earl of Pembroke*, HMB *Endeavour* was a robustly built, wooden-hulled ship with a very bluff bow. It had a square transom stern, near-vertical stem post, and a long boxlike body with almost vertical sides. The vessel also had very flat floors for most of its length, with only a small number rising sharply a few feet from either end of the vessel (Macarthur 1997: 19–45). According to archival plans, *Earl of Pembroke* was built along traditional lines with a two-piece keel running the full length of the hull (Figure 29). The keel was almost square at midships, narrowing slightly towards the stem and stern. To protect the keel during accidental groundings, a substantial false keel was added to *Endeavour* during its refit at Deptford. Structural timbers associated with the bow and stern were attached to either end of the keel, including the stem, sternpost, stemson, breast hooks, hawse timbers, cant frames and deadwood (Parkin 1997: 68–71).

No framing plan for *Endeavour* is known to exist, so this aspect of the vessel's construction is being informed by archaeological investigation. The framing pattern used to construct *Endeavour* appears to have been the 'middle-style double-frame type'. In this method of frame manufacture, first futtocks are offset from the keel but joined to the floor of the paired frame by single iron fastenings. The pattern was common in England between 1770 and 1818 (McKee 1976; Morris, et al. 1995). A series of single- and double-paired frames were placed across the hull at regular intervals. Because of each frame's size and shape, they were constructed in sections, with the lowermost timber (the 'floor') placed across the keel. Each floor was held in place with iron bolts and timber treenails. Attached to each arm of the floor was a first futtock, followed by second and third futtocks, which were either scarphed or butt-joined to each other. In the case of paired frames, a second frame was installed immediately adjacent to the first, and the two were fastened together. In areas where available timber could not be matched to the shape of the hull, 'filling pieces' (also known as 'fillets' or 'chocks') were used to fair the lines of the timbers (Lavery 1991: 83).

A substantial centreline timber called the keelson was placed over the top of the floors and frames and bolted to the keel to lock the entire assembly together. *Endeavour*'s keelson was reinforced with a second 'rider' or 'deadwood' keelson that extended from the stem to just aft of the

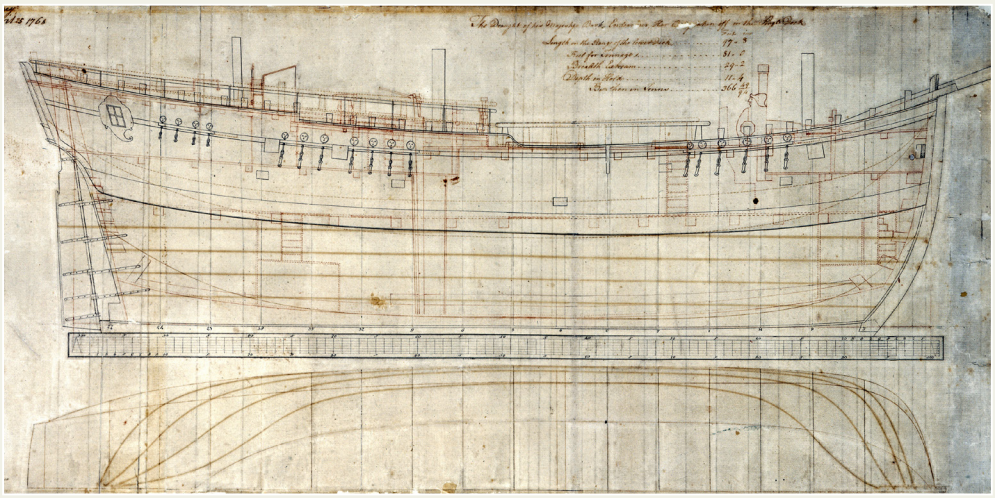


Figure 29. 1768 draft body plan of *Earl of Pembroke* produced at the dockyard at Deptford just after the British Admiralty bought the vessel. Note the 'rider' or 'deadwood' keelson. Image: Australasian Pioneers' Club collection.

mainmast. This extra centreline hull member appears to be a unique characteristic of 18th-century colliers and may be limited specifically to colliers built in Whitby. A rider or deadwood keelson is visible on the body plans of HMB *Endeavour* and HMS *Resolution,* and was noted on the shipwreck site of *General Carleton*, another Whitby collier built by Thomas Fishburn that wrecked on the Polish coast in 1785 (Babits and Ossowski 1999; 2008). Although commonly found on 19th-century wooden vessels, the rider/deadwood keelson (which is also referred to as a 'sister' keelson in 19th century contexts) is a very unusual attribute of 18th-century vessels (ADM 3814b; Marquardt 1995). A rider/deadwood keelson was not found on the collier *Betsy* sunk at Yorktown in 1780, nor the 18th-century collier shipwreck at Chub Heads Cut in Bermuda (Broadwater 1995; Watts and Krivor 1995). As there is no archival evidence that *Earl of Pembroke*'s rider/deadwood keelson was altered or removed during its service as *Endeavour* and *Lord Sandwich*, it was included as a diagnostic hull feature on the list of criteria outlined in the 2019 MOU between RIMAP and ANMM (Hunter, et al. 2019: 22).

The bases of *Endeavour*'s fore and main masts would have sat directly atop the rider/deadwood keelson (with a tenon at the bottom of each mast inserted into a corresponding mortise in the rider/deadwood keelson), while the smaller mizzen sat on a mast step attached to the orlop deck. *Endeavour* does not appear to have been outfitted with complex mast steps for its fore- and mainmasts. British shipbuilders during the 18th century often installed mortised wooden blocks or an assembly of blocks atop the floors and/or keelson to accommodate the tenoned heels of the fore- and mainmasts (Steffy 1994: 174, 296). A 'saddle' mast step comprising a large timber block with a central mortise that was mounted athwartships across the keelson was a common form that often appears in archival ship draughts of the period. However, neither these nor other types of complex mast step appear in the *Endeavour* plans, nor do they appear in draughts of Cook's other Fishburn-built vessels, HM Ships *Adventure* and *Resolution*. Further, archaeological investigation of *General Carleton* revealed the presence of mortises for the fore- and mainmasts let directly into the top of the rider keelson (Ossowski 2008: 133, 142–6). This suggests Fishburn may have preferred the use of simple mortises over more complex mast step assemblies.

Description of RI 2394's hull remains

Excavation of articulated hull remains on RI 2394 in September 2019 and January 2020, and again in October 2020 and September 2021, revealed construction attributes that are consistent with historical descriptions of *Earl of Pembroke/Endeavour/Lord Sandwich* (Hunter and Hosty 2020; Broadwater and Daniel 2021: 28–30). What follows is a description of those hull remains, as well as a discussion of commonalities between their attributes and those identified in *Earl of Pembroke*'s 1768 survey report. A comprehensive table of scantling measurements for each documented timber appears in tables 14 and 15.

Centreline timbers

One of the primary goals of the 2019 and 2020 field investigations at RI 2394 was to locate the shipwreck's keel and keelson. Both hull elements formed the vessel's backbone. The keel is the primary structural component of a wooden sailing ship and extends longitudinally along the bottom centreline of the hull, while the keelson is a corresponding longitudinal architectural component that lies atop the vessel's floors and locks them against the keel, thereby reinforcing the overall lower hull structure. Discovery of the surviving forward end of the keel in 2021 permitted additional details of this critical hull component to be recorded and analysed (Broadwater and Daniel 2021: 7). In addition, remnants of the scarph that joined the forward end

Timber	Moulded	Sided	Width	Thickness
Keel				
K1	–	13″		
K2	–	13″		
K3	–	13″		
K4 (bow end of keel)	11″ (below rabbet)	13″		
Stem				
ST (fragment)	–	–		
Keelson				
KL1 (concretion)	–	8″ to 13″		

Table 14. Scantling data for all timbers recorded on the shipwreck site RI 2394.

(*Continued over page*)

Timber	Moulded	Sided	Width	Thickness
Floors				
F1	17″ to 13½″	16″		
F2	14½″	16″		
F3	–	16″		
F4	15″	12″		
F5	–	13″		
F6	–	13″		
F7	–	13½″		
F8	–	15″		
F9	–	14″		
F10	–	14″		
F11	–	15″		
F12	–	13″		
F13	12″	12″		
F14	–	13″		
F15	–	13″		
F16	–	11″		
F17	–	12″		
F18	–	12″		
First futtocks				
FU1	12″ to 15″	6″ to 11½″		
FU2	5½″ to 6″	11″ to 20″		
FU3	13″	12″		
FU4	12″	8 ½″		
FU5	12″	–		
FU6	–	12″		
FU7	10″	14″ (narrows to 10″ at heel)		
FU8	–	11″		
FU9	–	12″		
Garboard strakes				
G1 (starboard)			–	–
G2 (port)			–	3″
Hull planking				
P1			10″ (buried)	–
P2			10″	–
P3			10″	3″
P4			10″	3″
P5			10″	–
P6			10″	–
P7			10″	–
P8			12″	2½″

(*Continued over page*)

Timber	Moulded	Sided	Width	Thickness
Ceiling planking				
C1			10″	4″
C2			12″ to 14″	3″ to 3½″
C3			12″	–
C4			8¾″	–
C5			12½″	–
C6			12″	3½″
C7 (Limber board/strake?)			6″	3½″
C8			12″	3″
C9			11¾ to 12¾″	3″
C10			13″	3″
C11 (Limber board/strake?)			6½″	3½″
C12 (Limber board/strake?)			4¼″ to 5¼″	3½″
C13 (Limber board/strake?)			5½″	3½″
C14 (appears angled to correspond to narrowing of hull at the stern)			12″ (visible)	2½ to 3″
C15 (appears angled to correspond to narrowing of hull at the stern and features 2″ diameter drilled circular hole)			12″ (visible)	2½ to 3″
C16			10″	–
C17			5″	–

Table 14. Scantling data for all timbers recorded on the shipwreck site RI 2394.

Timber	Length	Thickness	Height	Width/Diameter
Bilge pump tube				
PT1	–	–	10″ (preserved/ visible)	9½″ (external) 4½″ (internal)
Pump well				
PW1 (apron)	25″ (visible)	3″	–	26″
PW2 (partition)	23½″ (visible)	2¼″	10″	–
PW3 (partition)	20″ (preserved)	3″	6″	–
PW4 (corner post)	–	–	12″ (visible)	6″ (per side)
PW5 (stanchion)	–	–	10″ (visible)	3¾″ (per side)
PW6 (stanchion)	–	–	14″ (preserved)	3″ (per side)
Athwartships planks in pump well footprint				
AP1	15″ (visible)	1½″		17″
AP2	12″ (visible)	1½″		12″
AP3	12″ (visible)	2″		16″
AP4	8″ (visible)	1″		6″ (visible)

Table 15. Measurements of non-structural hull timbers, RI-2394 (*Lord Sandwich*, ex-HMB *Endeavour*).

of the keel with the vessel's stempost were also uncovered and documented (Broadwater and Daniel 2021: 7–10).

Keel

A section of the shipwreck's well-preserved keel (K1) was encountered during excavation of the central and western 'cells' of Excavation Unit 1 (abbreviated 'EU1-C' and 'EU1-W'). It has a sided dimension of 13 inches (33 centimetres), but its complete moulded height could not be determined because it is largely buried in the seabed and obscured by the vessel's garboard strakes. The top of the keel extends above the adjacent garboard strakes and their associated rabbets – notches cut into the top of the keel to accommodate the edges of the first hull planks, or garboard strakes – to a height of 1.5 inches (3.8 centimetres). Both Goodwin (1987: 7) and Wilson (2015: 94) state that such rabbet placement high up in the keel tends to be indicative of vessels built prior to 1780. Damage was noted along the western edge of the exposed section of keel and may be associated with a scuttling hole in the adjacent garboard strake (see discussion of planking below). A timber sample recovered from this section of the keel in 2019 was identified as European elm (*Ulmus* sp.) (Hunter and Hosty 2020; Ilic 2019: 1).

The extreme forward end of the keel (K4) uncovered in 2021 is worm-eaten and heavily eroded, but much of its original surface is still preserved and measures 13 inches (33.0 centimetres) sided. The scarph that connected it to the stempost measures 2 feet (0.61 metres) in length and has a depth of 4 inches (10.2 centimetres). When viewed in plan, the scarph is wedge-shaped and measures 6 inches (15.2 centimetres) at its forward end and 2 inches (5.1 centimetres) aft (Broadwater and Daniel 2021: 7–10). A large sheave covered the scarph at the time of its discovery, obscuring some details and limiting the extent to which it could be recorded. Consequently, it is unclear if its wedge shape is the result of natural processes or represents the original form of the scarph as let into the keel. One possible treenail hole and two iron concretions were located along the keel's upper sided surface and represent remnants of fasteners that once held the keel and stempost together.

Excavation around the forward end of the keel in Test Pit 6 South (TP6-S) revealed its moulded depth is 14 inches (35.6 centimetres). However, the height of the rabbet is 3 inches (7.6 centimetres). When this measurement is subtracted from the keel's moulded dimension, the remaining depth is 11 inches (27.9 centimetres), which is identical to what was noted in the 1768 Admiralty survey for *Endeavour*'s keel below the rabbet (Broadwater and Daniel 2021: 7–10).

A diagonal scarph was noted further aft along the forward end of RI 2394's keel but was not located in the same place as the forward keel scarph recorded on the 1768 Admiralty plans of *Endeavour* (Broadwater and Daniel 2021: 13, 29). Strangely, its form also differed from that shown on the 1768 draught, which instead depicts a vertical scarph. Based on its unusual placement and form, it was speculated the scarph could be a repair. Therefore, samples were collected from the two timbers that formed the join (Broadwater and Daniel 2021: 29). The presence of Australian and/or Indonesian hardwoods among the wreck site's bow timbers would provide compelling evidence that correlated with historical descriptions of the extensive repairs made to *Endeavour*'s bow section in Batavia following its grounding on Endeavour Reef in 1770.

While analysis of the samples did not reveal evidence of Australian and/or Southeast Asian timbers, it did confirm white oak (*Quercus* sp.) was used in the manufacture of the two keel sections that form the scarph (Ilic, 2021). Given that samples recovered from the keel in the wreck site's midships area were identified as European elm, the presence of white oak keel sections on either side of a scarph in the extreme forward end of the vessel is strongly suggestive of repair to the hull (VanHorn 2004: 15–18, 227–33). Further, 18th-century British shipwrights typically preferred elm over oak for keel timber so the presence of oak in the forwardmost section of RI 2394's keel hints that its use may have been influenced by haste and/or cost-cutting measures.

Keelson

No timber remnants of the keelson were encountered in any of the excavation units (EU1-C, EU1-W and EU4) or test pits (TP1, TP2, TP3 and TP4) where the footprint of the vessel's centreline was exposed in late 2019 and early 2020 (Hosty 2019: 195–208; Hosty 2020: 13–21). However, rectangular-shaped iron concretions were observed on the upper sided surfaces of floor timbers in the same locations as iron keel bolts. These concretions may represent a 'ghost' impression of part of the keelson formed by iron corrosion products that were trapped between it and the underlying floor timbers. The best-preserved example (KL1) is attached to the upper sided face of F1 and measures 12 inches (30.4 centimetres) across, which correlates well to the sided dimension of the keel (Hunter and Hosty 2020).

An iron keel bolt head and rectangular concretion conglomerate measuring 13 inches (33.0 centimetres) wide (corresponding with the now-absent lower sided surface of the keelson) by 12.5 inches (31.8 centimetres) long was observed on the upper sided surface of a floor (F5) uncovered in TP1. It is located along the vessel's centreline, and practically identical to concretions observed on the upper sided surfaces of the floor timbers in EU1-W and EU4. Large square/rectangular iron concretions are also present on the central upper sided surfaces of floors exposed in TP2 (F6) and TP3 (F7). Both measure 12 inches (30.4 centimetres) wide and are just over 13 inches (33.0 centimetres) long (Hunter and Hosty 2020).

Excavations in TP4 also resulted in exposure of the vessel's surviving centreline structure, as well as elements of framing. As observed elsewhere on the wreck site, the keelson is no longer present, but its former footprint is indicated by square- or rectangular-shaped iron concretions on the upper sided surfaces of the floor timbers that were once positioned beneath it (Hunter and Hosty 2020). A total of four floors (F8, F9, F10 and F11) were partially uncovered, each of which featured concretions measuring between 8 inches and 13 inches wide (20.3 centimetres and 33.0 centimetres, respectively), and lengths varying between 9.5 inches and 14 inches (24.1 centimetres and 35.6 centimetres, respectively).

Taken together, this archaeological evidence suggests a keelson was once present atop the keel of RI 2394. The reason for its absence at the site is unclear, but a likely cause is that it may not have been sufficiently buried beneath the seabed and was gradually destroyed by natural processes such as sediment scour and/or biological action. Archival research also raises the possibility that the keelson – along with the rider/deadwood keelson and its fore- and mainmast step mortises – may have been removed during extensive harbour dredging and electrical cable laying activities in the 1930s as part of an expansion of the Naval Torpedo Station on Goat Island, active over 1869–1970 (Abbass 2016: 18; Naval Undersea Warfare Center 2019: 5; *Report of the Board of Engineers for Rivers and Harbors – Newport Harbor*, War Department, Washington, 1937: 1–25). Abbass (2016: 18) also states that in the late 19th and early 20th centuries, US Navy divers training off Goat Island located several historic shipwrecks nearby, retrieving artefacts and using the wrecks for demolition practice.

It is possible the keelson and rider/deadwood keelson may have been removed due to deliberate human interference such as diving operations, channel dredging or cable laying (Abbass 2016; Hunter and Hosty 2020). Given the combined height of *Endeavour*'s keelson and rider/deadwood keelson was approximately 34.5 inches (about 0.9 metres), if it remained *in situ* at the time the Torpedo Station's cables were installed, it would have potentially lifted the cable above the seafloor. This in turn would have created a significant fouling hazard to mariners who anchored in the area, and potential damage to the cable, power supply and infrastructure it supported. The logical preventative measure would have been to intentionally lower the obstruction, and as no physical remnants of the keelson or rider keelson appear to exist on site, it seems likely they were intentionally removed.

Frames

A total of nine individual frames (four floors and five first futtocks) were uncovered and recorded during the August–September 2019 fieldwork. Six were revealed during excavation of the eastern cell of EU1 (EU1-E) and EU1-C, while the remainder were uncovered during excavation of EU4. An additional seven floors were documented following excavation of Test Pits 1 through 4 in January 2020 (Hosty 2019: 192–208; Hosty 2020: 14–19). During investigations of RI 2394 in late 2020 and early 2021, an additional 13 frames were uncovered and recorded along the entire length of the surviving articulated hull. All but three of these timbers are floors; the remainder have been identified as first futtocks (Broadwater and Daniel 2021: 24, 30).

Floors

All floors are robust in terms of their respective scantling measurements; however, the three examples located within and adjacent to EU1 in 2019 exhibit sided dimensions larger than the single floor observed in EU4. Only one floor in EU1 (designated F1) was completely excavated to reveal its overall scantlings. The upper sided faces of the two other floors (F2 and F3) were revealed through slumping of sediment along the northern and southern periphery of EU1-E (East) and C (Centre) and were opportunistically recorded (Hunter and Hosty 2020).

All three floors within and adjacent to EU1 are 16 inches (40.6 centimetres) sided, while the moulded height for F1 averages 17 inches (43.2 centimetres) before narrowing to 13.5 inches (34.3 centimetres) where it crosses the centreline. F2 (located to the north of F1) exhibits a moulded height of 14.5 inches (36.8 centimetres) where it intersects with the keel. Interestingly, all floors in EU1 also appear to have unfinished upper sided faces that are rounded at the junction with their moulded surfaces, rather than feature an interface that forms a right angle. In the case of F1, the upper sided face appears to transition to a finished surface (e.g. hewn relatively flat) as it crosses the vessel's keel. West of the centreline, this floor is covered by ceiling planking, so it is unclear whether its upper sided face reverts to an unfinished surface as it extends away from the keel on the opposite side of the hull (Hunter and Hosty 2020).

By contrast, the single floor timber in EU4 (designated F4) exhibits a smaller sided dimension (12 inches, or 30.5 centimetres), but has a greater moulded height (15 inches, or 38.1 centimetres). In terms of overall form, it is square-hewn with finished moulded and sided faces that intersect at an approximate 90-degree angle. The floors observed in Test Pits 1 through 4 also feature square-hewn finished surfaces but vary in terms of their sided dimensions (moulded heights were not recorded for these timbers due to limits imposed on excavation during the January 2020 fieldwork). The floors in TP1 and TP2 (F5 and F6) measure 13 inches (33.0 centimetres) sided, while a dimension of 13.5 inches (34.3 centimetres) sided was recorded for the floor (F7) in TP3 (Hunter and Hosty 2020).

The four floor timbers in TP4 documented in January 2020 feature sided dimensions of either 14 inches (35.6 centimetres, for F9 and F10) or 15 inches (38.1 centimetres, for F8 and F11). The relatively larger size exhibited by

the floors in TP4 is likely related to their proximity to the vessel's mainmast step/midships area, where more robust architecture was commonly employed to strengthen the hull. This is reinforced by the discovery in September 2021 of another floor (F16) between F8 and F9 with a sided dimension of 11 inches (Broadwater and Daniel 2021: 16). While smaller than the floors to either side of it, the presence of this timber creates an arrangement of three consecutive – or 'tripled' – floors that, when superimposed over the 1768 Admiralty plans of *Endeavour*, corresponds to the position of the bark's mainmast. The tripling of floors noted in TP4 may also represent the location of the vessel's 'master-couple' or 'master frame', an arrangement of floors (usually paired) that are positioned at the midpoint on a vessel's keel and comprise its widest, most robust frame.

Excavations in RI 2394's bow section in September 2021 revealed another framing arrangement in which multiple floors were positioned immediately adjacent to one another. In this case, two floors (F13 and F14) – measuring 12 and 13 inches sided, respectively – are butted against one another approximately 8 feet (2.4 metres) aft of the keel-stem scarph. Another floor (F12) with a sided dimension of 13 inches (33.0 centimetres) is positioned forward of the 'doubled' floors, with only a 5-inch (12.7-centimetre) space between them (Broadwater and Daniel 2021: 16). The location of the doubled floors corresponds to the position of *Endeavour*'s foremast when ANMM's archaeological site plan is superimposed with the 1768 Admiralty draught (cover image).

Bottom fillets were located beneath the arms of each floor uncovered in the bow section. These wedge-shaped timbers, which were installed to generate a hollow garboard and increase the hull's deadrise, had the same sided dimension as the floors above them and measured 7 inches (17.8 centimetres) moulded where their heels abutted the keel. Their overall lengths could not be determined, as their outboard ends extended into unexcavated seabed (Broadwater and Daniel 2021: 13, 24–6).

No further evidence of doubling or tripling of floors has been noted on RI 2394, suggesting it is a unique framing pattern quite unlike the standard paired-frame arrangement observed elsewhere throughout the wreck site. There is also a clear correlation between these unusual floor arrangements and the placement of *Endeavour*'s fore- and mainmasts. As noted previously, Fishburn-built vessels do not appear to have been fitted with complex mast steps that accommodated and took the weight and strain of their masts. In *Endeavour*'s case, it appears consecutive floor timbers were instead installed beneath the fore- and mainmasts to compensate for the lack of mast steps.

Three additional floor timbers were documented during the September 2021 investigations, one of which (F15) – located in the bow section approximately 15 feet (4.6 metres) aft of the keel-stem scarph – retained its entire port side arm. It is 13 inches (33.0 centimetres) sided, and its port arm measures 6.5 feet (2.0 metres) in length from the keel bolt where it crosses the centreline to its outboard heel. Assuming the starboard arm is the same length, the floor measures 13 feet (4.0 metres) across. The remaining floors (F17 and F18) are located along the starboard side of the stern section and poorly preserved where they cross the centreline. However, the upper sided surfaces of their starboard side arms were much better preserved and measured 12 inches (Broadwater and Daniel 2021: 16).

Wooden treenails with an average diameter of 1.5 inches (3.8 centimetres) are the predominant type of fastener in each of the floors recorded at RI 2394 between 2019 and 2021 (Broadwater and Daniel 2021: 10, 24). Very few iron fasteners are present. The notable exceptions are iron keel bolts, a small number of iron spikes associated with the vessel's ceiling planking, and two ½-inch (1.3-centimetre) diameter iron bolts protruding from one of the first futtocks in the stern section. At least one iron through-bolt penetrates the approximate centre of each visible floor and affixes it to the vessel's keel, although the concretions atop some floors appear to retain remnants of two bolts. The reason for the additional bolt is unclear, but one possibility is it may have affixed the now-absent keelson and rider keelson to the vessel's centreline assembly. Indeed, in the case of some floors with two bolts (e.g. F9 and F10), the head of one is clearly discernible, while the second appears to comprise only the bolt shaft. Although largely obscured by iron concretion, enough of the outline of a handful of keel bolt heads are visible to suggest that they average 5 inches (12.7 centimetres) in diameter (Hunter and Hosty 2020).

Two square holes for iron spikes were observed on the shipwreck site, one each in association with remnants of what may be 'thick stuff' or 'footwaling', a form of internal planking slightly thicker (typically 4 inches or greater) than the vessel's standard (or 'common') ceiling. Each square fastener hole measures 0.75-inch (1.9 centimetres) wide and is centrally placed in the plank with which it is associated. One was observed in F1, and the other in F4. The iron spikes that formed these holes affixed the internal planking to the floors beneath them.

First futtocks

Three of the wreck site's first futtocks were uncovered in EU1, and two exposed in EU4. Collectively, their respective scantlings are smaller than those of the floors. Two futtocks are positioned to either side of F1 in EU1. The example to the south of the floor (FU1) has a preserved visible length of 4 feet 7 inches (1.39 metres) and exhibits a sided dimension that gradually increases from 6 inches (15.2 centimetres) to 11.5 inches (29.2 centimetres) as it extends from the vessel's bilge towards its centreline. By contrast, its moulded height is 15 inches (38.1 centimetres) for much of its preserved length but narrows to 12 inches (30.5 centimetres) at its heel. A thin, roughly finished timber

was observed between the lower sided face of FU1 and the garboard strake beneath it. It appears to be a shim or wedge and would have been used to either raise the height of the futtock or fill an existing gap between it and the garboard (Hunter and Hosty 2020).

The futtock north of the floor (FU2) features a top fillet, a wedge-shaped timber installed atop the futtock's upper sided surface to elevate it to the height of the surrounding floors and create a uniform bilge ceiling. Krivor (1998: 127–8), VanHorn (2004: 188) and Wilson (2015: 50–1) all state that the use of top and bottom fillets was a highly unusual practice in North American shipbuilding during the 18th century due to the availability of suitable timber. By contrast, they have been found almost exclusively on remnants of British-built ships that survive in the archaeological record (VanHorn 2004: 188; Wilson 2015: 51). Notable examples include the collier *Betsy*, and Chub Heads Cut and Soldier Key shipwrecks (Broadwater 1980, 1989, 1995; Broadwater, et al., 1985; Morris 1991; Watts and Krivor 1995; Krivor 1998; Wilson 2015).

Degradation of the upper sided surfaces of both timbers has eroded the interface between them and created a prominent (but false) 'stepped' appearance. Combined, both timbers have an overall preserved visible length of 3 feet 7 inches (1.09 metres). FU2's sided dimension averages between 5.5 inches (14 centimetres) and 6 inches (15.2 centimetres), and its average moulded height is 20 inches (50.8 centimetres), although this dimension narrows to 11 inches (27.9 centimetres) at the heel. The heels of both FU1 and FU2 terminate 13 inches (33 centimetres) from the keel.

A third first futtock (FU3) is in EU1-W, directly across the vessel's centreline from FU2. Its heel is visible beneath the first articulated run of ceiling planking to the west of the keel, but the remainder of the timber is obscured by overlying hull structure. FU3's heel is 13 inches (33 centimetres) moulded, and 12 inches (30.5 centimetres) sided. The edges of its upper sided surface are slightly chamfered and the heel, which aligns approximately with the edge of the ceiling plank above it, is cut flat and level.

Two first futtocks were revealed during excavation of EU4, but only one (FU4) was exposed enough that its complete scantlings could be recorded. It is 8.5 inches (21.6 centimetres) sided and 12 inches (30.5 centimetres) moulded and extends away from the vessel's centreline for 18 inches (45.7 centimetres) before disappearing into EU4's western wall. A space of 2 inches (5.1 centimetres) separates it from F4. Only 5 inches (12.7 centimetres) of the upper sided surface of the other futtock (FU5) was visible, as the remainder was obscured by the southern wall of the excavation unit. Its moulded height is 12 inches (30.5 centimetres), as was its exposed length. The space between this futtock and F4 is 1 inch (2.5 centimetres). The heel of FU4 terminates 12 inches (30.5 centimetres) from the vessel's centreline, while that of FU5 is positioned 17 inches (43.2 centimetres) away (Hunter and Hosty 2020). As with the floors uncovered in EU1 and EU4, most fasteners used in conjunction with the first futtocks observed on the wreck site are wooden treenails that average 1.5 inches (3.8 centimetres) in diameter.

Two frames uncovered in the stern section during October 2020 (Broadwater 2020: 9–10) exhibit sided dimensions of 12 and 14 inches, respectively. The larger of the two, labelled in the field as 'Frame A North' (FU7) has a moulded depth of 10 inches (25.4 centimetres), but is also heavily degraded on its upper sided surface. It also features two 0.5-inch (1.3-centimetre) iron bolts and two treenails averaging 1.5 inches in diameter, and its exposed arm terminates in a cut end. When both frames were added to the overall ANMM hull plan, their respective placements did not cross the centreline, but were instead slightly offset, indicating they are first futtocks. This identity is further supported by the cut end on FU7, which forms the futtock's heel and is positioned 18 inches (45.7 centimetres) from the centreline.

Planking

A total of six articulated planks were exposed and documented during the August–September 2019 investigations, including four runs of ceiling and both of the vessel's garboard strakes (Hunter and Hosty 2021:117). In addition, two fragmentary examples of what may be ceiling or thick stuff/footwaling were noted in association with floor timbers on the port side of the vessel's keel. Part of a well-preserved plank was found resting atop one of the runs of ceiling and may be displaced ceiling or a limber board (loose ceiling planks that butted against the keelson and could be removed to examine the vessel's limber holes and water courses). A significantly narrower timber of approximately the same thickness as most of the observed ceiling planks was located atop another run of ceiling. It too appears to be disarticulated and may be a limber board or limber strake (a slightly thicker ceiling plank used to support one of the vessel's limber boards) (Hunter and Hosty 2020: 117).

Sections of three additional ceiling planks were recorded during the January 2020 fieldwork, two of which were ultimately identified as butt ends of the same plank (Hosty and Hunter 2021: 117). Two narrow planks like that observed in EU1-W were also noted and are likely disarticulated limber boards or limber strakes. Another narrow plank is present in TP3 but appears to be affixed to the floor timber beneath it. Additional hull planks were partially uncovered and recorded during the October 2020 and September 2021 investigations, including remnants of the port and starboard garboards in the forward end of the hull (Broadwater 2020; Broadwater and Daniel 2021: 13, 24, 26).

Garboard strakes

Portions of the wreck site's two garboard strakes were exposed and recorded during excavation of EU1-C and EU1-W in 2019. Garboards are runs of planking laid to either side of the keel on a wooden sailing vessel, and typically constitute the widest and thickest exterior strakes in the lower hull. The starboard garboard (G1) features a watercourse – a channel let into the garboard's internal face that allowed free passage of bilge water to the vessel's pump well(s). The watercourse measures 2.8 inches (7.0 centimetres) wide and is formed by the upper edge of the keel (above the back rabbet line) on one side, and a 1-inch (2.5-centimetre) deep notch let into the garboard itself on the other. Curiously, no limber holes that correspond to the watercourse were noted in the bottom sided faces of F1 and F3 (Hunter and Hosty 2021: 117).

The most striking feature of the garboard affixed to the port side of the keel (G2) is a large, oval-shaped hole that passes completely through it. Located immediately adjacent to the garboard's interface with the back rabbet, the hole measures 10.5 inches (26.7 centimetres) by 6.5 inches (16.5 centimetres) and appears to have been created with the intention of scuttling the vessel. It bears hallmarks of having been executed in haste with a heavy striking or cutting implement, such as a crowbar, axe, or adze. These indicators include its crude overall form and the presence of impact marks around its periphery. Such marks are observed not only to the interior face of the garboard, but also on the upper sided surface of the adjacent keel. Indeed, heavy blows to the garboard appear to have worked the wood grain apart and opened an additional 10-inch (25.4-centimetre) long fissure that is located approximately 5 inches (12.7 centimetres) outboard of the scuttling hole (Hunter and Hosty 2021: 110).

By contrast, scuttling holes observed on 18th-century British shipwrecks sunk under very similar circumstances – such as the transport *Betsy* at the Siege of Yorktown in 1781 – are markedly different. In *Betsy*'s case, a 'neat, rectangular hole [was] chiseled [sic] through the inner planking' just below the lower deck, followed by a 'second, irregular hole ... cut through the outer planking' (Broadwater 1989: 48). Similarly, one of the wrecked transports scuttled in Newport Harbor during the Battle of Rhode Island, RI 2125, also featured a 'square [scuttling] hole ... cut or punched through the outer hull planking' between two of the vessel's floors (Broadwater 1980; Broadwater, et al. 1985; Hosty and Hundley 2003: 40).

The presence of the scuttling hole allowed project archaeologists to record an accurate cross-section for G2. It is consistently 3 inches (7.6 centimetres) thick around the periphery of the hole, and presumably maintains this dimension across its entire length and width.

Sectional measurements for G1 could not be obtained, but its thickness is almost certainly identical to that of G2. Overall widths also could not be determined for either garboard, as their respective outboard seam edges were obscured beneath adjacent articulated hull structure, including floors, first futtocks and ceiling planking. It is presently unclear whether a watercourse like that observed on G1 was let into the interior surface of G2, as its expected footprint was all but obliterated by the scuttling hole.

Excavations in the forward end of the wreck site in 2021 revealed remnants of the port and starboard garboards in TP3-S and TP4-S. The surviving timber fabric of these architectural elements was significantly degraded and consequently precluded the collection of measurements that accurately reflected their original dimensions. However, the port garboard is the best-preserved example and extends 6 inches (15.2 centimetres) from the keel to its remaining heavily worm-eaten edge. It is 3 inches (7.6 centimetres) thick where it abuts the rabbet (Broadwater and Daniel 2021: 24).

Ceiling

As noted above, very little ceiling planking has survived to port of the wreck site's centreline and appears to have been largely destroyed by natural processes such as sediment scouring and biological action. The notable exceptions are two ceiling fragments attached to the upper sided surfaces of floors in EU1 and EU4, and a relatively intact – but narrower – example in TP3. In the case of the fragmented ceiling, surviving timber has mineralised because of an iron spike that affixed the ceiling to the floor beneath it. The example in EU1 (designated C1) is attached to F1, while that in EU4 (C8) is fastened to F4 (Hunter and Hosty 2021: 118).

Although heavily eroded and worm-eaten, C1 has retained enough timber structure that a determination can be made regarding its original width and thickness. It measures 10 inches (25.4 centimetres) wide and 4 inches (10.2 centimetres) thick. C1's thickness is on average an inch greater than that of the other ceiling observed on the wreck site (see discussion below) and this feature – in conjunction with its relatively close proximity to the vessel's centreline – strongly suggests it is thick stuff/footwaling rather than common ceiling. C8 is also heavily degraded, but it too retains enough original surface that an accurate assessment of its true dimensions could be made. It is 12 inches (30.5 centimetres) wide, but only 3 inches (7.6 centimetres) thick – a dimension more in keeping with most of the common ceiling documented during the 2019 field season (Hunter and Hosty 2021: 118).

The plank in TP3 (C11) is better preserved but significantly narrower than the two examples of ceiling recorded to port of the shipwreck's centreline. Its maximum visible width and thickness is 6.5 inches (16.5 centimetres) and 3.5 inches (8.9 centimetres), respectively. The plank extends from TP3's southern wall for 17 inches (43.2 centimetres) before terminating in an eroded end. Although similar in

size to the limber strakes/boards observed to starboard of the centreline, C11 is firmly attached to the floor beneath it (F7) with an iron bolt measuring 1 inch (2.5 centimetres) in diameter (Hunter and Hosty 2021: 118).

Four articulated ceiling planks were uncovered in EU1-W and EU2-E (located immediately to the west of EU1-W). All are located to starboard of the shipwreck's centreline and extend away from the keel towards the turn of the bilge. The largest example (C2) measures 14 inches (35.6 centimetres) wide and is located adjacent to the keel. Moving away from the centreline, the other three runs of ceiling (C3 to C5) exhibit widths of 12 inches (30.5 centimetres), 8.8 inches (22.2 centimetres) and 12.5 inches (31.8 centimetres), respectively. Only one example (C2) featured an exposed edge that could be accurately measured; however, its thickness (3.5 inches, or 8.9 centimetres) is almost certainly representative of the other runs of ceiling (Hunter and Hosty 2021: 119).

Portions of two additional ceiling planks, as well as one of C2's butt ends, were documented in TP1 and TP3 during the January 2020 excavations. They are oriented end-to-end to form part of a contiguous strake that is positioned immediately to starboard of the wreck site's centreline. Fortuitously, both ends of one plank (C9) were uncovered, which enabled calculation of its total length (13 feet, 6 inches or 4.11 metres). At its southern end, C9 butts against the northern end of C2 and is 11.8 inches (29.8 centimetres) wide. Its width gradually increases to 12.8 inches (32.4 centimetres) at its aft terminus, where it forms a butt joint with the other ceiling plank (C10) midway across the upper sided surface of an underlying floor (F7). Where exposed, the widths of C2 and C10 are 12 inches (30.5 centimetres) and 13 inches (33.0 centimetres), respectively. All ceiling observed in TP1 and TP3 average 3 inches (7.6 centimetres) thick, although the lower surface of C9 appears to bevel slightly downwards as it extends away from the centreline. This has created a 3-inch (7.6-centimetre) void between the bottom surface of the plank and the floor beneath it. The reason the plank's bottom surface is bevelled remains an open question but may have been intended to accommodate one of the vessel's adjoining limber boards or limber strakes (Hunter and Hosty 2021: 117).

Treenails averaging 1.5 inches (3.8 centimetres) in diameter were the only fastener type observed in conjunction with the common ceiling in EU1-W, EU2-E and TP3. Two are positioned within the seam between C2 and C3, while another occurs within the butt joint between C9 and C11. All constitute highly irregular fastener placements that may have been mistakes. Alternatively, they may have been installed intentionally to lock the ceiling planks edge-to-edge or end-to-end. Similar treenail placements have been noted on the shipwreck sites of *Sea Venture* (1609) and *Dartmouth* (1690), and may have been used in lieu of rider timbers, diagonal braces, or other internal reinforcement. The occurrence of treenails within planking seams on both shipwrecks appears to have been limited to the 'middle body of the hull where the frames and plank alignments are virtually at right angles' (Adams 2013: 126–7).

The butt end of another plank (C6) emerged from the northern wall of EU1-W during excavation. It is 12 inches (30.5 centimetres) wide and 3.5 inches (8.9 centimetres) thick. Only 6 inches (15.2 centimetres) of its length was visible. No fasteners were noted on the exposed portion of the plank and its overall length could not be determined. It rests directly atop C2 and is oriented parallel to the shipwreck's centreline, although about one-third of its visible width overlaps the edge of C2 and extends over the top of floor F2. This arrangement appears deliberate and suggests the plank may have been intentionally removed from its original position and set atop C2 – perhaps to facilitate access to the vessel's bilge. It is presently unclear where C6 was originally located within the hull, although the greatest likelihood is that it was positioned close to the (now absent) keelson. If originally located to starboard of the centreline, it almost certainly would have abutted the keelson and may have been used as a limber board. However, given C6's width is greater than the space between C2 and the edge of the concretion that may represent the keelson's footprint, the greater likelihood is that it was one of the runs of common ceiling affixed to framing immediately to port of the keelson (Hunter and Hosty 2021: 119).

Very few ceiling planks were uncovered during investigations of the wreck site's stern section in October 2020 and September 2021 (Broadwater 2020; Broadwater and Daniel 2021). The eroded end of one example (C16) rested atop a floor (F17) immediately adjacent to Test Pit 10-North (TP10-N) and measured 12 inches wide. Another possible ceiling plank (C15) was observed in Test Pit 6-North (TP6-N) during the October 2020 investigations. Described by Broadwater (2020: 8) as a 'large flat plank ... [that] did not seem to be aligned parallel to the keel', its visible width measures 12 inches, although the true dimension was partially obscured by sediment. Approximately 2 feet 6 inches (0.8 metres) of its length is exposed and abuts another plank (C14) for that entire distance. The second plank – which may comprise another run of ceiling – also exhibits a visible width of 12 inches, although its true dimension is obscured by the seabed.

Broadwater (2020: 9) observed that a circular hole measuring 2 inches (5 centimetres) in diameter was drilled through C15 but did not retain 'stains or concretion residue' indicative of a fastener hole. This suggests the hole could be a finger hold for a limber board, or perhaps a scuttling hole. The orientation of both C14 and C15 clearly does not align with the wreck site's centreline, which seems to indicate both planks are either disarticulated or may have been intentionally removed from their original positions within the hull. This proposal is reinforced by the orientation of six articulated hull planks in TP10-N (P2–P7), which are all in close proximity to C14 and C15, but

oriented parallel to the centreline. Both planks may have comprised ceiling that, like C6, originally butted against the keelson and were removed to facilitate access to the bilge. This makes sense, as the stern scuttling hole passes through two of the hull planks (P3 and P4) in TP10-N. Alternatively, C14 and C15 could be articulated ceiling that are angled to correspond to the narrowing of the hull in the stern. Superimposition of the archaeological site plan with *Endeavour*'s lower hold plan reveals a correlation between the angle of both planks and the line of the aft starboard hull.

Limber boards/strakes

What appears to be yet another ceiling plank (C7) was found lying atop C2. Like C6, it is oriented parallel to the centreline, is disarticulated and appears to have been removed from elsewhere within the vessel and intentionally placed atop C2. Indeed, C7 and C6 are positioned parallel to one another and their longitudinal edges butt closely together – an arrangement that seems too precise to have occurred randomly. C7 is noticeably narrower than the articulated runs of ceiling beneath and adjacent to it, and measures only 6 inches (15.2 centimetres) at its widest visible point. However, it is 3.5 inches (8.9 centimetres) thick, which correlates well to the other runs of common ceiling in EU1-W and EU2-E for which thicknesses are available. Approximately 4 feet (1.22 metres) of C7 was exposed during excavation; the remainder of the timber disappears into the northern wall of EU1-W and consequently its overall length is unknown. A circular hole measuring 1.5 inches (3.8 centimetres) in diameter is present approximately midway along C7's exposed length.

Ferrous staining of the timber surrounding the hole suggests it may have once contained an iron bolt. Alternatively, the staining may have originated from a ferrous object resting atop the plank, as there is no corresponding staining or concretion within the hole (Hunter and Hosty 2021: 120).

A timber (C12) with similar dimensions to C7 was partially exposed in TP1 and TP2. It appears to have been removed from its original position and is oriented parallel to the shipwreck's centreline. The timber is lying directly atop a run of ceiling planking that was detected – but not exposed – during the 2020 investigations. Approximately 4 feet 10 inches (1.47 metres) of C12's upper surface was uncovered during excavation; however, the ends of the timber remained buried in sediment and its overall length could not be determined. The plank's width narrows from 5.3 inches (13.3 centimetres) to 4.3 inches (10.8 centimetres) but is consistently 3.5 inches (8.9 centimetres) thick for the entirety of its exposed length (Hunter and Hosty 2021: 120).

Yet another narrow plank (C13) was revealed during excavation of TP4, immediately to port – and outside – of the footprint of the vessel's surviving pump well. Its dimensions approximate those of C7 and C12 and include a maximum width and thickness of 5.5 inches (14.0 centimetres) and 3.5 inches (8.9 centimetres), respectively. Only 1 foot 8 inches (50.8 centimetres) of C13's total length was exposed, but it is clearly oriented parallel to the shipwreck's centreline. The plank's ends and lower face were buried and not recorded. However, it appears to be resting atop another wooden hull component. It is presently unclear whether the timber beneath is a run of ceiling (Hunter and Hosty 2021: 120).

C7's relatively narrow width closely conforms to the 6-to-7-inch (15.2-to-17.8 centimetre) void between C2 and the western edge of the rectangular concretion atop F1. A similarly sized gap exists between C9 and the rectangular concretion atop F5, corresponding well with C12's preserved width. If the concretions represent the footprint of the keelson, C7 and C12 are very likely two of the vessel's limber boards. Because they were relatively portable and provided direct access to the keel and garboards, the limber boards were almost certainly removed at the time the vessel was scuttled. This would account for C7's seemingly intentional placement atop C2, and C12's position directly atop another run of (undocumented) ceiling planking. It could also explain the circular hole in C7, as limber boards were commonly outfitted with holes or slots to facilitate their removal and replacement (Hunter and Hosty 2021: 120).

Based on appearance and dimensions, C13 is probably also a limber board/strake. However, its location within the hull – positioned so that the pump well is situated between it and the vessel's centreline – is curious, and a notable departure from the other examples documented during the 2019 and 2020 excavations. One possible explanation is that C13 was removed from elsewhere along the centreline and stowed next to the pump well prior to the vessel being scuttled. Alternatively, it may have been used as a limber board/strake within the pump well itself and was intentionally removed to provide access to the garboards for those tasked with scuttling the vessel. The pump well was a relatively confined area, and the lack of working space within it likely necessitated complete removal of any form of obstruction, including loose hull components. The limber board may then have been placed on the ceiling planking just outside – and outboard – of the pump well where it was out of the way, but also easily accessible if needed.

Pump well

During excavation of TP 4, the stump of a cylindrical timber (PT1) was uncovered a short distance from a concentration of stone ballast at the northern end of the site (Hosty 2020: 18). Originally thought to be part of a stanchion, it was ultimately identified as the heel of one of the vessel's bilge pump tubes (Hunter and Hosty 2021: 121). Two upright planks located immediately west of the pump shaft

stump intersect at a 90° angle and form part of the timber partition that separated the vessel's pump well from the hold. The pump well was a box-like enclosure usually built to encompass the bilge pump tubes and protect them from shifting ballast or cargo within the hold. It was also intended to prevent debris from reaching the pump sump and causing irreparable damage to each bilge pump's mechanism.

The presence of the pump well explains the relative dearth of ballast stone in this area (as ballast would have been prevented from migrating into the well by its partitions) and identifies the location of the vessel's midships section. Most large 18th-century ships featured two 'suction' or 'common' bilge pumps that were located immediately adjacent to the mainmast and its corresponding mast step structure (Oertling 1996: 22–4). In the case of *Endeavour*, two additional bilge pumps and tubes were added to the vessel's original complement when the vessel was being equipped for Cook's voyage, and all four pumps were clustered around the mainmast (ADM 3814b: March 1768; Marquardt 2010: 40–1). However, these pumps were removed when the vessel was sold out of Admiralty service, and it is unclear how many pumps were refitted to the vessel thereafter (Erskine 2021: 6).

Bilge pump tube

PT1 is oriented vertically and passes through a wooden apron located directly beneath it. Its preserved exterior surface is bevelled to form six distinct sides so that it appears roughly hexagonal in cross-section when viewed from above. The tube's external diameter measures 9.5 inches (24.1 centimetres), while the internal aperture that passes through it is slightly eccentric (e.g. elliptical, or oval-shaped) and has a maximum diameter of 4.5 inches (11.4 centimetres). The surviving stump has a preserved height of 12 inches (30.5 centimetres).

The base of the tube could not be examined because the apron obscures it from view; consequently, it is unclear whether it features a sieve or intake channels (Hosty 2020: 18). Most 18th-century ships' bilge pumps were outfitted with sieves manufactured from a piece of lead or copper sheet. The sheet covered the intake bore at the base of the pump tube and was perforated with numerous holes that allowed bilge water to flow through while simultaneously preventing debris from entering the tube and clogging the pump (Oertling 1996: 30–3).

Oertling (1996: 30) notes a minimum of 'four channels were carved along radii to the center' [sic] of the pump tube's base and designed to allow bilge water to enter the bore. One or more facets were also often let into the heel of the tube to facilitate its placement between floor timbers or against the keelson, and firmly anchor it to the bottom of a vessel's hull.

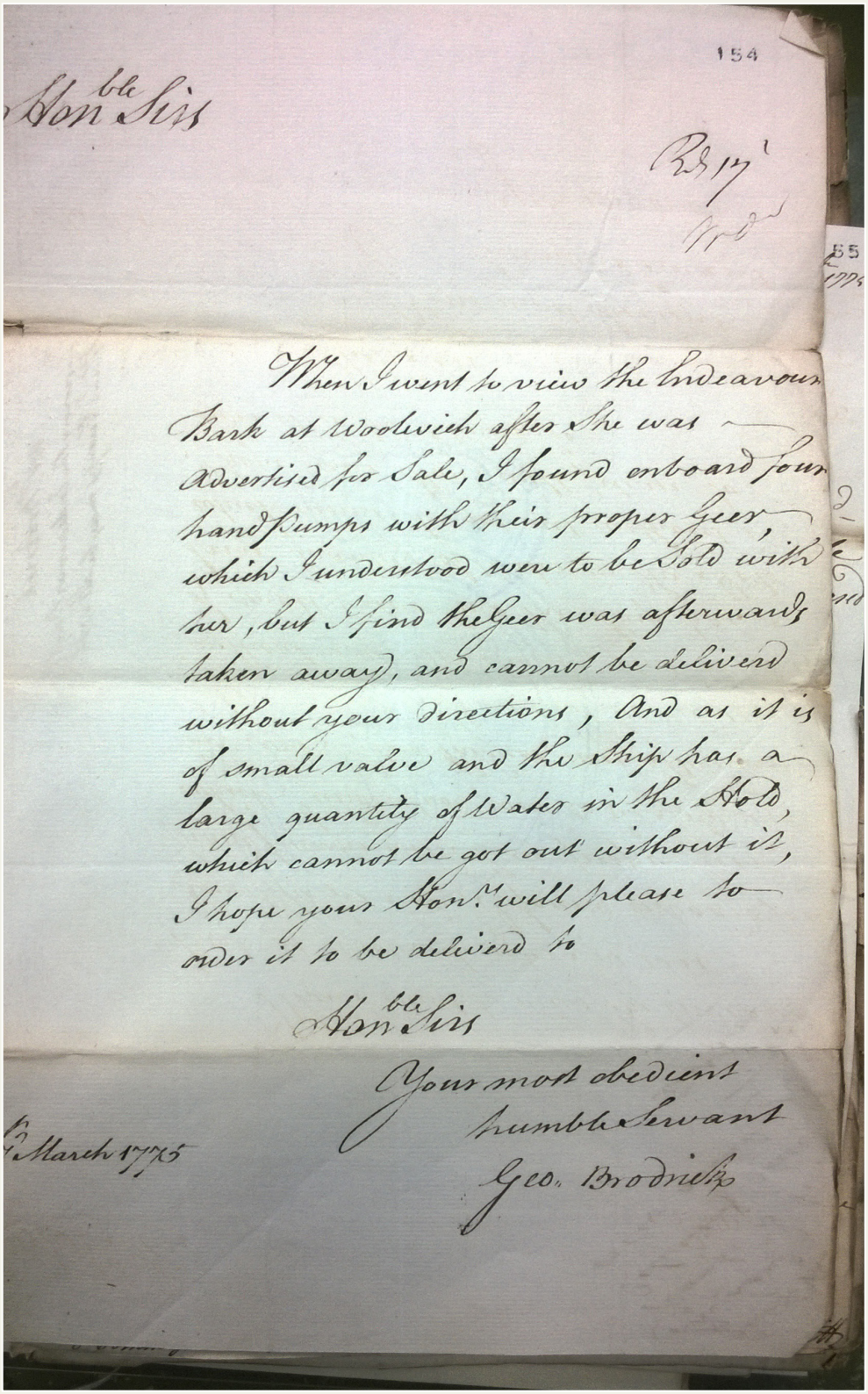
Whether facets of this kind are present on RI 2394's pump tube remains an open question. It is also presently unclear whether sections of F8 and F16 (the floors located directly beneath the pump tube) were cut away to accommodate its heel, although this seems likely, as the pump could not otherwise have reached the bilge. Seating a pump in this manner was not uncommon: In the case of HMS *Charon*, a 44-gun Fifth-Rate British warship sunk during the Siege of Yorktown in 1781, circular holes were cut 'a few inches deep into the tops of the floor timbers' to accommodate the pump heels (Oertling 1996: 30, 66). Indeed, modification of adjacent hull timbers (such as the keelson, frames and ceiling planking) to accommodate pump shafts has been noted on several historic shipwreck sites, including the Newport shipwreck, Cattewater wreck, Highborn Cay wreck, Emanuel Point I shipwreck, *San Juan*, *Santo Antonio de Tanna*, Otter Creek shipwreck, and *Nancy* (Redknap 1984: 29; Oertling 1987: 13; 1989: 247; Jackson 1991: 62; Jordan 2001: 306; Sabick 2004; Bernier and Grenier 2007).

The pump tube's cylindrical shape and lack of an accompanying tube – or aperture for a second tube in the apron – indicates it was part of a common, or 'suction', bilge pump. First used aboard ships in the late 15th or early 16th century, common pumps comprised a moving upper one-way valve attached to a rod, and a stationary lower valve with a 'claque' (or one-way flap) that allowed water to move past it (Oertling 1996: 22–4). The mechanism was contained within the tube, which until the late 18th century was often manufactured from a single tree trunk (with elm the preferred species utilised in European shipbuilding; see Oertling 1996: 10–13).

By contrast, the other type of pump then in common use – known as a 'chain pump' – was typically of more complex design and construction and utilised two shafts instead of one. The tube used to raise water from the bilge (the 'round chamber') was a hollowed log with an external profile that was either cylindrical or square, while the 'back case' that carried the pump's chain mechanism down to the bilge was a square-shaped shaft manufactured from individual timber planks fastened together (Oertling 1996: 64–7).

Archival sources indicate that *Endeavour* was outfitted with four common pumps (ADM 3814b: March 1768; Marquardt 2010: 40–1). Research conducted by Erskine has also revealed that following *Endeavour*'s survey in 1775, and prior to the vessel being purchased by George Brodrick and renamed *Lord Sandwich*, the 'proper gear' associated with its four 'hand' (common) pumps had been removed. This caused *Endeavour* to take on a 'large quantity of water' (Brodrick to Admiralty, 17 March 1775, ADM/1226/154; Figure 30). As it is unlikely that *Lord Sandwich* could pass survey for the Transport Service without being fitted with operational pumps, at least two pumps and their proper gear would have been reinstalled on the ship prior to its departure for North America. The removal of all pumps prior to 1776 (as noted in Brodrick to Admiralty, 17 March 1775 ADM/1226/154) is one possible

Figure 30. Archival documentation noting the removal of the gear associated with the four bilge pumps at the time *Endeavour* was sold out of Admiralty service (*George Brodrick to Admiralty, 17 March 1775*, ADM/1226/154). Photo: Nigel Erskine/ANMM.



154

Hon.ble Sirs

Rd 17

When I went to view the Endeavour Bark at Woolwich after she was advertised for Sale, I found onboard four hand Pumps with their proper Geer, which I understood were to be Sold with her, but I find the Geer was afterwards taken away, and cannot be delivered without your directions, And as it is of small value and the Ship has a large quantity of Water in the Hold, which cannot be got out without it, I hope your Hon.rs will please to order it to be delivered to

Hon.ble Sirs

Your most obedient humble Servant

Geo. Brodrick

17 March 1775

reason why archaeological investigation of the pump well in 2020 and 2021 only revealed the stump of one pump tube, rather than remnants of the four tubes installed on *Endeavour* in 1768.

Pump well structure

Architectural elements associated with RI 2394's pump well, some of which remain *in situ*, were documented during the January 2020 investigations (Hunter and Hosty 2021: 121). These include the apron that formed the floor of the well, two fragmented partitions that formed one of the well's corners, and an associated corner post. Two disarticulated stanchions that supported the partitions were observed lying on, or immediately adjacent to, the apron. A single mortise is located on the upper surface of the apron near the pump tube stump, and likely accommodated one of these support stanchions (Hunter and Hosty 2021: 121).

The apron (PW1) is the pump well's largest recorded structural component. It is a substantial plank-like timber that extends eastward from the interior edge of the longitudinal pump well partition (PW2) for 2 feet 2 inches (75.1 centimetres) before terminating 19 inches (48.3 centimetres) from the vessel's centreline. The void between the line of keel bolts and the apron's edge would have once accommodated the now-absent keelson, and possibly part – if not all – of the vessel's mainmast step assembly, if one was used in the vessel's construction. PW1's northern edge abuts the lateral pump well partition (PW3) and extends southward for 2 feet 1 inch (73 centimetres) before disappearing into TP4's southern wall. Where exposed, the apron's edge was 3 inches (7.6 centimetres) thick. The mortise observed on PW1's upper surface is located immediately adjacent to the pump tube stump. It is roughly square-shaped, measures 3 inches (7.6 centimetres) per side and is 2 inches (5.1 centimetres) deep (Hunter and Hosty 2021: 122).

PW2 once formed part of the pump well's western wall and was arranged parallel to the run of the hull. Now dislodged, it is no longer connected to PW3 and canted slightly towards the vessel's centreline. It is 2.3 inches (5.7 centimetres) thick and extends southward from PW3 for 23.5 inches (59.7 centimetres) before disappearing into the south wall of TP4. Where PW2 and PW3 intersect forms an approximate 90° angle and would have once comprised one of the pump well's corners. PW3 forms part of the pump well's northern wall and extends east from the corner for 20 inches (50.8 centimetres) before terminating in an eroded end. It is 3 inches (7.6 centimetres) thick and stands 18 inches (45.7 centimetres) above the apron. A square-hewn stanchion (PW4) measuring 6.5 inches (16.5 centimetres) in width per side is positioned vertically within the pump well at the intersection of PW2 and PW3. Although heavily eroded and worm-eaten on its upper end, the timber is otherwise well preserved and extends downwards for 12 inches (30.5 centimetres) before disappearing beneath PW3. Based on its location, orientation and size, PW4 functioned as one of the well's corner posts, but has undergone partial disarticulation and collapse (Hunter and Hosty 2021: 122).

Two smaller stanchions (PW5 and PW6) were also uncovered within the pump well's footprint and once served as internal vertical supports for the well's partitions. PW5 is located just east of PW1's eastern edge and positioned perpendicular to the shipwreck's centreline. It is a square-hewn timber, each side of which measures 3.8 inches (9.5 centimetres) wide. Approximately 10 inches (25.4 centimetres) of its overall length was exposed during the 2020 excavations; the remainder is buried beneath sediment between F8 and F9. PW6 was uncovered on the opposite (western) side of PW1, lying directly atop the apron and next to the 3-inch (7.6 centimetre) square mortise let into its upper surface. The stanchion is 14 inches (35.6 centimetres) long and square-hewn, each of the sides at its best-preserved end measuring 3 inches (7.6 centimetres) wide. Given their proximity and matching dimensions, the base of PW6 was almost certainly once positioned within the mortise (Hunter and Hosty 2021: 122).

As noted above, additional excavation was conducted in the pump well in September 2021 to locate and identify remnants of the other pumps. The search was based on the location of the existing starboard suction tube and configuration of the four pumps depicted on the 1768 Admiralty draughts. Using the Admiralty draughts and Marquardt (1995) as guides, test excavations were conducted within an area of the site where the second starboard pump was projected to be located. That search revealed no matching features, prompting the team to excavate areas where the two port pump tubes were thought to be located – again without uncovering evidence of pump structures. Finally, an area north of the pump well was excavated to confirm the existing pump tube was positioned in the starboard aft corner of the pump well. Additional excavation in the pump well area was curtailed out of concern it could exceed the terms of the archaeological permit (Broadwater and Daniel 2021: 10–12).

While no additional pump tubes were found, excavation within the surviving well revealed a series of four timber planks (AP1–AP4) arranged athwartships just forward of PW1. The planks average 14 inches (35.6 centimetres) wide, 1.5 inches (3.8 centimetres) thick, and terminate in cut ends that face towards the hull's centreline. As only a small portion of their surfaces were uncovered, it is unclear whether they were affixed in place or movable (Broadwater and Daniel 2021: 10–12). When integrated within the hull plan, their cut ends approximately align with the edge of the wreck site's missing keelson (indicated by rectangular fastener concretions on the upper sided surfaces of adjacent floors, including F7, F8, F9 and F16). The planks' purpose is presently unknown. Given they are relatively thin and arranged athwartships, they may have

functioned as specialized limber boards for inspecting the pump well. Alternatively, they may have comprised *de facto* 'floorboards' for the pump well and adjoining shot locker that simultaneously created a level surface and prevented debris from entering the bilge. Because they are located within the footprint of the two pumps installed in the forward part of *Endeavour*'s pump well, the planks may also have been installed to cover the voids left by the removal of those pumps in 1775.

Dunnage/quoins

Two small timbers were uncovered in EU2-W in direct association with RI 2394's hull but appear to be packing material such as dunnage. Both examples from RI 2394 (D1 and D2) were hewn from narrow logs that were bisected longitudinally (presumably with an axe) and cut into shorter sections with bevelled ends. In terms of overall appearance, both timbers share many traits in common and appear to have been manufactured from the same timber species. The flat, cut sides of both D1 and D2 face downwards and rest directly against the ceiling planks beneath them, while their upward-facing surfaces follow the natural curve of the logs from which they were hewn and are roughly semi-circular in cross-section (Hunter and Hosty 2020).

D1 is 1 foot 11 inches (58.4 centimetres) long and 4 inches (10.2 centimetres) in diameter. It appears to have been stripped of its bark and is positioned at an approximate right angle (athwartships) to the ceiling plank (C5) beneath it. The timber's western end forms an approximate right angle with the southern extremity of D2, which is oriented parallel to the run of the hull. Approximately 15 inches (38.1 centimetres) of D2's overall length was exposed during excavation; the remainder is buried in sediment and could not be measured. It measures 6 inches (15.2 centimetres) in diameter and – like D1 – appears to have been stripped of its bark (Hunter and Hosty 2020).

The arrangement of D1 and D2 at approximate right angles to one another appears to be intentional. In addition to their orientation, both timbers were immovable and may have been affixed to the hull, although fasteners (or their remnants) were not observed in association with either timber. In most cases, dunnage found in association with shipwreck sites comprises logs, branches and/or twigs arranged horizontally along the vessel's long axis (see Nash 2009: 40–1). However, dunnage could also be arranged laterally. In his treatise *The Rights of Seamen*, Isaac Ridler Butts included 'Rules for Dunnaging' that advised dunnage be placed athwartships to permit water to 'run ... more readily to the waterways, and into the scuppers' (Butts 1848: 105).

The 90° arrangement of D1 and D2 could represent the bedding and quoining technique, particularly given the remnants of a large wooden barrel were found immediately adjacent to both timbers. It is worth noting that a 'rough-cut log, flat on one side with a curved section cut out of the upper surface' was observed in the lower hold of the wrecked merchant vessel *William Salthouse* (1841) and identified as a 'quoin' (Staniforth 1987: 27). In terms of appearance, this timber closely resembles both D1 and D2 and suggests the latter examples may have been quoins rather than dunnage.

Archaeological site plan

Documented elements of the shipwreck's surviving hull are represented in the archaeological site plan that forms the gatefold rear cover of this report.

Surviving hull features compared with plans of HM Bark *Endeavour*

Of the four transport sites located north of Goat Island in the Limited Study Area, RI 2394 is the largest (in terms of overall length) by approximately 20.6 feet (6.0 metres). The scantlings and hull analysis indicate the vessel is a flat-floored, robustly built ship in the vicinity of 350 to 400 tons. Timber identification analysis indicates it is very likely a European-built ship.

Marquardt (1995) provides an extensive array of detailed drawings showcasing all components that comprised *Endeavour*'s hull, rig, interior features and equipment. However, his interpretation of the hull must be questioned, and his drawings compared with other sources, as he claimed they provided the most accurate and complete description of the vessel. Marquardt's work is based on the plans and historical descriptions of *Endeavour* available in British archives and museums, particularly the UK National Archives and National Maritime Museum in Greenwich, England (ADM 3814b, ADM 3814c).

It is noteworthy that no historical evidence of *Endeavour*'s framing arrangement (in the form of a framing plan) is known to exist. Given the relatively diminutive amount of RI 2394's surviving articulated hull structure, archival research has focussed on records that depict elements of the lower hull, particularly the keel, floors and first futtocks. These documents include the original survey of *Earl of Pembroke* when it was taken into Admiralty service in 1768, and subsequent surveys of *Endeavour* that took place at Woolwich on 2 and 5 February 1775 (see ADM 106/133/15; ADM 354/189/330; ADM 106/3402/424).

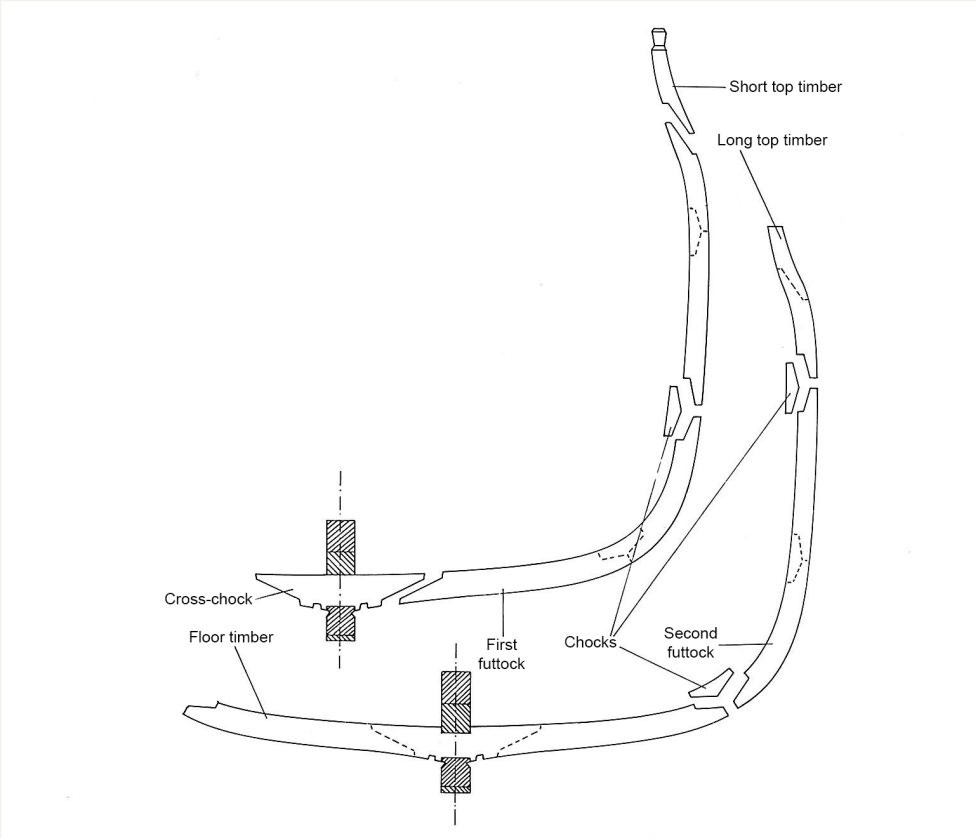


Figure 31. Proposed *Endeavour* framing schematic adapted from Marquardt (1995: 51).

Marquardt (1995) depicted *Endeavour*'s keel as assembled from three parts joined by two vertical scarphs, each of which measured 5 feet (1.50 metres) in length. If correct, this characteristic could be diagnostic, as each scarph might be observed from above as a seam dividing the upper sided surface of the keel at its centre for a length of 5 feet (1.50 metres). However, the ability to locate the scarphs would require knowledge of the position of either end of the keel.

Marquardt also illustrated what Broadwater (2020: 12) believes is an uncommon method of constructing ship's frames. He drew frames formed from bolting a short timber (called a 'cross-chock') over the keel. The cross-chock was then scarphed to two longer timber arms that he termed floor timbers (Figure 31). The frames are drawn by Marquardt as compound frames – an arrangement of floors and futtocks fastened in such a manner that they form double (or compound) frames. This pattern does not appear to match RI 2394's frames, which show first futtocks offset from the keel in a more common configuration for 18th-century merchant vessels (Morris et al. 1995: 127–9). If cross-chocks were used in Endeavour's framing arrangement, it would be relatively easy archaeologically to uncover a selection of floors to check for the tell- tale seams that indicate the presence of cross-chocks.

If Marquardt's drawings are correct, the width across the upper face of each cross-chock averages approximately 7 feet 2 inches (2.18 metres). However, at least one floor (F15) in the wreck site's forward section was uncovered to its outboard heel and no evidence of a cross-chock seam was noted. If RI 2394 is the shipwreck of *Lord Sandwich*, then this suggests Marquardt's theory that cross-chocks were used in *Endeavour*'s construction is in error. It is worth noting some of the vessel's frames were likely replaced over the course of its life and those replacements may have followed a different construction pattern (or no pattern at all), so the presence or absence of cross-chocks would not resolve the question of the wreck site's identity.

Another feature Marquardt illustrates are reinforcements at the scarphs between the keel and stem- and sternposts. A horseshoe plate is shown in schematics of *Endeavour*'s bow and an L-shaped bracket in the vessel's stern (Marquardt 1995: 48–9). Both are easily identifiable features that, if present, would have aided in the identification of the wreck site's bow and stern ends. Broadwater and Daniel (2021: 15, 19) note that investigation of the bow end of RI 2394's keel in 2021 did not reveal remnants of a horseshoe plate. They initially concluded the horseshoe plate could have been removed or succumbed to natural degradation, but no evidence of fasteners that would have affixed it to the keel were noted either, which

	RI 2394 (2019–21 archaeological surveys)	*Earl of Pembroke* (1768 Royal Navy survey)	*General Carleton* (1995–99 archaeological surveys)
Keel (sided)	13″	–	–
Keel (moulded, below rabbet)	11″	11″	–
Keelson (sided)	12″ (estimate)	–	5.5–16.5″
Keelson (moulded)	–	34.5″	31″
Floors (sided)	12–16″	14″	–
Floors (moulded)	12–17″	16″	–
First futtocks (sided)	6–14″	11″	7.8–13.3″
First futtocks (moulded)	5.5–15″	–	8.5″
Spacing between frames	1–2″	–	0.8–2.3″
Room and space	24–32″	29″	–
Lower hull planking (thickness)	3″ (garboard)	3″	3″ (average)
Lower hull planking (width)	10″	–	11.8″
Ceiling planking (thickness)	2.5–4″	–	3″ (average)
Ceiling planking (width)	5–14″	–	–
Treenails (diameter)	1.5″ (average)	–	1.5″ (average)

Table 16. Scantling data comparing shipwreck site RI 2394, 1768 Royal Navy survey of *Earl of Pembroke* and *General Carleton* shipwreck site (Knight 1933; Ossowski 2008; Hosty and Hunter 2022a).

calls into question Marquardt's illustration. This supposition is reinforced by the absence of horseshoe plates on *General Carleton*'s keel-stem assembly (Ossowski 2008: 133). However, RIMAP's 2024 report states 'an unidentified "C" shaped concretion [measuring] 5" x 5.4" [12.7 x 13.7 centimetres] with an inner dimension of 3.5" [8.9 centimetres]' was retrieved from near the bow end of the keel by one of its volunteer divers, but was replaced *in situ* without inspection or analysis (Abbass and Lynch 2024: 30). It is possible this artefact could represent a horseshoe plate fragment, but it would need to be recovered, de-concreted and analysed to confirm its identity.

Scantling data

Data recovered from RI 2394's hull was compared with scantling information contained within the Royal Navy's 1768 survey report for *Earl of Pembroke*, as well as an archaeological assessment of the wreck site of *General Carleton*, a collier of approximately 390 tons constructed at Whitby in 1777 (Table 16). Although the identity of *General Carleton*'s builder is uncertain, Baines (2008: 114) speculates it was Thomas Fishburn, who owned 'the major and most prolific shipbuilding business in Whitby in 1777 and specialised in larger vessels'. *General Carleton* was lost in the Baltic Sea near Gdansk, Poland in 1785, and excavated by the Polish Maritime Museum's Department of Archaeology between 1995 and 1999 (see Babits and Ossowski 1999; Ossowski 2008). The vessel's surviving hull was well preserved, and scantling measurements and other details were obtained for a variety of architectural members, including frames, hull and ceiling planking, and the keelson.

According to the 1768 survey, *Earl of Pembroke* was constructed with floors that were 16 inches (40.6 centimetres) moulded, and 14 inches (35.6 centimetres) sided. This correlates well to scantling measurements collected from RI 2394's floors, which range between 13.5 and 17 inches (34.3 and 43.2 centimetres) moulded, and 12 and 16 inches (30.5 and 40.6 centimetres) sided. Indeed, the average moulded and sided dimensions for RI 2394's documented floor timbers are 15.5 and 14 inches (39.4 and 35.6 centimetres), respectively. There are also notable similarities between RI 2394's first futtock scantlings, and those listed for *Earl of Pembroke*. Only the sided dimension – 11 inches (27.9 centimetres) – is provided in the 1768 report. This compares favourably to measurements obtained from RI 2394's first futtocks, which range between 6 and 20 inches (15.2 and 50.8 centimetres) sided, and average 11.2 inches (28.4 centimetres) for the entire assemblage documented between 2019 and 2021.

Other similarities between RI 2394's hull remains, and scantling data addressed in the Royal Navy survey of *Earl of Pembroke*, include room-and-space, and the thickness of lower hull planking. Room-and-space is the distance between the moulded edge of a frame and the same point on an adjoining frame, in which the *room* defines the part occupied by the frame, and the space the unoccupied distance between it and the adjacent frame (Steffy 1994: 278). The 1768 report lists *Earl of Pembroke*'s room-and-space as 2 feet 5 inches (0.73 metres), while RI 2394's recorded dimensions range between 2 feet (61.0 centimetres) and 2 feet 4 inches (0.71 metres), with an average of 2 feet 2 inches (0.66 metres). Measurements acquired from RI-2394's garboard strakes reveal they are 3 inches (7.6 centimetres) thick. This dimension corresponds exactly to the 1768 report, which notes an identical thickness for *Earl of Pembroke*'s 'plank of bottom from [the] floorheads to [the] keel' (e.g. lower hull planking including the garboards; see Knight 1933: 295).

General Carleton provides an excellent analogue for RI 2394, as it is the only known wreck site of an 18th-century Whitby collier to have been archaeologically investigated, and indeed is one of only three British-built 18th-century collier shipwrecks for which detailed hull data are currently available. At approximately 390 tons, *General Carleton* would have had scantlings comparable to those of *Earl of Pembroke*/HMB *Endeavour*/*Lord Sandwich* (368 tons). Research also indicates *General Carleton* was built in the shipyard of Thomas Fishburn in 1777. If so, its hull almost certainly shared design and construction attributes with *Earl of Pembroke*. One compelling example is the rider (or deadwood) keelson on the *General Carleton* wreck site. As stated previously, this unique feature was common on Fishburn-built colliers and known to have been incorporated within *Earl of Pembroke*'s centreline architecture (Babits and Ossowski 1999; Ossowski 2008:132–3).

Although only a very small percentage of RI 2394's hull structure was uncovered during investigations between 2018 and 2021, some notable similarities exist between its design and construction attributes and those of *General Carleton*. For example, both shipwrecks exhibit relatively flat floors and first futtocks that are very closely spaced – so much so, in fact, that the bottoms of their respective hulls form a virtual 'wall' of timber. The observed spacing between frames on RI 2394 ranges between 1 and 2 inches (2.5 and 5.1 centimetres), while that of *General Carleton* is 0.8 to 2.3 inches (1.9 to 5.7 centimetres) (Babits and Ossowski 1999; Ossowski 2008: 132).

British- and North American-built shipwrecks: an archaeological comparison by date

The Port Royal Ship, Port Royal, Jamaica (pre-1692)

(Clifford, 1993)

Most likely British-built, possible HMS *Swan* (1692)

Documented Timber Species

Slippery elm keel
Slippery elm false keel
No keelson present
No evidence of ceiling planks
White oak floors and futtocks
White oak deadwood timbers
Iron staples, iron spikes, iron bolts (keel, keelson)

Recorded Dimensions/Scantlings

Keel length: 74 inches (187.9 centimetres)
Keel (moulded): 8 inches (20.32 centimetres)
Keel (sided): 8 inches (20.32 centimetres)
Floors (moulded): 8 inches (20.32 centimetres)
Floors (sided): 9 inches (22.86 centimetres)
Futtocks (moulded): 8 inches (20.32 centimetres)
Futtocks (sided): 9 inches (22.86 centimetres)
Futtocks offset from centreline: 20 inches (50.8 centimetres)
Space between frames: 2–14 inches (5.08–35.56 centimetres)
External planking thickness: 3 inches (7.62 centimetres)

Elizabeth and Mary – Anse aux Bouleaus, Quebec, Canada (c. 1690)

(Dunning 2004)

North American/New England-built

Documented Timber Species

White oak futtocks
White oak external planks
Eastern white pine ceiling
Treenails, iron nails

The Phips Ship (pre-1690)

(VanHorn 2004)

North American/colonial Massachusetts-built, 45 tons

Documented Timber Species

White oak futtocks
White oak floors
White oak hull planking
White pine ceiling planking

Recorded Dimensions/Scantlings

Futtocks (moulded average): 4.7 inches (11.94 centimetres)
Futtocks (sided average): 6.3–10.2 inches (16.02–25.9 centimetres)
Floor and Space: various
External planking: 2 inches (5.08 centimetres)

Treenails predominant fastener type

The Rose Hill Shipwreck, Cape Fear River, Wilmington, North Carolina (c. 1740s)

(Wilde-Ramsing, et al. 1992)

Colonial built – Northern United States/Canada, 103 tons

Documented Timber Species

Hard maple keel
White oak keelson
Red oak ceilings
White oak and beech floors and futtocks
White oak outer planking
Red oak sternpost

Iron bolts and treenails predominant fastener types

Recorded Dimensions/Scantlings

Length overall: 67 feet (22.42 metres)
Beam: 22 feet (6.07 metres)
Keel length: 54.5 feet (16.61 metres)
Keel (moulded): 15 inches (38.10 centimetres)
Keel (sided): 8 inches (20.32 centimetres)
Keelson (moulded): 12 inches (30.48 centimetres)
Keelson (sided): 10 inches (25.4 centimetres)

Floors (moulded): 10.5 inches (26.67 centimetres)
Floors (sided): 11 inches (27.94 centimetres)
Futtocks (moulded): 10.5 inches (26.67 centimetres)
Futtocks (sided): 11 inches (27.94 centimetres)
External planking (thickness): 2.4 inches (6.09 centimetres)
Internal Ceiling (thickness): 2 inches (5.08 centimetres)

Other Attributes
Room and space: 11 inches and 11 inches (27.9 centimetres and 27.9 centimetres)

The Ronson Ship, New York City (c. 1700–40s)

(Riess 1987; Riess and Smith 1983)

Southern American colonies, possibly Virginia or the Carolinas, 260 tons

Documented Timber Species
White oak and live oak frames and futtocks
White oak keelson
White oak external planking
White oak internal (ceiling) planking
Pine decking
Keelson secured by iron bolts to frames
White oak, white pine, southern hard pine, hickory, juniper and ash treenails
White Pine mast

Iron bolts and treenails predominant fastener types

Recorded Dimensions/Scantlings
Length overall: 100 feet (30.48 metres)
Length between perpendiculars: 82 feet (24.99 metres)
Keel (moulded): 14 inches (38.1 centimetres)
Keel (sided): 12 inches (30.48 centimetres)
Floors (moulded): 8.5 inches (21.60 centimetres)
Floors (sided): 8.5 inches (21.60 centimetres)
Futtocks (moulded): 8.5 inches (21.60 centimetres)
Futtocks (sided): 8.5 inches (21.60 centimetres)
Futtocks offset from centreline: 11 inches (27.94 centimetres)
Space between frames: 6 inches (15.24 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
Ceiling planking (thickness): 2 inches (5.08 centimetres)

Brown's Ferry Vessel, Black River, Georgetown, South Carolina (c. 1740s–1750s)

(Albright and Steffy 1979; Hocker 1992)

Pre-1750s, Colonial built – South Carolina, 25 tons

Documented Timber Species
Yellow Pine plank keel-like structure
Live oak stem and sternpost
Live oak floors and futtocks
Yellow pine outer hull planking
Cypress wales
Cypress keelson

Treenails 1.2-inch diameter
Iron nails
Iron bolts at stem

Recorded Dimensions/Scantlings
Length overall: 50 feet, 3 inches (15.31 metres)
No keel (three planks side by side)
Keelson (moulded): 4 inches (10.16 centimetres)
Keelson (sided): 8–12 inches (20.32–30.48 centimetres)
Floors (moulded): 4.5 inches (11.43 centimetres)
Floors (sided): 4.0–6.5 inches (10.16–16.51 centimetres)
Futtocks (sided): 3.0–5.5 inches (7.62–14.0 centimetres)
Space between frames: 12–16 inches (30.48–40.64 centimetres)
External planking (thickness): 1.1–1.25 inches (2.80–3.17 centimetres)

Other Attributes
Stem secured to keel plank structure with a square scarph

Legare Anchorage Shipwreck (HMS *Fowey*), Biscayne, Florida (1748)

(Skowronek, et al. 1987)

Built Hull, England, 1744, 709 tons

Preserved length: 75 feet (23 metres)

Documented Timber Species
White oak floors and futtocks
White oak and or pine sacrificial planking
White oak stern knee
Hard maple keel
White oak keelson
White oak and hickory sister keelsons
Southern yellow pine chocks
White oak outer planking
White oak, hickory and southern yellow pine ceilings
Tropical hard woods

Treenails and iron bolts predominant fastener types
No mast step – mortise in keelson
Nine master (joined) frames

Recorded Dimensions/Scantlings
Length overall: 127 feet (38.7 metres)
Keel length: 42 feet 5 inches (12.92 metres)
Keel (moulded): 10.9–11.7 inches (27.68–29.71 centimetres)
Keel (sided): 9.6 inches (24.38 centimetres)
Keelson (moulded): 9.6 inches (24.38 centimetres)
Keelson (sided): 10.9 inches (27.68 centimetres)
Floors (moulded): 10 inches (25.4 centimetres)
Floors (sided): 9.5 inches (24.13 centimetres)
Futtocks (moulded): 8.5 inches (21.59 centimetres)
Futtocks (sided): 8.9 inches (22.06 centimetres)
Futtocks offset from centreline 12 inches (30.48 centimetres)
Space between frames: 4 inches (10.16 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
Ceiling planking (thickness): 2 inches (5.08 centimetres)

Other Attributes
Kentledge
Iron cannon
No copper sheathing
Limited lead sheathing
Stern absent, stem preserved but not surveyed.

The Terence Bay Shipwreck, Wreck Cove, Lower Prospect, Nova Scotia (1754)

(Carter and Kenchington 1985)

Colonial built, New England/Massachusetts, 100- to 120-ton schooner

Documented Timber Species
White oak floors and futtocks
White oak inner and outer planking
Red oak
Red or Scotch pine deck planking and beams
Larch

Treenails, iron bolts, iron nails predominant fastener types

Recorded Dimensions/Scantlings
Length overall: 70 feet (21.33 metres)
Floors (moulded): 6 inches (15.12 centimetres)
Floors (sided): 8 inches (20.32 centimetres)
Space between frames: 2 inches (5.08 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
Ceiling planking (thickness): 2 inches (5.08 centimetres)

Clydesdale Plantation Vessel, Back River, Savannah River, Georgia (c. 1750s)

(Amer and Hocker 1995)

Colonial-built, Southern American colonies, 1790s, 20–25 tons

Documented Timber Species
Yellow pine keel
Yellow pine external planking
Live oak floors and futtocks
Pine internal planking
Pine keelson
Live oak
Cypress

Iron nails, iron bolts and treenails predominant fastener types
No scantling or other measurements

HMS *Boscawen*, Lake Champlain, Vermont (1759)

(Cohn 1985; Kane, et al. 2007)

Colonial vessel built on Lake Champlain by British troops, 115 tons

Documented Timber Species
White oak keel
White oak keelson
White oak outer and inner hull planking
White oak gripe, main post, apron
White oak sternpost
White pine deck beams (unfinished)
White oak floors and futtocks (erratically spaced)
White oak and white ash treenails

Iron bolts, iron spikes, treenails predominant fastener types

Recorded Dimensions/Scantlings
Keel length: 65 feet (19.81 metres)
Keel (moulded): 14 inches (35.56 centimetres)
Keel (sided): 9.5–10.5 inches (24.13–26.67 centimetres)
Keelson (moulded): 6–10 inches (15.24–25.4 centimetres)
Keelson (sided): 10–11 inches (25.4–27.94 centimetres)
Floors (moulded): 8 inches (20.32 centimetres)
Floors (sided): 8 inches (20.32 centimetres)
Space between frames: 12–14 inches (30.48–35.56 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
Ceiling planking (thickness): 2 inches (5.08 centimetres)

French 'Bateau', Isle-aux-Noix, Richelieu River, Quebec, Canada (1760)

(Lepine 1978, 1981)

North American/colonial-built using Dutch and French techniques

Documented Timber Species

Blue oak outer and inner hull planking
Blue oak floors and futtocks
White oak/blue oak treenails

Iron bolts and iron spikes predominant fastener types

Recorded Dimensions/Scantlings

Surviving hull length: 147.63 feet (45.0 metres)
Floors (moulded): 2.95 feet (90.0 centimetres)
Floors (sided): 2.62 feet (80.0 centimetres)
Space between frames: 1.11 inches (34 centimetres)
External planking: 5.11–7.48 inches (13–19 centimetres) wide x 1.37 inches (3.5 centimetres) thick
Ceiling planking: 4.72 inches (12 centimetres) wide x 1.37 inches (3.5 centimetres) thick

Other Attributes

Substantial lower hull remains of a flat floored, keelless, doubled-ended, slightly built vessel
Treenails
Iron fastenings
Mortise frames

Reader's Point Vessel, St Ann's Bay, Jamaica (pre-1765)

(Gottschamer 1995; Cook and Rubenstein 1995)

West Indies, colonial-built, pre-1765, 100 tons

Documented Timber Species

White oak floors and futtocks
White oak and or pine sacrificial planking
White oak stern knee
Hard maple keel
White oak keelson
White oak and hickory sister keelsons
Southern yellow pine chocks
White oak outer planking
White oak, hickory and southern yellow pine ceiling
Tropical hardwoods

Treenails and iron bolts predominant fastener types

Recorded Dimensions/Scantlings

Length overall: 60 feet (18.28 metres)
Keel length: 42 feet 5 inches (12.95 metres)
Keel (moulded): 10.9–11.7 inches (27.68–29.71 centimetres)
Keel (sided): 9.6 inches (24.34 centimetres)
Keelson (moulded): 9.6 inches (24.34 centimetres)
Keelson (sided): 10.9 inches (27.68 centimetres)
Floors (moulded): 10 inches (25.40 centimetres)
Floors (sided): 9.5 inches (24.13 centimetres)
Futtocks (moulded): 8.5 inches (21.59 centimetres)
Futtocks (sided): 8.9 inches (22.06 centimetres)
Futtocks offset from centreline 12 inches (30.48 centimetres)
Space between frames: 12.3 inches (31.24 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
Ceiling planking (thickness): 2 inches (5.08 centimetres)

Other Attributes

Alternating floors and futtocks
First futtocks offset from keel
No mast step; mortise let into keelson
Nine master (joined) frames

Industry, Northeast Florida (1764)

(Meide 2015)

British-operated transport, West Indies, colonial-built sloop operating out of New York, pre-1764, 100 tons

No articulated hull remains

Recorded Dimensions/Scantlings

Length overall: 60 feet (18.28 metres)
Keel length: 42 feet 5 inches (19.92 metres)

Other Attributes

Eight British six-pounder cannon arranged end-to-end as cargo
Foodstuffs
Munitions
Artificers' tools
Military buttons
Shoes
Cooking equipment
Iron bar stock
Three single fluked (mooring) anchors
Grinding stones

El Nuevo Constante, Cameron Parish, Louisiana (1766)

(Hawkins, et al. 2015; Pearson and Hoffman 1995)

British-built three-masted ship, ex-*Duke of York* (pre-1764), 470 tons

Documented Timber Species

Elm keel
White oak keelson
White oak outer planking
Pine ceiling planking
White oak floors and futtocks
Spruce sheathing
Elm bilge pumps (four hexagonal pumps 3.5-inch internal diameter)
White oak treenails
Iron bolts, iron nails and iron tacks predominant fastener types

Recorded Dimensions/Scantlings

Length overall: 127.5 feet (38.86 metres)
Breadth: 30 feet (9.14 metres)
Depth: 19 feet (5.79 metres)
Keel length (preserved): 127 feet 5 inches (38.86 metres)
Thick stuff/stringers (moulded): 12 inches (30.48 centimetres)
Thick stuff/stringers (sided): 12 inches (30.48 centimetres)
Floors (sided): 11–13 inches (27.94–33.02 centimetres)
External planking (thickness): 4 inches (10.16 centimetres)
External planking (width): 13 inches (33.02 centimetres)
Sheathing: 1 inch (2.54 centimetres)

HMS *Swift*, Patagonia, Southern Argentina (1770)

(Elkin, et al. 2007; Grosso 2014; Murray, Elkin and Vainstub 2004)

British-built, at a Thames shipyard in 1763, 263 tons

Documented Timber Species

White oak floors and futtocks
White oak and/or pine sacrificial planking
White oak stern knee
Elm keel
White oak keelson
White oak outer planking
White oak ceiling planking
Pine mizzen mast

Treenails and iron bolts the predominant fastener types

Recorded Dimensions/Scantlings

Length overall: 91 feet 4 inches (27.8 metres)
Preserved length: 78 feet (23.77 metres)
Keel (moulded): 10.9–11.7 inches (27.68–29.71 centimetres)
Keel (sided): 9.6 inches (24.38 centimetres)
Keelson (moulded): 9.6 inches (24.38 centimetres)
Keelson (sided): 10.9 inches (27.68 centimetres)
Floors (moulded): 10 inches (25.4 centimetres)
Floors (sided): 9.5 inches (24.13 centimetres)
Futtocks (moulded): 4.3–4.7 inches (11–12 centimetres)
Futtocks (sided): 4.33–8.66 inches (19–22 centimetres)
Futtocks offset from centreline: 12 inches (30.48 centimetres)
Room and space between full floors 4 feet 4 inches (1.3 metres)
External planking (thickness): 1.57 inches (4.0 centimetres)
Ceiling planking (thickness): 1.57 inches (4.0 centimetres)
Deck planking (thickness): 1.96 inches (5.0 centimetres)

Other Attributes

Chock between first and second futtocks
Paired full frames separated by two filling frames

Chub Heads Cut Shipwreck, Bermuda (1750s–80s)

(Krivor 1994, 1998; Watts and Krivor 1995)

British-built; possibly the collier *Industry*, 170–210 tons

Documented Timber Species

European elm keel
White oak keelson
White oak outer planking
White oak ceilings
White oak floors and futtocks
White oak top and bottom fillet pieces
Scotch pine sheathing

Oak treenails, iron bolts, iron nails, iron tacks and occasional copper drift pins predominant fastener types

Recorded Dimensions/Scantlings

Length between perpendiculars (estimated): 72 feet (21.94 metres)
Keel length (preserved): 69 feet 9 inches (21 metres)
Keel (moulded): 12 inches (30.48 centimetres)
Keel (sided): 16 inches (40.64 centimetres)
Hogging piece (moulded): 10 inches (25 centimetres)
Hogging piece (sided): 19.5 inches (49 centimetres)
Keelson (moulded): 12.5 inches (31.75 centimetres)
Keelson (sided): 18 inches (45.72 centimetres)
Floors (moulded): 12–13 inches (30.48–33.02 centimetres)
Floors (sided): 12 inches (30.48 centimetres)
Futtocks (moulded): 4–10 inches (10.16–25.4 centimetres)
Futtocks (sided): 10 inches (25.4 centimetres)
Futtocks offset from centreline: 6–8.5 inches (15.24–21.60 centimetres)

Space between frames: 1.0–4.5 inches (2.54–11.43 centimetres)
External planking (thickness): 3 inches (7.62 centimetres)
Ceiling planking (thickness): 3 inches (7.62 centimetres)

Other Attributes

Each floor secured to the keel, hogging piece, and keelson with 1.3-inch diameter drift bolts
Offset futtocks
Hogging piece or deadwood keel/keelson
Floors randomly sided
Vertical scarph located at eastern end of keel: 12 inches (30.54 centimetres) moulded x 16 inches (40.64 centimetres) sided (indicating stem post).

Pillar Dollar Wreck, Biscayne Bay, Florida (1770–90)

(McKinnon 2016)

North American-built

Documented Timber Species

Shagbark hickory keel
Maple garboard
Maple hull planking
Aleppo and Canary Island pine hull planking
White oak sternpost
Hickory floors and futtocks
Pine sacrificial planking

Iron bolts, iron spikes and treenails predominant fastener types

Recorded Dimensions/Scantlings

Preserved length of keel: 36.08 feet (11.0 metres)
Keel length: 36.08 feet (11.0 metres)
Keel (moulded): 17.3 inches (44 centimetres)
Keel (sided): 13 inches (27 centimetres)
Keelson (moulded): 5.9 inches (15 centimetres)
Keelson (sided): 9.84 inches (25 centimetres)
Floors (moulded): 14.1 Inches (36 centimetres)
Floors (sided): 13 inches (34 centimetres)
Futtocks (sided): 14.1 inches (36 centimetres)
Futtocks (moulded): 13 inches (33 centimetres)
Garboard (thickness): 4.3 inches (11 centimetres)
External planking (thickness): 4.3 inches (11 centimetres)
Sacrificial planking (thickness): 1.57 inches (40 centimetres)

Other Attributes

Two-piece square keel with a 'Z' shaped scarph fastened by iron bolts
Lead sheathing
Futtocks offset from keel
Presence of *granel* (lime, sand and pebble mix used as permanent ballast between frames) associated with Iberian ships
Floor timber and futtock pairs fastened laterally by square iron bolts
No Iberian shipbuilding straits

Town Point Vessel, Pensacola, Florida (c. 1750s–81)

(Morris and Franklin 1995)

British colonial construction influenced by Spanish shipbuilding traditions, 30 tons

Documented Timber Species

Southern hard pine lower keel
White oak upper keel (secured by iron plates and spikes)
Pine stem
White oak apron
White oak floors and futtocks
No evidence of keelson
White oak and southern pine exterior hull planking (iron spiked to frames)
White oak ceiling planking
Bald cypress pump well
Tropical hardwood sternpost
White oak inner stern knee
White oak deadwood timber

Recorded Dimensions/Scantlings

Length overall: 35 feet (10.68 metres)
Keel (moulded): 15.9 inches (40.38 centimetres)
Keel (sided): 11 inches (27.94 centimetres)
No keelson
Floors (moulded): 6.9 inches (17.52 centimetres)
Floors (sided): 4 inches (10.16 centimetres)
Futtocks (moulded): 4.3 inches (10.92 centimetres)
Futtocks (sided): 3.1 inches (7.87 centimetres)
Space between frames: 8 inches (20.32 centimetres)
External planking (thickness): 1.2 inches (3.04 centimetres)
Ceiling planking (thickness): 0.8–1.4 inches (2.03–3.55 centimetres)

Deadman's Island Shipwreck, Pensacola Bay, Florida (c. 1770–80s)

(Finegold 1990; Rea 1981; Smith 1990)

Possible HMS *Florida*, Jamaican/British-built, 100 tons

Documented Timber Species

White oak floors, futtocks, inner and outer planking
Evidence of live oak and southern yellow pine planking
White oak keel and keelson

Iron bolts, spikes and white oak treenails predominant fastener types

Recorded Dimensions/Scantlings

Keel length: 50.10 feet (15.27 metres)
Keel (moulded): 20 inches (50.8 centimetres)
Keel (sided): 9.5 inches (24.13 centimetres)
Keelson (moulded): 9 inches (22.86 centimetres)
Keelson (sided): 11 inches (27.94 centimetres)
Floors (moulded): 8 inches (20.32 centimetres)
Floors (sided): 8 inches (20.32 centimetres)
Space between frames: 12–14 inches (30.48–35.56 centimetres)
External planking (thickness): 1.5 inches (3.81 centimetres)

Betsy (44YO88), Yorktown, Virginia (1772–81)

(Broadwater 1980; Broadwater, Adams and Renner 1985; Morris 1991; Morris, Watts and Franklin 1995)

British-built, 180 tons

Documented Timber Species

White oak keel
White oak and pine keelson (four pieces)
White oak outer hull planking
White oak floors and futtocks (roughly shaped to provide maximum amount of timber)
White oak stem
White oak beams
White oak gripe
White oak stern crutch
White oak sternpost
Pine deck planking
Pine masts

Recorded Dimensions/Scantlings

Length between perpendiculars: 73 feet 1.6 inches (22.31 metres)
Keel length: 68 feet, 2.5 inches (20.87 metres)
Keel (moulded): 13.25 inches (33.65 centimetres)
Keel (sided): 14.4 inches (36.57 centimetres)
Keelson (moulded): 8.5–23 inches (21.59–58.42 centimetres)
Keelson (sided): 14.4 inches (36.57 centimetres)
Futtocks (sided): 7–9 inches (17.78–22.86 centimetres)
Futtocks (moulded): 9–10 inches (22.86–25.4 centimetres)
Average space between frames: 1–5 inches: (2.54–12.7 centimetres)
External planking in bow (thickness): 2.4–2.5 inches (6.09-6.35 centimetres)
External planking in bow (width): 10 inches (25.4 centimetres)
External planking in stern (thickness): 5.8–6.8 inches (14.73–17.27 centimetres)
Ceiling planking (thickness): 2.5 inches (6.35 centimetres)
Ceiling planking (width): 8–12 inches (20.32–30.48 centimetres)

Other Attributes

Futtocks offset from centreline
Ship lap scarph secures the sternpost to the keel
Scarph arrangement for stem/keel is not known, although a lapped joint of some type appears most likely
Oak treenails, iron bolts and iron sheathing tacks predominant fastener types
Extensive use of top and bottom fillet pieces

HMS *Charon* (GL136) Yorktown, Virginia (c. 1778)

(Steffy 1981)

British-built, Harwich, England, 880 tons

Documented Timber Species

White oak hull planking
White oak floors and futtocks
Elm keel

Iron bolts and treenails predominant fastener types
Copper sheathed

Recorded Dimensions/Scantlings

Length between perpendiculars: 140 feet (42.67 metres)
Keel length: 115 feet (35.05 metres)
Keel (moulded): 15 inches (38.1 centimetres)
Keel (sided): 15 inches (38.1 centimetres)
Floors (sided): 10–14 inches (25.4–35.56 centimetres)
Space between frames: 3–8 inches (7.62–20.32 centimetres)
External planking (thickness): 3 inches (7.62 centimetres)
Ceiling planking (thickness): 2.5–5.0 inches (6.35–12.7 centimetres)

Cornwallis Cave Wreck (I44Y012), Yorktown, Virginia (c. 1780s)

(Johnston, Sands and Steffy 1978)

Most likely HMS *Fowey*, British-built, pre-1781, 550 tons

Documented Timber Species

Oak floors
Oak futtocks

Iron, copper and treenail fastenings

Recorded Dimensions/Scantlings

Length overall: 120–135 feet (36.57–41.14 metres)
Length between perpendiculars: 111 feet 9 inches (34.06 metres)
Keelson (sided): 14 inches (35.56 centimetres)
Floors (moulded): 10.5 inches (26.67 centimetres)
Floors (sided): 10.5–12 inches (26.67–30.48 centimetres)
Space between frames: 2 inches (5.08 centimetres)
External planking (thickness): 3 inches (7.62 centimetres)
Ceiling planking (thickness) 3.5 inches (8.89 centimetres)
Ceiling planking (width): 8.5–11 inches (21.59–27.94 centimetres)

The Burroughs Wreck (0007EDS), Edenton, North Carolina (1770–80)

(Goodall 2003; Rodgers and Corbin 2002)

Colonial/New England-built merchant sailing ship, pre-1770, 230–270 tons

Documented Timber Species

White oak floors and futtocks
White oak ceiling and outer hull planking
Keel not sampled
White oak keelson
Pine sacrificial planking

Mix of iron and treenail fasteners

Recorded Dimensions/Scantlings

Length overall: 96 feet (29.3 metres)
Preserved length: 85 feet (26 metres)
Keel (sided): 10 inches (25.4 centimetres)
Keelson (moulded): 9.6 inches (24.3 centimetres)
Keelson (sided): 9.6 inches (24.3 centimetres)
Rider keelson (moulded): 3.8 inches (9.1 centimetres)
Rider keelson (sided): 9.6 inches (24.3 centimetres)
Stem post (moulded): 9.6 inches (24.3 centimetres)
Stem post (sided): 9.6 inches (24.3 centimetres)
Stern post (moulded): 9.6 inches (24.3 centimetres)
Stern post (sided): 9.6 inches (24.3 centimetres)
Floors (moulded): 9.6 inches (24.3 centimetres)
Floors (sided) 9.6 inches (24.3 centimetres)
Futtocks (moulded): 8.3 inches (21.0 centimetres)
Futtocks (sided): 8.3 inches (21.0 centimetres)
Futtocks offset from centreline: 6 inches (15.24 centimetres)
Space between frames (room equal to space): 16.8 inches (42.7 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
Ceiling planking (thickness): 2.5 inches (6.0 centimetres)

Other Attributes

Rider or hog keelson installed above keelson
Futtocks offset from keel
Cant frames
Five-sided scarph chocks between floors and futtocks
Hook and wedge scarphs

Soldier Key Wreck (8DA416, BISC-22), North Biscayne National Park, Florida (1700–50)

(Wilson 2015)

British West Indiaman, approximately 250 tons

Documented Timber Species

White oak floors and futtocks
White oak ceilings
White oak outer planking
White oak keel
White oak chocks/fillets
Red pine sacrificial planking

Iron bolts, iron drift pins and treenails predominant fastener types

Recorded Dimensions/Scantlings

Preserved length: 42.65 feet (13.0 metres)
Calculated overall length: 80 feet (24.4 metres)
Keel (sided): 11–12 inches (27.9–30.4 centimetres)
Keelson (moulded): 10 inches (25.4 centimetres)
Keelson (sided): 10 inches (25.4 centimetres)
Floors (moulded): 11–16 inches (27.9–40.6 centimetres)
Floors (moulded average): 13.8 inches (35.0 centimetres)
Floors (sided): 6.7–9.0 inches (17.0–22.9 centimetres)
Futtocks (moulded): 8 inches (20.32 centimetres)
Futtocks (sided): 6.8–15.0 inches (17.27–38.10 centimetres)
Futtocks (sided average): 10.5 inches (26.67 centimetres)
Average space between frames: 12.2 inches (30.98 centimetres)
Ceiling planking (thickness): 1.8 inches (4.57 centimetres)
Ceiling planking (width): 14 inches (35.56 centimetres)
External planking (thickness): 1.8 inches (4.57 centimetres)
Sacrificial sheathing (thickness): 0.7 inches (1.78 centimetres)
Treenail (diameter): 1.25 inches (3.17 centimetres); treenail cross-section is octagonal

Other Attributes

Tar, hair and felt sheathing
Heavily built and fastened
Single floors with offset first futtocks
Single-piece keel with no obvious scarphs
Floors notched to accept keel
Triangular limber hole either side of keel
First futtocks fitted with top fillets at terminal end in bilge (to level futtocks with floors to take ceiling)
Every fifth pair of timbers are mould frames
Every floor timber bolted directly to keel

BISC-0002 aka, the 'English China Wreck', Biscayne National Park, Florida (1770–80)

(Bright and Brown 2013; Lawson, et al. 2016)

Possibly the *Hubbard* or *Litbury*, eastern North American/colonial built, 85–100 tons

Documented Timber Species

Birch floors and futtocks
Birch ceilings
Birch outer planking
Birch keel
Pine sacrificial planking

Iron bolts and treenails predominant fastener types

Recorded Dimensions/Scantlings

Preserved length: 59 feet (17.98 metres)
Calculated overall length: 80 feet (24.4 metres)
Keel (sided): 10 inches (25.4 centimetres)
Keelson (moulded): 10 inches (25.4 centimetres)
Keelson (sided): 10 inches (25.4 centimetres)
Floors (moulded): 11–16 inches (27.94–40.64 centimetres)
Floors (sided): 10 inches (25.4 centimetres)
Futtocks (sided average): 10.5 inches (26.67 centimetres)
Average space between frames: 2 inches (5.08 centimetres)
Room and space of 10 inches and 12 inches. (25.4-30.48 centimetres)
Ceiling planking (thickness): 1.8 inches (4.57 centimetres)
Ceiling planking (width): 14 inches (35.56 centimetres)
External planking (thickness): 1.8 inches (4.57 centimetres)
Sacrificial sheathing (thickness): 0.7 inches (1.77 centimetres)
Treenail (octagonal): 1.5 inches in diameter (3.81 centimetres)
Iron fasteners (diameter): 1 inch (2.54 centimetres); attached floors to frames at regular 24-inch (60.9-centimetre) intervals

Other Attributes

No stem, stern or upper framing elements observed
Tar, hair and felt sheathing
Rabbet high up on keel
Single floors with offset first futtocks 15–21 inches (38.1-53.34 centimetres)
Single-piece keel with no obvious scarphs
Floors notched to accept keel.
Floors run continuously across keel and symmetrical (not a long arm / short arm configuration)
Every floor timber bolted directly to the keel

Die Frau Metta Catharina Von Flensburg, Plymouth Sound (1786)

(Skelton 2010)

European/Denmark-built, 106 tons

Documented Timber Species

White oak floors and futtocks
White oak ceiling planks
White oak outer hull planking
Hickory mast hoops
Pine main mast
Pine pump shafts
Pine hull sheathing
Birch log dunnage
Oak treenails

Iron bolts every floor; iron spikes, wrought-iron nails and oak treenails predominant fastener types

Recorded Dimensions/Scantlings

Keel (moulded): 9.44 inches (24.0 centimetres)
Keel (sided): 9.44 inches (24.0 centimetres)
Height above garboard rabbet: 1.96 inches (5.0 centimetres)
Keelson (moulded): (23.0 centimetres)
Keelson (sided): 9.05 inches (29.5 centimetres)
Floors (moulded): 8.66 inches (22.0 centimetres)
Floors (sided): 10.23 inches (26.0 centimetres)
Futtocks (moulded): erratic dimensions
Futtocks (sided): erratic dimensions
Futtocks offset from centreline: 13.5 inches (24.29 centimetres)
Average space between frames: 11.81 inches (30.0 centimetres)
Treenails (average diameter): 1.18 inches (3.0 centimetres)
Iron bolts (average diameter): 0.98 inches (2.50 centimetres)
External planking (thickness): 2.36 inches (6.0 centimetres)
Ceiling planking (thickness): 2.36 inches (6.0 centimetres)

Other Attributes

Iron gudgeons

The Otter Creek Shipwreck, Oriental, North Carolina (c. 1780s–1800s)

(Jackson 1991; Wilde-Ramsing 1996)

North American/colonial-built, 100 tons

Documented Timber Species

White oak floors and futtocks
White oak keel
White oak ceiling planks (randomly fastened by iron spikes and treenails)
White oak outer hull planking
Hickory mast hoops
Red/Scots pine sheathing

Recorded Dimensions/Scantlings

Length overall: 58 feet (17.67 metres)
Keel length (preserved): 49 feet 3 inches (15.01 metres)
Keel (moulded): 12 inches (30.48 centimetres)
Keel (sided): 9–12 inches (22.86–30.48 centimetres)
Keelson (moulded): 12 inches (30.48 centimetres)
Keelson (sided): 13.5 inches (34.29 centimetres)
Floors (moulded): 12–13 inches (30.48–33.02 centimetres)
Floors (sided): 6.13 inches (15.57 centimetres)
Futtocks (moulded): 12 inches (30.48 centimetres)
Futtocks offset from centreline: 13.5 inches (34.29 centimetres)
Average space between frames: 3–27 inches (7.62–68.58 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
Ceiling planking (thickness): 2 inches 5.08 centimetres)

Other Attributes

Iron gudgeons
Oak treenails, iron bolts, iron spikes and wrought iron nails predominant fastener types

Barge Site (RI 2119), Newport, Rhode Island (c. 1778)

(Bassett, Hosty and Hundley 2001; Hosty and Hundley 2002, 2003)

Possibly North American- or British-built, pre-1778, 300–400 tons

Documented Timber Species

White oak floors and futtocks
White oak ceiling planks (randomly fastened by iron spikes and treenails)
White oak outer hull planking
White oak keelson

Treenails, iron bolts and iron spikes predominant fastener types

Recorded Dimensions/Scantlings

Keel length (preserved): 85 feet (25.9 metres)
Keelson length (preserved): 57 feet (17.37 metres)
Keel (moulded): 12 inches (30.48 centimetres)
Keel (sided): 12.5 inches (31.75 centimetres)
Keelson (moulded): 12 inches (31.75 centimetres)
Keelson (sided): 12.5 inches (31.75 centimetres)
Floors (moulded): 12–13 inches (30.48–33.02 centimetres)
Floors (sided): 10–11 inches (25.4–27.94 centimetres)
Floor and space: 24 inches (60.96 centimetres)
Futtocks (moulded): 11 inches (27.94 centimetres)
Futtocks (sided): 11 inches (27.94 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
Ceiling planking (thickness): 3 inches (7.62 centimetres)

Other Attributes

Flat-floored
Middle style double frame type (e.g., first futtock offset from keel but joined to the floor of the paired frame by an iron fastener)

Hospital Cannon Site (RI 2125), Newport, Rhode Island (c. 1778)

(Basset, Hosty and Hundley 2000a)

Possibly North American- or British-built, pre-1778, 100–150 tons

Documented Timber Species

Pine (possible Scots pine) keelson
White oak keel
White oak floors
White oak outer hull planking
White oak ceiling planking
White oak treenails
Baltic pine sacrificial planking

Recorded Dimensions/Scantlings

Keel (moulded): 15 inches (38.1 centimetres)
Floors (maximum sided): 11 inches (27.94 centimetres)
Floor and space: 12–18 inches (30.48–46.72 centimetres)
Outer hull planking (thickness): 2 inches (5.08 centimetres)

Other Attributes

Single, short, and sharply curved floors
Every second futtock offset from centre line with no adjoining floor
Treenails predominant fastener type

Devereaux Cove Shipwreck, Stockton Springs, Maine (c. 1779)

(Green 2002)

North American colonial-built, possibly a New England sloop

Documented Timber Species

Red oak floors and futtocks
Red oak outer hull planking
American white oak treenails

Iron bolts and treenails predominant fastener types

Recorded Dimensions/Scantlings

Preserved length: 52 feet (15.85 metres)
Keelson (sided): 14 inches (35.56 centimetres)
Floors (moulded): 5 inches (12.7 centimetres); moulded surfaces were heavily eroded
Floors (sided): 10.5–11.5 inches (26.67–29.21 centimetres)
Futtocks (sided): 10.5–11.5 inches (26.67–29.21 centimetres)
Average space between frames: 22 inches (55.88 centimetres)
External planking (thickness): 2.5–3.0 inches (6.35–7.62 centimetres)

Other Attributes

Possible fillets between futtocks and outer hull planking
Offset futtocks

Defence, Penobscot Bay, Maine (c. 1779)

(Mayhew 1973; Switzer 1983)

Built in Beverley, Massachusetts in 1779, 170 tons

Documented Timber Species

White oak floors and futtocks
White oak ceiling planking
White oak deadwood
White oak keel
Oak chocks
White pine masts
Pine decks
Pine bulkheads, shot lockers, bilge pump box

Minimal iron bolts; treenails predominant fastener type

Recorded Dimensions/Scantlings

Length overall: 72 feet (21.94 metres)
Keel (moulded): 14 inches (35.56 centimetres)
Keel (sided): 8 inches (20.32 centimetres)
Keelson (moulded): 9 inches (22.86 centimetres)
Keelson (sided): 11.5 inches (29.21 centimetres)
Floors (moulded) 8–15 inches (20.32–38.1 centimetres)
Futtocks (moulded): 8 inches (20.32 centimetres)
Futtocks (sided): 8 inches (20.32 centimetres)
Average space between frames: 5 inches (12.7 centimetres)
External planking (thickness): 2–2.5 inches (5.08–6.35 centimetres)

Phinney Site (ME 054-004), Penobscot River, Maine (1779)

(Hunter 2003, 2004)

Possibly Continental Navy brig *Diligent* (formerly HMB *Diligent*), built in Massachusetts c.1775, estimated 200–300 tons

Documented Timber Species

White oak floors and futtocks
White oak ceiling planking
White oak deadwood
White oak keel
Red oak stempost
Red oak garboard
White and red oak outer hull planking
White oak chocks

Iron bolts every second floor; treenails

Recorded Dimensions/Scantlings

Estimated length overall: 85–95 feet (26–29 metres)
Preserved length: 79 feet (24.1 metres)
Keel (moulded): 14.96 inches (38.0 centimetres)
Keel (sided): 15.74 inches (40.0 centimetres)
Keelson (moulded): 14.56 inches (37.0 centimetres)
Keelson (sided): 10.23 inches (26 centimetres)
Floors (moulded): 7.87 inches (20.0 centimetres)
Floors (sided): 9.44 inches (24.0 centimetres)
Futtocks (moulded): 7.87 inches (20.0 centimetres)
Futtocks (sided): 8.26 inches (21.0 centimetres)
Average space between frames: 22.04 inches (56.0 centimetres)
External planking (thickness): 1.37 inches (3.50 centimetres)
Garboard (thickness): 2.36 inches (6.0 centimetres)
Garboard (rabbeted below top of keel): 3.93 inches (10.0 centimetres)
Stempost (moulded): 16.92 inches (43.0 centimetres)
Stempost (sided): 6.69 inches (17.0 centimetres)

Other Attributes

Stem construction like that of *Betsy* (English-built) and *Eagle* (American-built)
Scarph joint unclear but most likely 'boxed'
Middle-style, double-frame pattern
First futtocks offset from, but close to, keel
Bluff-bowed, full bodied
Well-built, carefully fashioned and proportioned.
Possible cross chocks
Possible fillets

Storm Wreck (8SJ5459), St. Augustine, Florida (1782)

(McNamara 2014; Meide 2015; Veilleux and Meide 2016)

European (French?) built; possibly *Sally*, 50–100 tons

No articulated hull remains

Attributes of Interest

Bronze ship's bell (no name or identifying marks)
Four 4-pounder cannon (1760s) and two 9-pounder carronades (1780)
Several regimental buttons (1760s–1785)
Muskets
Military accoutrements
Cooking equipment
Personal effects

Nancy, Nottawasaga River, Ontario, Canada (1789–1814)

(Sabick 2004)

North American; built in Detroit in 1789, 100–120 tons

Documented Timber Species

Oak and red cedar floors, futtocks, and planking
Oak keel
Oak keelson

Treenails and iron bolts predominant fastener types

Recorded Dimensions and Scantlings

Length overall: 68 feet (20.72 metres)
Keel length: 59 feet 9 inches (18.22 metres)
Keel (moulded): 12.0–14.8 inches (30.48–37.59 centimetres)
Keel (sided): 8.0–9.5 inches (20.32–24.13 centimetres)
Keelson (moulded): 12 inches (30.48 centimetres)
Keelson (sided): 9 inches (22.86 centimetres)
Floors (moulded): 7.5–9.0 inches (19.05–22.86 centimetres)
Floors (sided): 8–9 inches (20.32–22.86 centimetres)
Space between frames: 25 inches (63.50 centimetres)
Futtocks (moulded): 8 inches (20.32 centimetres)
Futtocks (sided): 8 inches (20.32 centimetres)
Futtocks offset from centreline: 7–10 inches (17.78–25.4 centimetres)
External planking (thickness): 2 inches (5.08 centimetres)
External planking (width): 6–10 inches (15.24–25.4 centimetres)
Ceiling planking (thickness): 1.5 inches (3.81 centimetres)
Ceiling planking (width): 7–9 inches (17.78–22.86 centimetres)

Other Attributes

Moulded (joined) frames
Regular frames
Filler pieces (futtocks?)
Two-part keelson joined by a hook scarph
Keelson fastened to floors by iron bolts
Mast steps
Each external strake only two planks long (attesting to size of available timber)

HMS *Pandora*, Pandora Passage, North Queensland (1778)

(Gesner 2000)

Porcupine-class 24-gun frigate, British-built in 1778, 513 tons

Documented Timber Species

White oak exterior planking
White oak floors and futtocks
Elm keel
Elm sacrificial planking

Iron and copper bolts, and treenails predominant fastener types

Recorded Dimensions/Scantlings

Length between perpendiculars: 114 feet 3 inches (35 metres)
Keel length: 94 feet 3 inches (29 metres)
Breadth: 32 feet 2 inches (9.8 metres)
Draught: 15 feet (4.5 metres)
Keel (moulded): 15 inches (38.1 centimetres)
Keel (sided): 15 inches (38.1 centimetres)
Floors (sided): 10–14 inches (25.4–34.56 centimetres)
Space between frames: 3–8 inches (7.62–20.32 centimetres)
External planking (thickness): 3 inches (7.62 centimetres)
Ceiling planking (thickness): 2.5–5.0 inches (6.35–12.7 centimetres)

Other Attributes

Copper sheathed

Roosevelt Inlet Wreck, Lewes, Delaware (c. 1772–1800s)

(Krivor, et al. 2010)

Merchant ship bound for Philadelphia from Europe, likely *Severn* (1772) or *Maria Johanna* (1778)

Documented Timber Species

White oak thickstuff/stringer (?)

White oak ceiling planking

White oak exterior planking

Hard pine, hemlock, fir, cedar, redwood and/or cedar treenails

Recorded Dimensions/Scantlings

Preserved length: 75 feet (22.86 metres)

Longitudinal Thick stuff/stringer (preserved): 72 feet 3 inches (22.02 metres)

Thick stuff (moulded): 11.5 inches (29.21 centimetres)

Thick stuff (sided): 13.5 inches (34.29 centimetres)

External planking (thickness): 2.5–3.0 inches (6.35–7.62 centimetres)

Ceiling planking (thickness): 1.5–2.0 inches (3.81–5.08 centimetres)

Other Attributes

Artefact rich but limited structural remains

No keel or keelson observed

Hull remains consistent with British/British colonial shipbuilding traditions

Lack of New World timbers such as live oak or southern yellow pine led authors to state the vessel was not built in the southern colonies and was indicative of Old-World construction

Lead sheathing

Iron bolts, iron spikes, wrought iron nails and sheathing tacks, and treenails predominant fastener types

Eagle, Lake Champlain, Vermont (1814)

(Crisman 1987)

War of 1812 military vessel, North American-built

Documented Timber Species

Three-part keel of hard maple and white oak

Four-part keelson of white oak

Floor timbers of white oak, red oak, American elm, white ash, American chestnut, white pine and spruce

Hull planking of white oak and American chestnut

Ceiling planking of white pine, spruce, and white oak

White oak stem and stern

Recorded Dimensions/Scantlings

Keel (length overall): 106 feet 5 inches (34.43 metres)

Keel (moulded): 16 inches (40.64 centimetres)

Keel (sided): 12 inches (30.48 centimetres)

Keelson (moulded): 14 inches (35.56 centimetres)

Keelson (sided): 12 inches (30.48 centimetres)

Floors (moulded): 11–13 inches (27.94–33.03 centimetres)

Floors (sided): 8–10 inches (20.32–25.4 centimetres)

Room and space: 24 inches (60.96 centimetres)

Outer hull planking (thickness): 1.0–1.5 inches (2.54–3.81 centimetres)

Outer hull planking (width): 13–15 inches (33.02–38.1 centimetres)

Ceiling planking (thickness): 2–4 inches (5.08–10.16 centimetres)

Ceiling planking (width): 9–15 inches (22.86–38.1 centimetres)

Other Attributes

Iron bolts and fish plates used to join keel together

Keel comprises three timbers flat scarphed end to end

Stem and stern iron fastened

Floors iron fastened to keel/keelson

Floors rough and unfinished

Iron gudgeons

Iron bolts and nails, and treenails predominant fastener types

The case for identifying RI 2394 as *Lord Sandwich* (ex-HMB *Endeavour*)

Evaluation criteria

Because *Lord Sandwich* was deliberately scuttled, there is very low likelihood of locating one or more diagnostic artefacts that confirm the vessel's identity. In August 1778, the 14-year- old bark was likely stripped of everything that was valuable or reusable prior to being sunk, which means the wreck site is unlikely to contain artefacts such as regimental buttons, personal items with a maker's mark or owner's initials, or a ship's bell that directly links the hull remains to *Earl of Pembroke*, HMB *Endeavour* or *Lord Sandwich*.

In any archaeological investigation, there is a risk of 'Ruling Theory' wherein researchers may shape evidence to fit a preconceived outcome, such as a shipwreck's identity (Rodgers, et al. 2005: 24; Wilde-Ramsing and Ewen 2012: 112). To mitigate against this risk, ANMM and RIMAP adopted a 'preponderance of evidence' approach to identify, with a high degree of probability, which of the 13 scuttled transport shipwrecks in Newport Harbor represented the remnants of *Lord Sandwich*, formerly HMB *Endeavour* (Hosty and Hunter 2022b).

In 2019, RIMAP and ANMM signed a memorandum of understanding (MOU) that established 10 criteria necessary for the *Lord Sandwich* (ex-HMB *Endeavour*) shipwreck site to be identified with a reasonable degree of certainty (ANMM and RIMAP 2019: 6). The MOU confirmed that both parties agreed to identify RI 2394 as *Lord Sandwich* (ex-HMB *Endeavour*) if the following conditions were met:

1. Both (RIMAP's and ANMM's) sets of timber analyses confirmed RI 2394's keel is constructed of elm.
2. Both sets of timber analyses confirmed the majority of RI 2394's floors, futtocks, ceiling and hull planks are constructed of white oak.
3. There is limited or no evidence of North American timbers used in the construction of the vessel.
4. Most scantling measurements recovered from RI 2394 conform to those specified in the March 1768, February 1775 and February 1776 survey reports regarding HMB *Endeavour* and *Lord Sandwich*.
5. The keelson (if present) shows evidence of having a 'rider' or 'deadwood' keelson attached to its upper sided surface, as shown on HMB *Endeavour*'s body plan No. 3814(b) and 3814 (c).
6. RI 2394's overall preserved length (if extant) closely conforms with, or exactly matches, the known length of HMB *Endeavour*.
7. Additional structural features, such as the location of mast steps (if extant) and the shape of the hull, are consistent with those of HMB *Endeavour*.
8. Modifications to the ship's structure, such as scuttling holes, are consistent with what is known about the intentional sinking of *Lord Sandwich*.
9. *In situ* material culture, such as coal, ballast, personal effects and ship's fittings (e.g. iron gudgeons) are consistent with the known history of HMB *Endeavour* and/or *Lord Sandwich*.
10. Structural features, construction materials and/or construction techniques (e.g. wooden treenails, iron fastenings, iron gudgeons and pintles, and few or no copper fastenings) are consistent with those recorded in archival descriptions of *Earl of Pembroke*, HMB *Endeavour* and/or *Lord Sandwich*.

Upon review of a number of these criteria, Erskine (2021: 9) has pointed out that some, such as Criterion 1, 2, 4, 6 and 7, are similar enough in definition to Criterion 10 that the latter's inclusion in the preponderance of evidence approach poses 'a very real risk of duplicating evidence in favour of the theory that RI 2394 is *Lord Sandwich* (ex-HMB *Endeavour*)'.

RI 2394's structural features and construction materials and techniques, including the use of iron fastenings and wooden treenails, are consistent with known construction attributes listed for *Earl of Pembroke*, HMB *Endeavour* and *Lord Sandwich*. However, given that other evidence in the list of criteria would effectively be duplicated to support Criterion 10 and increase the risk of it being perceived as an example of 'Ruling Theory', the authors have opted to disregard Criterion 10 in this assessment.

Exclusion of sites RI 2119, RI 2125, RI 2579, RI 2580, RI 2595 and 'Site 9'

Shipwreck sites RI 2119, RI 2125, RI 2579, RI 2580, RI 2595 and 'Site 9' can all be excluded from consideration as they are located outside of the Limited Study Area established in 2017 (see Figure 8). Prior to 2020, the RIMAP/ANMM team confirmed that two archaeologically surveyed and excavated sites, RI 2119 ('Gamma') and RI 2125 ('Hospital

Cannon') did not fulfil the identification criteria (Hosty and Hundley 2000; 2001). Key failings for both sites included the absence of an elm keel, and the presence of a keelson but absence of any evidence indicating a rider or deadwood keelson. Furthermore, the preserved length of the surviving keel and timber scantlings for both RI 2119 and RI 2125 did not accord with surviving historic plans and survey documents for *Lord Sandwich* (ex-HMB *Endeavour*) (Erskine 2004).

Sites within the Limited Study Area: RI 2393, RI 2394, RI 2396/RI 2397, RI 2578 and RI 2794

Between 2016 and 2018, the team conducted Phase 1 (non-disturbance) surveys of five sites within the Limited Study Area: RI 2393 ('Rod'), RI 2394 ('Kerry'), RI 2396/ RI 2397 ('Greg'), RI 2578 '(Kathy') and an un-numbered site known as 'Caroline'. Between 2019 and 2021, project expeditions focussed primarily on RI 2394, the largest shipwreck site and most likely candidate for *Lord Sandwich* (ex-HMB *Endeavour*) (See Abbass 2016, 2017 and 2018).

Timber scantlings

Lord Sandwich was the largest of the five transports scuttled within the LSA (Abbass 2016: 42). Based on 'The Table of Minimum Dimensions of Timbers, Keelson, Keel, Planking etc.' in Sutherland's *The Ship-builders Assistant* (1711), Blanckley's *A Naval Expositer* (1750), *The Shipbuilder's Repository* (Anon, 1788) and, later, *Lloyd's Rules and Regulations for the Construction and Classification of Ships*, a vessel of its tonnage would feature scantlings far larger than those listed for the much smaller transports *Mayflower*, *Yowart* and *Earl of Orford*. The scantlings for *Lord Sandwich* would also be much larger than those for the most likely candidate for the transport *Peggy*, which recent research suggests was a 200-ton American-built ship. Consequently, the team focussed efforts on confirming or disproving Criterion 4: 'Most scantling measurements recovered from RI 2394 conform to those specified in the March 1768, February 1775 and February 1776 survey reports regarding HMB *Endeavour* and *Lord Sandwich*'.

Several of the sites investigated within the LSA did not meet this criterion. No hull timbers or diagnostic artefacts were observed at RI 2393, but the site's overall size was significantly less than that of RI 2394 and argued against its identity as *Lord Sandwich* (Hosty 2017: 119). The 'Caroline' site also lacked timber hull components or other features associated with a ship (such as hardware or fittings) and was ultimately ruled out as a shipwreck site (Hosty 2018: 147–9). RI 2578 contained isolated, eroded ship's timbers that were largely obscured by silt and sediment. These timbers also appeared to be disarticulated. Given RI 2578's overall length at 45 feet (14 metres) is less than that of RI 2394, it was ruled out as a candidate for *Lord Sandwich*.

RI 2396/RI 2397 featured several articulated ship's timbers exposed on the south-eastern side of its ballast pile. These timbers, tentatively identified as floors, exhibited sided dimensions between 22 and 24 centimetres (between 9 and 10 inches) (Hosty 2016: 95). The sided dimensions listed for *Earl of Pembroke*'s floors during the vessel's 1768 survey were 14 inches (35.6 centimetres), a figure that is nearly 25% larger than those recorded for RI 2396 and RI 2397. Consequently, this site too was ruled out as a candidate for *Lord Sandwich*.

Scantling measurements were recorded for RI 2394 in 2018, 2019, 2020 and again in 2021. While timber surfaces exposed above the sediment were heavily eroded and infested with marine borers, those exposed during excavation were pristine and provided the team with excellent scantling data. These data were compared with archival information related to the design, construction, refit and repair of *Earl of Pembroke*, *Endeavour* and *Lord Sandwich*. RI 2394's scantlings compare very favourably with those listed for *Earl of Pembroke* when the vessel was first surveyed on 27 March 1768, before entering Royal Navy service (see Table 8). Additional scantling information recorded in 2020 in the site's midships area was compared with scantlings contained within the 1768 survey report, as well as an archaeological assessment of the wreck site of *General Carleton*, a collier of approximately 390 tons constructed at Whitby in 1777 (see Table 14).

The scantlings recorded for RI 2394 compare favourably with those known to have been used in the construction of *Earl of Pembroke* (later *Endeavour* and *Lord Sandwich*) and therefore satisfy Criterion 4. No other shipwreck site within the LSA features scantlings that indicate an 18th-century vessel of this size.

Keelson

The incorporation of a second 'rider' or 'deadwood' keelson is a rare architectural attribute of 18th-century ships. However, this hull element appears to be a feature common to Whitby-built colliers and is known to have been fitted to *Earl of Pembroke* in 1764. It is also recorded on the original draft plan (No 3814[b]) of HMB *Endeavour*, which was produced in 1768 (Hunter et al. 2019: 22). As there is no evidence this addition to the keelson was altered or removed during the vessel's subsequent service, Criterion 5 states 'the keelson (if present) shows evidence of having a "rider" or "deadwood" keelson as shown on the HMB *Endeavour* body plan No. 3814(b) and 3814 (c)'.

Excavation of RI 2394 between 2019 and 2021 exposed portions of the wreck site's surviving centreline structure, as well as elements of framing. The keelson is no longer present, but its former footprint is indicated by square- or rectangular-shaped iron concretions on the upper sided surfaces of the floor timbers that were once positioned beneath it. These concretions may represent a 'ghost' impression of part of the keelson formed by iron corrosion

products that were trapped between it and the underlying floor timbers. The reason for the keelson's absence is unclear, but a likely cause is that it may not have been sufficiently buried beneath the seabed and was gradually destroyed by natural processes such as sediment scour and/or biological action. It is also possible the keelson may have been removed due to deliberate human interference such as clearance diving operations, channel dredging or cable laying (Abbass 2016: 18; Hunter and Hosty 2020).

While there are distinct archaeological signs that a substantial keelson was once present on RI 2394, it is no longer present, due to either environmental or human factors, or a combination of both. Consequently, the preponderance of evidence approach dictates information associated with this criterion is insufficient to confirm or refute RI 2394's identification as *Lord Sandwich* (ex-HMB *Endeavour*).

Length of keel

Criterion 6 states 'the overall preserved length of RI 2394 (if extant) closely conforms with, or exactly matches, the known length of HMB *Endeavour*'. Because the other transport shipwreck sites in the LSA were excluded from consideration due to their overall size, a focus of field research between 2019 and 2021 was to locate and document RI 2394's keel. In September 2019, a section of the shipwreck's keel was uncovered during excavation. Additional investigations in October 2020, which included a metal detector survey out to the 119-foot (36.27 metres) mark on the baseline, and probing of the seabed 30 feet (9.14 metres) north of the 95-foot (28.90 metres) mark to the 125-foot (38.10 metres) mark, revealed the northern end of the site is no longer extant beyond the edge of the stone ballast pile due to severe erosion and a heavy marlstone-like sediment layer. Abbass (2019: 11) states that visual observations indicated the site was more dynamic than previously understood and that more hull timber had become exposed over time, especially in the area to the north of the modern steel cable that crosses the site. The last section of articulated hull was located at the 95-foot (29-metre) mark on the old baseline (Abbass 2021: 12; Broadwater 2020).

By contrast, the keel is well preserved at its southern terminus, where the keel-stem scarph is still present (Abbass 2021: 1; Broadwater and Daniel 2021: 8). The presence of this scarph verified that RI2394's bow faces south. Survival of the keel's forward end and associated scarph also permitted the team to measure the distance between it and the surviving bilge pump stump, which on *Endeavour* was originally located immediately adjacent to the mainmast. This distance – 50 feet 10 inches (15.5 metres) – is nearly identical to that of *Endeavour* (51 feet 6 inches, or 15.7 metres) based on comparison of the site plan to the 1768 Admiralty plans (Admiralty Draught No. 3814(b), 28 March 1768). Given the bow end of the keel is eroded and worm eaten, this could account for the 8-inch (20.3-centimetre) difference between the two sets of measurements.

Although the northern (stern) end of RI 2394's keel is no longer extant, the distance between its southern (bow) end and the surviving starboard bilge pump shaft is compatible with the distance between these features on *Endeavour*'s 1768 plan. As there is a distinct correlation between these two sets of measurements, and they are based on distances between specific architectural features that can also be correlated historically and archaeologically, they satisfy Criterion 6. This in turn supports the premise that RI 2394 is *Lord Sandwich* (ex-HMB *Endeavour*).

Additional structural features

Criterion 7 states 'additional structural features such as the location of mast steps (if extant) and the shape of the hull are consistent with those of HMB *Endeavour*'. Discovery of RI 2394's keel-stem scarph revealed it was significantly different from the 'table' and 'box' scarphs typically used in mid-to-late 18th-century British shipbuilding (see Figures 22–26). When compared with the keel-stem scarph shown on *Endeavour*'s 1768 Admiralty plan (see Figure 22), the resemblance between the two in terms of form and size are unquestionable.

A survey of extant 18th-century ship plans held in the collections of the National Maritime Museum, Greenwich revealed draughts for 40 individual vessels, ranging from *Albion* (built 1763; NMM J2579) to *Chichester* (built 1785; NMM J5188). Only one of these sets of plans displayed a keel-stem scarph like that observed on RI 2394. That vessel, *Marquis of Rockingham* (built 1770), was another Whitby collier built by Thomas Fishburn, and was later commissioned by the Royal Navy and renamed HMS *Raleigh*. It was renamed again – this time HMS *Adventure* – and used by James Cook on his second voyage of exploration between 1772 and 1775 (Figure 32).

A literature review of comparable historic shipwrecks has revealed only one other 18th- century site with a keel-stem scarph similar to that of RI 2394. That site, known as the Chub Heads Cut shipwreck, is located in Bermuda and tentatively been identified as the remains of a late 18th-century British-built collier (Watts and Krivor 1995: 97–108). In the case of the Chub Heads Cut shipwreck, the vertical scarph was clearly more than 12 inches (30.5 centimetres) moulded while its sided dimension was 16 inches (40.6 centimetres). Krivor (1998: 17) also notes the 'forward end of the keel was half lapped vertically to the side of the stem post and then fastened from both sides with iron bolts driven though from either side'.

Excavation of RI 2394 in January 2020 and September 2021 resulted in the discovery of two sets of closely spaced frames that deviate from the frame spacing so far uncovered throughout the remainder of the site (Hosty 2020: 14–19; Hunter 2020: 14; Broadwater and

Daniel 2021: 16). Three of these timbers are floors located adjacent to the bilge pump well that appear to be 'tripled' together as a group. The other group comprises a pair of floors spaced closely together 8 feet (2.4 metres) aft of the keel's forward end. While unusual, pairing or 'tripling' of floors in this manner could be explained as a form of 'master frame' used in whole moulding the vessel's other floors and futtocks. Whole moulding is a method of ship design in which the shape of the frame(s) in the hull's midships section are determined first, and those of the frames in other sections of the hull are thence derived via incremental modifications.

The presence of paired and 'tripled' frames is not diagnostic on its own. However, when their relative positions on RI 2394 are compared with *Endeavour*'s 1768 plans, they align exactly to the locations of the foremast and mainmast. From a ship design and construction perspective, this is logical, as installation of groups of floors beneath the foremast and mainmast would have provided reinforcement to the hull in areas where the weight and torsional stress exerted by the masts was greatest.

Taken together, the unusual form of RI 2394's keel-stem scarph and the presence of paired and 'tripled' floors in the exact locations of *Endeavour*'s fore- and mainmasts

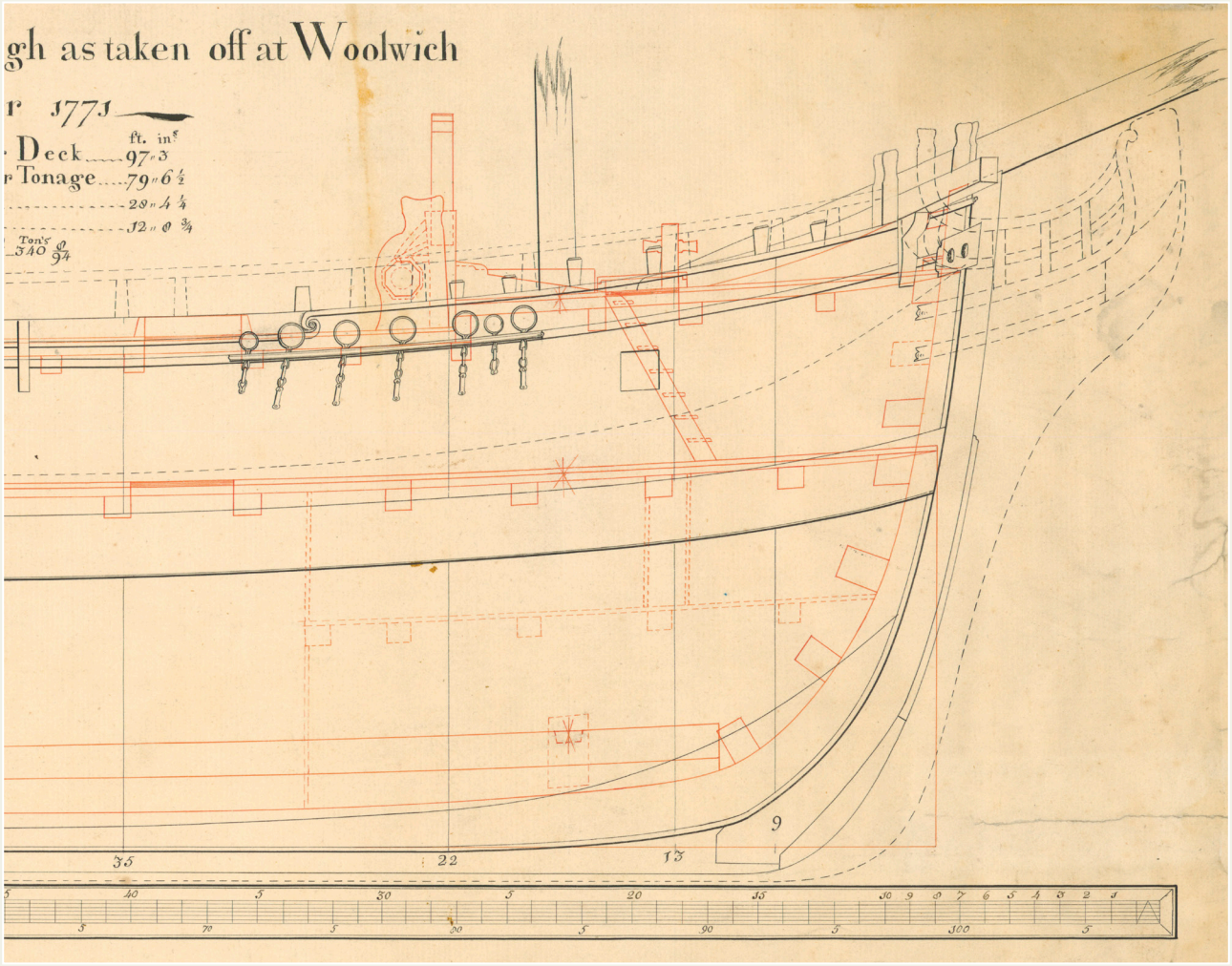


Figure 32. Extract from the body plans of His Majesty's Sloop *Raleigh* as taken off at Woolwich in November 1771. Image: Royal Museums Greenwich 19483.

constitute additional unique structural features that correlate to archival sources. They in turn satisfy Criterion 7 and provide compelling evidence that RI 2394 is *Lord Sandwich* (ex-HMB *Endeavour*).

Modification to ship's structure

Criterion 8 states 'modifications to the ship's structure, such as scuttling holes, are consistent with what is known about the intentional sinking of *Lord Sandwich*'. The 2019 excavations of RI 2394 resulted in discovery of a crudely formed, oval-shaped hole in the garboard affixed to the port side of the keel. It bore hallmarks of having been executed in haste with a heavy striking or cutting implement and was undoubtedly created with the intention of scuttling the vessel. A second scuttling hole was documented in September 2021 among hull planking at the stern end of the articulated hull. This hole exhibited straight sides and clean cuts, indicating edged tools were used to create it (Broadwater and Daniel 2021: 16).

The presence of at least two scuttling holes on RI 2394 matches a pattern observed on other wreck sites of vessels intentionally sunk by British forces during the American War of Independence. These include *Betsy* in Yorktown (scuttled 1781) and RI 2125, a transport scuttled in Newport Harbor in 1778 and investigated by the project team in 2002 (Broadwater 1980; Broadwater, et al. 1985; Broadwater 1989: 48; Hosty and Hundley 2003: 40). RI 2394's scuttling holes also provide substantial proof that the wreck site is one of the British transports intentionally sunk during the Battle of Rhode Island. This in turn satisfies Criterion 8 and supports the argument that RI 2394 is *Lord Sandwich* (ex-HMB *Endeavour*).

Timber analysis

Criterion 1 states that 'both RIMAP's and ANMM's sets of timber analysis confirm that RI 2394's keel is constructed of elm', while Criteria 2 and 3 note 'both sets of timber analyses confirm the majority of RI 2394's floors, futtocks, ceiling and hull planks are constructed of white oak' and 'there is limited or no evidence of North American timbers used in the construction of the vessel'. In 2018, timber samples were collected from five of RI 2394's hull timbers. These timbers were identified as floors, ceiling planking and a hold pillar or stanchion (see Table 8). In 2019, seven more timber samples were collected from RI 2394, comprising six individual elements of hull structure and another sample from a timber specimen believed to be dunnage (see Table 11). All but two of the timber samples were identified as white oak (*Quercus sp.*) and the predominance of this genus of timber, coupled with the complete absence of North American timbers such a live oak (*Quercus virginiana*) or red oak (*Quercus rubra*) is highly indicative of a European-built ship (VanHorn 2004: 15– 18; 227–33). Furthermore, the presence of an elm (*Ulmus* sp.) keel is indicative of a European-built vessel, as this timber – and its North American equivalent, American elm (*Ulmus americana*) – was not held in high regard by colonial American shipbuilders, who preferred live oak instead (Mitchell 1994: 64; Ilic 2019: 1; VanHorn 2004: 227–33).

All five timber samples collected from RI 2394's bow section during the 2021 investigations were identified as white oak (*Quercus sp.*) by both the ANMM- and RIMAP-appointed experts. Although no evidence of non-European (e.g., Australian and/or Southeast Asian) timbers were found among the samples, the presence of white oak in two keel sections was notable. Given samples recovered from the keel in the wreck site's midships area were identified as European elm, the presence of white oak keel sections on either side of a scarph in the extreme forward end of the vessel is strongly suggestive of repair to the hull. Further, as 18th-century British shipwrights typically preferred elm over oak for keel timber, the presence of oak in the forward keel hints that its use may have been influenced by haste and/or cost-cutting measures.

One possible explanation is that one or more sections of keel within RI 2394's bow were replaced over the course of the vessel's career. Coincidentally, *Endeavour*'s bow section and the lower hull in the vicinity of the starboard forechains, approximately eight feet (2.43 metres) aft of the stem, were the parts of the ship most severely affected when it grounded on the Great Barrier Reef in 1770. These sections of the hull were repaired in Batavia in 1770 and again in 1775 when *Endeavour* was surveyed prior to being sold out of service. They were also included in repairs to the vessel noted in February 1776 when it was surveyed prior to being accepted by the Transport Service.

A predominance of white oak in RI 2394's construction, coupled with the presence of a European elm keel and no evidence of hull elements hewn from North American timber, all indicate a European (British) origin for the vessel and satisfy Criteria 1, 2 and 3. Further, evidence suggesting repairs to RI 2394's bow section correlates well with the histories of *Endeavour* and *Lord Sandwich*. Finally, while two other transports scuttled in the LSA – *Yowart* and *Mayflower* – are known to have been built in Great Britain, both were at least 100 tons smaller than *Lord Sandwich*, and would be expected to exhibit hull lengths and scantlings much smaller than that of RI 2394. Given this evidence, Criteria 1, 2 and 3 have been satisfied and support the contention that RI 2394 is *Lord Sandwich* (ex-HMB *Endeavour*).

Material culture

Criterion 9 states '*in situ* material culture, such as coal, ballast, personal effects and ship's fittings (iron gudgeons), are consistent with the known history of HMB *Endeavour* and/or *Lord Sandwich*'. Because the transports scuttled in Newport Harbor in August 1778 were stripped prior to

their loss, only small amounts of *in situ* material culture would be expected within these shipwrecks. It is unlikely that artefacts associated with Cook's voyage to Australia would remain within the vessel's hull over the course of its entire use-life, although the prospect cannot be ruled out entirely. The greater likelihood is that material culture associated with the vessel's identity as *Lord Sandwich* would be encountered. This would include artefacts associated with the *Larsborg du Corps* Hessian Brigade transported to America aboard *Lord Sandwich* in 1776, or Americans kept as prisoners aboard the vessel in 1777 and 1778 (Abbass 2021: 2).

Numerous late-18th century artefacts including bricks, a lead sounding weight (RI 2394 2020-1000 #0011b), barrel staves, a possible leather diaphragm from a ship's pump (RI 2394 2021-0922 #000a), animal bone and glass shards were found within RI 2394's sealed sediment deposits during excavations conducted between 2019 and 2021. However, only two – a copper-alloy button and a fragmented clay pipe stem – have been identified as items that may once have been associated with a particular individual or cultural group (such as a military regiment). Unfortunately, neither exhibit diagnostic marks that would allow such an association to be firmly established (Abbass 2021; Abbass and Lynch 2024: 50).

Archaeological evidence suggesting RI 2394's use as a prison ship

Prior to being scuttled by British forces in August 1778 to defend the entrance to the inner harbour at Newport, Rhode Island, *Lord Sandwich* was used to incarcerate American prisoners, several of whom were civilian citizens of Newport. The names of at least 61 of these individuals are known, although others were almost certainly imprisoned aboard the vessel and remain unidentified. The British military's use of prison ships during the American War for Independence is well documented, and several first-hand accounts exist that detail the daily rituals and conditions faced by those who were incarcerated. However, most of these accounts address a single prison ship – the former British warship *Jersey*, moored at Wallabout Bay in Brooklyn, New York between 1779 and 1783 – and most were published several years after the events they chronicle took place (Hunter 2022).

Nonetheless, information contained within these accounts is useful, and those authored by *Jersey* prisoners were reviewed for details that could potentially serve as archaeological signatures indicative of a prison ship and those incarcerated aboard it. These signatures could include evidence of prisoner activities, activity areas and attire, as well as prison- specific vessel modifications and fittings (such as metal grates and manacles) and were considered during analyses of RI 2394's hull remains and material culture assemblage.

Dearth of small finds and other artefacts

One significant difference between RI 2394 and other transport shipwrecks excavated in Newport Harbor thus far is the former site's relative dearth of artefacts. Indeed, except for a lead sounding weight, a handful of undecorated buttons and lead shot, one damaged copper handle, a round piece of leather that may be a diaphragm from a bilge pump, and a small number of wooden sheaves, no intact small finds have been documented or recovered from RI 2394 since archaeological excavation of the site commenced in 2018 (Abbass and Lynch 2024: 275–81).

Even fragmented artefacts – such as broken pipe stems and ceramic sherds – have been found in smaller overall numbers than would perhaps be expected on such a relatively well-preserved shipwreck. By contrast, other transport shipwreck sites excavated in Newport Harbor, such as RI 2119 and RI 2125, have revealed a large number and variety of small finds, including a 'cluster' of spirit bottle bases, numerous ceramic sherds, fragments of a Southeast Asian porcelain figurine, intact wooden handles, the wooden base and spindles of a sandglass, metal and wooden buttons, lead shot and several wooden sheaves. Interestingly, these relatively artefact-rich sites are in waters shallower than RI 2394 and appear to have endured verifiable instances of site disturbance prior to being archaeologically investigated (Bassett, et al. 2020a: 18–25; Hosty, et al. 2002: 39–41).

One logical explanation for the relative absence of small finds on RI 2394 is the vessel was stripped of everything of value prior to being scuttled. However, both RI 2119 and RI 2125 are also believed to be scuttled transports and retain larger and more diverse artefact assemblages. With that in mind, another explanation is that RI 2394 may have functioned as a prison ship and was routinely cleaned to prevent the spread of illness among its incarcerated population. Aboard *Jersey*, former inmate Ebenezer Fox (1847: 107) recalls that prisoners 'were confined in the two main decks below ... [while] the lowest dungeon [the hold] was inhabited by those prisoners who were foreigners'. While the captives aboard *Lord Sandwich* between late 1777 and early 1778 appear to have been American, the vessel's significantly smaller size relative to that of *Jersey* (a former fourth-rate ship-of-the-line) likely necessitated the use of every available space as prisoner accommodation, including the hold. Already cramped, dark and largely devoid of sunlight and fresh air, these below-decks areas risked becoming a breeding ground for contagion.

The best means of improving squalid conditions and preventing the spread of disease aboard a prison ship was to keep its accommodation areas clean. According to Fox (1847: 110–11), *Jersey*'s prisoners were permitted to spend the day on the ship's weather deck, while a select group:

> who were for the time called the 'working party', performed in rotation the duty of bringing up hammocks and bedding for airing, likewise the sick and infirm, and the bodies of those who had died during the night ... After these services, it was their duty to wash the decks. Our beds and clothing were allowed to remain on deck till we were ordered below for the night.

Dring (1829: 64–5) echoes Fox's description, noting the working party's activities, which included 'wash[ing] down the main decks below', were 'performed daily' while 'the prisoners remained upon the upper deck'. Sherburne (1831: 117) goes further, recalling instances in which 'there came orders to remove all the prisoners from the *Jersey*, on board of transports, in order to clean the ship'. Although intermittent, this cleaning regimen apparently lasted 'a few days', after which the prisoners 'were all put on board the *Jersey* again' (Sherburne 1831: 117).

While the ritual of cleaning a prison ship daily could explain the lack of artefacts, so too could the manner in which personal possessions were used and maintained by the incarcerated. Prisoners were afforded few possessions to begin with, and most only had the clothes on their back. Any object that could be used as a weapon or means of

Criterion	Preponderance of evidence
That most scantling measurements recovered from RI 2394 conform to those specified in the March 1768, February 1775 and February 1776 survey reports of HMB *Endeavour* and *Lord Sandwich*, respectively.	The scantlings recorded for RI 2394 compare favourably with those known to have been used in the construction of *Lord Sandwich* (ex-HMB *Endeavour*). No other site within the LSA features scantlings that indicate an 18th-century vessel of this size.
That the keelson (if present) shows evidence of having a 'rider' or 'deadwood' keelson as shown on the HMB *Endeavour* body plan No. 3814(b) and 3814 (c).	While there are distinct archaeological indicators that a substantial keelson was once present on shipwreck site RI 2394, the timber itself has now disappeared, either through environmental or human factors. The preponderance of evidence approach dictates this criterion is insufficient to confirm or deny that RI 2394 is *Lord Sandwich*.
That the overall preserved length of RI 2394 (if extant) closely conforms with, or exactly matches, the known length of HMB *Endeavour*.	The length of keel from the bow to the surviving bilge pump tube on RI 2394 is almost identical to the length of keel from the bow to the same feature shown on the 1768 Admiralty plans of HMB *Endeavour*. As *Lord Sandwich* is the largest transport known to have been lost in the LSA, based on a preponderance of evidence approach this finding supports the premise that RI 2394 is *Lord Sandwich*.
That additional structural features such as the location of mast steps (if extant) and the shape of the hull are consistent with those of HMB *Endeavour*, and that structural features, construction materials and/or construction techniques are consistent with those of *Earl of Pembroke*, HMB *Endeavour* and/or *Lord Sandwich* (e.g. wooden treenails, iron fastenings, iron gudgeons and pintles, and few or no copper fastenings).	Taken together, the shape of the keel-stem scarph in the bow and the presumptive location of the fore- and mainmasts on RI 2394 are virtually identical to those shown in the 1768 Admiralty plans for HMB *Endeavour*. These structural features support the contention that RI 2394 is *Lord Sandwich*.
That modifications to the ship's structure, such as scuttling holes, are consistent with what is known about the intentional sinking of *Lord Sandwich*.	The presence of two scuttling holes on RI 2394 provides convincing evidence that the shipwreck is one of the scuttled 1778 transports. The preponderance of evidence indicates this modification is consistent with the site being *Lord Sandwich*.
That both RIMAP's and ANMM's sets of timber analysis confirm that RI 2394's keel is constructed of elm.	Analyses of timber samples indicate RI 2394 is a British-built vessel and identified species (European oak and elm) are consistent with timbers used in the construction of *Earl of Pembroke*/HMB *Endeavour*/*Lord Sandwich*.
That *in situ* material culture, such as coal, ballast, personal effects and ship's fittings (iron gudgeons), are consistent with the known history of HMB *Endeavour* and/or *Lord Sandwich*.	No material culture recovered thus far from RI 2394 confirms or refutes the identity of the shipwreck site as *Lord Sandwich* (ex-HMB *Endeavour*).

Table 17. Assessment of evidence against agreed criteria to identify site RI 2394 as the shipwreck of *Lord Sandwich* (ex-HMB *Endeavour*).

escape was confiscated. Certain items, such as soap or fresh fruit and vegetables, could be procured, but only if the prisoner had the means to pay for it. According to Dring (1829: 57), many *Jersey* prisoners kept their possessions in 'chests, boxes and bags'. These were kept belowdecks and 'arranged in two lines along the deck, about ten feet [3.04 metres] distant from the sides of the ship; thus leaving as wide a space unincumbered in the middle part of each deck ... as our crowded situation would admit' (Dring 1829: 57). Not surprisingly, some of the prisoners 'usually slept on the chests, in order to preserve their contents from being plundered during the night' (Dring 1829: 58). Prisoners undoubtedly prized the few possessions they had and took great care to ensure they were not lost or stolen. This behaviour, when taken in conjunction with a prison ship's daily cleaning regimen, would be expected to significantly limit the volume and variety of artefacts in its assemblage.

Finally, the relative lack of small finds, and particularly personal artefacts, could simply be an indicator of the appalling conditions in which the prisoners were kept. As mentioned previously, *Jersey*'s lower hold, or 'dungeon', was reserved for 'foreigners', who were likely French and Spanish soldiers and sailors captured while serving as allies to the American cause. They appear to have been singled out for the horrific conditions in which they were kept, for as Dring (1829: 58–9) notes:

> the lower dungeon ... was inhabited by the most wretched in appearance of all our miserable company. From the disgusting and squalid appearance of the groups which I saw ascending the stairs which led to it, it must have been more dismal, if possible, than that part of the hulk where I resided. Its occupants ... had seen and survived every variety of human suffering.

Tellingly, Dring (1829: 59) also observes these same prisoners 'possessed no clothing except the remnants of those garments which they wore when first brought on board'. Unable to procure 'a piece of thread, or even a needle', these men couldn't patch their clothes, which 'had been worn to tatters by constant use', nor could they obtain 'a razor or an ounce of soap' to shave and bathe (Dring 1829: 59). Prisoners stripped of practically everything except the literal rags they were wearing would have very little, if anything, to leave to the archaeological record.

While few specifics are known of *Lord Sandwich*'s use as a prison ship at Newport, there is some indication that conditions for those incarcerated aboard it were less than ideal. On 5 November 1777, 22 prisoners aboard *Lord Sandwich* were sent ashore. By 19 November, smallpox was ravaging Newport and had been traced to 'the [town's] inhabitants that came from the prison ship' (Anon 1860: 36). Those who remained aboard *Lord Sandwich* endured additional hardship in 1778. A fierce snowstorm struck Newport on the night of 6 February and 'did much damage among the shipping' (Anon 1860: 37). Two weeks later, conditions aboard *Lord Sandwich* and another prison ship, the transport *Rachel and Mary*, had deteriorated to such an extent that 11 inmates had died, and subscriptions were being taken from Newport's citizens to supply the surviving prisoners with 'great quantities of clothing', as they were 'found ... in great distress' (Anon 1860: 37). By early March 1778, the number of sick prisoners aboard both ships had become so great they were transferred to *Lord Sandwich*, which departed for Providence, Rhode Island on the 8th. It is unclear what happened to the prisoners once they arrived in Providence, but there is no record of *Lord Sandwich* being used as a prison ship following the conclusion of this voyage.

While the overall dearth of material culture associated with RI 2394 – especially when compared to the artefact assemblages found on RI 2119 and RI 2125 – is suggestive that it may have functioned as a prison ship before being scuttled, this conclusion is speculative at best. A more holistic assessment of the artefact assemblage reveals nothing has been recovered from the site so far that exhibits diagnostic information consistent with the known history of HMB *Endeavour* and/or *Lord Sandwich*. Viewed through the lens of the preponderance of evidence approach (specifically Criterion 9), there is nothing among RI 2394's small finds that either confirms or refutes the site's identity as *Lord Sandwich* (ex- HMB *Endeavour*).

Conclusion

Taken together (Table 17), the preponderance of evidence is strongly in favour of shipwreck site RI 2394 as the remains of *Lord Sandwich* (ex-HMB *Endeavour*).

Further research

Based on data and results collected up to and during the September 2021 field season, it is recommended that another field expedition of 10–15 days' duration should be conducted at RI 2394 to:

1. locate and confirm the northern extremity of hull remains along with its iron rudder fittings
2. continue the search amidships for evidence of additional bilge pumps
3. assess the condition of the four cannons on the site, replace existing protective anodes and add additional anodes if required
4. add frames and other hull features to the site plan
5. assess the archaeological potential of the deeper deposits on the starboard side of the site and develop an excavation proposal and permit application if the deposit merits intrusive investigation
6. assist in the development of a conservation management plan for the site
7. Assist in the development of an interpretive/educational plan for the site.

Conclusion

Extensive archival research undertaken in 1998 by Australian historians Mike Connell and Des Liddy determined that HMB *Endeavour* was renamed *Lord Sandwich* and sent to Newport, Rhode Island as a British troop transport in 1778 (Connell and Liddy 1997). Additional research undertaken by RIMAP's Kathy Abbass built upon the work of Connell and Liddy and confirmed *Lord Sandwich* was subsequently scuttled by British forces to protect the northern approaches of Newport Harbor (particularly the North Battery) from a French Fleet in August 1778 (Abbass 2016: 11; Erskine 2017: 66). Further archival research undertaken by Nigel Erskine (2017: 65) in 2016 and 2017 confirmed the names and the details of five vessels scuttled by the British in August 1778 within a section of Newport Harbor that would later be identified as the Limited Study Area (LSA). One of these vessels was the 368-ton *Lord Sandwich*. The other four vessels and their registered tonnages were *Mayflower* (160 tons), *Earl of Orford* (200 tons), *Peggy* (200 tons) and *Yowart* (250 tons).

In any archaeological investigation, there is a significant risk of 'Ruling Theory', in which researchers may intentionally or inadvertently shape evidence to fit a preconceived outcome, such as an historic shipwreck's identity. This risk is perhaps best represented within maritime archaeology by the case of the Beaufort Inlet Wreck, which was identified as Blackbeard's ship *Queen Anne's Revenge* (Rodgers, et al. 2005: 24; Wilde-Ramsing and Ewen 2012: 112). The very real possibility that identification of the *Lord Sandwich/Endeavour* shipwreck site could be influenced by Ruling Theory led ANMM's Paul Hundley and Abbass to adopt a 'preponderance of evidence' approach to identifying the site in 1999. This approach would use a combination of archaeological and archival evidence to develop a series of criteria that would establish – with a high degree of probability – which of the 13 scuttled transport shipwrecks in Newport Harbor represented the remnants of *Lord Sandwich*, formerly HMB *Endeavour* (Abbass 2001: 15; Hosty and Hunter 2022b).

In the wake of Erskine's revelatory work, in 2019 RIMAP and ANMM signed a memorandum of understanding that established 10 criteria necessary for the *Lord Sandwich* (ex-HMB *Endeavour*) shipwreck site to be identified with a reasonable degree of certainty (ANMM and RIMAP 2019: 6). While not discounting data in the form of small finds and potential diagnostic artefacts, the agreed criteria were heavily biased towards surviving structural elements of the hull. This was based on visual surveys of all 18th-century shipwreck sites in the LSA, which revealed hull remains were the largest observable and identifiable items left behind after more than 200 years of anthropomorphic and environmental influences and impacts. In addition, *Endeavour*'s hull remains would constitute the oldest and most original archaeological fabric associated with that vessel – a fact enhanced by the known presence of detailed ship draughts and Admiralty survey data from 1768 with which they could be compared.

The 10 'preponderance of evidence' criteria included lack of American timbers in the vessel's construction; a European elm keel; predominant or exclusive use of white oak in the hull's construction; scantling measurements conforming to those specified in the March 1768, February 1775 and February 1776 survey reports for HMB *Endeavour* and *Lord Sandwich*; a length overall (bow to stern) conforming with, or exactly matching, the known length of HMB *Endeavour*; an archaeological site location conforming to the locale within Newport Harbor where *Lord Sandwich* was scuttled; evidence of hull repairs conforming to those known to have been carried out in Batavia and England; scuttling holes or other evidence the vessel was intentionally sunk; and the presence of architectural features matching those of *Endeavour*.

Superimposition of RI 2394's shipwreck site plan over *Endeavour*'s 1768 lower hold and lower deck plans revealed several hull features – including the positions of the surviving pump shaft stump and pump well partitions, bow end of the keel, and locations of doubled and tripled frames relative to the foremast and mainmast – aligned perfectly with their counterparts on the archival documents. Yet another compelling concordance appears in the form of RI 2394's rare half-lap scarph at the bow end of the keel and the keel-stem scarph shown on *Endeavour*'s 1768 Admiralty sheer draught. When compared, the two were an exact match in terms of both form and size.

This correlation of the historic plans to the shipwreck site is even more remarkable given most 18th-century vessels, including *Earl of Pembroke/Endeavour*, were built by 'rack of eye' – a shipbuilding tradition in which a shipwright's tacit knowledge and understanding, aided by geometric or proportional rule, was used to construct a vessel to a desired tonnage and set of dimensions. 'Rack of eye' construction did not utilise builder's plans, which meant no two ships were built the same. This argues against the likelihood of RI 2394's hull remains so closely matching another of the scuttled transports in Newport Harbor.

All available evidence suggests *Lord Sandwich* was at least 100 tons larger than the next-largest vessel (*Yowart*) scuttled in the LSA – a marked size discrepancy that would be reflected in the overall length of the surviving hulls of each shipwreck site, as well as their respective timber scantlings. As this report has detailed, RI 2394 is the largest shipwreck site within the LSA and exhibits attributes that fulfil the criteria agreed upon by RIMAP and ANMM in 1999, and again in 2019. Consequently, the preponderance of evidence supports this shipwreck site's identification as *Lord Sandwich* (*ex*-HMB *Endeavour*), and at the same time discounts any of the other investigated shipwreck sites as that of James Cook's renowned ship of exploration.

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Appendices

Appendix 1. Construction details from *The Voyage of* Endeavour, *1768–1771*

Exact transcriptions from *The Journals of Captain James Cook on his voyage of Discovery: The Voyage of* Endeavour, *1768–1771*, edited by J.C. Beaglehole (Sydney: The Boydell Press in association with Hordern House, 2015). Explanatory remarks added in *italics*.

Date	Abridged journal entry
2 Apr 1768	Fitting out *Endeavour* at Deptford.
27 May 1768	[Cook] hoisted [his] Pendant (pennant) and took charge of the ship agreeable to [his] Commission. Employed crew taking on board stores and provisions.
31 May 1768	Cook to Navy Board (ADM 106/1163) Eight tons of iron ballast to be taken on board Bark *Endeavour*. Ballast supplied by Deptford Yard Officers.
30 Jun 1768	Additional iron ballast requested to bring her down by the stern.
17–18 Aug 1768	Caulkers, carpenters and joiners employed in fixing gentlemen's cabins and building a platform over the tiller arm. Powder taken on board and stored in magazine.
19 Aug 1768	Read to the Ship's Company the *Articles of War* and the *Act of Parliament*. Crew paid two months wages.
26 Aug 1768	Put to sea having on board 94 persons, including Officers, Seamen Gentlemen and their servants, near 18 months provisions, 10 Carriage guns, 12 swivels with good store of Ammunition and stores of all kinds.
14 Sep 1768	Caulkers employed working on ship's sides off Island of Madeira.
28 Oct 1768	This day spent pumping water out of the ground tier of casks and filling the empty casks with salt water to keep the vessel ballasted.
15–19 Nov 1768	At Rio de Janeiro – ship's company employed heeling and 'boot topped'* the Starboard and larboard sides, forge set up to repair iron work, caulkers employed on hull. *'Boottopping' was the cleaning and greasing of the upper part of the ship's bottom – the 'boothose tops' were the first three strakes or planks below the water's edge and were generally tallowed when the ship was ordered to cruise*
12 Dec 1768	Caulkers and carpenters employed caulking the quarter deck and waterway seams.
14 Dec 1768	Decks being caulked.
8–11 Jun 1769	Tahiti – ship's company employed on heeling and boot topping the larboard and starboard sides – vessel's hull very fowl (foul), sheathing damaged in places, coated the larboard side with 'pitch and brimstone'.

7–9 Jun 1769	Employed careening both sides of the ship and paying them with pitch and brimstone, bottom in good order, no trace of worm.
3–4 Aug 1769	Taitea (Society Islands). [Cook] went ashore to look for a suitable source of stones for ballast and a watering place. Found both very close to anchorage in Rautoanui Bay. Vessel warped in and moored in 28 fathoms. Carpenters employed in stopping leaks in Powder room and fore-sail room. *By the evening of the 4th the crew had taken on 20 tons of stone ballast.*
8 Nov 1769	Heeled and scrubbed both sides of the ship.
18–19 Dec 1769	Queen Charlotte Sound – Carpenters employed blacking the ship's bends, caulking the sides, repair general defects, forge set up to repair tiller braces. *'Bends' were the wales of the ship, hull planks that were broader and thicker than the rest and, extended the length of the vessel from bow to stern.*
16–17 Jan 1770	Pelorus Sound (?) New Zealand – Careened the ship's hull, payed the starboard side with Tallow and 'Venetian Red'* – scraped and cleaned the hull. A transom** was built for the tiller. Hands also employed taking on board stone ballast to be placed at the bottom of the bread room to bring the ship down by the stern. **The use of 'Venetian Red' meant to pay, daub or smear the lower exterior hull with preparations of tar, oil, tallow, resin, red ochre to protect the planks of the ship from the water, marine growth, shipworm infestation, etc.* ***Transoms were cross timbers that held together the stern of the ship – normally the tiller passed inboard over the tiller transom to which the rudder head was attached by band and bracket. The transom built for* Endeavour*'s tiller broke throughout the voyage.*
11 Jun 1770	Vessel struck a rocky reef [later to be called Endeavour Reef] – sounded around ship, three to twelve feet around the vessel [(Endeavour had a draught of 13 feet 6 inches, or a draught of 4.1 metres]). Started to lighten ship and attempted to kedge off. *To 'kedge off' is to deploy an anchor away from a vessel and then attempt to draw the vessel of the reef by hauling in on the attached anchor line.* Started the water casks, threw overboard the six mounted guns, iron and stone ballast, casks, hoops, staves, oil jars, decayed stores, etc. up to 50 tons in weight. *Over twenty tons of iron and stone ballast along with six carriage guns were cast over the side of the ship. The crew attached buoys to the guns for possible later recovery.*
17–18 Jun 1770	Vessel run ashore in Endeavour River. As the ship lay fast, got down fore yard, fore topmast booms. Vessel floated and was warped into the harbour, moored alongside a steep beach. Made a stage from the ship to the shore, erected tents for the sick and for officers, provisions, etc. Landed empty casks and some provisions.
19 Jun 1770	Set up Smith's forge, commenced making iron work, landed all provisions, got four remaining guns out of the hold and mounted them on the quarterdeck, got spare anchor and anchor stock from the shore, remaining stores and ballast that were in the hold.
20 Jun 1770	Got out all the officer's stores, ground tier of water now having nothing in the fore and main hold but the coal and a little stone ballast.

21 Jun 1770	Powder, stone ballast, wood (firewood?) brought out of the ship, coals trimmed aft to get the bow (where the damage occurred) higher out of the water. Water coming in a little abaft the main mast and about 3 feet from her keel, had to clear the hold entirely to get at the leak. Had to remove all the coal.
22 Jun 1770	Most of the coal out; warped* the ship a little higher up the harbour – draught of water forward was 7′ 9″ , aft 13′ 6″ . Leak was found to be at *Endeavour* Floor Heads** – a little before the Starboard fore chains – here the rocks had made their way through four planks and even into the timbers (frames) – wounded three other planks. Planks entirely cut away, scarcely a splinter left. Fortunately the timbers were very close together – otherwise the vessel would have been lost – large pieces of coral rock, fothering, sand and grit had made their way between the frames, stopped the waters from coming in. Part of the sheathing was gone from under the larboard (port) bow) – part of the false keel, remainder much shattered. Fore foot and main keel also damaged. Damage aft could not be seen – Carpenters employed on repairs, forge set up to make (iron) bolts and nails. **'Warping' is another term for 'kedging' or using lines and anchors to move a vessel in a particular direction.* ***'Floor heads' were the upper ends of the floor timbers, e.g., the framing of the 'floor' or bottom of the ship. The chains were the assemblage of the parts whereby the lower shrouds of the mast were secured to the outer hull of the ship. Hence the primary leak (apart from the widespread damage) was located along the bottom of the hull, forward of the ship in front of the foremast and on the starboard side – at the turn of the bilge.*
23 Jun 1770	Carpenters employed shifting the damaged Planks. Starboard side examined at low tide.
24 Jun 1770	Carpenters finished the starboard side, vessel heeled over, work commenced on larboard side – Went to work repairing the sheathing under the larboard bow – where they found two planks cut through.
25 Jun 1770	Carpenters busy repairing sheathing and planking under the larboard bow – Whole of larboard side examined – parts of sheathing off abreast the main mast about her floor heads, part of one plank a little damaged.
26 Jun 1770	Carpenters finished off larboard bow and every other place the tide would permit them to work. Attempted to float off the ship.
27 Jun 1770	Endeavour River – Set up forge to repair iron work, carpenters employed caulking ship, restocking an anchor.
6 Jul 1770	Endeavour River – hardly 4 feet of water under ship but could not repair sheathing that was beat off the place being under water. Three strakes of the sheathing gone, 7–8 feet long, main plank rubbed. Vessel hove off and commenced to reload stores. 8 tons of water stowed in the ground tier after hold.
7 Jul 1770	Employed taking on board coal, ballast, caulking the ship.
9 Jul 1770	Carpenters, Smiths and Coopers all at respective employment, seamen employed taking onboard stone ballast.
14 Jul 1770	Seamen again employed taking on board stone ballast, airing sails etc.

21 Jul 1770	Carpenters finished repairing pumps. Caulking ship etc.
28 Jul 1770	Carp's [Carpenters] finished caulking the ship.
1 Aug 1770	Pumps in very poor condition, wood decayed, one quite useless, water making about 1" per hour.
14 Aug 1770	As soon as the vessel was outside the reef – found ship was more seriously damaged – leaks increased so that one pump could just keep pace with it.
11 Oct 1770	Anchored in Batavia Roads – Carpenters Report The ship very leaky – makes from twelve to six inches per hour – Occasioned by her main keel being wounded in many places and the scarph of her stem being very open. False keel gone beyond the midships (from forwards and perhaps farther) as I had no opportunity of seeing for the water when hauled ashore for repair. Wounded on her larboard side under the Main Channel* where I imagine the greatest leak is (but could not come at it for the water). One pump on the larboard side useless the others decayed within 1½" of the bore. Otherwise Masts, Yards, Boats and Hull in pretty good condition. *Cook spoke to his Officers concerning the leak – as the vessel was now very unsafe – and had to be repaired.* *He may have made a mistake in describing the damage in his 11 October journal entry, as the main leak was actually on* Endeavour*'s starboard side. This is evidenced by the fact – that most of the repairs carried out at Endeavour River were reportedly to the hull's starboard side. – However, a possible explanation is that the Carpenter successfully repaired this area and stopped the major leak.* **The 'Main Channel' of the chain wale comprised part of the chains (standing rigging). It was a thick plank that projected horizontally from the side of the ship and was the attachment point where to which the shrouds were fastened.*
12 Oct 1770	At Batavia – [*Cook had fitted a lightning conductor (an iron chain) to* Endeavour *at Batavia that* 'carried the electrical matter over the side of the ship' *the vessel was struck by lightning while moored in the port city's roadstead* of Batavia].
18–? Oct 1770	'Onrust ('Coopers') Island – received on board 3 barrels of tar and one barrel of pitch – proceeded to unload ship, repair rigging, etc for major repairs on hull of *Endeavour*.
29–31 Oct 1770	Clearing ship ready for heaving down and careening.
9 Nov 1770	Vessel larboard side of the ship keel out – found the bottom in very poor condition. False keel gone to within 20 feet of the stern post – Main keel wounded in several places – great quantity of sheathing off, several planks much damaged especially under the main channel near the keel – where two and half planks near 6 feet in length were within 1/8th of an inch of being cut through. Worms had made their way into the timbers.
10 Nov 1770	Had to caulk and repair upper works as water was coming in when vessel heaved over for careening.
12 Nov 1770	Finished larboard side. Prepared to careen starboard side – very little damage. Repairs completed by the evening of the 13th Nov.
14 Nov 1770	Bottom now repaired – very efficient yard. Vessel hove down using two masts rather than the English practise of using only one.
16 Nov 1770	Took on coals and ballast. Sent off decayed pump, new one made by yard.
17–30 Nov 1770	Employed rigging ship, getting on board stores and water, repairing rigging and sails.

9 Dec 1770	New pump taken on board.
10 Dec 1770	Employed crew painting and scraping hull and upper works.
25 Dec 1770	Completed loading and repairs.
26 Dec 1770	After completing provisioning and taking the surviving gentlemen and crew on board weighed anchor and left port.
12 Feb 1771	Died of the flux after a long and painful illness Mr John Satterly, Carpenter, a man much esteemed by me.
13 Jul 1771	Arrived off Portland and anchored in the Downs.

Appendix 2. Glossary

The definitions listed below are adapted from Steffy (2012).

Abaft: In, behind or towards the stern (back) of a ship.

Aft: In or behind the stern of a ship.

Amidships: In the middle of a ship.

Analysis: The process in which a find or artefact and its associated archaeological context is assessed, identified, classified, dated and interpreted.

Apron: A curved timber affixed to the top of the forward end of the keel and the after surface of the stem (bow); an inner stem post.

Archaeology: Knowledge of human life through the study of human antiquities, especially of the prehistoric period (no written sources) and usually by excavation. However, underwater archaeology also includes the historic period (written sources).

Archaeological context: The physical setting, location and cultural association of artefacts and features within an archaeological site.

Artefact/artifact: Any object made or modified by humans. Artefact assemblages from underwater sites can, and often do, include not only items expected in land excavations, but also items often not preserved on land – for instance organic material such as wood, foodstuffs, leather, paper and fabric. Shipwreck sites also contain artefacts associated with seafaring, including with the ship itself, such as fittings, equipment and rigging, but also ordnance, cargo and the personal possessions of passengers and crew.

Athwartships: Across the ship from side to side; perpendicular to the keel.

Australian National Maritime Museum (ANMM): The ANMM is a Sydney-based Commonwealth of Australia statutory authority established by the *Australian National Maritime Museum Act 1990*. Since its establishment in 1991, the Museum has been a world leader in the preservation, promotion and sharing of Australia's maritime heritage. The Maritime Archaeology Program at the Museum was established in 1993.

Ballast: A heavy substance such as rock or metal placed in the lower part of a ship to improve its stability, trim and control.

Bark: In the 18th century a type of wooden vessel defined by the shape of its hull, which included a square bilge, flat floors, bluff bow and a full or square stern with windows. His Majesty's Bark *Endeavour* is described in archival sources as a 'cat-rigged bark'.

Barque: In the 19th century a type of sailing vessel with three or more masts with the fore and main masts rigged with square sails and the aft or mizzen mast rigged with fore-and-aft sails. In some cases, the aft mast may carry a fore-and-aft sail on its lower yard and a square-rigged sail above.

Beam (baulk): A timber mounted athwartships to support decks and provide lateral strength. Large beams were sometimes called baulks.

Beam shelf: An internal longitudinal structural timber that runs fore and aft, upon which the deck beams rest and are supported.

Bilge: The lowest part of a ship's inner hull on either side of the keel. When used in its plural form, 'bilges', it refers to the various cavities between the frames (floors and futtocks) where bilge water tends to collect.

Block/pulley: A composite object colloquially known as a 'pulley' that comprises cheeks, sheaves (pronounced 'shivs') and sheave pins. It is commonly used as a lifting or pulling mechanism that reduces the amount of force required to move, lift or pull an object such as a mast, spar, gun carriage or sail.

Bottom: The underwater portion of a fully loaded vessel.

Bow: The forwardmost part of the hull of a ship or boat. The ship's bow is usually designed to enable the vessel to pass efficiently through the water. Bow shapes vary considerably depending upon function and necessity. The forwardmost part of the bow is called the 'stem' or 'forestem'. In large wooden vessels, the bow or stem is comprised of several different timbers.

Boxing/box scarph/boxing joint: A type of scarph used primarily to join the keel to the stem or keel timbers to each other.

Breadth: The width of a hull, sometimes called the 'beam'.

Butt: The lateral end of a hull plank or timber.

Butt joint: The union of two planks or timbers whose ends are perpendicular to their lengths.

Cant frames/cant timbers/cants: A framing member mounted obliquely to the keel centreline in the ends of a vessel. Canting provides better frame distribution and permits more nearly rectangular cross-sections of the timbers along the vessel's incurving ends.

Caulk: To drive oakum, moss, animal hair or other fibrous material into the seams of planking and then cover it with pitch to make the seams watertight.

Ceiling: The internal timber planking of a wooden vessel that lines the hold

of a ship, protecting the outer hull planking, floors and futtocks from damage. Ceiling planks are usually flush fitted and sometimes secured by timber or iron fastenings. They are not usually caulked.

Chain-wale or channel wale: A broad, thick timber that projects horizontally outwards from the port and starboard sides of a wooden ship abreast (next) to the fore, main and mizzen (stern) masts. The wale or channel acts as the base for the chains, to which the standing rigging, or shrouds, to support the masts are attached to the sides of the ship.

Chamfer: A bevelled edge, the flat, sloping surface created by slicing the edge of a timber.

Chock: A wooden or metal wedge or block placed against a wheel or rounded object such as a cask to prevent it from moving. In wooden ship building the term is also used to describe a tapered block that is inserted either under a ship's floor or between a floor and futtock to fill in the space, lock the timbers in place, and prevent movement.

Common ceiling: The ordinary ceiling used to prevent cargo and ballast from falling between the floors and futtocks (frames). Usually made of thin planking, common ceiling seldom contributed to the strength of a vessel's construction.

Concretion: Stone-like encrusted clump/conglomerate created by natural elements, such as seawater, around an artefact. Concretion most commonly forms around metal artefacts, and particularly those manufactured from iron.

Conservation: The scientific process of preserving cultural heritage. In the case of artefacts from underwater cultural sites, conservation usually involves managing waterlogged material, often with high chloride concentrations.

Context: An artefact's place of origin and its association with other artefacts and structures within an archaeological site. The careful investigation of objects in situ (in original position) gives far more valuable information than just the object itself. An object without context tends to have lost its story. Context and provenance are sometimes used interchangeably, but strictly speaking, context refers to the artefact's original position whilst provenance refers to its history, ownership and location after discovery or recovery.

Copper-fastened: A vessel with fastenings made of copper.

Corrosion: Except for gold, all metals corrode in seawater. Corroded metals pose a significant conservation problem and can be very difficult to treat. In some cases, highly reactive metals such as iron may disappear entirely, leaving only a cavity inside a concretion, which can be filled with resin or plaster to produce a cast of the artefact.

Deadwood: Blocks of timber assembled on top of the keel, usually at the ends of the vessel, to fill out the narrow parts of the hull. Timbers built into the bow or stern of a ship that are too narrow to allow installation of frames.

Deadwood knee: A structural knee timber placed within the deadwood to support the sternpost.

Deck: The timbers forming the horizontal floor spaces within the ship's general structure upon which crew can walk and cargo can be stored.

Deck beam: Ordinary or auxiliary timber beams that run across the vessel from beam shelf to beam shelf, supporting the deck of a wooden vessel. 'King', 'strong' or 'main' beams are those timbers that support hatches, masts and companion ways.

Dendrochronology (tree-ring dating): A method of dating structural timber by a comparative study of annual rings (growth rings) in tree trunks. Depending upon annual weather changes, the rings are thinner or thicker, creating a fingerprint-like pattern. Reference charts for such patterns have now been created covering several thousand years. Dendrochronology cannot be used in dating most Australian native species due to highly irregular growth rings, or in some cases their complete absence.

Diagnostic feature: A specific or unique structural feature on a ship's structure or artefact (such as a name or date) that serves as supporting evidence in a diagnosis or identification.

Diagonal scarph: An angular junction of two planks or timbers.

Draught/draft: The distance between the waterline of a vessel and its keel. The minimum depth of water in which a boat willscribe a drawing or plan of a vessel.

Drift bolt: A cylindrical bolt, headed at one end, that is slightly larger in diameter than the hole into which it is driven into.

Dunnage: Loose packing material used to protect the interior hull of a ship or its cargo from damage during transit.

Excavation: The process of uncovering all or part of an archaeological site by removing soil or sediment, and recording the context, location, type, size and amount of cultural material (including any structure or hull of a vessel, if apparent) prior to removing or recovering all or part of the material. Excavation is a destructive process that will radically change or destroy the archaeological record, so it should only be undertaken by qualified and experienced archaeologists who have demonstrated that excavation is the only means by which answers can be found to specific research questions.

False Keel: A thin timber keel or strip beneath the main keel of a vessel. It is used to protect the main keel from accidental damage, protect the heads of bolts holding the keel together, and increase the vessel's lateral (sideways) resistance when

under sail. The false keel could be more easily replaced when damaged.

Filling frame: A frame composed of a single row of timbers, usually scarphed together, that filled a space between the main, or doubled, frames of a ship.

Filling piece: A single timber or block used to fill out an area, such as the space between frames, to maintain rigidity and strength.

Fish plate: A metal plate used to join two timbers together.

Flat scarph: The union of two planks or timbers whose diagonal ends were nibbed (cut off) perpendicular to their ends.

Floor: A relatively flat structural timber that crosses over the keel of the ship and, in association with the futtocks, makes up the frames or 'ribs' of a wooden ship.

Floor head: The outer extremity of the floor timbers.

Forefoot: A curved piece of timber between the forward end of the keel and the knee of the head; also known as the 'gripe'.

Foremast: The mast nearest the bow of a ship.

Frame: A transverse timber, or line of assembled timbers, that provide the body shape of a vessel and to which the planking and ceiling are attached. Frames are sometimes called timbers or, erroneously, 'ribs'. From the 18th century onwards, frames consisted of floors, futtocks and top timbers. Square frames are those set perpendicular to the keel. In the bow and stern, frames were set obliquely to the keel and known as cant frames. Frames that run parallel to the keel and stem are sometimes called knuckle timbers; more accurately, these were hawse pieces and knight heads, the latter being frames adjacent to the apron or stemson that extended above the deck to form bitts and support the bowsprit. Aftermost frames were called fashion pieces and formed the shape of the stern.

Futtock: A structural timber that in association with other futtocks and floors make up the frames or 'ribs' of a wooden vessel. Futtocks are numbered depending on their position relative to the floor, with the closest futtock to the floor or keel called the '1st Futtock', the second closest '2nd Futtock', etc.

Garboard strake: The external hull plank closest to a vessel's keel.

Grid: A system of squares or rectangles superimposed over an archaeological site that divides it into smaller, more manageable areas allowing for precise documentation and recording of the locations of artefacts and features. In the case of underwater sites, the grid can be made of solid aluminium framing or other material.

Gudgeon: A metal socket or bracket attached to the sternpost of a wooden vessel upon which the pintle (hinge) of a ship's rudder fits.

Hawsehole/Hawsepipe: A reinforced hole in the ship's bow through which the ship's anchor cable or hawser passes.

Hawse piece/Hawse timber: A fore-and-aft framing timber whose heel was fayed (tightly joined) to the forwardmost cant frame and which reinforced the bow of a large, bluff (round)-bowed vessel. Hawse pieces were so named because the hawseholes were partially cut through them.

Hold: The interior area beneath a vessel's main deck in which the cargo, or sometime passengers, are stored or housed. The lower part of the interior of a vessel's hull.

Hook scarph: The union of two planks or timbers whose angular ends are offset to lock the joint. Hook scarphs are sometimes locked with wedges or keys.

Horseshoe/horseshoe clamp or plate: A U-shaped iron plate fastened across the seam of the stem and forefoot to strengthen it.

Hull: The shell (inner and outer planking) and framework (floors and futtocks) of a ship.

Hull fastenings: Metal nails, spikes and bolts used to secure the structural timbers of a boat together. Wooden fastenings are usually called treenails or dowels.

Keel: The bottom-most longitudinal structural element of a vessel around which the hull of the ship is constructed. The keel runs along the centreline of the vessel from stem (bow) to stern and is usually the first part of the ship constructed. The floors (lowest parts of the ship's framing) run across the keel and are supported by the keel and secured to the keelson, which is installed above them.

Keelson: A reinforcing longitudinal structural element that runs along the centreline of the vessel from bow to stern and sits atop the floors and keel. In the case of HMB *Endeavour/Lord Sandwich*, an additional 'sister' or 'rider' keelson sat atop the keelson, and extended from just aft of the stempost to just aft of the mainmast. On occasion, large square timbers were placed at the floor head line, or near the bilge, usually above the bilge keels. These were called bilge keelsons or, in some British documents, sister keelsons. Secondary keelsons did not necessarily run the full length of the hull, instead terminating at the ends of the hold, the last square frames, or some other appropriate location.

Kentledge: Cast pig-iron oblong blocks used as ballast in the ship's hold. Because of their size and weight, kentledge tended to be used as permanent long-lasting ballast, unlike stone or shingle, which could be more easily moved or replaced.

Knee/knee timber: An angular piece of timber used to reinforce the junction of two surfaces of different planes. Usually made from the crotch of a tree where two large branches intersected, or where a branch or root joined the trunk.

Lead sheathing: Sheets of lead affixed to the lower hull beneath the waterline to repel marine organisms. Small strips of lead sheet known as 'tingles' were also used for small repairs to the hull.

Length overall: The maximum length of the ship, taken between the verticals at the bow and stern. In the 18th century, the overall length was used to calculate the tonnage of wooden ships.

Limbers: Watercourses or channels alongside or central to the keel or keelson, through which water could drain into the pump well.

Limber boards: Ceiling planks next to the keelson that could be removed to clean the limber holes below. On some vessels limber boards were laid transversely above the centreline of the keel, although in most cases they followed the line of the ceiling planking. Holes or slots were sometimes cut into limber boards so they could be more easily lifted and replaced.

Limber hole: A hole cut through the bottom surface of a frame or other structural timber. Designed to prevent water accumulating against that timber and to aid in draining the hull of water.

Limber strake: The lowest permanent ceiling strake, fastened to the tops of the frames next to the limber boards and keelson.

Line: The general term used for most of the cordage or 'ropes' used on a vessel. Lines always had more specific names, such as 'mizzen topsail halyard', which described its use.

Lines/hull lines/ship lines: The various shapes of a hull. Expressed graphically, a set of geometric projections, usually arranged in three views, that illustrates the shape of a vessel's hull.

Maritime archaeologist: Person qualified and experienced in the discipline of maritime archaeology. Like all specialist archaeological areas, training in archaeological techniques alone does not suffice for an individual to qualify as a maritime archaeologist. Tertiary qualifications at a postgraduate level need to be combined with suitable qualifications and experience in working underwater.

Maritime archaeology: The archaeological study of humans and their interactions with the sea, lakes and rivers. This field can include sites that are not underwater but that are related to maritime activities such as shipwreck survivor camps, lighthouses, port facilities and shore-based extractive industries such as sealing, whaling and fishing.

Mast: A vertical timber on a ship that supports the sails and rigging. Masts are named dependent upon their position and function, such as 'mainmast' for the principal mast of the vessel, 'foremast' for the mast closest to the vessel's bow, and 'mizzenmast' for the mast astern of the mainmast.

Mast step: A structural timber placed on top of the keelson that supports the base of the ship's masts. On some vessels the mast was 'stepped' directly into the keelson with no additional timber structure used.

Material culture: Objects or artefacts made, altered, or used by humans.

Midship/midships: A contraction of amidships and consequently, in a general sense, it refers to the middle of a vessel. However, in ship construction it is often used as an adjective referring to the broadest part of the hull, wherever it may be.

Moulded/moulded dimension: The various dimensions of timbers as seen from the sheer and body views of construction plans; the dimensions determined by the moulds. Thus, the vertical surfaces (the sides) of keels, the fore-and-aft sides of the posts, the vertical or athwartships surfaces of frames, etc. Normally, timbers are expressed in sided and moulded dimensions, while planks and wales are listed in thicknesses and widths. Moulded and sided dimensions are used because of the changing orientation of timbers, such as frames, where 'thick' and 'wide' or 'height' and 'depth' become confusing.

Mortise: A cavity cut into a timber to receive a tenon.

Mortise-and-tenon joint: A union of planks or timbers by which a projecting piece (tenon) was fitted into one or more cavities (mortises) of corresponding size.

Nautical archaeology: The archaeological study of ships and shipbuilding. Like maritime archaeology, it can include sites that are not underwater, but are related to ships and shipbuilding, including ship burials, shipwreck remains in terrestrial environments, or shipbuilding yards.

Outboard: Situated near or on the outer side of a vessel; toward the outer side.

Photogrammetric3DReconstruction (P3DR): A relatively new algorithmic process in which highly detailed and visually accurate digital 3D models or digital reproductions of real-world objects, such as artefacts or entire shipwrecks, can be generated from multiple digital still images. These are processed through a powerful computer using photogrammetric software programs such as AgiSoft.

Pintle: A vertical pin at the forward edge of a stern-hung rudder that fits into a gudgeon on the sternpost to form a hinge. On most vessels, they were welded or cast to a bracket, the arms of which were fastened to the sides of the rudder.

Pitch/tar: A dark, sticky substance used to caulk seams or spread over the inner or outer surfaces of hulls. Pitch provides waterproofing and protection against some forms of marine life. Pitches were variously derived from the resins of certain evergreen trees; from bitumens, such as mineral pitches; or from the distillation of coal tar, wood tar, etc.

Planking (hull): Relatively thin longitudinal structural timbers which in carvel hull construction are laid edge to edge and fastened to a timber floor or futtock (frame or 'rib') providing a smooth outer surface. The planks are neither attached to, nor slotted into, each other and are sealed with a caulking sealant between the planks to keep water out.

Port/port side/larboard: The left side of a vessel when facing forward towards the bow.

Provenance: The chronology of ownership, custody or location of an historical object or archaeological artefact.

Pump: A device that moves, lifts or pushes fluid by some form of mechanical action. Pumps can be classified into three major types according to the method they use to move fluid: direct lift, displacement and gravity. In the 18th century, the most common type of pump found aboard vessels was the 'common pump', a long wooden tube the lower end of which rested upon the ship's bottom, between floors. Inside the tube were two simple valves, an upper valve attached to a moveable pump spear, and a fixed valve at the bottom of the pump tube. By lifting the spear, the upper valves draw water through the tube and then discharges it at the top, or head, of the pump.

Pump well: Compartments in the lower hold of a vessel that accommodate the lower ends of its bilge pumps. Wells were constructed to keep pumps clear of any cargo or ballast that might block and prevent them from working.

Rabbet: A groove or cut made in a piece of timber in such a way that the edges of another piece could fit into it to make a tight joint. Generally, the term refers to the grooves cut into the sides of the keel, stem, and sternpost, into which the garboards and hooding ends of the outer planking were seated.

Rake: The angle of a ship's timber or mast relative to the keel.

Rhode Island Marine Archaeology Project (RIMAP): A group founded in 1992 to include members of the diving and non-diving public in a professionally organised and directed effort to study Rhode Island's maritime history and maritime archaeology.

Rider/rider frame: An internal frame seated atop the ceiling to which it was fastened. Riders could be single pieces, but more often were complete frames composed of floor timbers, futtocks and top timbers. Installed either transversely or diagonally, they provided extra stiffening for the overall hull structure.

Rider keel: One or more additional keels bolted to the bottom of the main keel to increase its strength. It should not be confused with a false keel, the primary purpose of which was to protect the keel's lower surface.

Rider keelson/false keelson: An additional keelson, or one of several additional keelsons, bolted to the top of the main keelson of a large ship.

Rigging: The system of lines, cables and chains used to support the masts (standing rigging) or to control and set the yards and sails (running rigging).

Room and space: The distance from the moulded edge of one frame to the corresponding point on an adjoining frame, usually measured at or near the keelson. The part occupied by the frame is called the 'room', while the unoccupied distance between it and the adjacent frame is called the 'space'. On large ships of the last few centuries, where filling frames were placed between double frames, the term applied to the distance between the moulded edge of one double frame to the corresponding point on the next double frame.

Rudder: A timber, or assembly of timbers, that could be rotated about an axis to control the direction of a vessel while underway. Until the middle of the medieval period, common practice was to mount rudders on one or both stern quarters. These were known as quarter rudders. However, by the late medieval period, it appears most vessels of appreciable size were steered by a single rudder hung at the sternpost. These were known as stern-hung rudders.

Scantlings: The principal timbers of a vessel and/or their dimensions.

Scarph/scarf: An overlapping joint used to connect two timbers or planks without increasing their dimensions.

Scupper: An opening in the base of a ship's gunwale that allows water to drain off the deck.

Seam: The longitudinal joint between two timbers or planks; the term usually refers to planking seams, the longitudinal juxtaposition of the edges of planks in the sides or decks, which were made watertight.

Sheathing: A thin covering of metal or wood, to protect hulls from marine life or fouling, or to stabilize and protect surface material applied for that purpose. Sheathing was mostly used in the form of copper, lead, zinc, or alloy sheets, or thin wooden planks known as 'furring' or 'deals'.

Sheer: The upward curve of a vessel's longitudinal lines when viewed from the side. The size and angle of a vessel's sheer can indicate its type.

Shift: The act of arranging butts and scarphs so that adjacent joints are not in vertical alignment, thereby avoiding possible hull weakness.

Ship: Strictly speaking, a three-masted vessel with square-rigged sails on all three masts. The term is more generally used to describe most medium or large ocean-going vessels.

Shipworm (*Teredo navalis*): A species of marine mollusc that eats wood. It only resides in salt water.

Shot locker: A small compartment, usually located near the foot of the mainmast, used for storage of round shot (or 'cannonballs').

Shrouds: The standing rigging of a vessel running vertically from the chains to the masts.

Silentworld Foundation (SWF): An Australian based not-for-profit organisation founded in 1997, with a focus on supporting and promoting Australasian maritime archaeology, history, culture and heritage. SWF curates a research museum and manages several archaeological and conservation projects in Australia and overseas.

Sided/sided dimension: The dimension of an un-moulded 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.

Standing rigging: Rigging used to support the masts and spars of a sailing vessel and not normally adjusted during its operation.

Starboard: The right side of a vessel when facing forward.

Stem: A near-vertical structural timber attached to the keel of the ship at the forwardmost part of the vessel. Colloquially called the 'bow'.

Stern: The rear part of a ship, technically defined as the area above the sternpost.

Sternpost: Main structural timber at the rear of a vessel that extends from the keel to the deck upon which the rudder is usually hung.

Strake: Strictly speaking, the overlapping outer hull planks of a clinker-built vessel. However, the term is also used to describe a particular line or run of planking.

Thick stuff: A term referring to the thick ceiling planking located in the bottom of a vessel's hull.

Timbers: In general context, all wooden hull members; specifically, those members that formed the frames of a hull.

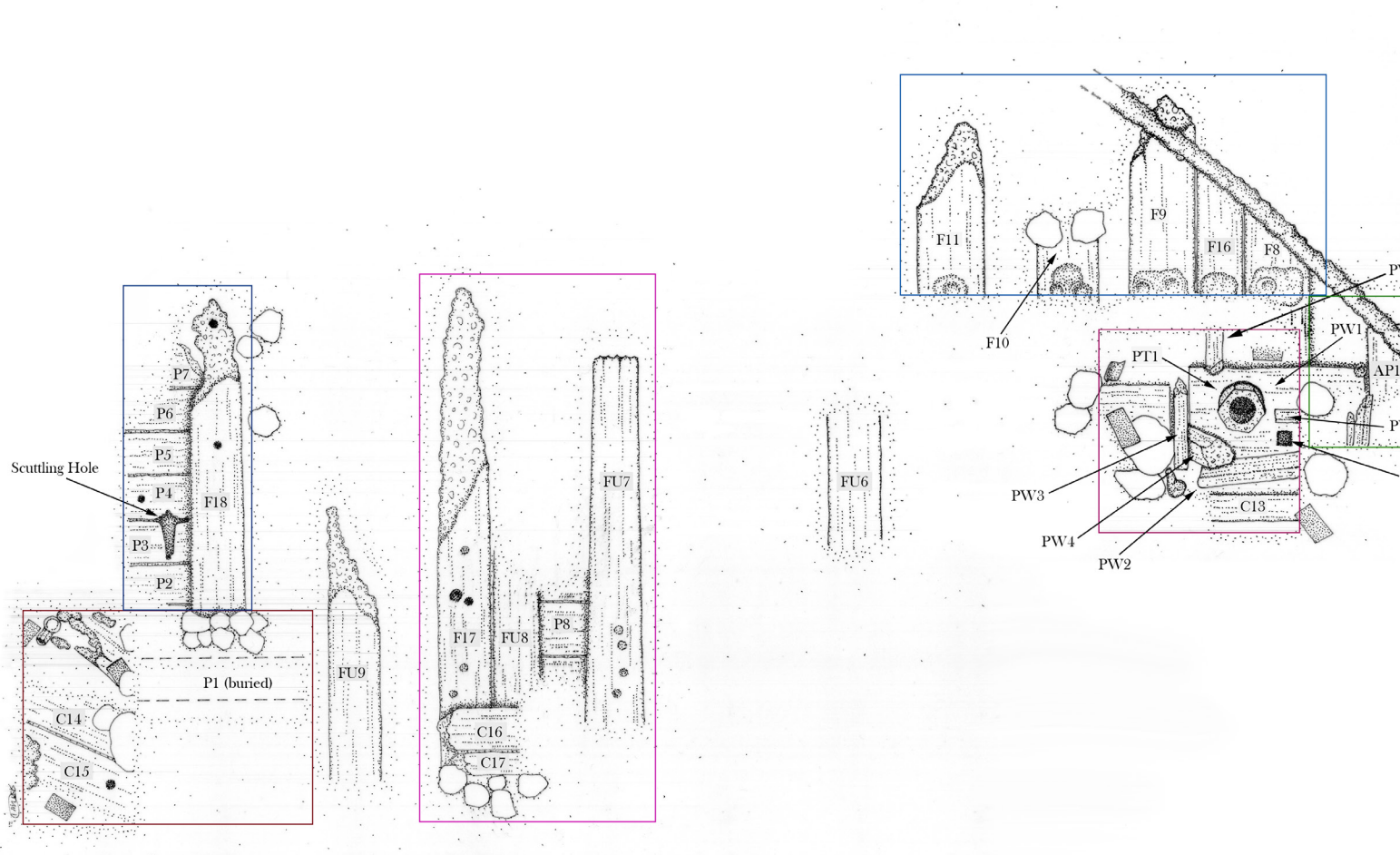
Ton: The unit of measurement used to specify the size of a ship. In the 18th century, tons used in shipping were units of volume (100 cubic feet) and did not represent a vessel's weight or displacement.

Tonnage: A measurement of the internal volume of a vessel. The basic units of measurement are the Registered Ton, equivalent to 100 cubic feet, and the Measurement Ton, equivalent to 40 cubic feet. The calculation of tonnage is complicated by many technical factors and their definitions changed several times during the 18th and 19th centuries.

Thwart: A structural timber crosspiece found on a wooden vessel that goes from one side of the hull to the other side in a particular area.

Treenail/trunnel: A long, round wooden pin or nail used to affix a vessel's planks to its floors and futtocks. Treenails could also be also used to secure floors and futtocks to each other.

Waterway: A thick timber plank, or angled iron or steel beam, that runs along the outer edge of the deck of a vessel. It joins the vessel's side to its deck and directs water overboard via the vessel's scuppers (drains) or freeing ports (holes cut in the side of the bulwarks).

Wells: Compartments in the lower hold of the vessel that accommodated the lower ends of the ship's bilge pumps. Wells were constructed to keep the pumps clear of any cargo or ballast that might block the pumps and prevent them from working.

Archaeological plan of shipwreck site RI 2394 (*Lord Sandwich*, ex-HMB *Endeavour*) produced from investigations between 2019 and 2021. Image: James Hunter/ANMM.