

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

Preliminary report

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Executive summary

His Majesty's Bark *Endeavour* is an important vessel in Australian maritime history and one that elicits mixed opinions. For some the Pacific voyage led by James Cook over 1768–71 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 1778.

This report outlines the archival and archaeological evidence that may lead to the identification of the shipwreck site of *Lord Sandwich*, formerly HMB *Endeavour*. The site, known as RI 2394, is in Newport Harbor, in the state of Rhode Island, USA. As the culmination of a 22-year program of archival and archaeological research, the identity of RI 2394 as *Lord Sandwich* (ex-HMB *Endeavour*) could be made 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 America in support of British campaigns. In 1778, this 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 established the final fate of *Endeavour* via archival research. Their work was extended by members of the Rhode Island Marine Archaeology Project (RIMAP), and in consequence the state of Rhode Island in 1999 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 *Endeavour*.

In 1999, the Australian National Maritime Museum (ANMM) commenced working with RIMAP 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 expeditions 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* (ex-HMB *Endeavour*).

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. This Limited Study Area (LSA), just to the north of Goat Island, included just five of the 13 transports sunk in 1778, of which *Lord Sandwich* was the largest by a substantial margin. 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.

The two largest shipwreck sites, RI 2578 and RI 2394, were considered the most likely candidates for the remains of *Lord Sandwich* (ex-HMB *Endeavour*). 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. Although a substantial iron anchor and a small iron cannon are also present, the RI 2578 site does not feature sufficient characteristics to be identified as *Lord Sandwich* (ex-HMB *Endeavour*).

RI 2394 is substantially larger than RI 2578, with visible remains covering an area 18.2 metres long x 7.3 metres wide. 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 present on the site, along with a lead scupper. Analyses have been undertaken on the timber, ballast and artefacts located on the site.

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, whilst not containing evidence of possible exotic (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. 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 between the stem 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* (ex-HMB *Endeavour*) (see Abbass 2000; RIMAP and ANMM 2019). Based on a preponderance of evidence, sufficient of these criteria have been met to tentatively identify RI 2394 as the remnants of James Cook's *Endeavour*. If confirmed, this identification would suggest securing the highest possible level of legislative and physical protection for the site, given its historical and cultural significance to Australia, New Zealand, the United Kingdom, and the United States of America.

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 ⁴⁹/₆₄ tons burthen (Beaglehole 1995: 606-607).

'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).

¹ Fishburn ended up building 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* also share the same unusual joint/scarph at the junction of the stem and forward end of the keel.

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. Whilst 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. 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 in the Downs (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 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).

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.

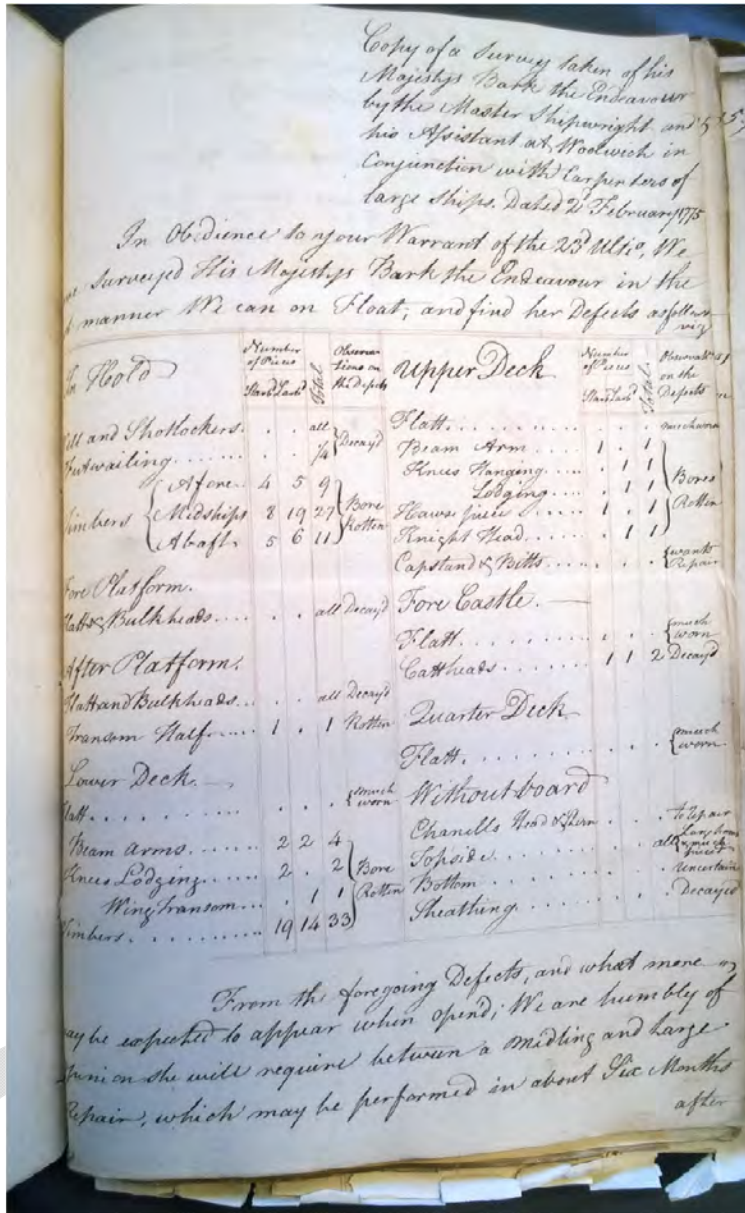


Figure 1. Report to the Admiralty noting the significant repairs required in 1775 to keep *Endeavour* operational and seaworthy (ADM 354/189/330 Navy Board: Bound Out-Letters: Woolwich; National Archives, Kew).

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 that *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. 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 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 on to 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 to establish a British garrison at Newport 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 *Kingsfisher*, and frigates *Juno*, *Cerberus*, *Orpheus*, *Lark*, *Flora* and *Falcon* were subsequently burned and sunk.

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 to prevent the French ships from coming too close to shore and cannonading the town and its protective artillery batteries and garrisons (Erskine 2017:66). The vessels listed in the margins of Brisbane's orders were *Lord Sandwich*, *Earl of Orford*, *Yowart*, *Peggy*, *Mayflower*, *Esther*, *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, 1777–1778, 328).

The five scuttled transports to the north of Goat Island were *Earl of Orford*, *Mayflower*, *Peggy*, *Yowart* and *Lord Sandwich*. 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. 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. Pierre Orzanne, 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 during the Battle of Rhode Island, 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* (ADM 106/3404, Public Records Office, Deptford Yard copy book). Interestingly, this list did not include the 190-ton armed snow *Mayflower*, built at Whitehaven in 1757 (Erskine 2017: 71).

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

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

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 Harbour, and two in the channel between Blue Rocks (now called Gull Rock) and Coasters Harbour (Figure 2).

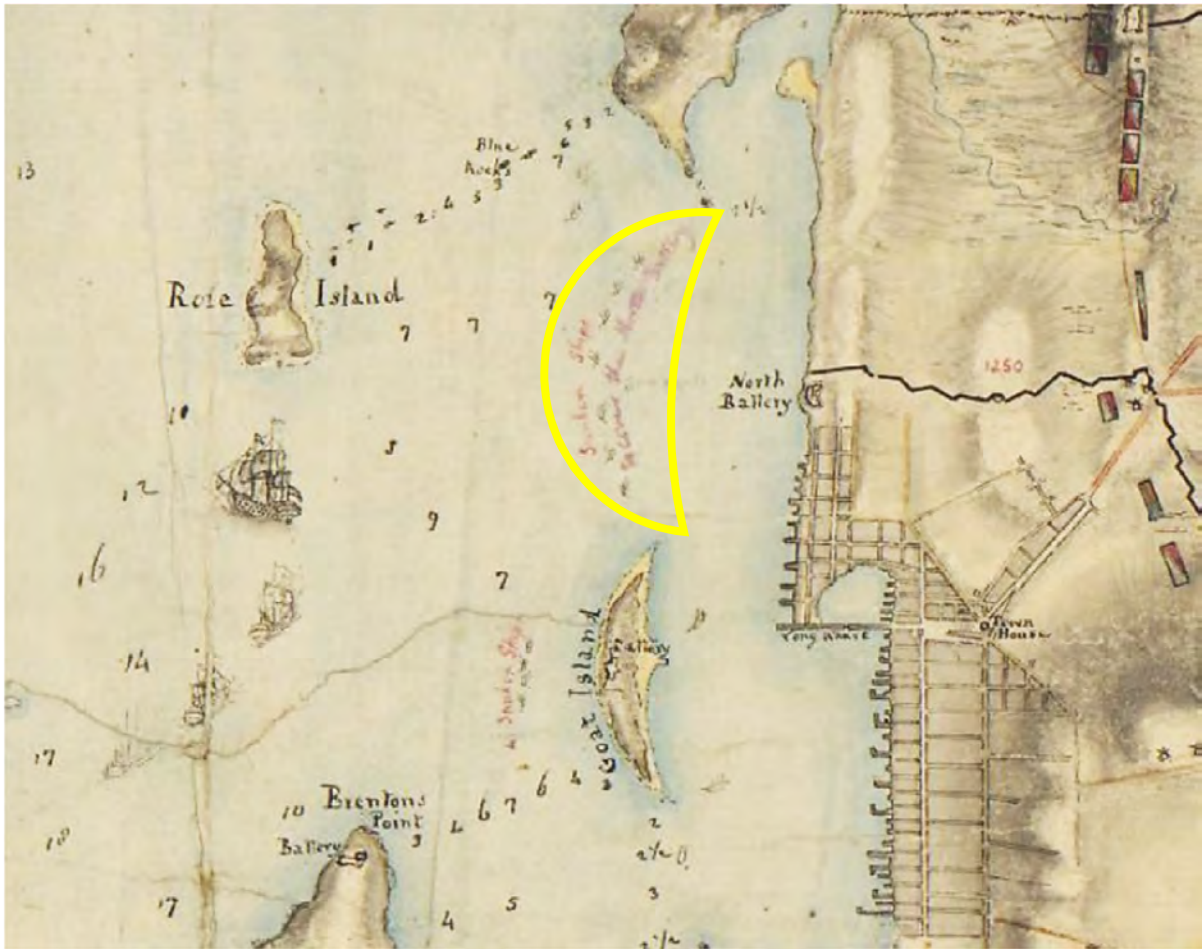


Figure 2. Edward Fage, [Newport and its environs, ca. 1778], William L. Clements Library, University of Michigan, 8380. Note 'Sunken Ships' indicated due west of North Battery (circled).

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 drew up 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 Harbour (Figure 3).



Figure 3. Plan de la position de l'armée française 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 Bâtisseurs' – the remains of the ships sunk by the British in 1778.

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 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).

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 some scuttled vessels were later re-floated. Finally, the letter stated 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).

In 2019, this area was designated by RIMAP as the Limited Study Area and would be the focus of all future search and survey activities.

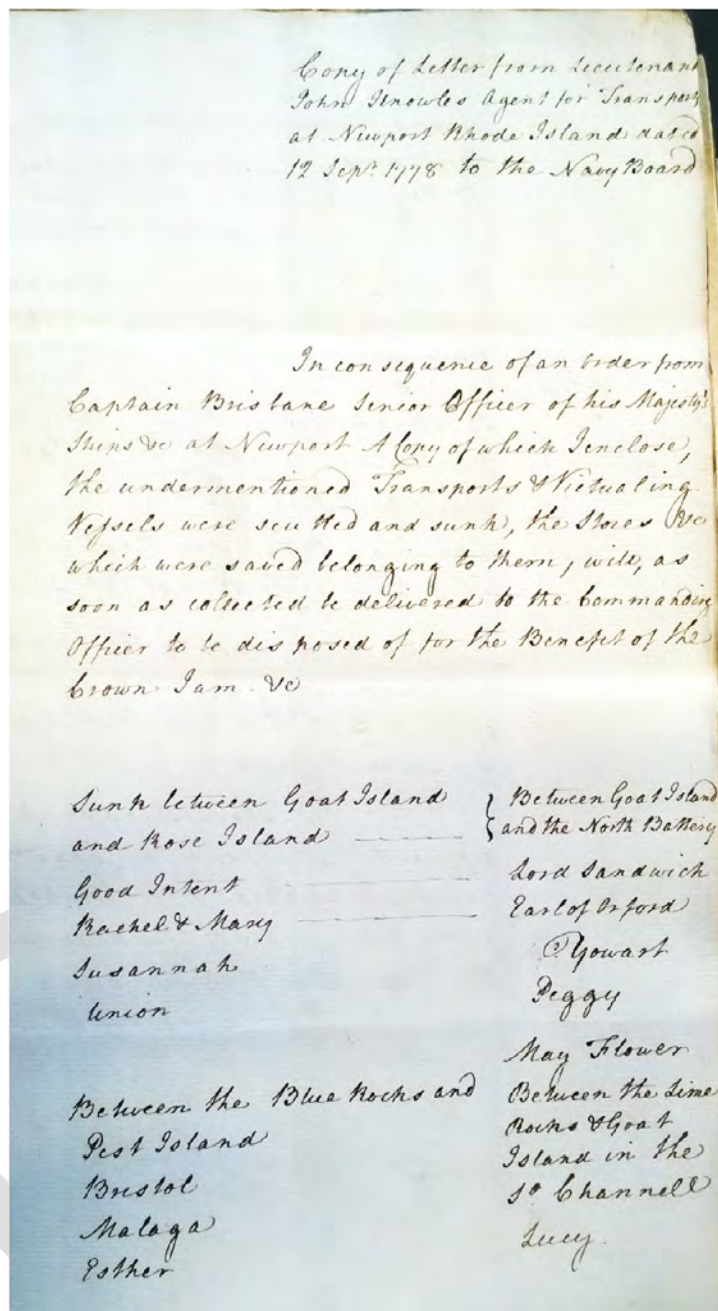


Figure 4 List of transports scuttled in Newport Harbor in 1778 (ADM 354/198/21 Navy Board: Bound Out-Letters: Copy of Letter from Lieutenant John Knowles, Agent for Transports at Newport, Rhode Island 12 September 1778; National Archives, Kew).

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

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

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).

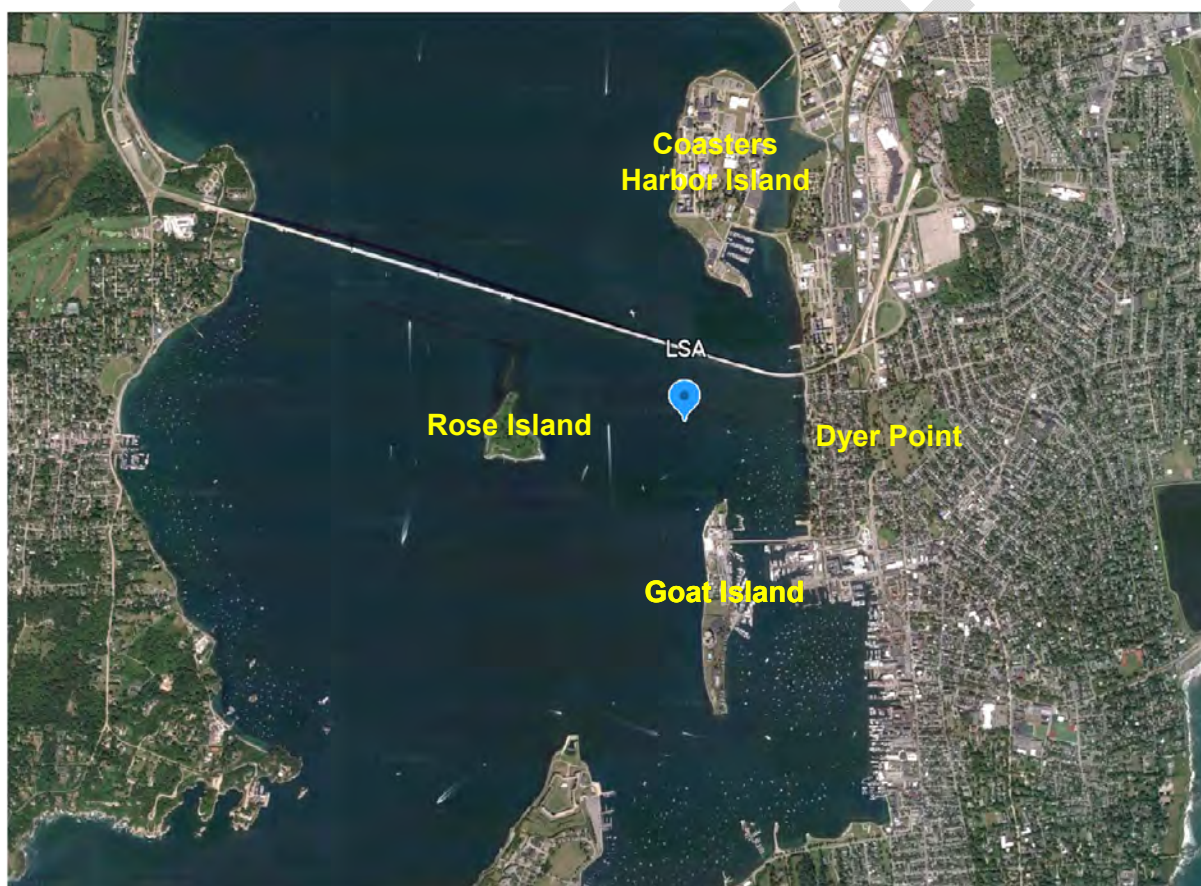


Figure 5. The area of Newport Harbor in which British vessels, including Lord Sandwich, were scuttled in August 1778. Google Earth. 'LSA' indicates the approximate centre of the Limited Study Area in which the wreck of Lord Sandwich is located.

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. 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 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 330 millimetres per 100 years (Hale 1998). Based on tidal records, the depth of water in Newport Harbor has increased approximately 800 millimetres 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).

Climate

The prevailing winds of Narragansett Bay blow from the northwest in winter and from the southwest in summer. 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) above normal level.

Tides and underwater visibility

Tidal movement in Narragansett Bay is minimal. 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 plankton and algae blooms during the summer months, underwater visibility during this time of year is often less than 1 metre (3 feet).

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 36°F (2°C). 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 squawteague (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).

Cultural processes

Rhode Island was established in 1639 by British 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.

By the mid-1700s, relations between the Rhode Island Assembly and British Crown began to sour. 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. Further acts of rebellion followed, including the burning of HMS *Liberty* in 1769 and the British customs schooner *Gaspee* in 1772.

In June 1775, the Assembly of the Crown Colony of Rhode Island created the first navy in the North American colonies. The Rhode Island Navy consisted of two armed vessels, the 12-gun sloop *Katy* and six-gun galley *Washington*, and 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.

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. 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. The navy built a large coaling station at Melville on Aquidneck Island in 1901 and the Naval Torpedo Factory at Goat Island in 1906. 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 impacted the scuttled transports. Cultural activities that have affected these sites include the placement of anchors, moorings, and electrical cables across the harbour floor, dredging of channels, underwater diving operations, and explosives testing. Numerous torpedo and underwater explosives tests conducted in Newport Harbor as part of the station's research

and development activities would no doubt have impacted the Revolutionary War shipwrecks in the area (Souza 1999, cited in Abbass 2001: 20).

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 Canonicut 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 (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 1041 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 1200 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, 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 1200 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).

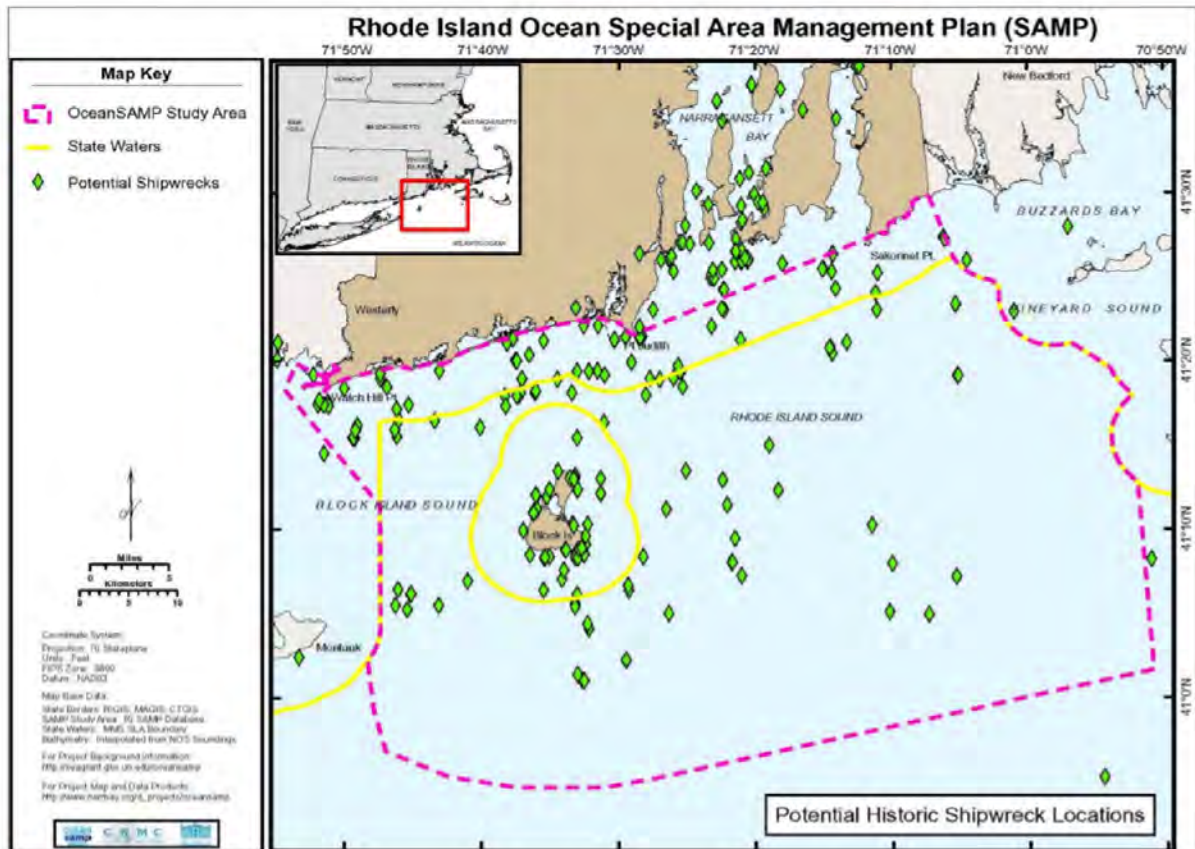


Figure 6. Potential Historic Shipwreck Locations in Rhode Island. From Rhode Island Ocean Special Area Management Plan (Mather 2010: 380, University of Rhode Island, Figure 4.2).

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 2010: 383–8). Further information regarding shipwrecks within the Newport Harbor Original Study Area and the Limited Study Area can be found in the ‘Candidate shipwreck sites’ section of this report.

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 (see Appendix 4. Extracts from relevant US statutes and rulings). 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 three 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. 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. 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.

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. *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 or surveying, identifying, documenting, and evaluating shipwreck sites (Delgado 1998).

In Rhode Island, historic shipwrecks are administered through the State Heritage 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* (see Appendix 4. Extracts from relevant US statutes and rulings).

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

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 such a formalised declaration, the British government may have a legitimate claim to shipwreck site RI 2394.

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 transports. RIMAP was awarded exclusive title to conduct archaeological work on the transport sites, via a Memorandum of Understanding (MOU) with RIHPHC (Abbass 2001). However, in May 2019 RIHPHC, acting under advice of the Rhode Island Attorney General, terminated the MOU and ended the exclusive arrangement between the State and RIMAP. 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 2019).

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*, Dr Kathy Abbass identified the names of several transports assigned to Newport during the conflict, including *Grand Duke of Russia*, *Rachel and Mary*, and *Lord Sandwich* (Abbass 2001: 1).

Abbass is RIMAP's founder and principal archaeological investigator. In January 1999 she announced that she had uncovered archival information at London's Public Records Office (PRO) that suggested the remains of HMB *Endeavour* lay in waters off Newport, Rhode Island (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, Director of the Endeavour Foundation, following a lead published by Sydney maritime historians Mike Connell and Des Liddy (1997: 40–49). Connell and Liddy 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).

5	Mansfield	J Stansford	90	Yrmtb	75	Reynolds	9	Wy.	AI	3	1
	Sp			len. rfd	78						
6	North	J. Boyd	350	Whitby	61	B Camper	14	Co Trnsp	E I	F	i
	Mermaid			lrp 75 &	78			6 Guns			
7	North	Bg W. Dwinn	200	Rde llt	73	Capt. & C.	12	Co Lond.	E I		
						6 guns					
8		Bg W Martin	90	NEng.	73	DWtrs & c	10	Co SKits	E I	1	1
9		Bg A Quarip	140	NEng.	67	Mll. Prrae	13	Queb. Be	E 2		
220		S G. Rofs	200	Philad	71	T Scott & c	13	Lo Antig	E I	R.	i
		A Kild.		4, 10, 3 & 2	2 P			C.			5
1	Rochford	J Lambert	320	River	49	B Camper	14	Lo Trnsp	E I		
	Sa & dya			www 66, trp	75						
2	Sandwich	J Blanchard	350	Whitby	64	J. Mather	16	Lo Trnsp	E I		
	Endeavour			trp	73						
3	Brodenell	S W Devrs	300	Shields	68	J Wilkenson	14	Lq Trnsp	AI	T.	i
				wd & rfd	75						10
4	Shuldham	H. Pascall	600	River	63	Durand & c	18	Lo Trnsp	E I		
	Nrthmbri'c					20 guns					
225	Townsend	H. Spence	700	River	64	J. Mather	18	Lo Trnsp	E I	E. I	
	Salisbury	S		3 Dr		20-9 & 4-6 P					3

Figure 7. Extract from Lloyd's Register of Shipping (1777), showing HMB Endeavour renamed as Lord Sandwich. Emphasis added. Photo. A. Frolows, ANMM.

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 (Mellefont 1999; Abbass 2001: 5–7).

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* (ex-HMB *Endeavour*). 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 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, and again in 2019, as additional survey work 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 the Newport Navy Hospital Pier. Officially designated RI 2125 (its Rhode Island state archaeological site number), 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.* 1999). 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.* 2000).

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.* 2000).

In mid-August 2000, the team commenced investigation of two shipwrecks lying adjacent to one another in 12 to 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.

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* (ex-HMB *Endeavour*) (Bassett, *et al.* 2000; 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 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: 5–2). 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. 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. 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 Fage Chart and Knowles report indicated several transports were scuttled before the Battle of Rhode Island (Hosty 2015).

As identification of the *Lord Sandwich* wreck site was proving elusive, in 2016 Dr Nigel Erskine (ANMM's former Head of Curatorial Research) commenced a review of all archival material relating to HMB *Endeavour* and *Lord Sandwich*. The project sought relevant archival documents housed at the PRO, British National Archives, Caird Library at Royal Museums Greenwich, British Library and ANMM's Vaughan Evans Research Library. A scholarly article written by Erskine (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 a Limited Study Area (LSA) north of Goat Island. Four historic shipwrecks were located within the boundaries of the LSA and designated the site numbers RI 2393, RI 2394, RI 2396/RI 2397, and RI 2578.

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. Efforts concentrated on an area of seabed 250 to 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. At the conclusion of this round of fieldwork, the project partners agreed that RI 2394 appeared to be the largest shipwreck site of the four within the LSA, and therefore the most likely candidate for *Lord Sandwich* (ex-HMB *Endeavour*).

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*. RIHPHC granted permission to excavate a small area of RI 2394 to expose deeply-buried and better-preserved sections of articulated hull structure.

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 a number 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) (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-to-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 (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*.

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, and special care was taken to identify evidence of repairs in areas where *Endeavour's* hull was known to have been damaged. 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. 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 continued to progress with a photogrammetric 3D reconstruction (P3DR) survey of the site that had commenced in 2019.

During September–October 2020, Dr John Broadwater joined the project team to act as a 'surrogate' for ANMM's maritime archaeologists, who were forbidden 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, 1985 and 1995). Activities undertaken in October 2020 continued previous site investigations of RI 2394, including the effort to locate the northernmost preserved end of the hull with probing, metal detecting and limited excavation. 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 30.48 metres (100 feet) north of the southern end of the site, and east of the new centreline.

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. Coordinated by RIMAP, the principal objective of this round of fieldwork was to collect additional data that might solidify RI 2394's identity as *Lord Sandwich* (ex-HMB *Endeavour*). 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 the aforementioned tasks were intended to collect as many details of the vessel's design and construction as possible to correlate them 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 significantly out of alignment with the orientation of the articulated hull's centreline. 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 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. 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 . 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:

- 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 2. 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.
- Continuing historical and cultural interest in the voyages of Cook and *Endeavour*.

Construction materials

Historical sources such as Sutherland (1711) imply that British-built ships such as *Earl of Pembroke/Endeavour* were constructed predominantly of English white oak (for floors and futtocks, as well as ceiling and hull planking), elm (for the keel, stem post, and possibly the keelson), Baltic pine (for all masts) and possibly fir (for the upper deck). These historical sources are supported by comparative archaeological surveys of 18th century shipwrecks in North American waters (Steffy, 2004: 256–9; VanHorn, 2004: 15–18, 227–33).

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/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.

In contrast, 18th-century vessels built in North America tended to use hard maple (*Acer nigrum*), white oak (*Quercus alba*), yellow pine (*Pinus jeffreyi* or *Pinus ponderosa*), southern hard pine (*Pinus taeda*, *Pinus echinata*, *Pinus elliotii* 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 palustris*), red cedar (*Juniperus virginiana*) and red oak (*Quercus rubra*) (Steffy, 2004: 256-9; 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 (e.g., 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 Expositor* (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 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 cannons were sent to various institutions and museums in Australia and internationally (Greenwich, Philadelphia, Auckland, 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.

In the 18th century, Royal Navy ballast or 'kentledge' was manufactured to a specific size (3 feet x 6 inches x 6 inches (900 millimetres x 150 millimetres x 150 millimetres) and weight (320 lbs, 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).

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

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%

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.

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 2. 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.

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.

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* (ex-HMB *Endeavour*). 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. 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, however, as the British transports were stripped of fixtures and fittings (and indeed anything that could be recycled or reused) prior to being scuttled in 1778.

Historical documentation

In 2016, Dr Erskine, ANMM's Head of Research, 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 Research 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* (ex-HMB *Endeavour*) has been extensively researched. The remaining four vessels became the subject of a more exhaustive archival study conducted by Erskine in 2017–18 and Dr James Hunter, ANMM's Curator of Naval Heritage and Archaeology, in 2020–22 (Table 4).

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.

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

Although the 1778 report by Lieutenant John Knowles indicates that five British transports were scuttled within the Limited Study Area (historically, the area between the northern end of Goat Island and the North Battery), to date only four eighteenth-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.

Earl of Orford

Earl of Orford was an American-built ship that was 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 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 (Syrett 2015: 114; Erskine 2017: 70). 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 forward, 5 feet 7 inches midships and 6 feet 2 inches 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, 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, 1781–1784). However, as the other details remain the same, one can only surmise 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). 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* by the authors has revealed *Earl of Orford* is listed *beyond* 1781 (as *Earl of Oxford*) and doesn't 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 the result of information about the vessel's fate being slow to reach, and be confirmed by, Lloyd's of London. There is also the possibility 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 gap between a 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 harbor. This gap suggests 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 the 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, 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).

Peggy

Unpublished research by Hunter (2021) has established that five vessels named *Peggy* were registered with the Transport Service between 1776 and 1778 (see Appendix 3. Review of candidate vessels registered in 1778 as *Peggy*). One was no longer registered by 1778, while three other vessels continued to operate well beyond that date. One *Peggy*, however, appeared in the 1776 and 1778 editions of *Lloyd's Register*. This vessel was a 200-ton single-decked ship with a 13-foot draught. It was built in America in 1766 and captained by C. Campbell. This *Peggy* does not appear in *Lloyd's Register* after 1778, suggesting it went out of service that same year or soon afterwards. Based on Erskine's and Hunter's combined research, the most likely candidate for the *Peggy* sunk at Newport in August 1778 was an American-built, single-decked ship of 200 tons (Figure 8). However, it remains possible that the *Peggy* scuttled as a blockship was another vessel that was subsequently raised and returned to service.

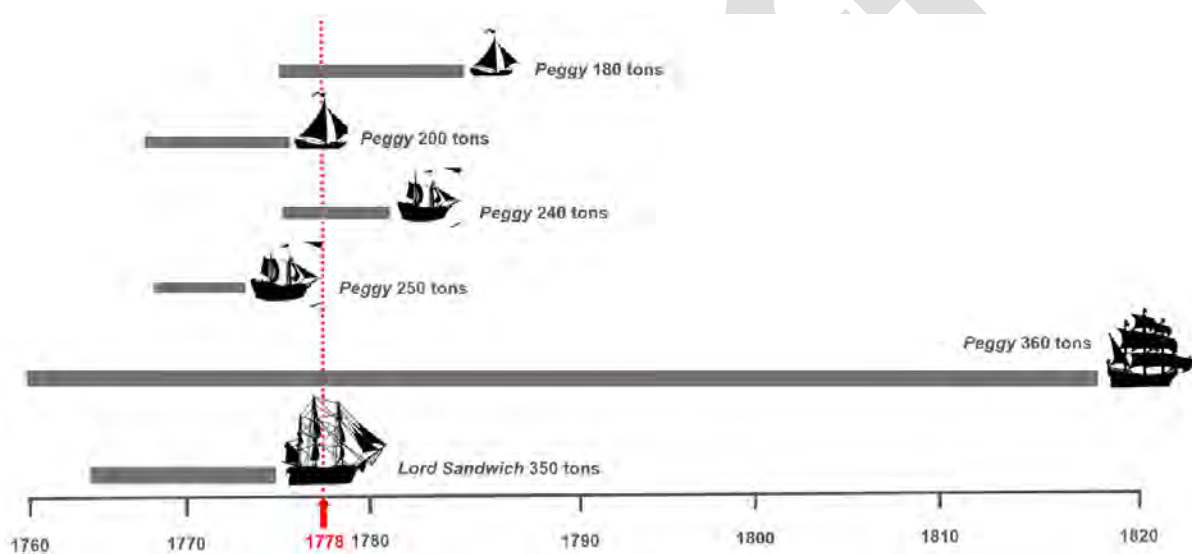


Figure 8. Simplified diagram indicating the known fates of all transports in Lloyd's Register between 1776 and 1778 bearing the name *Peggy*. Unpublished research by James Hunter. Ship images are illustrative only.

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 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).

Lord Sandwich

As noted in Figure 8 above, *Lord Sandwich*, formerly *Endeavour*, was listed as a 350-ton ship in the 1777 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. In addition to systematically ensuring no potential shipwreck sites remained unsurveyed, 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 depicted in Figure 9.

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.

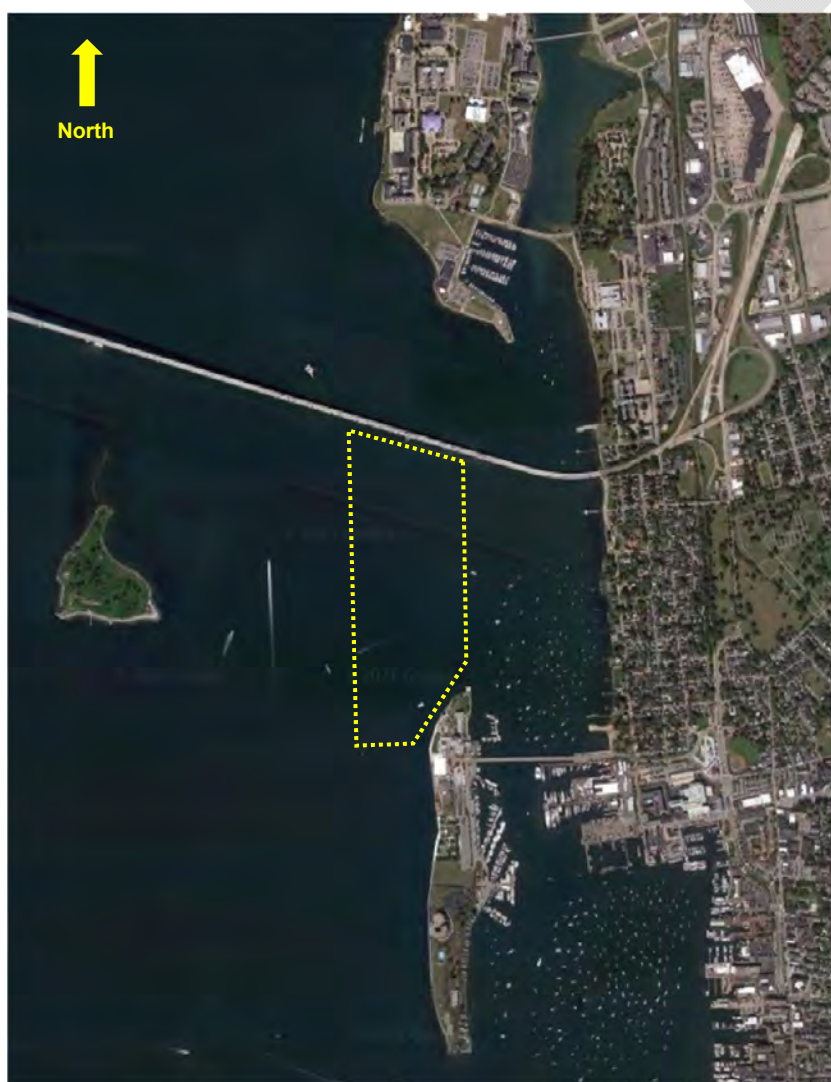


Figure 9. Approximate location of underwater archaeological sites in Newport Harbor considered to be possible locations of vessels scuttled in 1778. Google Earth. Dotted yellow line indicates the Limited Study Area established in 2017. [NOTE: Figure amended to remove locations on 11 February 2022].

Original Study Area

Archival research conducted around the turn of the 20th century suggested the general location of scuttled British transports to be anywhere within Newport Harbor indicated by 18th century maps and illustrations. 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 9.

RI 2119 ('Gamma' site)

In 2000, the RIMAP-ANMM team commenced investigation of two shipwrecks lying adjacent to one another in 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 12 metres long, 5 metres across and 1 metre high, and consisted of numerous dark river-rounded rocks that were possibly basalt or granite.

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 south across the ballast mound, permitting the removal of undisturbed timber, silt, coal and stone samples, as well as collection of scantling measurements. 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 5). Unfortunately, it was not possible to isolate the origin of the oak species to a locale more specific than the northern hemisphere.

Table 5. Timber sample analysis from RI 2119, conducted by CSIRO Forestry and Forest Products Section.

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

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 similar to *Lord Sandwich* (ex-HMB *Endeavour*). The anchor was a wooden-stocked Old Pattern Long-Shanked Admiralty variant that dated to the late 18th century. Its dimensions – 3.7 metres long, 0.5 metre span between flukes and 0.75 metre 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* survey report. RI 2119's scantlings were also close to those recorded for *Endeavour* (Table 6). The team also 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*.

Table 6. Scantlings measured from shipwreck site RI 2119, during the 1768 survey of HMB *Endeavour*, and as listed in the 1857 edition of Lloyd's Register of Shipping Rules and Regulations.

	RI 2119	<i>Endeavour</i>	Lloyd's
Keel (sided)	12.5"	12.5"	
Keelson (sided)	12.5"	12.5"	
Stem	15"		
Floor (sided)	10–11"	14"	11"
Floor and space	24"	29"	25"
Lower futtock (sided)	11"	11"	9.5"
Ceilings	10" x 3"	3"	2.75"

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). 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.

RI 2125 ('Naval Hospital Cannon Site' 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 survey and was at the time the most likely contender for *Lord Sandwich* (ex-HMB *Endeavour*) (Abbass 1998: 14).

RI 2125 is located in 5 to 6 metres of water, 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 15 metres long by 10 metres wide that rises to a height of 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.

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. Ten small samples were also recovered from some of the hull's structural timbers and areas where repairs were evident. These were analysed by timber specialists in the United States and Australia (Table 7).

Table 7. Timber sample analysis from RI 2125, conducted by CSIRO Forestry and Forest Products Section.

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

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.

Hull elements revealed during excavation included a massive keelson complete with scarp 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 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 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.

The team noticed major differences between RI 2125 and archival information pertaining to *Lord Sandwich's* (ex-HMB *Endeavour's*) design and construction. All floors uncovered in the 10 x 10-foot grid were far too short to match the dimensions listed for *Lord Sandwich/Endeavour*. 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. 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. 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 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-to-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 in 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.* 2019, 2020).

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.* 1999).

‘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 20.1 metres north-to-south by 12.8 metres east-to-west. Survey lines were strung every 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*.

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.

This site was briefly surveyed and tentatively identified as a scuttled transport shipwreck site. However, because it is located outside of 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.

In 2001 the RIMAP-ANMM team paired with the US Navy Undersea Warfare Center (NUWC) to undertake an extensive remote sensing survey of Newport Harbor. This sub-bottom profiling study include conducted at Coddington Cove, where the Royal Navy frigate *Juno* was abandoned and burnt during the Battle of Newport in August 1778. Here the sub-bottom profiler was able to detect a significant anomaly below the sediment of the Cove, which were possibly the remains of a vessel. The system was also tested on the sites of three other Royal Navy frigates – *Cerberus*, *Orpheus* and *Lark* – which were abandoned and burnt at the same time as the *Juno*. Here the sub-bottom profile system proved to be very successful 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 unsurveyed areas within the LSA in 2015 and 2016. Survey areas were divided into 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 (Hosty 2016: 88–93).

RI 2393 ('Rod' site)

RI 2393 is located approximately 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 9.0 metres north-to-south, and 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* (ex-HMB *Endeavour*), 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 250 metres north of RI 2578 and appears quite small when compared with RI 2578 and RI 2394. Visible remains cover an area 7.3 metres north-to-south by 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 22 and 24 centimetres. A large 19th century iron anchor is located 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).

RI 2578 ('Kathy' site)

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

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 extents (Hosty 2018: 151,157).

'Caroline' site

A possible archaeological site, nicknamed 'Caroline', is located in the LSA's south-western corner. When surveyed in 2017 it consisted of a thin scatter of brick, ballast stone, glass, and ceramic fragments that covered an area approximately 18.2 metres north-to-south by 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 24.3 metres by 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. 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 18.2 metres north-to-south by 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 11.88 metres (39 feet) at the northern end of the site, and increases to 13.10 metres (43 feet) at its southern extremity. 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 1.67 metres (5 feet, 6 inches) and 1.5 metres (5 feet), respectively. 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).

September 2019 fieldwork

In 2019 an area encompassing three consecutive frames in the approximate centre of the site was chosen for excavation. These elements of hull structure were relocated and a steel excavation grid measuring 0.91 metres wide by 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 (0.305-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 whilst 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), limber channel (to aid in draining the vessel's lower hull) and the upper surface of the keel itself (Hosty 2019: 204). However, the keelson and rider/deadwood keelson assembly was 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 biological action and/or other natural processes. However, as there are no surviving timber remnants of the keelson, nor visible evidence of the iron bolts used to fasten it to the keel, another possible theory is that it was intentionally removed – perhaps as part of a training exercise undertaken by divers associated with the naval base at Goat Island. The keelson may also have been removed or destroyed because of dragging or other activities undertaken to remove hazards to navigation.

The team observed a large oval-shaped, jagged edged hole in one of the garboard strakes, and speculate 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 surface faces 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 confirms 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 13315, Folio 197–198).

Table 8. Scantlings measured from the shipwreck site RI 2394, during the 1768 survey of HMB *Endeavour*, and as the 1857 edition of Lloyd’s Register of Shipping Rules and Regulations.

Structural feature	RI 2394	<i>Endeavour</i>
Keel (sided)	13"	12.5"
Keel (moulded, below rabbet)	--	
Keelson (sided)	12" (estimate)	12.5"
Keelson (moulded)	--	
Floors (sided)	12–16"	14"
Floors (moulded)	13.5–17"	
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)	

January 2020 fieldwork

When excavation of RI 2394 resumed in 2020, five test pits were placed along the hull’s centreline at 2 to 4-metre intervals. They were excavated to a depth between 100 and 500 millimetres and covered an area ranging from 800 to 1500 square millimetres. Ship’s structure, including floors, futtocks and internal 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). 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 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. A hull plan generated from site recording during the 2019 and 2020 investigations was scaled to the same size and superimposed with the 1768 Admiralty plan of *Endeavour*. 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 2003: 40–1).

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. Figure 10 and Figure 11 show the areas on the site where the expedition team focused most of its efforts.

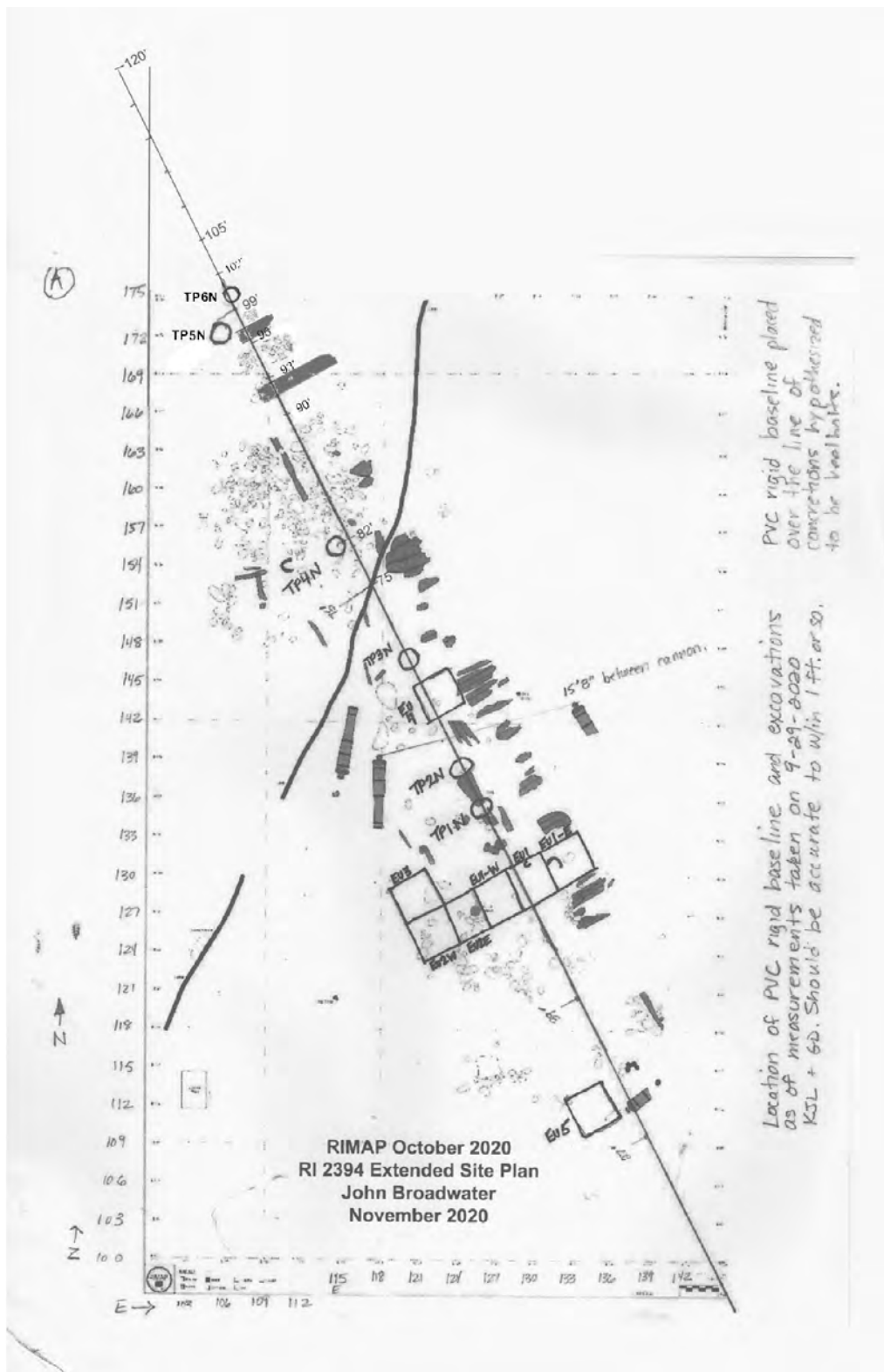


Figure 10. RI 2394 Site Map Showing October 2020 work area (RIMAP site map, with additions by John D. Broadwater).

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 (Test Pit 6 North, or TP6N) excavated closest to the frames. 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 hull (exterior) 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 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 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.

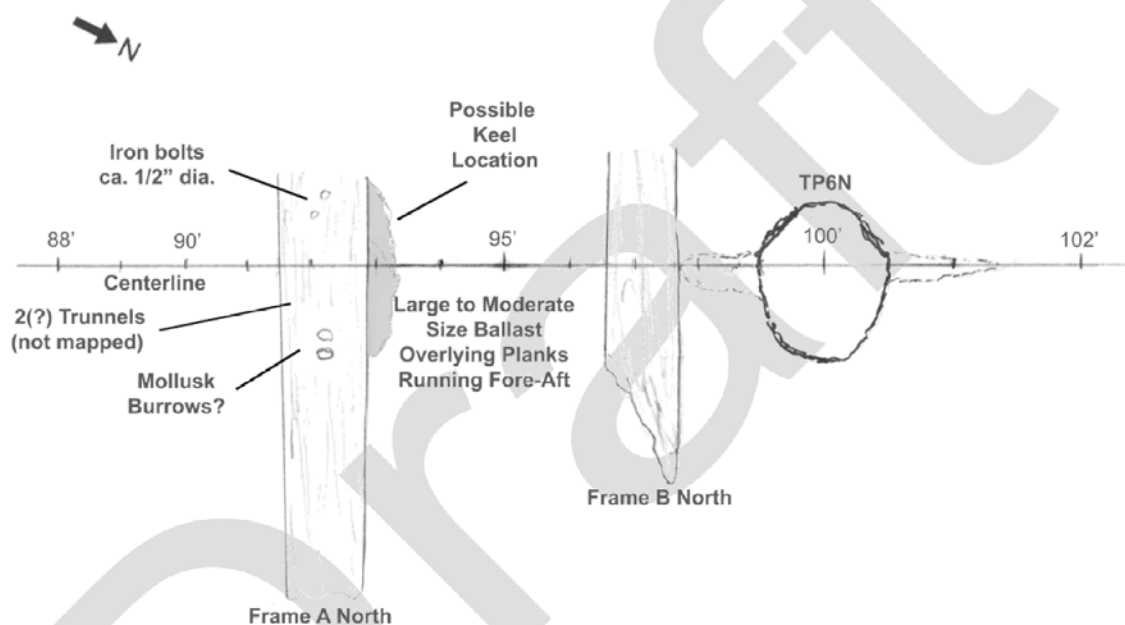


Figure 11. RI 2394 area of concentration, October 2020 (John D. Broadwater).

Figure 11 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 (approximately ½-inch, or 1.3-centimetre, diameter) iron bolts. 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.

Pump well structure

Architectural elements associated with RI 2394's pump well, some of which remain *in situ*, were documented during the 2020 investigations. 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 a distance of 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. PW1's northern edge abuts the lateral pump well partition (PW3), and extends southward for a distance of 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.

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 2¼ inches (5.7 centimetres) thick and extends southward from PW3 for 23½ inches (59.7 centimetres) before disappearing into the south wall of TP4. Where PW2 and PW3 intersect forms an approximate 90-degree 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 6½ 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 3¾ inches (9.5 cm) 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 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 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 dunnage 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-degree 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.

[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 appears to be the largest (in terms of overall length) by approximately 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 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 (ADM 3814b, ADM 3814c), particularly the British National Archives and National Maritime Museum in Greenwich.

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).

Marquardt (1995) depicted *Endeavour's* keel as being assembled from three parts joined by two vertical scarphs, each of which measured 5 feet 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. However, the ability to locate the scarphs would require knowledge of the position of either end of the keel.

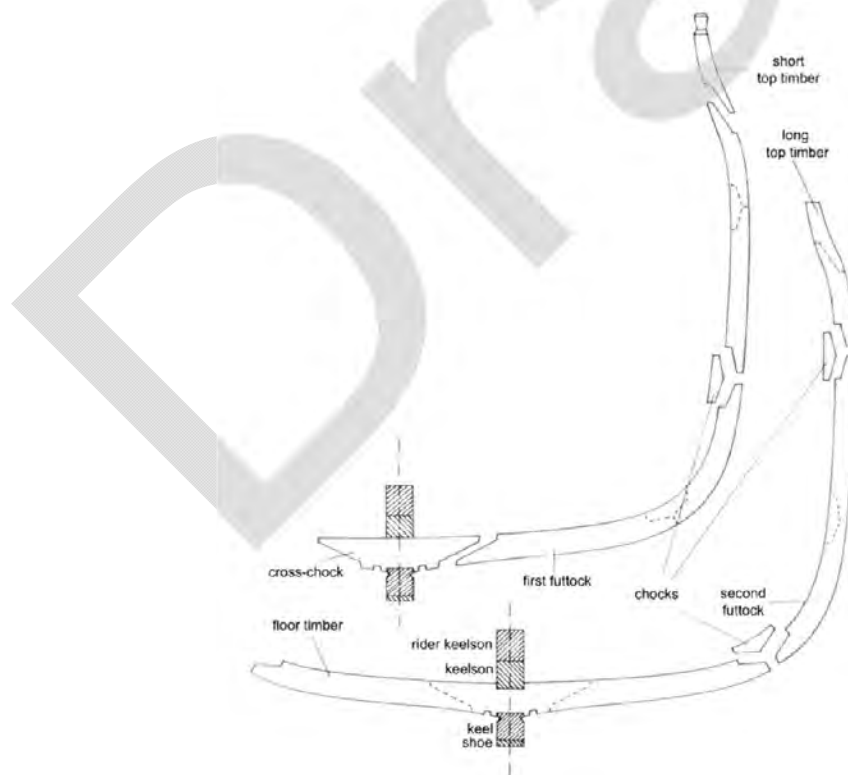


Figure 32. *Endeavour* framing schematic (Marquardt, 1995: 51).

12 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 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 a floor timber – even if installed as an emergency replacement – would have been affixed to the keel with more robust metal fasteners.

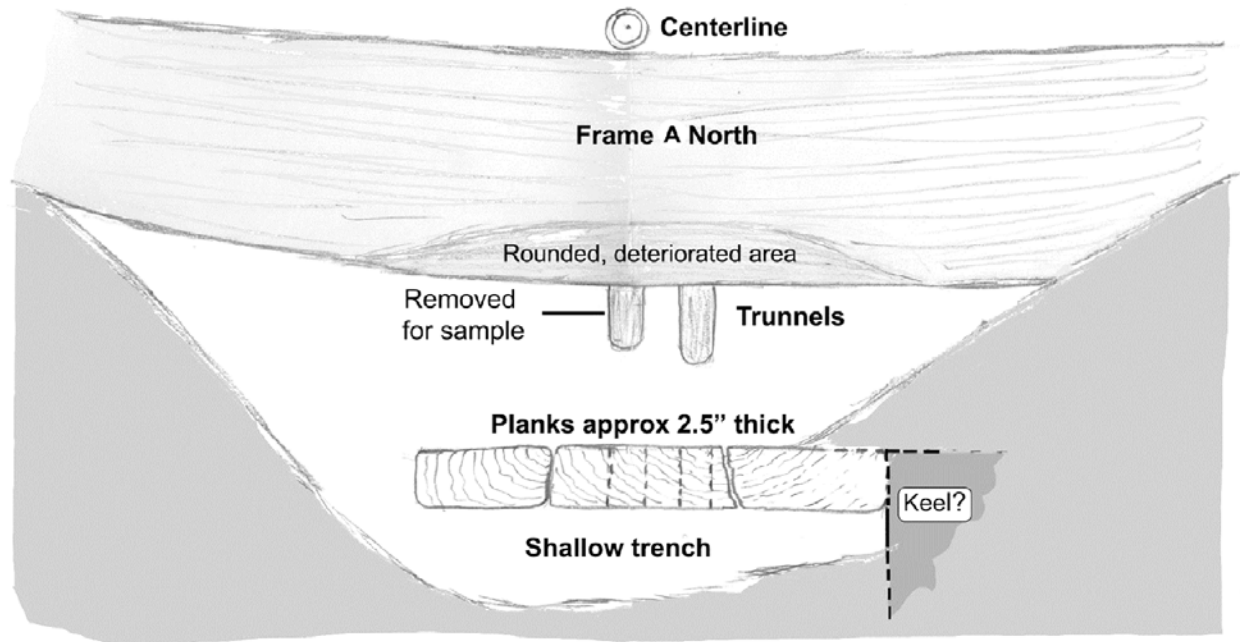


Figure 12. Cross-section through TP6N southern extension, at Frame A North, facing south, showing outer planking pulled free from Frame B North. Also shown is the possible keel, located on the last dive. Scale approximate. (John D. Broadwater).

Figure 13 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) hole has been drilled (Object No. 14 in Figure 13). 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. 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. Alternatively, it may be a hull plank and the hole a scuttling hole produced with a drill.

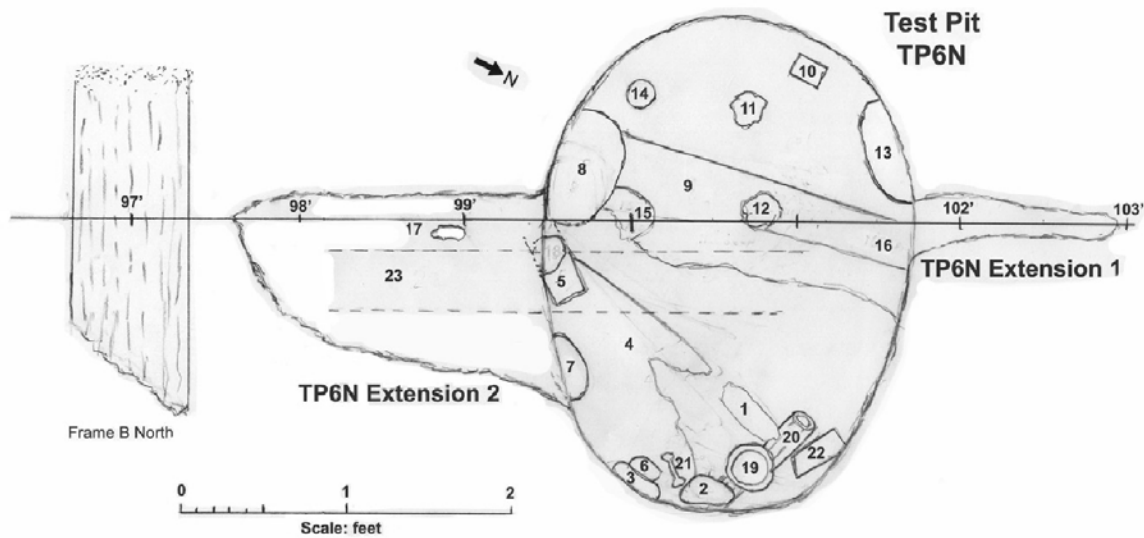


Figure 13. RI 2394: Details of test pit TP6N (John D. Broadwater).

Key to labels in Figure 13.

1. Concretion 7" dbg*
2. Concretion 5" dbg
3. Concretion 5" dbg
4. Wood 8" dbg, 6" East of centerline, 2" thick
5. Brick 5" dbg
6. Stone 7" dbg
7. Stone?
8. Stone
9. Wood plank, 6" exposed width
10. Brick
11. Wood fragment, 10: dbg
12. Wood fragment
13. Concretion
14. Wood plank
15. Bottle fragment, 7" dbg
16. Glass fragment, 12" dbg
17. Metal disk, 4" dia., 7" dbg
18. Sounding lead, "XIII", 9" 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

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

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

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

Conclusions from September 2020 fieldwork

At the conclusion of the September-October 2020 expedition, it was revealed the PVC centreline baseline installed on RI 2394 was significantly out of alignment with the orientation of the articulated hull's centreline. 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 (45.7 centimetres). 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 12). If the timber in question is the keel, an argument can be made that the plank with the hole is a limber board. 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. 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. Excavation enabled the team to confirm the thickness of RI 2394's exterior planking, which proved to be between 2½ and 3 inches (6.4 and 7.6 centimetres). This correlates well with the documented thickness of *Earl of Pembroke's* hull planking 'from [the floorheads] to the keel', which was recorded as 3 inches in the 1768 survey report (Knight 1933: 295).

Although the team encountered small finds, the quantity and variety were relatively 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.

September 2021 fieldwork

The fieldwork strategy developed for September 2021, as authorised in the permit granted by RIHPHC, 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.

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 that RI 2394's bow faces south (see Figure 14 and Figure 15). The stem was absent, save for a small remnant timber fragment found lying within the scarph.

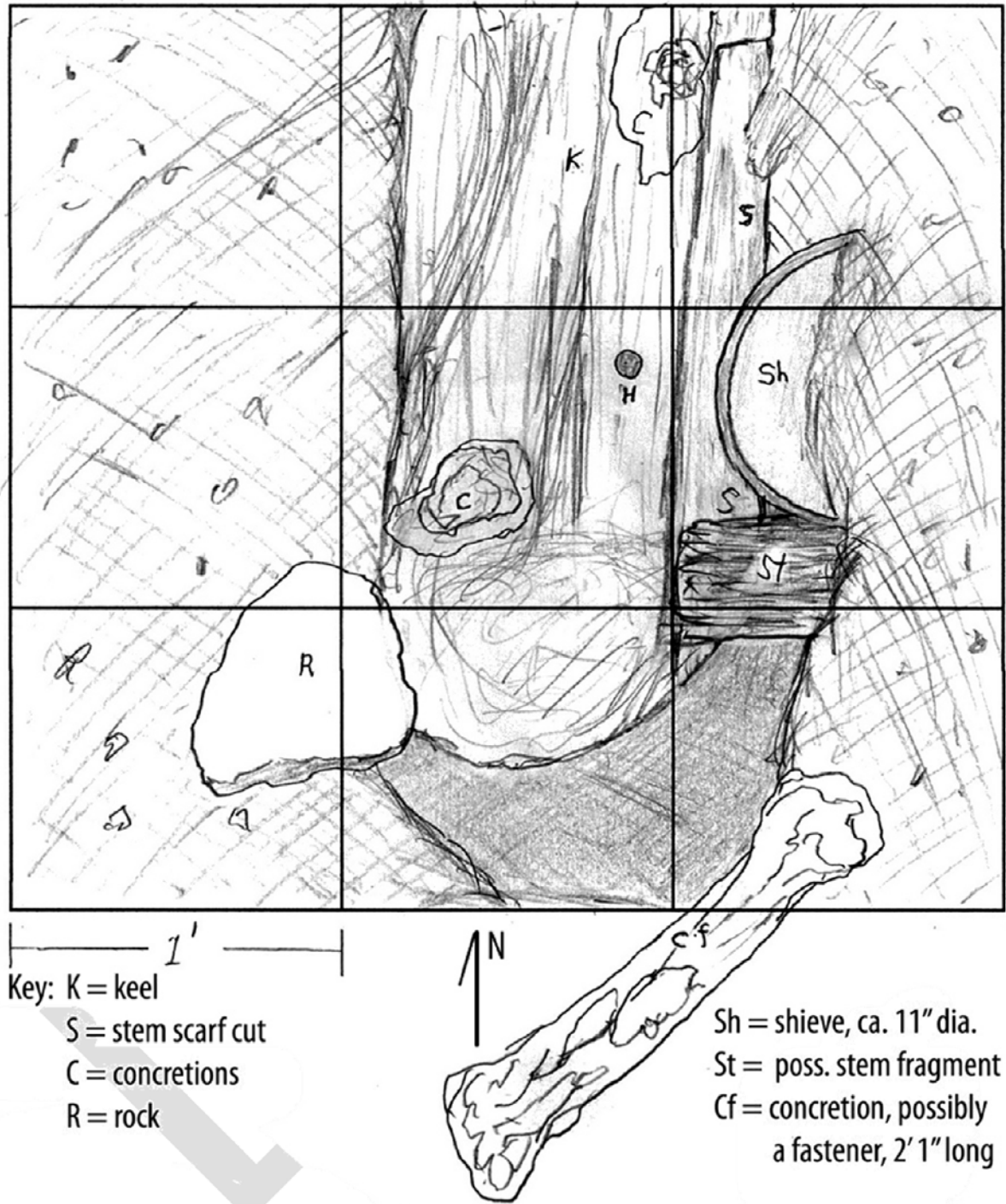


Figure 14. South end of keel, showing stem-keel scarph in plan view. Note that north is up (John D. Broadwater).



Figure 15. Photomosaic of keel's southern terminus, showing scarp for the stem (beneath wooden sheave at image centre). Note that north is up (John D. Broadwater and Joshua Daniel).

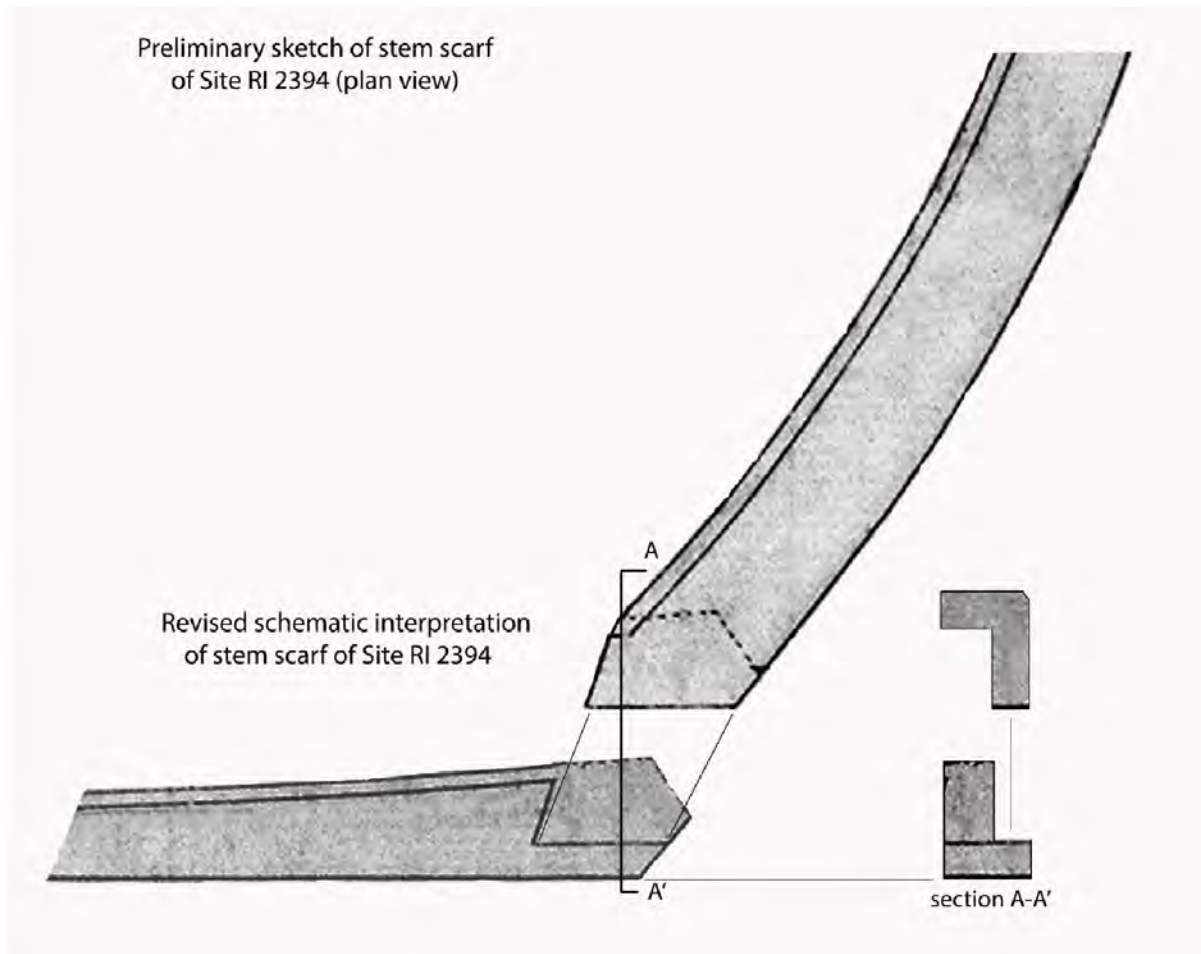


Figure 16. Reconstruction of RI 2394's stem scarf (John D. Broadwater)

The survival of the keel-stem scarf – 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 15.17 metres (49 feet 10 inches). Second, it provided details of the scarf itself, which appears to be a rare form of stem attachment, as discussed below. The location of the bow end of the keel was very close to its predicted position, based on superimposition of RI 2394's 2019–20 site plan with the 1768 Admiralty plan (Admiralty Draught No. 3814(b), 28 March 1768).

The extant forward end of the keel measures 33 centimetres (13 inches) sided. The 0.60-metre (2-foot) long scarf was let into the keel to a depth of 10 centimetres (4 inches). It measures 15 centimetres (6 inches) wide at its forward preserved edge and 5 centimetres wide (2-inches) aft, creating a 'wedge' shape when viewed in plan. The presence of a large wooden sheave atop the approximate middle of the scarf limited the extent to which it could be excavated, so it is presently unclear whether the wedge shape is due to natural processes or a result of intentional manufacture (Figure 16).

The use of a half-lap scarf 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 3.5 square feet, or 0.33 square metres) 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 (45.7 centimetres) 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 2021).

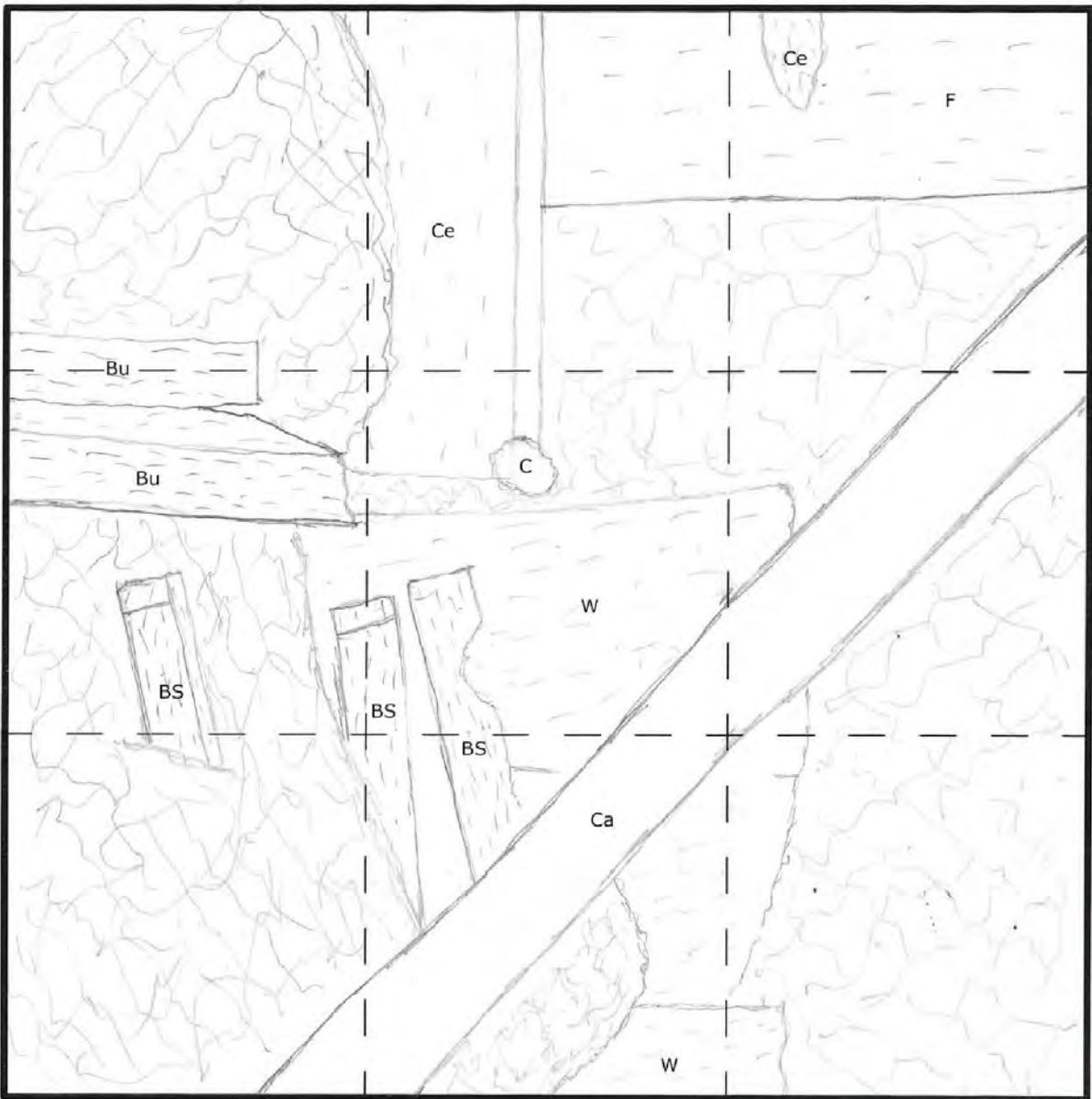
One possible treenail hole and two iron fastener concretions were located atop the keel. While the keel's forwardmost end is worm eaten, remnants of what appears to be the finished top edge of the keel survive. No evidence of other timbers typically used to form the bow structure – such as deadwood or 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.

[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 accounted 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.

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. A large area within and forward of the pump well was exposed and carefully mapped (Figure 17 and Figure 18). Scaled plan view sketches, drawn with a 3-foot x 3-foot mapping grid, will add more detail to the overall site plan and provide a starting point for future excavations in this area.

Following the 2021 excavation of the pump well, Erskine (2021: 6) shared 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. This in turn could account for the absence of a second starboard bilge pump shaft on RI 2394.



C=Concretion	BS=Barrel Stave
B=Ballast	F=Frame
Ca=Cable	Bu=Bulkhead
Ce=Ceiling	W=Wood Planking



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

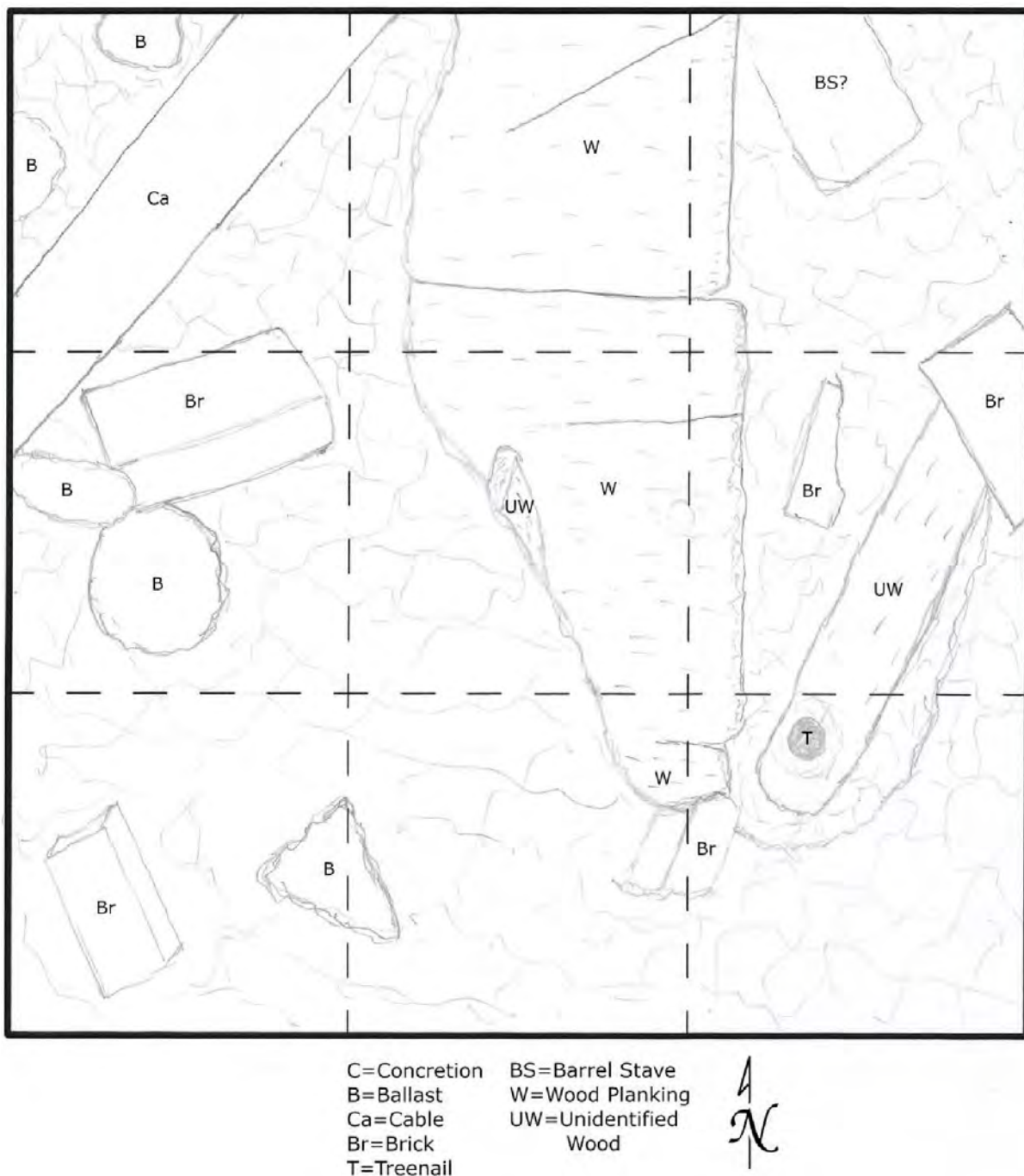


Figure 18. Pump well test pit, south section (Joshua Daniel).

Improvements to baseline placement and the 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. Figure 19 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.

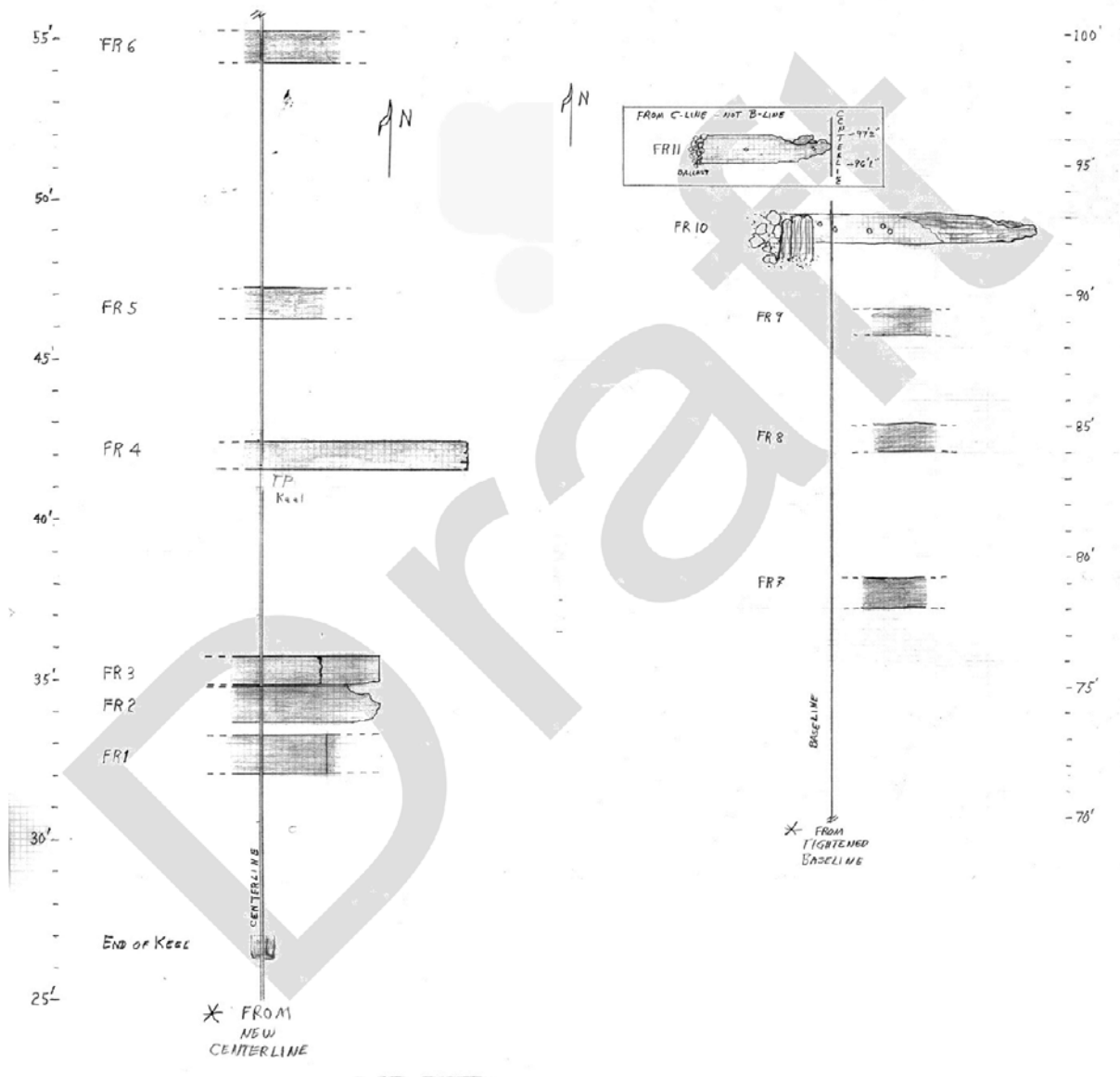


Figure 19. Locations of exposed frames, set against the new baseline (left) and the tightened original baseline (right) (John D. Broadwater).

Search for the northern preserved extent of the site

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 the 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.

A shallow trench (Test Pit 10-North) was excavated adjacent to the northern moulded face of the frame located at 29.2 metres (96 feet) 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 (Figure 20, Figure 21 and Figure 22). The hole is located at the 29.56-metre (97-foot) mark on the centreline baseline and is offset 1.37 metres (4 feet 6 inches) (Figure 22).

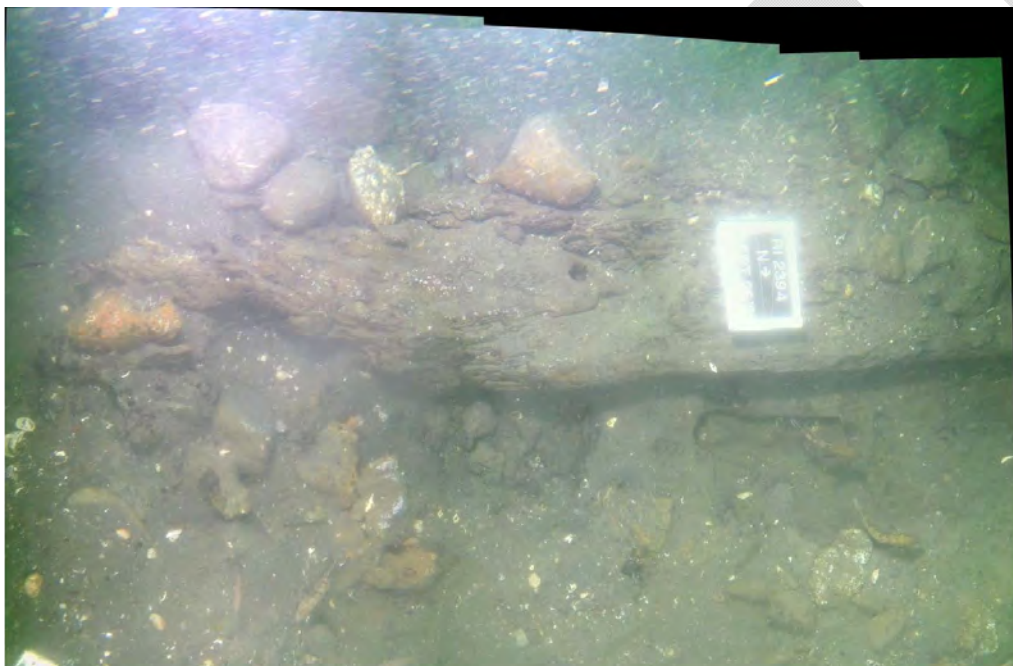


Figure 20. Mosaic showing frame and scuttling hole beneath letter board, north to bottom (John D. Broadwater).

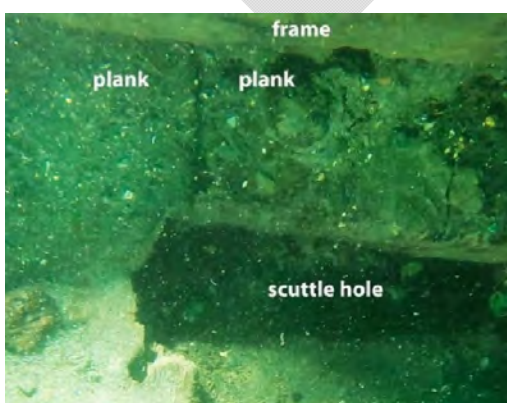


Figure 21. Close-up image of scuttling hole on the north side of the keel (John D. Broadwater).

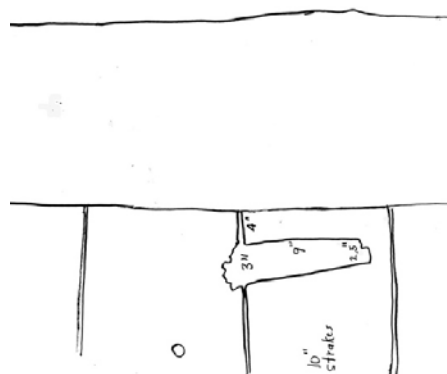


Figure 22. Sketch of scuttling hole (plan view, north to bottom)(John D. Broadwater).

Testing the hypothesis

There is no question the bow end of RI 2394's keel has been located and identified. Although the stem was missing (save for a small fragment), the scarph that once joined it to the keel was clearly visible (Figure 14 and Figure 20).

During the mid-to-late 18th century, British shipwrights had 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 16) is compared with the scarph shown in the Admiralty plans of *Endeavour* (Figure 23), there is no question they match exactly in both form and dimensions. As illustrated Figure 24, 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 in 1994. This vessel is now in the ANMM collection (Figure 25 and Figure 26).

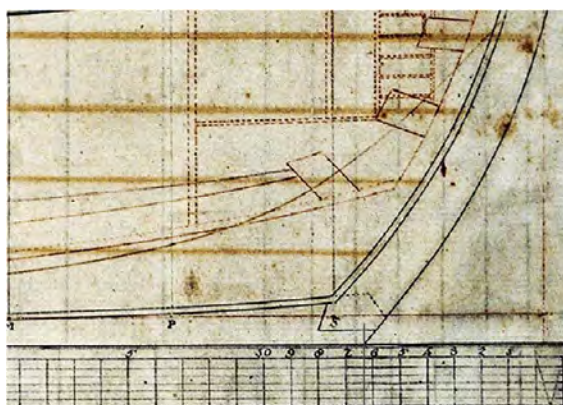


Figure 23. Detail of 1768 Admiralty draught showing Endeavour's unusual keel-stem scarph (National Maritime Museum No. 3814b, 28 March 1768).

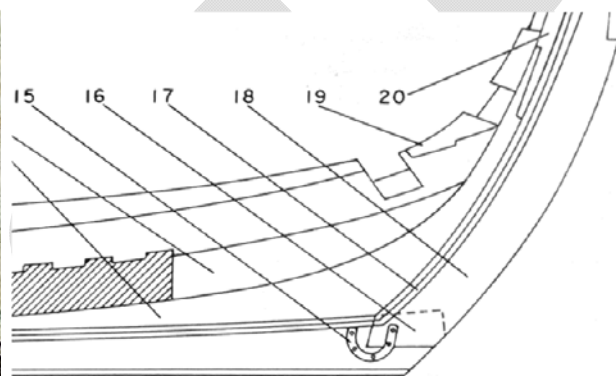


Figure 24. Detail of illustration showing Endeavour's unusual keel-stem scarph braced by a horseshoe plate (Marquardt 1995: 49).

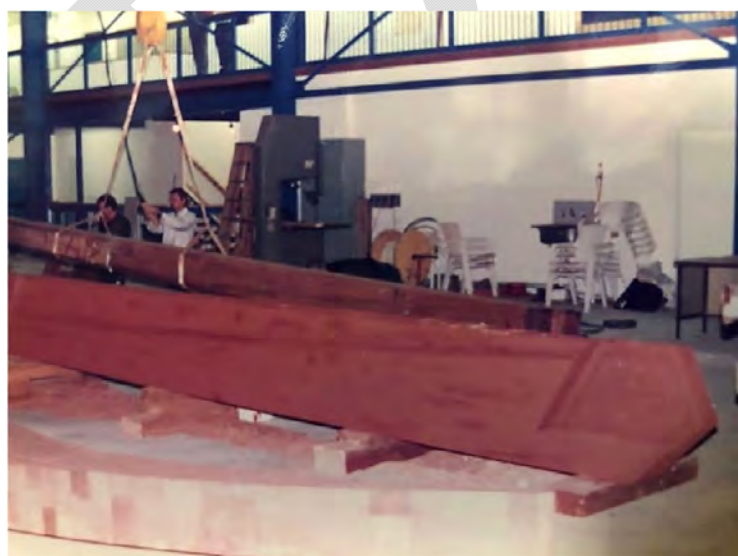


Figure 25. Keel of Endeavour replica showing the exposed keel-stem scarph (HM Bark Endeavour Foundation, Australian National Maritime Museum Collection).



Figure 26. 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 27 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 that used to join Endeavour's keel and stem.

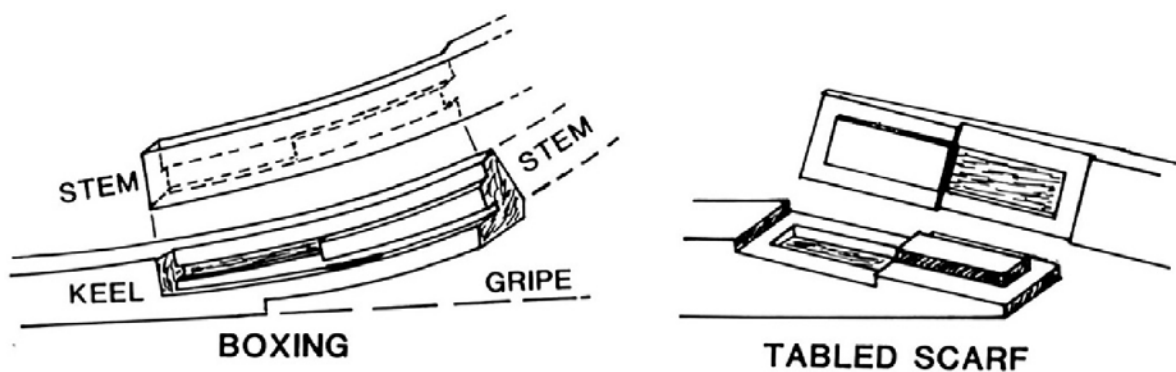


Figure 27. Typical scarphs for joining a stem and keel together (Steffy 1994: 292).

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 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: 15–19).

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, and care was taken to ensure necessary overlap (no less than 60%) among the captured images. Care was taken to capture at least two of 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 enable 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, and the sheer volume has meant that generating a composite 3D model of the entire shipwreck has been 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 models 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.). 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. 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).

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 (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 (Hunter, *et al.* 2019).

Positive identification of RI 2394's structural timbers will provide 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 (e.g., 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-party 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 (Hosty 2018: 158).

All five samples were analysed by an expert wood scientist, Dr Jugo Ilic (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. Analytical results (Table 10) identified all five samples as White Oak (*Quercus* sp.), which indicated the vessel was European-built. This conclusion was reinforced by the absence of North American timbers such as Live Oak (*Quercus virginiana*) or Red Oak (*Quercus rubra*).

Table 10. Timber sample analysis from material sourced from RI 2394 in 2018, conducted by Know Your Wood.

Structural feature	Timber type	Likely origin
Possible floor	White Oak group (<i>Quercus</i> sp.)	USA or Europe
Possible floor	White Oak group (<i>Quercus</i> sp.)	USA or Europe
Possible floor	White Oak group (<i>Quercus</i> sp.)	USA or Europe
Possible ceiling plank	White Oak group (<i>Quercus</i> sp.)	USA or Europe
Stanchion/hold pillar	White Oak group (<i>Quercus</i> sp.)	USA or Europe

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

No timber sample information from RIMAP was received by ANMM for comparative analysis. The timber samples acquired 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.

Table 11. Timber sample analysis from material sourced from RI 2394 in 2019, conducted by Know Your Wood.

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

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 North American timbers, reinforces the findings of the 2018 timber sampling regimen and is strongly suggestive of a European-built ship (VanHorn 2004: 15–18, 227–33). The presence of an elm (*Ulmus* sp.) keel is also indicative of a European-built vessel. Elm 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 using elm but notes its use in British-built vessels such as the Chub Head Cut shipwreck in Bermuda.

The sample obtained from the dunnage was identified as birch, a timber found in both North America and Europe. It was not unusual for dunnage to be sourced 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 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 28). 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 in an effort to identify possible use of Indonesian timbers in repairs to the keel.

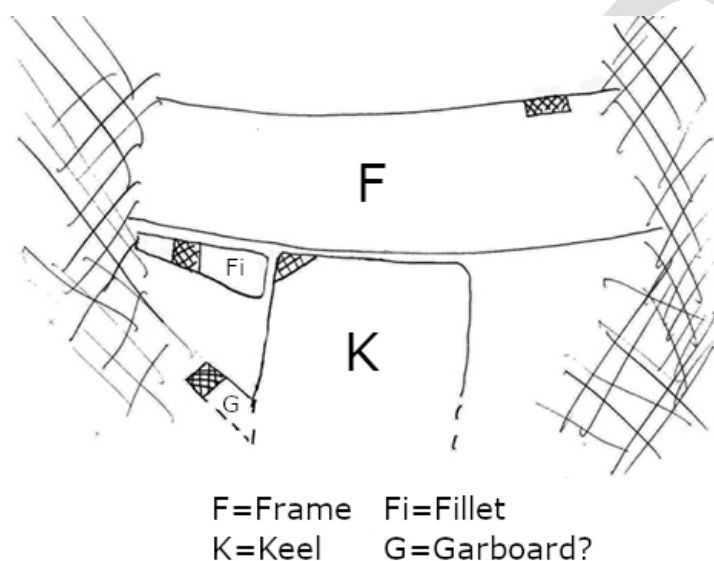


Figure 28. Locations where wood samples were recovered from TP3-S, facing north (John D. Broadwater).

The timber samples allocated for analysis in Australia were in transit at the time of writing. According to RIMAP's timber specialist, Dr Lee Newsom, all recovered timber samples fell within the White oak group, as shown in Table 12.

Table 12. Timber sample analysis from material sourced from RI 2394 in 2021, performed by Dr Lee Newsom.

Sample	Scientific name	Commercial or trade name
A (Keel – TP3-S)	<i>Quercus</i> sp.	White Oak group (true oak)
B (Keel – TP4-S)	<i>Quercus</i> sp.	White Oak group (true oak)
C (Floor – TP3-S)	<i>Quercus</i> sp.	White Oak group (true oak)
D (Fillet – TP3-S)	<i>Quercus</i> sp.	White Oak group (true oak)

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 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 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 (ADM106/3402/424).

Artefact analysis

A variety of artefacts were located and recovered from RI 2394 during the 2019 field season, including glass bottle fragments, undecorated copper-alloy buttons, animal bones, wooden sheaves (pulleys associated with the ship's running rigging) and parts of an articulated

wooden barrel (Hunter, *et al.* 2019: 22). None of these items features identifying features which may indicate the identity of the shipwreck.

Cannons

Four iron cannons are known to be present on RI 2394. During the September 2021 investigations, team members inspected the cannon located near the southern (bow) end of the site at the 9.32-metre (30 feet 5 inches) 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 sketch below (Figure 29) shows the cannon is lying on its side with one trunnion facing upward and the muzzle facing west (towards the wreck 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 measurements 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. Sacrificial anodes installed on frames attached to the two cannons – Cannon 1 and Cannon 2 – in RI 2394's midships section were also inspected in September 2021.

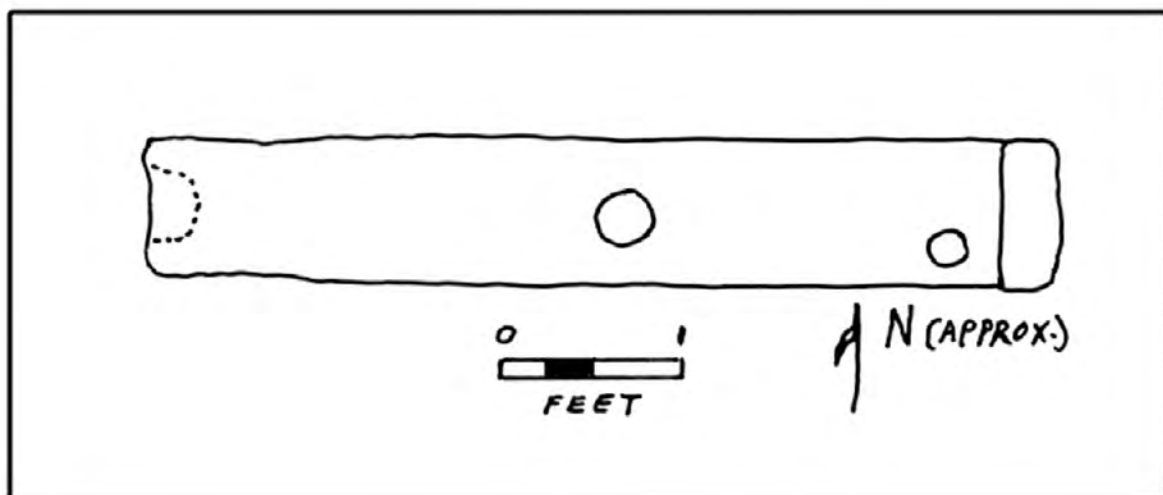


Figure 29. Sketch of the southernmost cannon (John D. Broadwater).

Description and analysis of RI 2394's hull remains

Originally constructed as the Whitby collier *Earl of Pembroke*, HMB *Endeavour* was a strongly 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* had been built along traditional lines with a two-piece keel running the full length of the hull (Figure 30). 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).

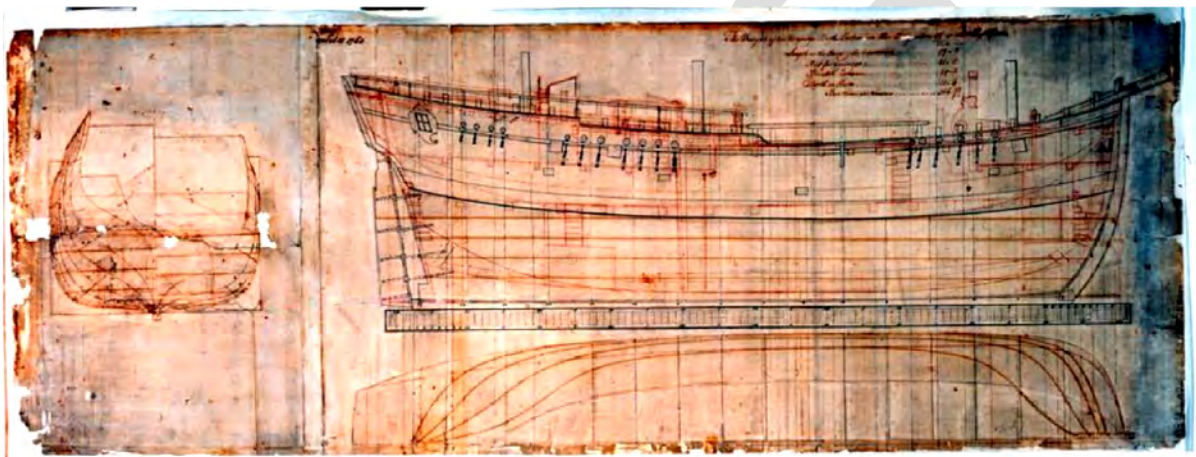


Figure 30. 1768 draft body plan of *Earl of Pembroke* produced at the dockyard at Deptford just after the British Admiralty bought the vessel. Note the double or deadwood keelson. Photo: P. Hundley.

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).

A substantial centreline timber called the keelson was placed over the top the floors and frames and bolted to the keel to lock the entire assembly together. *Endeavour's* fore- and mainmast would have sat directly atop the keelson (with a tenon at the bottom of each mast inserted into a corresponding mortise in the keelson), while the smaller mizzen sat on a mast step attached to the orlop deck.

Endeavour's keelson was reinforced with a second 'rider' or 'deadwood' keelson that extended from the stem to just aft of the 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/deadwood keelson is visible on the body plans of HMB *Endeavour* and HMB *Resolution*, and was noted on the shipwreck site of *General Carleton*, a Whitby-built collier that wrecked on the Polish coast in 1785 (Babits and Ossowski 1999). 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 Head 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).

Description of RI 2394's Hull Remains

Excavation of a section of articulated hull remains on RI 2394 in September 2019 and January 2020 revealed construction attributes that are consistent with historical descriptions of *Earl of Pembroke/Endeavour/Lord Sandwich*. 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 (Hunter and Hosty 2020).

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.

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 – channels cut into both upper edges of the keel to receive the garboards – to a height of 1½ inches (3.8 centimetres). 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) (Hunter and Hosty 2020).

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. 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 wide (corresponding with the now-absent lower sided surface of the keelson) by 12½ inches 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 wide and are just over 13 inches long.

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. 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 (20.3 centimetres and 33.0 centimetres) wide, and lengths varying between 9½ inches and 14 inches (24.1 centimetres and 35.6 centimetres).

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. Archival research also raises the possibility that the keelson – along with the fore and main mast steps – may have been removed during extensive harbor dredging and electrical cable laying activities in the 1930s as part of an expansion of the Naval Torpedo Station on Goat Island.

It is possible the keelson may have been removed due to deliberate human interference such as diving operations, channel dredging or cable laying (Hunter and Hosty 2020). Given the combined height of *Endeavour's* keelson and rider 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).

Floors

All floors are robust in terms of their respective scantling measurements; however, the three examples located within and adjacent to EU1 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 13½ inches (34.3 centimetres) where it crosses the centreline. F2 (located to the north of F1) exhibits a moulded height of 14½ 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 cm), but has a greater moulded height (15 inches, or 38.1 cm). 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 13½ inches (34.3 centimetres) sided was recorded for the floor (F7) in TP3. By contrast, all four floor timbers in TP4 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 may be related to their proximity to the vessel's mainmast step/midships area, where more robust architecture was commonly employed to strengthen the hull.

Wooden treenails with an average diameter of 1½ inches (3.8 centimetres) are the predominant type of fastener in each of the floors observed in both excavation units and all four test pits. Very few iron fasteners are present. The notable exceptions are iron keel bolts and a small number of iron spikes associated with the vessel's ceiling planking. 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 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 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 $\frac{3}{4}$ -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 11½ 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. 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 5½ 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 8½ inches (21.6 centimetres) sided and 12 inches (30.5 centimetres) moulded and extends away from the vessel's centreline for a distance of 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 1½ inches (3.8 centimetres) in diameter.

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 (large exterior hull planks positioned to either side of the keel). In addition, two fragmentary examples of what may be ceiling or thick stuff/footwaling were noted in association with floor timbers on the eastern 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).

Sections of an additional three ceiling were recorded during the January 2020 fieldwork, two of which are butt ends of the same plank. Two narrow planks similar to 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.

Garboard Strakes

Portions of the wreck site's two garboard strakes were exposed and recorded during excavation of EU1-C and EU1-W. 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 garboard to the west of the keel (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 2¾ 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 2020).

The most striking feature of the garboard affixed to the eastern 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 10½ inches (26.7

centimetres) by 6½ 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 include its crude overall form and the presence of impact marks around its periphery – 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 a 10-inch (25.4-centimetre) long fissure that is located approximately 5 inches (12.7 centimetres) outboard of the scuttling hole.

By contrast, scuttling holes observed on eighteenth-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] chiselled 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.

Ceiling

As noted above, very little ceiling planking has survived to the east 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 2020).

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.

The plank in TP3 (C11) is better preserved but significantly narrower than the two examples of ceiling recorded to the east of the shipwreck's centreline. Its maximum visible width and thickness is 6½ inches (16.5 centimetres) and 3½ 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 the west 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.

Four articulated ceiling planks were uncovered in EU1-W and EU2-E (located immediately to the west of EU1-W). All are located to the west 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), 8¾ inches (22.2 centimetres) and 12½ inches (31.8 centimetres), respectively. Only one example (C2) featured an exposed edge that could be accurately measured; however, its thickness (3½ inches, or 8.9 centimetres) is almost certainly representative of the other runs of ceiling.

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 west of the wreck site's centreline. Fortuitously, both ends of one plank (C9) were uncovered, which enabled project archaeologists to calculate 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 11¾ inches (29.8 centimetres) wide. Its width gradually increases to 12¾ inches (32.4 centimetres) at its northern 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.

Treenails averaging 1½ 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 done 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 3½ 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 the west 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 east of the keelson.

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 3½ 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 1½ 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.

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, is oriented parallel to the shipwreck's centreline, and 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 5¼ inches (13.3 centimetres) to 4¼ inches (10.8 centimetres) but is consistently 3½ inches (8.9 centimetres) thick for the entirety of its exposed length.

Yet another narrow plank (C13) was revealed during excavation of TP4, immediately to the west – and outside of – the footprint of the vessel's surviving pump well. Its dimensions approximate that of C7 and C12 and include a maximum width and thickness of 5½ inches (14.0 centimetres) and 3½ 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.

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 and corresponds 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.

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. Originally thought to be part of a stanchion, it was ultimately identified as the heel of one of the vessel's bilge pump tubes. Two upright planks located immediately west of the pump shaft stump intersect at a 90-degree 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 ships featured two 'suction' or 'common' bilge pumps that were located immediately adjacent to the mainmast and its corresponding mast step structure (Oertling 1996: 22-24). In the case of *Endeavour*, two additional bilge pumps and tubes were added to the vessel's original complement, and all four pumps were clustered around the mainmast (ADM 3814b; March 1768; Marquardt 2003: 40-41).

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 9½ 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 4½ 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. 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' 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, but there is no doubt the heel was installed to rest between floor timbers F8 and F9 (which are located in the immediate vicinity of the mainmast step, and therefore in the lowest part of the hull).

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 fifteenth or early sixteenth 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 eighteenth 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 *Endeavour* was outfitted with four common pumps (ADM 3814b; March 1768; Marquardt 2003: 40–1).

Archival 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*, all 'four hand pumps with their proper gear' were removed from the vessel, causing it to take on a 'large quantity of water' (Brodrick to Admiralty, 17 March 1775, ADM/1226/154; Figure 1). As it is highly unlikely that *Lord Sandwich* could pass survey for the Transport Service without pumps being fitted, at least two pumps would have been reinstalled on the ship prior to its departure for North America. The removal of the pumps with their accoutrement prior to 1776 is the most likely 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.

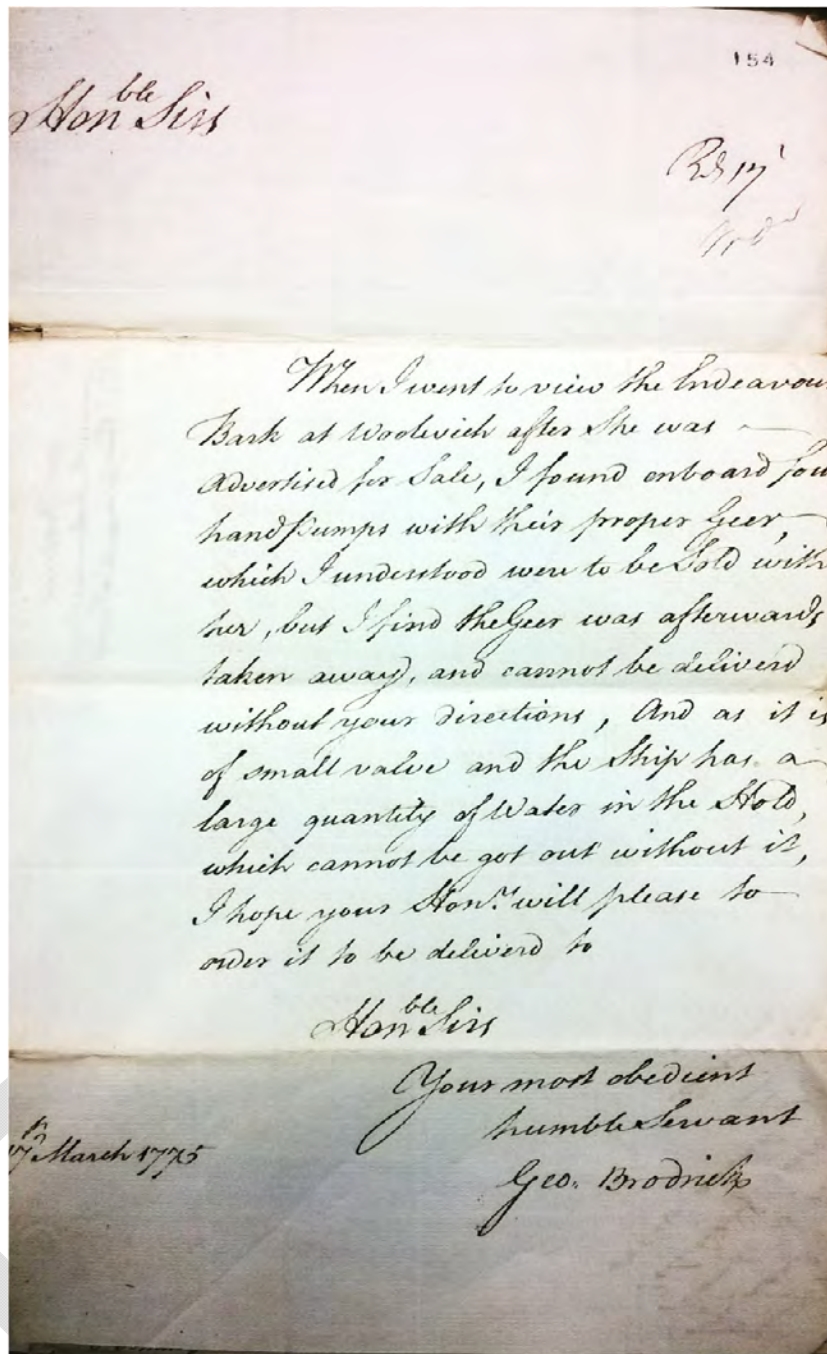


Figure 31. Archival documentation noting the removal of two bilge pumps at the time that Endeavour was sold out of Admiralty service (George Brodrick to Admiralty, 17 March 1775, ADM/1226/154).

Pump well structure

Architectural elements associated with RI 2394's pump well, some of which remain *in situ*, were documented during the 2020 investigations. 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 a distance of 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. PW1's northern edge abuts the lateral pump well partition (PW3), and extends southward for a distance of 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.

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 2¼ inches (5.7 centimetres) thick and extends southward from PW3 for 23½ inches (59.7 centimetres) before disappearing into the south wall of TP4. Where PW2 and PW3 intersect forms an approximate 90-degree 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 6½ 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 3¾ inches (9.5 cm) 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 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 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 dunnage 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-degree 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.

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 appears to be the largest (in terms of overall length) by approximately 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 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 (ADM 3814b, ADM 3814c), particularly the British National Archives and National Maritime Museum in Greenwich.

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).

Marquardt (1995) depicted *Endeavour's* keel as being assembled from three parts joined by two vertical scarphs, each of which measured 5 feet 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. However, the ability to locate the scarphs would require knowledge of the position of either end of the keel.

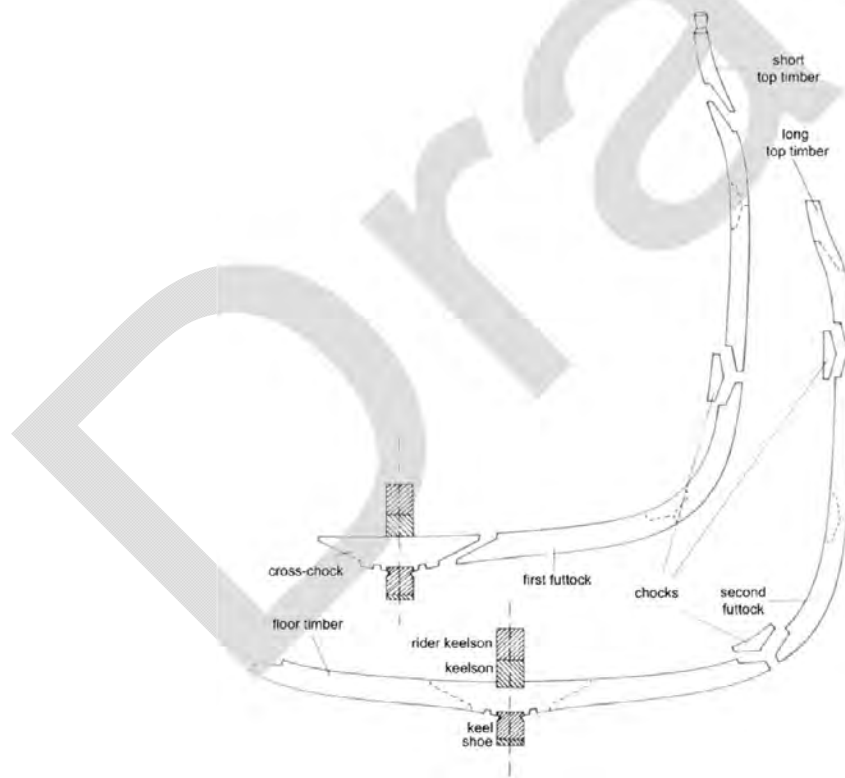


Figure 32. *Endeavour* framing schematic (Marquardt, 1995: 51).

Marquardt also illustrated what Broadwater (2020) 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 32). 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 drawings of RI 2394's frames, which show first futtocks offset from the keel in a more common configuration for 18th-century merchant vessels. If cross-chocks were used in *Endeavour's* framing arrangement, it would be relatively easy 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), so future investigations only need to clear the top of a floor for a distance of 4 feet (1.22 metres) from the centreline to confirm the presence of a cross-chock seam. It is worth noting that 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 that 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 aid in the identification of the wreck site's bow and stern ends.

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 12).

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.

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 very likely built in the shipyard of Thomas Fishburn; 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.

Although only a very small percentage of RI 2394's hull structure was uncovered during the 2019 and 2020 investigations, 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 $\frac{3}{4}$ to $2\frac{1}{4}$ inches (1.9 to 5.7 centimetres).

Table 12. Scantling data comparing shipwreck site RI 2394, 1768 Royal Navy survey of Earl of Pembroke and the General Carleton shipwreck site.

	RI 2394 (2019 archaeological survey)	Earl of Pembroke (1768 Royal Navy survey)	General Carleton (1995–99 archaeological surveys)
Keel (sided)	13 in.	--	--
Keel (moulded, below rabbet)	--	11 in.	--
Keelson (sided)	12 in. (estimate)	--	16½ to 5½ in.
Keelson (moulded)	--	34 ½ in.	31 in.
Floors (sided)	12 to 16 in.	14 in.	--
Floors (moulded)	13½ to 17 in.	16 in.	--
First Futtocks (sided)	5½ to 11½ in.	11 in.	7¾ to 13¼ in.
First Futtocks (moulded)	11 to 20 in.	--	8½ in.
Spacing Between Frames	1 to 2 in.	--	¾ to 2¼ in.
Room and Space	24 to 32 in.	29 in.	--
Lower Hull Planking (thickness)	3 in. (garboard)	3 in.	3 in. (average)
Lower Hull Planking (width)	--	--	11¾ in.
Ceiling Planking (thickness)	3 to 4 in.	--	3 in. (average)
Ceiling Planking (width)	6 to 14 in.	--	--
Treenails (diameter)	1½ in. (average)	--	1 ½ in. (average)

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, *et al.* 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*.

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 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 confirm 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*, *Endeavour*, and *Lord Sandwich*. However, given 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 2016 (see Figure 9). 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. Key failings for both sites included the absence of an elm keel, and the presence of a keelson but absence of a rider or sister 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*).

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

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*).

Timber scantlings

Lord Sandwich was the largest of the five transports scuttled within the LSA. Based on 'The Table of Minimum Dimensions of Timbers, Keelson, Keel, Planking etc.' in *Lloyd's Register of Shipping Rules and Regulations* (1857, 1864), 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 research by Hunter suggests was a 200-ton American-built ship (see Appendix 3). 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 is also 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 50% larger than those recorded for RI 2396/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 (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 (Table 12).

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)'.

As noted above, no timber hull components were noted at the RI 2393 or 'Caroline' sites, while RI 2578's visible timbers were heavily eroded and disarticulated. RI 2396/RI 2397 is believed to constitute the shipwreck of a vessel much smaller than *Lord Sandwich*.

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 (Hunter and Hosty 2020).

While there are distinct 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*.

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 concluded the northern end of the site was no longer extant beyond the edge of the stone ballast pile due to severe erosion. The last section of articulated hull was located at the 95-foot (29-metre) mark on the old baseline (Broadwater 2020).

By contrast, the keel is well preserved at its southern terminus, where the keel-stem scarp is still present (Broadwater and Daniel 2021: 8). The presence of this scarp verified that RI 2394's bow faces south. Survival of the keel's forward end and associated scarp as 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, or 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*.

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 scarp revealed it was significantly different from the ‘table’ and ‘box’ scarps typically used in mid-to-late 18th-century British shipbuilding (see Figures 23-27). When compared with the keel-stem scarp shown in *Endeavour*’s 1768 Admiralty plan (see Figure 23), 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* (1785; NMM J5188). Only one of these sets of plans displayed a keel-stem scarp similar to 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 33).

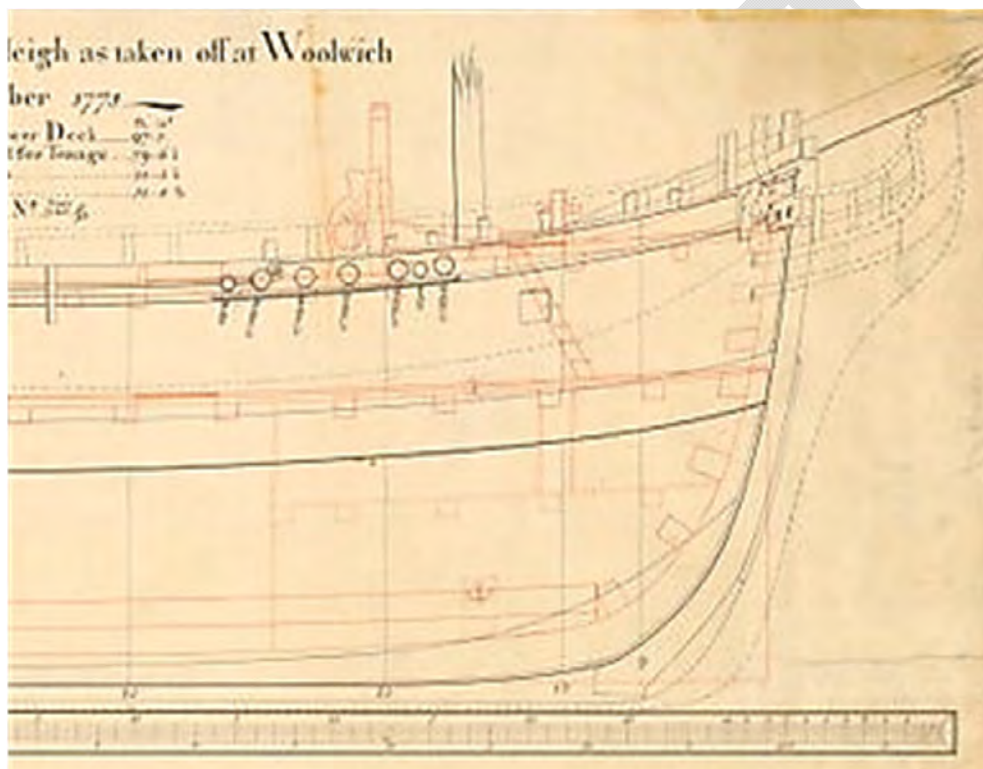


Figure 33. Extract from the body plans of His Majesty's Sloop *Raleigh* as taken off at Woolwich in November 1771. Royal Museum Greenwich 19483.

A literature review of comparable historic shipwrecks has revealed only one other 18th-century site with a keel-stem scarp similar to that of RI 2394. That site, known as the Chub Head Cut Wreck, is located in Bermuda and has tentatively been identified as the remains of a late 18th-century British-built collier (Watts and Krivor 1995: 97–108).

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 midship section are determined first, and those of the frames in other sections of the hull are derived from it/them via incremental modifications.

The presence of paired and 'tripled' frames is not diagnostic on its own. However, when their relative positions are compared with *Endeavour's* 1768 plans, they align exactly to the locations of the fore- and mainmast steps. 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 scarp and the presence of paired and 'tripled' floors in the exact locations of *Endeavour's* fore- and mainmasts 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*.

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 the discovery of a crudely formed, oval-shaped hole in the garboard affixed to the eastern side of the keel. It bore hallmarks of having been executed in haste with a heavy striking or cutting implement and appears to have been created with the intention of scuttling the vessel. A second scuttling hole was documented in September 2021 among hull planking at the northern end of the articulated hull. This hole exhibited straight sides and clean cuts, indicating edged tools were used to create it (Broadwater and Daniels 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*.

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 Criterion 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 10). 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 as 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 was not highly regarded by American shipbuilders, who preferred to use live oak (*Quercus virginiana*) instead (Ilic 2019; 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.*). 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 scarp 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 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*.

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 extremely 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.

Numerous late-18th century artefacts including bricks, a lead sounding weight, barrel staves, animal bone and glass shards have been found within RI 2394's sealed sediment deposits as a result of 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.

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 firsthand 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.

Possible Hull Modifications

During the September 2021 investigations, an unusual architectural feature was noted within RI 2394's centreline hull structure in the area immediately forward of the pump well. This feature comprises at least four timber planks running athwartships, with exposed butt ends that terminate at the approximate footprint of the wreck site's longitudinal centreline timbers (e.g., keel and keelson). It is unclear whether these planks are positioned above ceiling planking, but a run of ceiling was documented approximately two feet (0.6 metres) forward of, and in alignment with, the upper surface of the forwardmost athwartship plank. No other examples of athwartship planking have so far been observed on the site, which suggests it is likely limited to the area immediately forward of the pump well (Hunter 2022).

In an account of his captivity aboard *Jersey*, Alexander Coffin notes 'a platform of boards about two and a half feet high' was installed between decks in the hulk's midships area. The platform was intended 'for those prisoners to sleep on who had no hammocks' but was also 'used frequently [by the incarcerated] to sit and play at cards to pass the time' (Dandridge 1911: 317–18). Given the positioning of the athwartship planks in RI 2394's approximate midships section, it is possible they could have been installed as a *de facto* 'platform' to

provide prisoners with a level surface upon which to sleep, as well as elevate them above the vessel's ceiling planking and any bilgewater or other moisture that may have collected on it.

Another possible explanation for the athwartships planking is that it served as a level surface for a cooking hearth or heating stove. The need to feed prisoners *en masse* required that a prison ship be outfitted with a large cauldron, or 'Great Copper'. According to prisoner Ebenezer Fox (1847: 105–6), this cooking implement aboard *Jersey* comprised a 'great copper vessel, that contained between two and three hogheads of water, set in brick work. The form of it was square, and it was divided into two compartments by a partition'. Another prisoner, Andrew Sherburne (1831: 111), noted its size was 'perhaps five feet square and four feet deep. The beef would fill the copper within a few inches of the top; the copper was then filled up with water, and the cover put on'. He also stated the wood used to fuel the fire beneath the cauldron 'was green chesnut [sic]'. Coincidentally, the distance from the forward end of RI 2394's pump well to the run of ceiling mentioned earlier is approximately six feet (1.8 metres) (Hunter 2022).

In addition to the Great Copper, smaller stoves were also used aboard *Jersey* for both cooking and heating. According to Sherburne (1831: 115):

There was a small sheet-iron stove between decks, but the fuel was green, and not plenty; and there were some peevish and surly fellows generally about it. I never got an opportunity to set by it; but I could generally get the favor of some one near it to lay a slice of bread upon it, to warm or toast a little, to put into my wine or water.

As with the large cooking cauldron, the possibility exists the athwartships planks on RI 2394 could have been used to create a level platform upon which a small cooking/heating stove was placed.

Another feature noted on RI 2394 that potentially supports the hearth/cookstove hypothesis is a preponderance of whole and partial bricks scattered within and around the pump well, as well as atop and adjacent to the athwartship planking. In addition to the scattered examples, a concentration of whole bricks was found in association with a partial wooden container during the September 2021 investigations. While the identity of the wooden container was not confirmed – but has tentatively been identified as a large oblong barrel – it appears to have been filled with bricks and then positioned on its side in the hold parallel to the run of the hull, just forward and to starboard of the pump well's forward bulkhead.

Fox (1847: 105) notes the use of 'brick work' to surround *Jersey*'s Great Copper. Prisoner Thomas Dring (1829: 46) expands slightly upon this description, stating the prison ship's large cooking cauldron 'was enclosed in brick work, about eight feet square'. The presence of a container full of bricks in close proximity to the athwartship planking is intriguing, and a possible explanation is that they were used to construct the 'brick work' for a cooking cauldron or stove that also necessitated creation of a level, makeshift platform upon which it could sit. Once the vessel's use as a prison ship ended, the cauldron/stove and its hearth were dismantled, and the bricks stowed in a wooden barrel immediately adjacent to where they were used. Why the container of bricks was abandoned with the vessel when it was scuttled remains a mystery, but hints it was not highly valued.

Lord Sandwich operated as a prison ship between October 1777 and March 1778 and was specifically selected for use as a blockship in the lead up to the Battle of Rhode Island (*The*

Historical Magazine 1860: 37; Pierce 1899: 77, 84, 90; Abbass 2001: 4; Popek 2015; Erskine 2017: 67–9; Johnson 2020: 90, 224; Desrosiers 2021: 234). The weather in February and March 1778 was reportedly very cold, with ‘a very heavy storm of snow’ striking Newport on 6 February and conditions in the town ‘so extremely cold’ on 4 March that ‘some of the inhabitants ... [were reportedly found] frozen to death in their houses’ (*The Historical Magazine* 1860: 37). Therefore, it is entirely feasible a stove or cauldron and its accoutrement were installed in the vessel’s hold to provide heat and/or food for the prisoners, but later dismantled and either stowed or removed. This could explain the archaeological signatures observed on RI 2394 and offers a potential line of evidence linking the shipwreck site and *Lord Sandwich*.

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, an undecorated copper-alloy button, one damaged copper handle, 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. 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 (Bassett *et al.* 2020:18–25; Hosty *et al.* 2002: 39–41). 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.* 2020: 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*, 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 belowdecks 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 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 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 a prison ship's 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 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' (*The Historical Magazine* 1860: 36). Those who remained aboard *Lord Sandwich* endured additional hardship in February 1778. A fierce snowstorm struck Newport on the night of the 6th and 'did much damage among the shipping' (*The Historical Magazine* 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' (*The Historical Magazine* 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*).

Conclusions of the preponderance of evidence approach to identification of the shipwreck site RI 2394

Archival evidence has clearly demonstrated that five vessels were scuttled by British forces within the Limited Study Area (LSA) of Newport Harbor in August 1778 (Table 4). These vessels and their registered tonnage were *Mayflower* (160 tons), *Earl of Orford* (200 tons), *Peggy* (200 tons), *Yowart* (250 tons) and *Lord Sandwich* (350 tons). It is possible that *Peggy* could have been a ship of 360 tons, but if so it was later refloated, remained in use until 1821, and could not be one of the wrecked vessels in the LSA. Available evidence suggests *Lord Sandwich* was at least 100 tons larger than the next-largest vessel, *Yowart*. This discrepancy should be reflected in the length of the surviving hulls of each shipwreck site, as well as their respective timber scantlings. Because RI 2394 is the largest shipwreck site within the LSA, and exhibits attributes that fulfil the nine criteria agreed upon by RIMAP and ANMM in 2019, the preponderance of evidence strongly supports this shipwreck site's identification as *Lord Sandwich*, formerly HMB *Endeavour*.

The formal criteria agreed upon in 2019 to establish the identity of RI 2394 as *Lord Sandwich* (ex-HMB *Endeavour*) are summarised below in Table 13.

Table 13. Assessment of evidence against agreed criteria to identify site RI 2394 as the shipwreck of Lord Sandwich.

Criterion	Preponderance of evidence
That most of the scantling measurements recovered from RI 2394 conform to those specified in the March 1768, February 1775, and February 1776 survey reports of HMB <i>Endeavour</i> and <i>Lord Sandwich</i> respectively.	The scantlings recorded for RI 2394 compare favourably with those known to have been used in the construction of <i>Lord Sandwich</i> . No other site within the LSA features scantlings that indicate an 18 th -century vessel of this size.
That the keelson (if present) shows evidence of having a 'rider' or 'deadwood' keelson as shown on the HMB <i>Endeavour</i> body plan No. 3814(b) and 3814 (c).	While there are distinct signs that a substantial keelson was once present on the shipwreck site RI 2394, that structure has now disappeared either through environmental or human factors. The preponderance of evidence approach dictates that this criterion is insufficient to confirm or deny that RI 2394 is <i>Lord Sandwich</i> .
That the overall preserved length of RI 2394 (if extant) closely conforms with, or exactly matches, the known length of HMB <i>Endeavour</i> .	The length of keel from the bow to the bilge pump on RI2394 compares very closely with the length of keel from bow to bilge pump shown on the 1768 Admiralty plan for HMB <i>Endeavour</i> . As the <i>Lord Sandwich</i> 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 <i>Lord Sandwich</i> .
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 <i>Endeavour</i> , and that structural features, construction materials, and/or construction techniques are consistent with those of <i>Earl of Pembroke</i> , HMB <i>Endeavour</i> and/or <i>Lord Sandwich</i> (e.g., wooden treenails, iron fastenings, iron gudgeons and pintles, and few or no copper fastenings).	Taken together, the shape of the bow scarp and the presumptive location of the fore and main masts on RI 2394 bear a striking resemblance to those shown in the 1768 Admiralty Plan for HMB <i>Endeavour</i> . Taken together, these structural features support a preponderance of evidence approach that RI 2394 is <i>Lord Sandwich</i> .
That modifications to the ship's structure, such as scuttling holes, are consistent with what is known about the intentional sinking of <i>Lord Sandwich</i> .	The presence of two scuttling holes on the RI 2394 site is substantial proof that the shipwreck is one of the scuttled 1778 transports. The preponderance of evidence indicates that this modification is consistent with the site being <i>Lord Sandwich</i> .








That both RIMAP and ANMM sets of timber analysis confirm that RI 2394's keel is constructed of elm.

The preponderance of evidence approach suggests that it is extremely unlikely that RI 2394 is the North-American built *Earl of Orford* or *Peggy*, based on the proposition that the *Peggy* sunk in Newport Harbor in 1778 was a North American-built ship of 200 tons. Analysis of the available timber samples indicate RI 2394 is a British-built vessel and are consistent with the timbers likely used in construction of *Earl of Pembroke/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*.

Based on the preponderance of evidence approach, no material culture associated with the RI 2394 site can confirm or refute the identity of the shipwreck as *Lord Sandwich*.

Table 14. Agreed criteria to identify site RI 2394 as the shipwreck of *Lord Sandwich*.

Agreed criteria for identification of RI 2394 as <i>Lord Sandwich</i>	Criterion met	Criterion not met	Pending
1			Awaiting analysis of ANMM timber samples
2			Awaiting analysis of ANMM timber samples
3			
4			
5 Criterion dismissed N/A (no keelson present)			
6			
7			
8			
9 Criterion dismissed N/A (no evidence to date to support the finding of diagnostic material culture)			
10 Criterion dismissed (replicated criteria)			

Further research

Based on data and results collected up to and during the September 2021 field season, Broadwater and Daniel recommend 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
2. search for evidence of additional bilge pumps
3. seek additional archaeological evidence that could help confirm the site's identity
4. add frames and other hull features to the site plan.

It is hoped that wood samples collected during the 2021 field season can be analysed as soon as possible, in case one or more are identified as Australian and/or Southeast Asian tropical hardwoods indicative of repairs made to *Endeavour's* hull in Batavia in 1770.

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Appendices

Appendix 1. Significance assessment for HMB *Endeavour*

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

The 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 Thomas Matra – contributed to the European occupation of the Australian continent from 1788.

Under the *Historic Shipwrecks Act 1976* and influenced by the ICOMOS Burra Charter, the Commonwealth has provided 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.

HMB *Endeavour* is a highly 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, and Daniel Solander.

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 British Royal Navy as the ideal vessel to undertake a voyage of scientific exploration and discovery to a remote part of the world.

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

These scientists not only recorded some of the earliest European encounters with the Aboriginal and Torres Strait Islander peoples of Australia, but also prepared the first written recordings 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 the *Endeavour* is taught at primary school 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 Whitby, England.

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.

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 struck 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 a number of innovative underwater testing processes that were 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
- nuclear science.

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.

Appendix 2. Construction details from *The Voyage of Endeavour 1768–1771*

Extracts transcribed 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).

Date	Abridged journal entry
2 nd April 1768	Fitting out <i>Endeavour</i> at Deptford.
27 th May 1768	Cook hoisted his Pendant and took charge of the ship agreeable to his Commission. Employed crew taking on board stores and provisions.
31 st May 1768	Cook to Navy Board (adm 106/1163) 8 tons of iron ballast to be taken on board Bark <i>Endeavour</i> . Ballast supplied by Deptford Yard Officers.
30 th June 1768	Additional iron ballast requested to bring her down by the stern.
17 th – 18 th 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 th Aug 1768	Read to the Ship's Company the articles of War and the Act of Parliament. Crew paid two months wages.
26 th 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 th Sept 1768	Caulkers employed working on ship's sides off Island of Maderia.
28 th 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 th – 19 th 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. <i>'Boottopping' was the cleaning and greasing of the upper part of the ship's bottom – the 'boothose tops' were the strakes or planks below the water's edge and were generally tallowed when the ship was ordered to cruise.</i>
12 th Dec 1768	Caulkers and carpenters employed caulking the quarter deck and waterway seams.
14 th Dec 1768	Decks being caulked.

- 8th – 11th June 1769 Tahiti – ship's company employed on heeling and bootopping the larboard and starboard sides– vessel's hull very fowl, sheathing damaged in places, coated the larboard side with 'pitch and brimstone'
- 7th – 9th June 1769 Employed careening both sides of the ship and paying them with pitch and brimstone, bottom in good order, no trace of worm,
- 3rd – 4th August 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 ballast.
- 8th Nov 1769 Heeled and scrubbed both sides of the ship.
- 18th – 19th Dec 1769 Queen Charlotte Sound – Carpenters employed blacking the ships bends, caulking the sides, repair general defects, forge set up to repair tiller braces, bends were the wales of the ship, broader and thicker than the rest, extended the length of the vessel from bow to stern.
- 16th – 17th Jan 1770 Pelorus Sound ? New Zealand – Careened the ship's hull, payed the starboard side (with Tallow and Venetian Red' (to pay, daub, smear with preparations of tar, oil, tallow, resin, red ochre to protect the planks of the ship from the water, growth, worm etc, - scaped and cleaned the hull. a transom was built for the tiller (it broke throughout the voyage).
- Hands also employed taken on board stone ballast to be placed at the bottom of the bread room to bring the ship down by the stern.
- 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.*
- 11th June 1770 Vessel struck a rocky reef (later to be called *Endeavour* Reef) - , sounded around ship, three to twelve feet around the vessel (*Endeavour* drew 13' 6"); Started to lighten ship and attempted to kedge off.
- 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.
- Twenty tons of iron and stone ballast. Six carriage guns, buoys fixed to the guns for possible later recovery. Severe leak managed to heave the ships off but concerned at foundering in deeper water.

Difference between top of ceiling plank and the top of the outside plank 16" – 18"

- 17th – 18th June 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 cask and some provisions.
- 19th June 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,
- 20th June 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.
- 21st June 1770 Powder, stone ballast, wood (fire wood?) 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 3feet from her keel, had to clear the hold entirely to get at the leak. Had to remove all the coal.
- 22nd June 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 bolts and nails (iron)
- Floor heads were the upper ends of the floor timbers ie: 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 leak (apart from the widespread damage) was on the bottom of the

	ship in front of the foremast and on the starboard side – at the turn of the bilge.
23 rd June 1770	Carpenters employed shifting the damaged Planks. Starboard side examined at low tide –
24 th June 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 th June 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 th June 1770	Carpenters finished off larboard bow and every other place the tide would permit them to work. Attempted to float off the ship
27 th June 1770	Endeavour River – Set up forge to repair iron work, carpenters employed caulking ship, restocking an anchor
6 th July 1770	Endeavour River – hardly 4feet 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 th July 1770	Employed taking on board coal, ballast, caulking the ship,
9 th July 1770	Carpenters, Smiths and Coopers all at respective employment, seamen employed taking onboard stone ballast.
14 th July 1770	Seamen again employed taking on board stone ballast, airing sails etc.
21 st July 1770	Carpenters finished repairing pumps. Caulking ship etc.
28 th July 1770	Carp's finished caulking the ship.
1 st August 1770	Pumps in very poor conditions, wood decayed, one quite useless, water making about 1" per hour,
14 th August 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 th October 177	Anchored in Batavia Road's – 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 scarp 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 1 ½" of the bore. Otherwise Masts, Yards, Boats and Hull in pretty good condition.

10th Oct 1770

J Seetterly

Cook had spoken to Officers concerning the leak – vessel now very unsafe – and had to be repaired.

Cook may have made a mistake in transcribing the damage – for the main leak had been on the starboard side – most of the work at Endeavour River conducted on starboard side – but the Carp could have done a very good job and that leak had been repaired.

Channel of chain wale was part of the chains and was the thick plank projecting horizontally from the side of the ship where the shrouds were fastened.

12th Oct 1770

At Batavia – Cook had fitted a lightning conductor (an iron chain) carried the electrical matter over the side of the ship – when *Endeavour* was struck by lightning in the roads of Batavia.

18th – ? Oct 1770

'Onrust' Coopers Island (Batavia) – 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*.

29th – 31st Oct 1770

Clearing ship ready for heaving down and careening.

9th Nov 1770

Vessel larboard side of the ship keel out – found the bottom in very poor condition. False keel gone to within 20feet 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 6feet in length were within 1/8th of an inch of being cut through. Worms had made their ways into the timbers.

10th Nov 1770

Had to caulk and repair upper works as water was coming in when vessel heaved over for careening.

12th Nov 1770

Finished larboard side. Prepared to careen starboard side – very little damage. Repairs completed by the evening of the 13th Nov.

14th Nov 1770

Bottom now repaired – very efficient yard. Vessel's hove down using two masts rather than the English practise of using only one.

16th Nov 1770

Took on coals and ballast. Sent off decayed pump, new one made by yard.

17 th – 30 th Nov 1770	Employed rigging ship, getting on board stores and water, repairing rigging and sails.
9 th Dec 1770	New pump taken on board.
10 th Dec 1770	Employed crew painting and scraping hull and upper works.
25 th Dec 1770	Completed loading and repairs.
26 th Dec 1770	After completing provisioning and taking the surviving gentlemen and crew on board weighed anchor and left port. Have lost seven men to disease and illness with a further 40 sick and the remaining ship's company in a weak condition.
17 th Jan 1771	Java Head bore ENE 4 – 5 leagues.
27 th Jan 1771	Departed this life Mr Sidney Parkinson, Natural History Painter.
29 th Jan 1771	Departed this life Mr Charles Green sent by the Royal Society to observe the Transit of Venus.
31 st Jan 1771	In the course of the last thirty six hours have lost another six men to the flux.
12 th Feb 1771	Died of the flux after a long and painful illness Mr John Satterly, Carpenter, a man much esteemed by me.
15 th March 1771	Arrived off Cape Town. Saluted the castle and took the sick ashore.
16 th April 1771	Departed Cape Town.
13 th July 1771	Arrived off Portland and anchored in the Downs.

Appendix 3. Review of candidate vessels registered in 1778 as *Peggy*

Erskine (2017: 76–77) 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 *Peggy*, a common name for British- and American-built vessels in the 18th century.

Building on Erskine's research, a comprehensive review of *Lloyd's Register of Shipping* was undertaken, with particular emphasis placed on editions published on and around 1778, when the Battle of Rhode Island occurred. In addition to the 360-ton ship *Peggy* identified by Erskine (discussed below), four other vessels of interest are listed under that name.

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 for 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, although further research is necessary to confirm this hypothesis.

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 it disappears from the register after 1784, this vessel could not have been scuttled at Newport in 1778 – unless it was subsequently refloated.

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.

Discussion

Of the *Peggy* candidates identified by Erskine – and those additional candidates addressed above – 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.

With the exception of the 200-ton *Peggy* built in the American colonies, all of 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. Its scantlings and timber composition would clearly distinguish it from the size and construction of *Lord Sandwich/Endeavour*.

Appendix 4. Extracts from relevant US statutes and rulings

USA Public Law 100-298 Abandoned Shipwreck Act

Full text of *An Act to Establish the Title of States in Certain abandoned Shipwrecks, and for Other Purposes*: <https://www.congress.gov/100/statute/STATUTE-102/STATUTE-102-Pg432.pdf>

§ 2. Findings

The Congress finds that —

- (a) States have the responsibility for management of a broad range of living and nonliving resources in State waters and submerged lands; and
- (b) Included in the range of resources are certain abandoned shipwrecks, which have been deserted and to which the owner has relinquished ownership rights with no retention.

§ 3 Definitions

(d) the term "shipwreck" means a vessel or wreck, its cargo, and other contents;

§ 4. Rights of access

It is the declared policy of the Congress that States carry out their responsibilities under this Act to develop appropriate and consistent policies so as to—

- (c) Allow for appropriate public and private sector recovery of shipwrecks consistent with the protection of historical values and environmental integrity of the shipwrecks and the sites.

§ 6. Rights of ownership

(a) United States Title – The United States asserts title to any abandoned shipwreck that is—

- (1) embedded in submerged lands of a State;
- (2) embedded in coralline formations protected by a State on submerged lands of a State; or
- (3) on submerged lands of a State and is included in or determined eligible for inclusion in the National Register.

(c) Transfer of Title to States – The title of the United States to any abandoned ship wreck asserted under subsection (a) of this section is transferred to the State in or on whose submerged lands the shipwreck is located.

Full text of Act: <http://webserver.rilegislature.gov/statutes/title42/42-45/index.htm>

§ 42-45-5. Powers and duties

(a) The commission shall:

(1) Establish criteria for evaluating historical, architectural, or cultural sites, buildings, places, landmarks, or areas so as to determine their value in terms of national, state, or local importance and to adjudge their worthiness for inclusion in the state register;

(5) Cause to be prepared plaques or markers made of some suitable material to be erected on, or affixed to with the permission of the owner, in a conspicuous place, those sites or buildings determined worthy of inclusion in the state register;

(10) Advise the department and agencies of state government of the appropriateness, suitability, proper procedures, and other safeguards which should be observed in preserving, displaying, or using items contained in the catalog of articles of historic, architectural, or archaeological interest. When notified of any proposal to physically alter, change the location or method of storage, or change the manner of utilization or public accessibility, or to otherwise significantly affect any item listed in the catalog, the commission shall advise the responsible agency in writing, accompanied by any maps, drawings, photographs, or other explanatory material necessary. If a written advisory is not given within sixty (60) days of receipt of a notice of proposed action, the commission shall be deemed to approve the proposal. If more than sixty (60) days are needed to evaluate a proposal and render an advisory, arrangements for a reasonable extension shall be made by the commission and the department or agency concerned. Advisories given by the commission in accordance with this section shall be followed by the department or agency concerned unless there are compelling reasons for not doing so. In these cases, a statement of the reasons, together with a copy of the commission's advisory, shall be submitted to the governor for determination;

(12) Appoint a state review board from among its own members and such other persons as it may desire, one of whom shall possess the background and qualifications of an historian, one of whom shall be an architect or architectural historian, and one of whom shall be an archaeologist as required by the office of archaeology and historic preservation in the national park service. The state review board shall approve nominations to the state and national registers of historic places, approve the removal of properties from either register, and otherwise act in an advisory capacity to the historical preservation and heritage commission;

§ 42-45-9. State historic preservation officer

The governor shall designate a state historic preservation officer to serve at his or her pleasure and until his or her successor is appointed and qualified. The state historic preservation officer for the national park service shall also serve as state historic preservation officer. The state historic preservation officer shall act as the state's representative to the federal government, to other states, and to other interested parties in matters of historic preservation.

Full text of Act: <http://webserver.rilegislature.gov/statutes/title42/42-45.1/index.htm>

§ 42-45.1-3. Definitions

As used in this chapter:

(1) "Field investigations" means the study of the traces of human culture at any land or water site by means of surveying, sampling, excavating, or removing surface or subsurface objects, or going on a site with that intent.

(2) "Site" means any man-made landform, fort, earthwork, habitation area, burial ground, historic or prehistoric ruin, mine, cave, or other location which is or may be the source of important archaeological data.

(3) "Specimen" means all relics, artifacts, remains, objects, or any other archaeological evidence of a historical, prehistorical, or anthropological nature which may be found on or below the surface of the earth, and which have scientific or historical value as objects of antiquity or as archaeological samples.

(4) "Underwater historic property" means any shipwreck, vessel, cargo, tackle, or underwater archaeological specimen, or part thereof, including any found at refuse sites or submerged sites of former habitation, that has remained unclaimed for more than ten (10) years on the bottoms of any navigable waters and territorial seas of the state.

§ 42-45.1-4. Property and investigative rights of state

(a) The state of Rhode Island and Providence Plantations reserves to itself the exclusive right and privilege of field investigation on sites owned or controlled by the state, its agencies, departments, or institutions, in order to protect and preserve archaeological and scientific information, matter, and objects. All the information and objects derived from state lands shall remain the property of the state and be utilized for scientific or public educational purposes.

(b) Furthermore, subject to any local, state, or federal statute, the title to all bottoms of navigable waters within the state's jurisdiction in the territorial sea, and the title to any underwater historic properties lying on or under the bottoms of any other navigable waters of the state, is hereby declared to be in the state, and the bottoms and underwater historic properties shall be subject to the exclusive dominion and control of the state.