SITE 44YO88

THE ARCHAEOLOGICAL ASSESSMENT

OF THE

HULL REMAINS AT

YORKTOWN, VIRGINIA

A Thesis

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By

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INTRODUCTION

The Battle of Yorktown ended on October 19, 1781 when General Charles O'Hara surrendered the British garrison to the French and American forces under Generals Washington and Rochambeau. This defeat was the final act in the southern campaign conducted by the British Army under the command of General Charles, Lord Cornwallis. The campaign, which began in Charleston, South Carolina, in December of 1779, was a complex combined operation utilizing sea power and land forces. The troops ashore were supported, supplied and transported by sea. This was possible so long as the ocean, bays, and rivers were controlled by the Royal Navy. Cornwallis' defeat at Yorktown occurred when that control was denied by the French fleet working in conjuction with the American and French forces ashore. Yorktown was the last major battle of the American Revolution to be fought on American soil. The direct legacy of this American victory was to be the lasting independence of the United States of America.

The history of this campaign and battle has been the topic of innumerable books, studies, and papers. The scholars responsible for these works have been aided and guided by the tremendous amount of documentary material available on the subject. The personal journals of participants, the vessel logs, official correspondence, regimental order, books and reports by both the victors and the vanquish have provided the information that these studies have been built upon. Unfortunately little detailed information is available on the specific vessels that played such a significant role in this campaign. This is due to the fact that most of the vessels that supported Cornwallis were merchant craft hired into the service of the Crown.

Details of design, hull shape, construction and rigging are well documented for warships from the later half of the eighteenth century. The Royal Navy required detailed plans and design drawings for any vessel that was ordered from the shipyards of England.[1] Warships taken as prizes were also documented by the Royal Navy before entering service. There were well documented standards for warship construction down to the most minute detail.[2] Conversely very little was recorded on the merchant vessels of the day. Ships built for trade were built by numerous yards, generally to the specific needs of each individual owner. These vessels seldom had complete plans or standard design features and were frequently built by "rack of eye" to the customer's specialized requirements. Although conventions for construction of merchant ships existed they are at best poorly documented.[3] Therefore almost no detailed plans are available for the study of the merchantmen of the eighteenth century. Maritime empires were built on transoceanic trade and merchant shipping was the lynchpin of that enterprise. Without a merchant fleet England would have had no Empire worth speaking of. The importance of collecting accurate information on the vessels that supported the development of the British Empire has been widely recognized.

Today that information survives almost exclusively in the archaeological record. The material legacy of the Battle of Yorktown represents a priceless record of British maritime heritage. Resting on the bottom of the York River in a protective environment are the hulls of at least seven merchantmen lost in 1781.[4] To date only two other merchantmen from the eighteenth century have been excavated. The "Ronson Ship", found buried in New York is an early eighteenth century vessel that was used as a wharf and then abandoned. The wharf site was filled in to increase the habitable land along Lower Manhattan. The *Amsterdam* was a ship from the middle of the century and was also partially excavated from a submarine environment off England's southeast coast. Although these vessels were extensively recorded neither was as well preserved or as complete as the ship at Yorktown. The hulls at Yorktown are from the last half of the eighteenth century and are a unique and valuable study collection. With an exact *terminus ante quem* and a protective estuarine environment the Yorktown fleet offers an opportunity to study, in detail, the design and construction of late eighteenth century merchantmen. The best preserved of these vessels, 44YO88, was selected for an extensive research excavation.[5] The hull remains at this site have provided invaluable information on shipbuilding technology in the last quarter of the eighteenth century. The archaeological data generated by this excavation adds a great deal of specific detail to the previously well documented historical accounts of merchant craft in the service of the British Empire during the American Revolution.

FOOTNOTES

[1]James Dodd and James Moore, Building the Wooden Fighting Ship (New York: Facts on File Publications, 1984), p.51.

[2]Ibid., pp. 52-57.

[3]David R. MacGregor, personal communication, November, 1987.

[4]John D. Broadwater, John O. Sands, and Gordon P. Watts, Jr., "Report of an Archaeological Survey of Several Shipwreck Sites Near Yorktown, Virginia", report submitted 8 December 1975 to Virginia Historic Landmarks Commission.

[5]In the Wisconsin State Archaeologist's County Code File for cataloging archaeological sites the state number is 44, the county code for York County is YO, and the site number is 88.

CHAPTER I

SITE DESCRPITION

Location

Yorktown is located in eastern Virginia on the southern bank of the York River (Figure 1). Only 54.7 km from the Atlantic Ocean but 12.8 km above the river mouth, it offers both a protected anchorage and a naturally deep channel. These factors have caused Yorktown to be regarded as an ideal port since the Colonial period. Although no longer an active commercial port, Yorktown is still the location of two major naval installations and a Coast Guard training facility. The town proper is situated on a series of low bluffs overlooking a narrow beach. To the south west of the beach flat fields stretch towards the James River, 18km away. The James and the York form the peninsula on which Yorktown is located . The most conspicious geological feature in Yorktown is the "Great Valley", the remains of a lateral tributary channel from the Paleozoic era. This feature runs from the bluffs to the main river channel. Site 44Y088 is directly offshore from Yorktown's beach in 6.7 m of water on the upriver shoulder of this channel.

Geography

Yorktown lies in southeastern Virginia, which forms the southern edge of the Chesapeake-Delaware Embayment.[1] Various high stands of sea level throughout time have created a coastal zone consisting of a series of plains, all of which slope slightly to the east.[2] These plains are bounded by scarps, three of which converge at Yorktown.

The bluffs at Yorktown are an outcrop of the Yorktown Formation, the most recent strata in the Chesapeake Group. This formation extends from Cape Hatteras, North Carolina to the Rappahannock River in Virginia.[3] The Yorktown Formation was laid down approximately sixteen million years ago (MYA) and consists of shelly sand, coquina, sand and silt.[4]

During the Wisconsin Glacial Age, approximately 100,000 years before present (BP),a rapid decrease in temperature resulted in a sea level drop of 100 meters.[5] The six major estuaries of the present day Chesapeake Bay became firmly entrenched at this time as unidirectional tributaries of the Ancestral Susquehanna River. These rivers as well as the smaller streams draining into them attempted to cut through the underlying strata to reach base level, a state where the river's velocity is sufficient to carry the sediment load.[6] It was this cutting down process that produced the York River's deep main channel and the smaller lateral channels feeding into it.

Some eighteen thousand years BP the glaciers that formed during the Wisconsin Age began to melt and the sea transgressed back over the land. As the sea level rose the Ancestral Susquehanna and its tributaries were submerged, thus initiating the formation of the modern Chesapeake Bay. With this inundation the York changed from a unidirectional tributary to an estuarine river system with tidal processes affecting it for its entire length. With a tidal flow in two directions the sediment deposition was altered radically and silts and clays began to accumulate. These sediments came from both offshore marine sources and from upland drainage. As these sediments accreted the smaller channels that were already innundated begin to fill with depositional material and the York begin to assume its present configuration.

Site Environment

The modern York is one of six major western rivers emptying into the Chesapeake Bay. Deepest of the six, the York is formed by the confluence of the Mattaponi and the Pamunkey Rivers 64 km above the mouth. Tidal influence runs the length of the York and continues up both of its tributaries for several more kilometers. The average width of the York is 3 km and the maximum depth is 26 m at mid-channel. Directly offshore from Yorktown the salinity ranges from 23 parts per thousand (ppt) during the summer months to 18 ppt in the winter. Diurnal tidal range is approximately 1 meter and water temperature varies from a summer high of 25 degrees C to a midwinter low of 5 degrees C. The average current speed is approximately three knots.

Sediment deposition rates vary with the seasons. Upland drainage is greater during the spring and creates a faster depositional rate. Erosion is more intense during the winter storm season and sediment transport is outward towards the bay. Sediment deposition and the unique bathymetry of the Yorktown site have combined to produce an ideal protective environment for the remains of 44YO88.

As previously stated, the hull rests on the upriver shoulder of a small lateral paleo-channel. When the ship went down she settled into the accumulated sediment already present within this feature. This started the preservation process by protecting the hull remains from the detrimental effects of the river almost immediately. Other vessels lost at Yorktown came to rest outside of this channel where pre-existing depositional material was much thinner. Consequently those hulls were exposed to the hostile river environment much longer than 44YO88 and do not have the same degree of preservation.

Site History

The hull and its contents, having settled into the silt already present in this channel, were rapidly covered by additional sediment. This rapid covering was the second factor in the preservation of the site. The third and final factor in this equation is a process known as Redox Potential Discontinuity (RPD). RPD is simply the depth of sediment below which oxidation ceases.[7] The RPD for sediment in the York River is very slight and varies from a few millimeters to a centimeter depending on its precise composition.[8] With so little sediment required to halt oxidation the already partially buried hull was protected from deterioration very quickly, resulting in excellent preservation of the remains. The combination of these three circumstances left 44YO88 undisturbed in a protective envelope for over two hundred years.

Since 1781 the shoreline has gradually moved south as erosion and channel migration slowly altered the configuration of the river.[9] The protective envelope formed by the lateral channel maintained the vessel remains in excellent shape throughout this geomorphological sequence. It also protected the site from a hostile river environment.

Yorktown has a long and well documented history. In addition to its colonial history as a tobacco port and its major role in the Revolutionary War Yorktown was also a battleground in the Civil War. Pre-historic and pre-contact habitation occurred throughout the region but the exact number and location of these sites is not yet fully recorded. Many of these sites are no doubt inundated from sea level rise and will remain undiscovered until a systematic survey is undertaken.[10]

Yorktown was originally laid out in 1691, down river from the first English settlement on the York at Chisiack.[11] By 1711 the towns most prominent feature was a large windmill which became a landmark for mariners navigating the Bay.[12] By the middle of the eighteenth century Yorktown was a major tobacco port for the lower Bay. In the first half of that century small river communities like Yorktown, Cabin Point, Urbanna. Occuquon, and Port Royal came into prominence as transshipment ports for tobacco, Virginia's leading export. Tobacco, grown farther upland, was rolled or shipped to these towns for pick up by trans-oceanic merchant vessels. Yorktown became the leading port with the passage of the Tobacco Inspection Acts of 1730 and 1747.[13] With the passage of these acts came the establishment of customs warehouses at Yorktown where all tobacco was cleared for shipment to England.

Yorktown became not only the port that handled the tobacco for export but also the one where goods from Europe and the West Indies entered into

Virginia.[14] With a deep channel, a good holding ground, and high bluffs close to the water's edge Yorktown was an ideal port. It was located close to the mouth of the river and had quick and easy access to the ocean. It was also relatively ice free and within a day's ride of the colonial capital, Williamsburg. There were good roads available on both sides of the river providing easy passage for those traveling by land. These blessings would bring disaster to the town in 1781 when Lord Cornwallis and his Southern British Army seized the port for use by the Royal Navy. Fortification of the town and the subsequent siege of the garrison by French and American forces almost completely destroyed Yorktown. The fleet supporting Cornwallis was also destroyed, scuttled in the harbor (See Chapter 2). The battle ended on October 19, 1781 when the British surrendered, bringing to a close the last major campaign to be fought on American soil during the war.

After the destruction of the town Yorktown's maritime importance waned. Although still an active river port it was gradually eclipsed by Norfolk as the principal entrepot on the lower Bay. As overland access to Norfolk increased Yorktown became less significant and eventually turned into a rural backwater used only by the local watermen.

Yorktown's tactical and strategic significance, however, brought a second invading army in the middle of the nineteenth century. In 1862 Union General George McClellan initiated his peninsula campaign against the Confederates from the harbor at Yorktown. Anxious to strike at the Rebel capital of Richmond, McClellan brought the Army of the Potomac down the Bay to the York River.

McClellan subjected Yorktown to a second siege, this one over a month in duration. The siege was over on May 4, 1862. The badly out numbered

Confederates abandoned their earthworks, many built upon old British entrenchments, and retired slowly up the peninsula.[15] The southerners, under General Macgruder forced the overly cautious McClellan to make a slow advance towards the interior.

As McClellan closed on Richmond from the south he found himself facing the new commander of the Army of Northern Virginia, General Robert E. Lee. Lee and Stonewall Jackson, two of the best commanders in the conflict, stopped McClellan in the vicious fighting that came to be known as "The Seven Days" (June 25-July 1, 1862). Some of the most savage combat of the war occurred during this week, which culminated in the slaughter at Malvern Hill. Although a Union victory on the field, Malvern Hill was a strategic victory for the South as Richmond was saved when McClellan was relieved of command for timidity. The Army of the Potomac was withdrawn from the peninsula to Aquia Creek to support the Union forces under General Pope.[16]

Yorktown had survived a second siege and again slipped back into obscurity, a forgotten river port occasionally visited by steamships from up the Bay.[17] In 1917 Yorktown regained some of its prominence when the U.S. Navy established a mine depot upriver from the town.[18] Today this facility is Naval Weapons Station Yorktown, an essential secure port for the Atlantic Fleet. Yorktown also hosts a deep water Amoco oil terminal, a Coast Guard Training Facility, and Cheatam Annex, an auxiliary naval loading complex. All of these operations were placed in Yorktown due to its naturally deep channel and sheltered anchorages.

Archaeological work on the specific Revolutionary War sites at Yorktown has been carried out on both the land fortifications and on the vessels Cornwallis lost in the harbor. Prior to archaeological investigations however, salvage and looting took their toll on the vessels lost in the harbor. Official salvage began almost before the guns had cooled.

The French were given title to all vessels, both floating and sunken, in recognition of their critical participation in the seige.[19] After the departure of the main body of the French Fleet Captain La Villebrune and a small flotilla remained in Yorktown to salvage as much as they could from the sunken British ships. H.M.S. Guadalupe, one of the few warships present, was actually refloated and sailed back to France where she served in the French Navy.[20] Other vessels that were not refloated were stripped of their mast and spars by the French and by the enterprising local population. By the spring of 1782 the French departed, but the locals continued to scavenge the wrecks littering the waterfront. By 1783 the British ships were still plainly visible as witnessed by this description in Johann David Shoepf's journal, "the Ships sunk in the river for the protection of the garrison were still in their places, and it is thought not worthwhile to raise them,...."[21]

The next effort to salvage material from these ships, that is salvage sanctioned by the authorities, occurred in 1852. Thomas Ashe, a local waterman, was granted permission from the Commonwealth of Virginia to, "search for and recover the guns and equipments...[from] an English frigate or vessel, which was sunk in the York River."[22] Ashe was distraught to discover however, that the cannon he thought to be bronze were in fact worthless iron.

In 1934 the National Park Service and the Mariners' Museum, with assistance from the Newport News Shipbuilding and Dry Dock Company, recovered numerous artifacts from the river. Timbers, cannon, bottles, and small artifacts were collected but no records exist to document where they came from. Some of these pieces still survive in Park Service collections but survive in poor condition and with no provenience are of little archaeological value.[23]

In 1949 an Army diver from Fort Eustis made several dives on wrecks in the York River for an Army radio show, "Time for Defense." Newspaper accounts indicate that these dives continued until 1954, but again no records were kept.[24] By this time sport divers, using newly available scuba equipment, begin to visit and loot the sites.[25] It was not until the 1970s that scholarly investigations on these vessels began.

John Sands, a graduate student in history, began investigating these sites through documentary research. This research became the cornerstone for all future investigations of these sites. By 1973, Sands, Ivor Noel-Hume, an archaeologist, and Norman Scott, an engineer, had participated in a series of meetings with the Virginia Historic Landmarks Commission. The result of these meetings was the nomination of these wrecks to the National Register of Historic Places.[26] In 1975 Sands, working with Gordon Watts, North Carolina's underwater archaeologist, and John Broadwater, conducted a brief magnetometer survey of the river. Several sites were pinpointed and extensive damage from looting was clearly evident. As a result of this survey, in April of 1976 Virginia passed the Underwater Historic Properties Act to protect submerged cultural resources. A follow on survey was conducted and an intensive excavation of one site was initiated.[27]

The American Institute of Nautical Archaeology, under the direction of Dr. George F. Bass, conducted an detailed excavation of site 44YO83 in the summer of 1976. An attempt was made to utilize a portable cofferdam to surround the site so that the water could be clarified. This was not successful due to strong currents and large tidal shifts. The project did, however, document the site to the point of identifying the wreck as a large British transport lost in 1781.[28]

The recommendation for further research from Dr. Bass led Virginia to seek additional funding to continue the work. This came in the form of a grant from the National Endowment for the Humanities. The subsequent project was directed by John Broadwater and located nine of Cornwallis' vessels. Two were identified as H.M.S. Charon, the flagship, and H.M.S. Fowey. The other seven wrecks were supply and transport vessels. A detailed assesment of the state of preservation of these wrecks was made through test excavations. Warships of the period being rather well documented, an extensive excavation of the best preserved merchantman was decided upon. The best preserved was judged to be 44YO88.

A detailed research design was completed by Broadwater in 1981. It called for complete excavation of YO88 within a steel cofferdam. The cofferdam was to protect the site and the staff from the hostile river environment and to enable a filtration system to clarify the water for better recording. A second grant was received from NEH and the cofferdam was completed in 1982. Once the structure was complete a filtration system was installed. This system was constantly modified throughout the project. Although visibility was improved considerably the cofferdam never became the "swimming pool" originally envisioned. On occasion, however, visibility did reach thirty feet, enabling visitors to the site to see the vessel's remains from the pier. At all times visibility was more than adequate for accurate data recovery.

Excavation and recording was conducted from 1983 until 1988. Field seasons ran from early May until the end of December. The winter months were spent in the laboratory and on the drafting table, or in various archives both in the States and abroad. Throughout the duration of the project volunteers were incorporated in all field operations to some extent. The Program in Maritime History and Underwater Research at East Carolina University provided interns during the fall and conducted field schools at the site during the summers of 1983, 1984, 1986, 1987, and 1988. The protective environment provided by the cofferdam was an ideal training and teaching facility for these students. The project directly benefited from this joint venture with ECU by having a highly motivated group of individuals to work on the vessel. With the conclusion of the 1988 field season analysis and reporting was conducted on a full time basis. Failure to secure additional funding terminated the project in 1990, and all ongoing research reflects the personal interest of the project staff. The artifact collection is either in storage, on display at the Yorktown Victory Center, or undergoing conservation at East Carolina's laboratory under the direction of the University's Archaeological Technician, Brad Rodgers. The site was completely backfilled and the cofferdam was dismantled in the summer of 1990. This task was carried out by the Navy's Mobile Diving and Salvage Unit Two as a training operation.

FOOTNOTES

[1]Grover Murray, Geology of the Atlantic and Gulf Coastal Province of North America (New York: Harper and Brothers, 1961), p. .

[2]Gerald H. Johnson, Guide Book to the Geology of the York-James Peninsula and the South Bank of the James River (Williamsburg, Virginia: Guide Book number 1, Department of Geology, College of William and Mary, 1969), pp.10-11.

[3]J.D. Mclean, Jr., "The Formation of the Yorktown Formation in the York-James Peninsula of Virginia, With Notes on the Associated Mullusks", Bulletins in American Paleontology, volume 36, number 160, (1956): pp. 255-294.

[4]Johnson, Guide Book, pp. 10-11.

[5]T.H. Clark and C.W. Stearn, The Geological Evolution of North America: A Regional Approach to Historical Geology (New York: Ronald Press, 1960), p. .

[6]Joseph Michael Carron, "Geomorphic Processes of a Drowned River Valley: Lower York River Estuary, Virgina", (Master's thesis, Virginia Institute of Marine Science, College of William and Mary, 1976), p. 116.

[7]Jeffrey S. Leviton, Marine Ecology (Englewood Cliffs, New Jersey: Prentice-Hall Incorporated, 1982), p. 240.

[8]R. Joseph Neubauer, personal communication, December, 1987.

[9]Carron, "Geomorphic Processes", p. .

[10]Marley R. Brown, III, and Kathleen J. Brandon, ed. Towards a Resource Protection Process: Management Plans for James City County, York County, City of Poquoson, and City of Williamsburg. (Williamsburg, Virginia: Office of Archaeological Excavation, Colonial Williamsburg Foundation, 1985), pp. 121-125.

[11]Charles E. Hatch, Jr., ed., Colonial Yorktown's Main Street and Military Entrenchments (New York: Publishing Center for Cultural Resources, 1974), p. 3.

[12]Ibid., p. 12.

[13]Arthur Pierce Middleton, The Tobacco Coast, A Maritime History of the Chesapeake Bay in the Colonial Era (Newport News, Virginia: Mariner's Museum, 1953), p. 50.

[14]Ibid., p. 51.

[15]Atlas to Accompany the Official Records of the Union and Confederate Armies (Washington: Government Printing Office, 1891-1895), plate 15.

[16]J.G. Randall and David Herbert Donald, The Civil War and Reconstruction (Lexington, Massachssetts: 1969), pp. 210-219.

[17]Anthony Burgess and H. Graham Wood, Steamboats Out of Baltimore (Cambridge, Maryland: Tidewater Publishers: 1968), p. 147.

[18]Historic Preservation Plan for Naval Weapons Station, Yorktown, Virginia (U.S. Army Corps of Engineers, Mobile District), Draft copy, unpublished, 1990, p. 24.

[19]Henry P. Johnston, The Yorktown Campaign and the Surrender of Cornwallis (New York: Harper and Brothers, 1881), p. 188.

[20]John O. Sands, Yorktown's Captive Fleet (Charlottesville: University Press of Virginia for the Mariner's Museum, 1983), p. 115.

[21]Johann David Schoepf, Travels in the Confederation, translated and edited by Alfred J. Morrison (New York: Beergman, 1968), p. 85.

[22]Ibid., p. 118.

[23]Richard Raymond, personal communication, August, 1989.

[24]Sands, Yorktown's Captive Fleet, p. 133.

[25]Richmond Times-Dispatch, 2 August, 1954.

[26]Sands, Yorktown's Captive Fleet, p. 138.

[27]George F. Bass, Ivoe Noel-Hume, John O. Sands, and Richard J. Steffey, "The Cornwallis Cave Shipwreck", Report submitted to the Virginia Historic Landmarks Commission, 1976. pp. 15-17.

[28]Ibid., p. 9.

CHAPTER II

HISTORY OF THE VESSEL TYPE

The Coal Trade

At the beginning of the eighteenth century coal was primarily used for domestic heating. Wood, long the fuel used to warm the homes of England, had been supplanted by the coal that was readily available throughout the country. Mining procedures continued to improve and the coal supply increased. In the first quarter of the eighteenth century two discoveries brought about an increased demand for coal from an unexpected source, manufacturing.

First, Abraham Darby proved the feasibility of using coke, a coal product, as a charcoal substitute for iron smelting. This speeded the production process considerably. Second the use of coal in converting pig iron to bar iron made the production of iron implements easier and more economical.[1]

As the demand for coal increased the problem of transporting this bulky material was excerbated. Coal was transported by cart, wagon way, keel craft and coastwise navigation. Even as good roadways and the canal system were improved, the demand for coal continued to outstrip the supply available at the docks. Shipping enough coal to satisfy the growing demands of industry grew into a major problem and a major industry. It was however, an accepted fact that coal could be carried twenty times farther by water than by land for the same unit price.[2] This simple economic formula led to the massive coal trade along the English coast.

Colliers

The coal trade became the single largest employer of English bottoms throughout the eighteenth century.[3] As early as the Restoration, the tonnage of colliers exceeded the tonnage of all other merchant vessels combined. Adam Smith observed in his work The Wealth of Nations that the coal trade "employs more shipping than all the carrying trades of England."[4] A trade this lucrative was bound to demand attention from merchants, seamen, and shipwrights as vessels were needed in ever expanding numbers to carry fuel for industry and for hearth.

Ironically colliers (as the vessel type came to be called) were not originally a class designed or built vessel. They were often vessels converted to the trade after serving in other capacities for many years.[5] As the carrying of coal grew to be a major trade venue, however, colliers assumed not only their title but also a reputation for being sturdy vessels with large holds for maximum cargo capacity. J.H. Parry described colliers thus in Trade and Dominion :

> Colliers had to be strong. They were solidly built of oak; their proportions were moderate; their tumblehome relatively slight; and with robust transome sterns. They retained, on the other hand, some of the virtues of the fluyt: their full section (i.e. flat floor); their capacious, almost rectangular holds; their simplicity and economy of size. They had bluff bows and straight stems, with no beakhead and a modest cutwater; they were built for strength and carrying capacity, not for speed and certainly not for looks.(6)

By the mid-eighteenth century the colliers were certainly definable in terms of characteristics, if not by actual dedicated design particulars. These characteristics were the result of the demands the ship's function. The flat floors gave these vessels a shallow draft as well as a large cargo capacity and the ability to take the ground well. With docking facilities rather limited in many coal ports ships often had to lie aground while awaiting dock space. At some up country ports colliers deliberately beached to allow low tide loading directly out of high-wheeled carts.[7] At the other end of the trade route in London colliers would again lie aground while awaiting dock space at the always crowded coal docks. This kept the roads free for navigation.[8] It was the flat floors and heavy construction inherent in their hulls that enabled colliers to operate in this manner.

Probably the greatest single influence on vessels in the coal trade was Dutch ship building design.[9] England fought three wars with the Netherlands in the seventeenth century. The first war was lasted from 1652 to 1654, the second from 1664 to 1667, and the third from 1672 to 1674. Dutch vessels taken as prizes during these three conflicts were found to be not only sturdy but also flat floored and with enormous cargo capacity relative to their overall size.[10] By the beginning of the eighteenth century, however, these captured Dutch ships were about to reach the end of their useful service careers. It therefore became necessary to produce English merchantmen to carry coal for the ever expanding factory demands. These English vessels were heavily influenced by the Dutch design concepts of strength, capacity and, equally important, economy of operation. This was a radical departure from traditional English ship design philosophy, which stressed strength and speed over economy.

With an eye towards a large profit margin merchant ship owners sought vessels with a small crew relative to vessel size. The Betsy and Sally, a collier brig of 170 tons carried a nine-man crew on a 1766 voyage. This number of mariners was deemed " a full and sufficient compliment or number of hands to navigate her or any other ship of the like burden and rigging...."[11] The key to a small crew was simplicity of rig. To this end the coal trade made use of a high percentage of brigs, a simple two masted configuration. The mainsail was rigged fore and aft and sail handling was relatively easy. This rig was considered to be not only economical but also reliable and it gave the vessel better pointing characteristics in contrary winds, essential for coastal trade.

All of the characteristics described above were evolved rather than designed. These evolved traits would carry the collier beyond the coastwise trade onto other tasks and services far removed from England's shores.

Colliers in the American Revolution

When war broke out between British colonists in America and the mother country, England was confronted with a logistical nightmare. England's empire, although founded on maritime commerce, was woefully unprepared to support an army in the field across the Atlantic Ocean. Like most maritime powers England had devoted her Navy primarily to warships. Few ships were dedicated to transport or logistical support roles. As a result of this situation the Crown was forced to turn to privately owned merchantmen that comprised the carrying trade. Unable to build or buy outright all the needed bottoms, the Crown sought to hire or lease transport and cargo vessels to sustain the army's campaigns in America. Ships were needed not only for trans-Atlantic passages but also for supply and transport services within the colonies.[12]

To acquire the needed merchant shipping several administrative boards were created to secure ships.[13] Unfortunately for the English they inundated themselves with so many administrative organs that hiring practices were very rapidly turned into a bureaucratic muddle. The Navy Board, Ordinance Board and Treasury Board all attempted to hire cargo ships for the increasing and varied demands of the forces serving in North America. Each of these organizations maintained their own hiring practices and pay scales as they sought to acquire shipping for their own needs. These needs were often overlapping and inter-agency competition and varying rates of hire made vessel acquisition difficult for all involved. None of these organizations could formulate policy however, and were forced to wait on Cabinet decisions on every functional detail.[14] This fact alone added a tremendous amount of "red tape" to an already cumbersome mechanism.

For merchant ship owners the war offered an opportunity to turn a handsome profit. Since government hired ships were insured by the Crown and generally traveled in protected convoys, hiring a vessel into Royal service was a shrewd and generally safe practice. Ships operating alone under the owner's flag were not only easy pray for privateers but they were expensive to insure during wartime.[15]

Merchant craft hired into service were rigorously surveyed and rated. Payment was based upon capacity, seaworthiness, crew size and provisions aboard.[16] At the outbreak of hostilities the standards were quite stringent. However as the war dragged on expediency and the pressing need for shipping forced a relaxation of these rules. An example of this was the exception made in 1776 when the Navy Board hired several Dutch vessels in the Netherlands. Prior to this the Navy Board had stipulated that it would only hire English bottoms.[17] Crew size was also specified by policy and again this rule was to become a victim of the war's length. Original Navy Board specifications called for 7 men per 100 tons. This was ammended in 1780 to 6 men per 100 tons.[18] Not only were ships becoming more difficult to acquire but seamen were becoming scarce as well.

Difficulty in securing vessels grew in direct proportion to the war's length. Bottoms were hired either on short term or long term contracts. However these ships did not always manage to return to their home ports at the end of their contracts. Once in the colonies vessels often were "dragooned" by local commanders for the immediate tactical needs of their operations.[19] This practice drastically reduced the number of cargo ships available for trans-Atlantic convoy duty. Thus tactical expediency confounded strategic logistical support. Shipping was badly needed by the far-flung British forces in the colonies, both for logistics and transport to the battle field. Hidebound though the British Army was, it did adapt readily to amphibious operations. The British were perceptive enough to disregard waterways as obstacles and use them as avenues of attack. The bays and rivers of the colonies offered themselves to this tactical doctrine quite well. As British operations spread throughout the colonies, forces delivered by sea and supported by sea became a standard tactic. The British used this tactic frequently but not always to its full potential. These amphibious operations were hindered by limited shipping and poor communications. Another major problem in these combined operations was that throughout the war the navy retained control of the transports despite the army's vehement protests.[20]

The ships hired to support these efforts were as varied as the trades that they came from. Large full hulled cargo vessels were required as well as ships capable of transporting troops and horses. Seaworthiness, as assessed by the King's Dockyard Officers, was also of paramount importance. In order to be hired by the Crown a ship had to be in good condition with the requisite crew and provisions. All of these factors were evaluated in the assesment of a vessel offered for hire.

With so many merchantmen engaged in the coal trade it is easy to understand why so many colliers appear in the lists of ships in the King's service.[21] It was not merely their numbers, however, that made colliers so attractive to the procurement officers. Prior to the war colliers had come to the attention of the navy as ideal vessels of exploration. James Cook, who had served his apprenticeship on colliers, specified the type when he requested ships for his exploratory voyages to the Pacific.[22] By this time their stout construction, good sea keeping qualities and easy handling had become the hall marks of the type. John Hawksworth, in a 1773 pamphlet, praised colliers as " more roomy ... and might be navigated by fewer men than vessels of similar burden."[23]

Indeed here was a vessel type seemingly design dedicated for military transport service. Not only sturdy and roomy but, because of the room to size ratio and small crew, an economical vessel as well. All of these features were considered praiseworthy by the Navy Board. Once in America these craft were considered even more suitable for use as transports heading into shallow and often uncharted waters. Therefore colliers could function as attack transports as though designed for this onorous task. Able to lie aground and not be damaged, capable of carrying large cargos and not requiring large crews, colliers were to become the backbone of the amphibious operation undertaken by the forces of the empire.

FOOTNOTES

[1]Michael W. Flinn, *The History of the British Coal Industry*, 2 vols. (Oxford: Clarendon Press, 1984), II: 20.

[2]Ibid., p. 146.

[3]John U. Nef, *The Rise of the British Coal Industry*, 2 vols. (London: George Rutledge and Sons, Limited, 1932), II: 239.

[4]Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (New York: , 1932), p. 570.

[5]Nef, *The Rise of the British Coal Industry*, I: 85-89.

[6]J.H. Parry, *Trade and Dominion* (London: , 1971), p. 282.

[7]David R. MacGregor, personal communication, December, 1987.

[8]Ibid.

[9]Ralph Davis, *The Rise of the English Shipbuilding Industry in the 17th and 18th Centuries* (Newton Abott: David and Charles Publishers, 1972), p. 61.

[10]Ibid., p. 61.

[11]G. Chalmers, *Estimate of the Comparative Strength of Great Britain* (London: 1794), p. 57.

[12]David Syrett, *Shipping and the American War 1775-1783; A Study of British Transport Organization* (London: Althone Press, 1970), pp. 61-106.

[13]Ibid., pp. 1-60.

[14]Ibid., p. 2.

[15]*Lloyds Register*, 1770-1782. Reprint ed. (London: Gregg Press, n.d.).

[16]Syrett, *Shipping*, pp. 106, 113, 118.

[17]Ibid., p. 98.

[18]Ibid., pp. 114-115.

[19]Ibid., p. 168.

[20]Ibid., p. 51.

[21]Lloyds Register, 1770-1782.

[22]David R. MacGregor, Merchant Sailing Ships, 1775-1815, Their Design and Construction (Watfords, Herts, England, 1980), pp. 8, 51.

[23]Cited in Nef, The Rise of the English Coal Industry, II: p. 391.

CHAPTER III

THE SOUTHERN CAMPAIGN 1779-1781

Lord Cornwallis' surrender of the British garrison at Yorktown, Virginia was one army acknowledging defeat by another. It was an American victory brought about by the intervention of French sea power. Yorktown was the final chapter in the British campaign in the south; a campaign that had made extensive use of naval support for the troops ashore. The ultimate defeat of the British is attributable to their failure to retain control of the sea and the logistical lines of support that the ocean provided.

The defeat at Yorktown was the culmination of a strategy that was grounded in the British failure to secure the northern colonies. The British quickly surmised that quieting the rebelious northeast was not the path to total victory. Despite a string of victories on the battlefields of the upper colonies the colonial forces continued to resist. By 1778 a new strategy, advocated by Lord George Germain, was adopted in the hopes of bringing the colonies to heel. Although not the author of this strategy, Germain, Lord Commisioner of Trade and Plantations and Secretary of State for the Colonies, was the driving force behind it from its implementation to its ultimate failure.[1]

The precis of the southern strategy was simple and straightforward. Occupy and control the colonies still loyal to the crown, seize and hold the southern colonies with large loyalist populations and deny the southern colonies the ability to trade their most valuable export, tobacco. The southern colonies, with their extensive bays, sounds, and rivers and poorly defended ports, were the ideal tactical environment for combined military operation. This would entail using an army transported, protected, and supplied by sea. This concept was not new to the British who had used these tactics successfully in riverine assaults, in combat on the Lake Champlaine and in amphibious raids along the northeast coast.[2] It was hoped that once the troops were ashore the local loyalists would rally to the Crown and that without revenue from the southern trade the north would crumble.

By using the combined operational tactics already proven in battle the British could move south with several advantages. With no real navy to speak of the colonists would be unable to interdict the sea lines of communication or stop the British from landing assault troops where ever they desired. This would give the British a high degree of mobility and their choice of the battlefield while denying the colonists the use of the waterways as avenues of trade. Thus the British could wield a two edged sword tactically and also achieve the strategic goals previously discussed. With Lord Germain as the political force behind this strategy it would fall to Sir Henry Clinton, Commander of the British Army in North America, to be the the battlefield executor.

On March 8, 1778 Germain ordered Clinton to implement the new strategy. The first phase of the plan called for the seizure of the ports above New York, halting colonial trade out of the northeast. This was to be followed by the southern assault in the fall when the southern climate was more amenable to campaigning. In this order Germain specifically made reference to the use of combined operations, particularly in Maryland and Virginia:

> While these operations are carrying on every Diversion should be made in the Provinces of Virginia and Maryland, that the remaining troops which can be spared for offensive service, in conjunction with the Fleet, will admit of. The great number of deep Inlets and navigable Rivers in those Provinces expose them in a peculiar manner to Naval Attacks, ...(3)

The order continued to outline the strategy and tactics that Germain desired. It was the beginning of the British campaign in the south.

Although there had been several actions in the south already, including the seizure of Savannah in 1778, the road to Yorktown actually began in December of 1779. At this time Clinton and his second in command, Lord Cornwallis, sailed from New York to Charleston, South Carolina to initiate the campaign that would hopefully win the war. Although Germain was vitally interested in the Chesapeake Bay, the only action there at this time had been a one month incursion to Portsmouth the previous April. Germain wished to keep a force in being within the Bay area and ordered Clinton to return to Portsmouth and secure a port for the navy and a base for extended operations in Virginia and Maryland.[4]

Charleston fell to the British on May 12, 1780. The Royal Navy had convoyed the vessels supporting the assault and provided escort for these unarmed merchantmen. In addition to protecting these essential supply vessels the navy also provided direct fire support for the troops ashore and conducted the assault landing operations. One problem that became immediately apparent was the lack of a unified command structure. The army and the navy had separate chains of command with no commander in chief. Clinton was the general in command of the army in North America but had little or no control over the naval vessels essential to this combined operation. Naval command of the squadrons operating out of New York fell on the shoulders of Admiral Mariott Arbuthnot who frequently disagreed with Clinton's conduct of the war. Arbuthnot was a sick and cautious man who did not enjoy the rigors of campaigning, nor did he appreciate the constant demands that Clinton made on his naval assets. This lack of unified command and the basic failure of the two commanders to achieve a good working relationship was a constant problem for the British. Although the Americans had no navy to speak of, their newest ally, France, did. A French squadron in Rhode Island was sufficient to convince Arbuthnot that he could not possibly release any more of his vessels for operations in the south. Although the French were not directly threatening the British positions in New York Arbuthnot wanted to retain as many vessels as possible to defend the area.[5]

With the fall of Charleston, Clinton returned to New York to arrange another operation in the Chesapeake in compliance with Germain's orders. Arbuthnot frustrated his attempts to secure additional naval assets for both the South Carolina action and the new incursion into Virginia. As Clinton worried about naval support he was continuing to organize the move into the Chesapeake. Finally Clinton was given some assistance when Admiral Sir George Rodney arrived in New York with the Leeward Islands Squadron and provided ships and supplies from this unit.[6] By October 27, 1780 a post had been secured at Portsmouth under the command of General Leslie. Leslie was convoyed to the Bay under orders to make a "diversion in favor of Lieut. General Earl Cornwallis.".[7] Cornwallis' actions in the interior of South Carolina were not as fruitful as hoped for, and he was anxious for a second force in the South to draw some of the rebel forces back into Virginia. Once in Portsmouth, however, Leslie was informed by Lord Rowdon that his greatest assistance to Cornwallis would be to continue south. He therefore abandoned Portsmouth again and sailed south for Wilmington, North Carolina to effect a junction with Cornwallis and his troops.[8] Enroute to Wilmington he encountered H.M.S. Galatea and was told to proceed further south to Charleston.[9] Leslie arrived in Charleston on December 14, 1780. Thus

Portsmouth had been occupied and abandoned twice by the British and no rebel forces had been drawn north.

A new concern arose for Germain: the French fleet in the West Indies might take advantage of this situation in Virginia and occupy the Chesapeake Bay. He therefore pressed for a third expedition into the Bay that would hold in place as an occupying force.[10] This set in motion the third British combined operational force under the command of General Benedict Arnold. Arnold took 2000 troops and a small naval convoy to Portsmouth with orders to harass rebel forces and merchant vessels. This Arnold did with a vengeance, raiding far up the James River and into the Bay. He captured several vessels, destroyed the shipyard on the Chicahominy River and burned warehouses as far inland as Richmond. He also established a permanent position at Portsmouth to support these interdiction and harassment raids.

The French made their naval presence felt on February 8, 1781 with a brief reconnaissance of the Bay. This operation was undertaken at the request of the Commonwealth of Virginia, which was feeling the sting of Arnold's presence.[11] Finding the confines of the Bay not to their liking the French continued north to Rhode Island. However the British realized that if the French came once they could well return in force. The naval assets at Arnold's disposal were woefully inadequate to fight off the French fleet.

Clinton realized the peril that the Portsmouth garrison would be in should the French return and promised to send reinforcements to Arnold. Clinton also feared landbased action against Arnold from the rebel forces in Virginia under the command of the Marquis de Lafayette. On March 16, 1781 a squadron under Arbuthnot fought a brief skirmish with elements of the French fleet at the mouth of the Chesapeake Bay, forcing the French to withdraw.[12]

The British retained control of the Bay but Arbuthnot quickly returned to port in New York.[13]

Additional troops under General Phillips were loaded on board transport vessels in New York and convoyed to Portsmouth on March 26, 1781. Phillips was tasked with reinforcing Arnold and securing a good anchorage for large warships that was easily defensible.[14] Phillips and Arnold continued to operate out of Portsmouth throughout the spring, raiding up the rivers with their highly mobile amphibious assault troops. This rapid deployment force was able to control the lower Bay and the rivers emptying into it. British strategy was working well at this point, despite Cornwallis' difficulties in the Carolinas. The British troops in Portsmouth were executing their combined operations exactly as Germain had hoped. With Cornwallis not finding the Loyalist support that he had hoped for Clinton ordered him north to Virginia to reinforce the success of Arnold and Phillips. However, Cornwallis was only to come north after securing the Carolinas, with or without the support of the indigenous Loyalist population.[15] This goal continued to elude Cornwallis and left him anxious to attain success on the battlefield.

With that in mind Cornwallis abandoned the Carolinas and marched his troops overland towards Virginia with his fleet of supply and support ships sailing north for Portsmouth. Cornwallis eventually arrived in Virginia on April 17, 1781 and joined forces with Arnold and Phillips at Petersburg. Upon arriving Cornwallis assumed overall command of the troops in Virginia.

By July, with fresh orders from Clinton, Cornwallis looked for a port to occupy for the coming winter. This was to be a permanent post that would be defensible and offer an icefree anchorage for the Royal Navy. Shunning the confines of the Elizabeth River at Portsmouth Cornwallis selected

Yorktown. He was assured that the Royal Navy could control the Bay and protect the supply vessels needed to support his troops in garrison. Utilizing naval vessels, transports, victuallers, prizes, and local coastal craft, Cornwallis moved his force to Yorktown, taking possession of the town on August 1, 1781.[16] British troops occupied both sides of the river and the ships supplying the army rode at anchor in Yorktown's harbor.

On August 6, Lafayette and the militia under his command observed the vessels at Yorktown and the British activity on both shores. Although surprised that Cornwallis was at Yorktown he immediately dispatched a letter to General George Washington informing him of the situation and advising: "Should a fleet come in at this moment, our affairs would take a very happy turn."[17] This tactical reconnaissance was the beginning of the end for the British.

Since securing the area in August the British had been fortifying the town for a possible attack from the landward side. They erected earthworks around the perimeter of Yorktown as well as a series of outlying star forts. On the Gloucester side of the river they also erected a smaller defensive perimeter so that they could control the narrow "pass," the stretch of water between Tyndall point and York point (Figure 2). The garrison carried out communications with New York by sea and continued to receive supplies along these same ocean routes. By the end of August, however, the situation had changed.

On August 28 the French Fleet arrived from the West Indies. The French commander, the Comte de Grasse, brought his fleet to Lynnhaven Bay, just inside the capes at the entrance to the Chesapeake, in an attempt to trap the British forces at Yorktown. The French also brought troops and supplies at the behest of General Washington. Washington also hoped to use the

French fleet to his advantage. When Cornwallis moved his forces to Yorktown earlier in the month Washington had the tactical opportunity he was waiting for.[18] On September 5, 1781 the Royal Navy fought a fleet action against the French who were allowed to come out of the Bay and form line of battle. Although neither side did significant damage to the other the British retired from the field, leaving the French in control of the entrance to Chesapeake Bay.

The French then sent a squadron under Admiral the Comte de Barras to the mouth of the York River while the main body of the fleet retained its position at Lynnhaven. Upon seeing French warships off the river mouth Cornwallis realized his worst nightmares had come true. The British began to take weapons and ammunition from the vessels in the harbor to bolster the land defences.[19] With the French closing off the Bay to either reinforcements or escape the transport ships attached to Cornwallis' army took on several new roles as the British went over to the defensive. These ships were no longer needed to transport troops to a new point of attack or to carry additional supplies to the army ashore. The British were no longer a mobile assault force. At this stage in the battle these vessels were used as floating depots and work platforms. They also offered means of escape should the opportunity arise.

The chance for the British forces to escape never arose. Washington was holding positions above the British garrison in New York. After feigning an attack on New York and leaving a token force behind, General Washington made a rapid overland march from the northern battlefields to Virginia. The French troops brought up from the Indies on de Grasse's ships were put ashore on the James River side of the peninsula and the land forces needed to assault Yorktown began to coalesce into a siege army. The French also provided the heavy siege artillery needed to reduce the fortifications that the British had erected as well as the expertise in siege warfare that the Americans lacked. Cornwallis was torn between attempting to escape and holding firm at Yorktown. Placing his trust in the Royal Navy to come to his relief he ordered the fortifications strengthened and elected to hold at Yorktown. Despite the differences in opinion between the army and navy commanders over the Royal Navy's role in the campaign the navy was still considered the protector and provider of the Southern Army, even in the eyes of its detractors. On September 16, Cornwallis notified Clinton that he would, and could, hold onto Yorktown.[20] By September 28 the French and American forces had invested Yorktown by land. The French fleet had already sealed of the entrance to the Bay and the river mouth and the British garrison was completely cut off. At this point the vessels in the harbor no longer represented a viable option for escape and had no value as troop transports. Most of the ships at Yorktown were merchantmen hired into the service of the Crown as transports, victuallers, and supply ships (See chapter 3). Most were lightly armed and had no chance of fighting their way clear of the French fleet. With the chance of of escape by sea gone Cornwallis stripped the remaining weapons and ammunition from the warships and armed merchant craft and added these weapons to his defensive line ashore.[21] Several vessels were prepared for use as fire ships in the hope that they would drive the French squadron from the mouth of the York River, allowing the trapped fleet at Yorktown access to the Bay and a chance to sail north up the Chesapeake. This incendiary raid took place on the night of September 22, led by Captain Palmer of the Royal Navy aboard a design dedicated fireship, H.M.S. Vulcan. The raid failed, however, when a captain of one of the converted merchantmen ignited his ship prematurely allowing de

Barras and his squadron to slip their anchors and drift out into the Bay.[22] This was the last offensive naval action undertaken by the British at Yorktown.

Prior to this abortive assault, however, Cornwallis had begun to employ a somewhat expensive but standard tactic to protect the river side of his position. He scuttled several merchantmen in an arc along the beachfront at Yorktown to impede any attempts that the French might make at an amphibious assault. The British had done this before, at Savannah, Narragansett Bay , and in the Delaware River.[23] This operation was begun on September 16, the day that Cornwallis assured Clinton that he would hold until relieved. A Hessian mercenary officer, Captain Ewald recorded the date in his journal as the day ten vessels were sunk as "barriers."[24] St. George Tucker, a local citizen, also made note in his journal on October 2 that "I could also discover that the British had sunk several square rigged Vessels near the shore at the distance of one hundred and fifty, or two hundred yards from it...."[25]

Not all of the support ships were scuttled in this operation and those still afloat performed other tasks to aid the army. Some of the vessels in the harbor served as work platforms for the manufacture of wooden timbers for the earthworks and gun pits. Others served as repair shops and as stationary supply depots. This direct logistical support had occurred throughout the campaign and was an expedient at Yorktown where the size of the post was rather restricted and work space was at a premium (See chapters 4 and 5).

Also in accord with British combined operations doctrine was the positioning of warships to provide direct fire support for the troops ashore. The five warships present at Yorktown were used to support the defenses on both sides of the river. H.M.S. Charon, the flagship, was slightly above Yorktown to support the redoubt manned by the 23rd Welsh Fussillers. This was to cost the British their flagship when the French and Americans began their bombardment of the entrenchments on October 9. On October 10 a heated round of solid shot from a French battery landed in the sail locker of the Charon and set her ablaze. She drifted to the Gloucester side of the river, smashed into the transport Shipwright and ignited her, and then burned to the waterline. Only her sinking stopped the fire.[26] Artillery fire continued to damage the ships throughout the siege.[27] Although some of these vessels were sunk no accurate count was taken of these losses. Additional ships were scuttled following the opening of the bombardment but the French assault from the river never materialized.

By mid-October the siege lines had tightened and numerous outlying British positions had been captured. The heavy siege guns kept up a constant rain of shot and shell and Cornwallis' casualties slowly mounted. With no relief in sight Cornwallis made his only escape attempt of the battle. On the night of October 16 the British attempted to ferry their troops across the river to the Gloucester side, where the investing French forces were weaker. It was hoped that once on the north shore the British could break out and march north with the bulk of the American and French forces trapped south of the York. This plan failed when a savage squall blew down the river capsizing several of the small boats being used and drowned dozens of soldiers. The operation was cancelled. Banastre Tarleton the British cavalry commander, knew that this was the last gasp of the Yorktown garrison.[28] Although Clinton had sailed a relief convoy to sail for Yorktown on October 19 Cornwallis was unaware of this fact.[29] With mounting casualties and dwindling supplies Cornwallis faced disaster.

Unable to break out of the trap that Washington had sprung, Cornwallis elected to surrender and save his army to fight another day.

His fleet however was another matter. No longer needing the ships that remained afloat for support services Cornwallis ordered the ships scuttled to prevent their capture. Although most of the captains appeared to have complied with this order several did not.[30] This was due to the fact that the merchant vessels were privately owned and only hired into temporary service with the crown.

On October 19, 1781 the British garrison formerly surrendered. The once proud British Southern Army was defeated and the fleet that had supported it was at the bottom of the York River. Title to all vessels, both sunken and afloat, was given to the French in the formal surrender document.[31]

The naval support for the southern campaign had been a success for almost two years. Although the joint action of the army and navy had suffered under strained relations and divided command the combined operations tactics had been well executed. The only failure was at the very end; the French fleet had been able to control the entrance to Chesapeake Bay when the British needed it most. The original southern strategy of the British had been predicated on a non-existent naval force under rebel control. Cornwallis had made good use of "his" fleet until he decided to wait for relief rather than attempt to escape either up the York River or out into the Bay and then northward. The hired merchant vessels had performed their given tasks well and served a useful purpose even when they had been scuttled as barriers. Although the British lost their final battle in the campaign, their use of merchant vessels and naval power to sustain and protect and army ashore would become a model for other armies in other wars. The repercussions from this defeat would continue for years, as would the settlement of losses accrued by the merchant ship owners whose vessels were sunk at Yorktown. Despite the fact that these ships were insured by the crown upon entering service very few of the owners were ever compensated for their loss. On his return voyage to England Lord Cornwallis was pursued by a French privateer; fearing capture he hurled his documents overboard, including vessel roles and losses at Yorktown.[32] Without this documentation the owners of the merchant ships lost at Yorktown were never to receive the restitution that they deserved for their sacrifice in the service of the crown.

FOOTNOTES

[1]John O. Sands, Yorktown's Captive Fleet (Charlottesville: University Press of Virginia for the Mariner's Museum, 1983), p. 2.

[2]John A. Tilley, The British Navy in the American Revolution (Columbia, South Carolina: University of South Carolina Press, 1987), pp. 75-79, 92-96, 101, 111-112, 138, 161.

[3]Germain to Clinton, 27 September 1779, Clinton Papers, cited in Sands, Yorktown's Captive Fleet, p. 6.

[4]Germain to Clinton, 8 March 1778, Clinton Papers, cited in Sands, Yorktown's Captive Fleet, p. 7.

[5]Ibid., p.9.

[6]Ibid., p. 10.

[7]Clinton to Leslie, 12 October 1780, Clinton Papers, cited in Sands Yorktown's Captive Fleet, p. 11.

[8]Lord Rawdon to Leslie, 24 October 1780, Clinton Papers, cited in Sands, Yorktown's Captive Fleet, p. 12.

[9]Gayton to Phillips, 31 December 1780, ADM 1/1839, "Gayton", P.R.O., cited in Sands, Yorktown's Captive Fleet, p. 12.

[10]Germain to Knox, 29 December 1780, Knox Papers, cited in Sands, Yorktown's Captive Fleet, pp. 13-14.

[11]Chevalier Destouches to unknown, 31 March 1781, French Naval Archives, Margy 9420, folios 75-76, Bibliotheque National, Paris, cited in Sands, Yorktown's Captive Fleet, p. 17.

[12]Tilley, The Royal Navy, pp. 217-226.

[13]Ibid., p. 227.

[14]Sir Henry Clinton to William Phillips, 10 March 1781, Benjamin Franklin Stephens, ed., The Campaign in Virginia 1781, 2 vols., (London: B.F. Stephens, 1888), I: 347-350.

[15]Clinton to Cornwallis, 13 April 1781, 30/55, folio 3446, P.R.O., cited in Sands, Yorktown's Captive Fleet, p. 28.

[16]Henry P. Johnston, The Yorktown Campaign and the Surrender of Cornwallis (New York: Harper and Brothers, 1881), pp. 69-70.

17 Lafayette to George Washington, 6 August 1781, Memoirs, Correspondence and Manuscripts of General Lafayette, Published by His Family (London: Saunders and Otely, 1837), p. 425.

18 Tilley, The Royal Navy, pp. 252-253 ; Johnston, The Yorktown Campaign, pp. 97-99.

19 Log of the Emerald, manuscript copy, private collection, n.d.

20 Lord Cornwallis to Clinton, 16 September 1781, Stephens ed., The Campaign in Virginia, II: 157.

21 "The Dohla Journal, 1781", William and Mary Quarterly, 2d ser. 22 (1942) : 244 ; Thomas Symonds to Graves, 8 September 1781, ADM 1/489, folios 454-55, P.R.O., cited in Sands, Yorktown's Captive Fleet, p. 60.

22 John Knox Laughton, ed., Journal of Rear Admiral Bartholomew James (London: Navy Records Society, 1896), p. 117, cited in Sands, Yorktown's Captive Fleet, p. 60.

23 Samual P. Coker, The Maritime History of Charleston (Coker Press) p. ; Sands, Yorktown's Captive Fleet, p. 63.

24 Johann Ewald, Diary of the American War: A Hessian Journal, trans. and ed. Joseph P. Austin (New Haven: Yale University Press, 1979), p. 327.

25 St. George Tucker, "Diary of the Siege of Yorktown, 1781", William and Mary Quarterly, 3d ser. 5 (1948): 391.

26 Log of the Emerald, entry 10 October 1781, manuscript copy, private collection, n.d.

27 "The Dohla Journal", p. 251.

28 Banastre Tarelton, A History of the Campaigns of 1780 and 1781, in the Southern Provinces of North America (London: T. Cadell, 1787), p. 388.

29 Sands, Yorktown's Captive Fleet, p. 88.

30 Log of the Emerald, manuscript copy, private collection, n.d.

31 Johnston, The Yorktown Campaign, p. 188.

32 Thomas Tonken to Commissioner's of His Majesty's Navy, 21 January 782, ADM 49/2, folio 273, P.R.O., cited in Sands, Yorktown's Captive Fleet, . 108.

CHAPTER IV

FIELD INVESTIGATIONS

Description of the Work

The Yorktown Shipwreck Archaeological Project was an innovative and unique excavation of a sunken vessel. A sheet steel cofferdam was used to separate site 44YO88 completely from the surrounding waters. Unlike other projects that used a cofferdam, however, the water was not pumped out. Using a filtration system and intensive chemical treatment the water that remained in the cofferdam was clarified to allow detailed and accurate recording underwater (Figure 3). This approach enabled the archaeological staff to record data in unprecedented detail. The cofferdam was built in 1982 using funds from a grant from the National Endowment For The Humanities.[1] The cofferdam concept was the result of a desire to apply the painstaking methodology of terrestrial archaeology to a submerged site in a hostile environment. Excavation began in 1983 and continued until December of 1988 (see Chapter 1).

With the cofferdam defining the parameters of the site the initial thrust of the project was a thorough excavation of a merchant vessel from the eighteenth century.[2] As the investigation progressed original methods were modified as were project goals. Some initial methods were discarded and several new techniques were added with hard won experience. The original technique of recording in only one square was modified to area excavation due to the size of the timbers in the hull.

The entire site was divided into 5'x5' squares, designated by columns and rows (Figure 4). This system was used throughout the project for recording purposes and as a reference for horizontal and vertical control. A moveable grid of 2" Poly Vinyl Chloride pipe (PVC) was constructed to delineate each square and to serve as scaffolding. This structure prevented disturbance of the site and also prevented sediment disturbance which could greatly reduce visibility. The grid was surveyed into position and referenced to a USGS benchmark located in Yorktown. By recording each artifact within a square relative to this grid structure an accurate position was established in both the horizontal and vertical planes. All material within each square was mapped to scale underwater and numbered according to square designation.

Arbitrary 4" levels were originally used in an effort to establish vertical control and stratigraphy. This eventually led to a stratigraphic shorthand reflected in designation by sediment type and level. This was not stratigraphy in the true sense of the word but was used as a means of designating general levels. Briefly, each artifact recovered was designated by square, sediment type, level within that sediment, and quantity within that square. Exact position was mapped relative to the grid and drawn accordingly. Thus a recovered piece labeled 204-J4-5 would be an item from square 204, in sediment type J, level 4 within that sediment, the fifth piece recovered. This system was used to record each piece recovered in the field log and would become the catalog number for that artifact in the lab. In addition each piece was tagged underwater for mapping purposes. The hull itself was recorded in an entirely different manner as a structurally intact feature. The recording of the hull will be discussed in detail further in this chapter.

A system of slant ranges was also used to verify grid position and to grid recorded artifacts. This system, designated the ABC system, used three tapes pulled from surveyed points on the cofferdam walls. The tapes were pulled to a point and the three values recorded. Plotted on a computer, these measurements translated to a precise point in space on an x,y,and z axes.[3] Although this was time consuming and cumbersome the accuracy and verification each system afforded the other was well worth the effort.

All excavation was done with 4" airlifts powered by a Bauer Compressor. As many as five lifts could be operated simultaneously and each lift could be easily repositioned as needed. Mesh bags were attached to the outflow ends of the lifts to insure that no small objects missed on the bottom were lost over the side. The material in the bags was carefully screened by an archaeologist working topside and each lift was designated by square and level to provide a provenience for any material recovered in the bag.

All material, after being mapped <u>in situ</u>, was brought to the surface, recorded in the field catalog, photographed, and drawn to scale. The objects were then placed in holding tanks of river water until they could transported, in smaller tanks, to a laboratory facility in Williamsburg for conservation and analysis. After analysis the pieces that were to be retained were started on various conservation schedules. Those pieces not to be held for exhibit or study collections were retagged and returned to holding racks underwater at the site. There redeposited pieces were eventually reburied inside the hull when the site was backfilled.

As work progressed it became apparent that there was far less artifactual material within the hull than original test excavation had indicated. An excellent collection of cooperage was recovered. That material provided the coopers at Colonial Williamsburg with several examples of coopering variations that had previously only been theorized. Numerous shoes, small personal items and dozens of empty bottles were also scattered throughout the hull. A few rigging items and a large quantity of line were recovered from the bow in the area of the hull that would have served as the bosun's store. Also a variety of military items were uncovered including three casks filled with over ten thousand musket balls. These rounds were the appropriate caliber for the Brown Bess musket, the standard British shoulder weapon of the period. In addition to these pieces a large quantity of local timber was found lying on top of the sand ballast. Many of these pieces were partially worked into square beams and planks with one example partially adzed into a square. One end of this timber was buried in the sand ballast and the adze was propped against the bulkhead beside it. The chips from this carpentry project were still lying on the ballast pile. It was the hull remains at site 44YO88, however, that made the entire project worthwhile.

With so little documentary evidence of merchant ship design and construction from the eighteenth century the recording of the hull of YO88 in exhaustive detail became the focus of the last three field seasons for the project. After completing the excavation interior of the ship it was decided to disassemble portions of the hull underwater to facilitate documentation of construction features and recording of the hull lines. With over eleven vertical feet of the hull preserved it would be possible to generate a complete set of waterlines for the vessel.

The entire starboard side of the vessel was completely excavated. Both sides of the interior of the bow and stern were totally uncovered and the exterior of the bow and stern on the starboard side were exposed. A small balk was left undisturbed on the port side between the mainmast and the aft end of the forwardmost keelson component (Plates 1 and 2). At this point the bilge ceiling was tagged and recorded in detail, to scale. All frames were tagged, S1-S68 on starboard and P1-P66 on port, using plastic labels to provide constant reference points. With tagging completed, disassembly of the vessel was initiated.

First, all of the bilge ceiling on the starboard side was carefully removed. The ceiling in the bow and stern was then removed from the port side. All strakes were brought to the surface and individually drawn to a scale of 1" to 1'. Special attention was given to graffiti and construction marks, which were also recorded by rubbing graphite onto onion skin paper overlaying the figures. Both masts were unstepped and the sacrificial planking was removed from the exterior of the hull in the exposed bow and stern excavation areas. Sacrificial planking was also removed from the rudder and along the lower edge of the starboard main wale for the length of the hull. All frames were recorded in complete detail including fasteners, molded and sided dimensions (width and thickness), and scarph chock positions. Also all frames were sampled to identify wood type. The stem and stern posts were recorded both inside and outside and all scarphs, fasteners, and wear patterns were completely documented. The keelson was also partially disassembled and two cant frames were removed for analysis. The pump well assembly was likewise disassembled. Samples were taken of bilge residue along the entire length of the keel on both sides of the hull. When all constructional information had been acquired the shape of the hull was recorded.

To record the hull's shape a level baseline was stretched down the centerline of the vessel. Fifteen level lines were then stretched perpendicular to the baseline. At each of these perpendicular lines station data was recorded. A plumb bob and tape were dropped every six inches to generate the points of the hull's curvature. This painstaking recording allowed a set of waterlines to be generated for the entire hull. These lines were worked up on a Computer Aided Drawing and Design system provided by Advance Marine Engineering. With a prime computer design dedicated to naval architecture a highly accurate set of lines was produced (Plates 3, 4, 5, 6, and 7).

The data acquired from the hull remains of YO88 constitutes the most accurate and complete information ever taken from a field project in this country. The data generated by this excavation is, in several instances, totally unique. The Yorktown Shipwreck Archaeological Project provides new insights into merchant vessel design and construction during the latter half of the eighteenth century.

Description of the Hull

The initial site map produced in 1982 reveals a vessel of almost 73 feet in overall length with a beam of slightly over 23 feet (Figure 5). Figures 1 through 21 are at the end of the text. Plates 1 through 7 are in an enclosure on the back cover. Stumps of two masts were visible as were the starboard frame tops, stem and stern posts and the rudder. Also identifiable were two deck beams, two lodging knees, the deck clamp and the top of the wale. With excavation and recording completed five years later the following dimensions have been established for the hull:

Space between perpendiculars:	73′ 1-5/8″
Maximum beam to outside of planking:	23′ 7-1/4″
Depth of hold:	9′ 10″
Draft, fore and aft:	9′ 6″

Given these dimensions, the following formula was used to calculate tonnage, burthen:

$$\text{Tonnage, burthen} = \frac{(L - 3/5\ B) \times B \times B/2}{94}$$

$$= \frac{[73.1325 - 3/5\ (23.725)] \times 23.725 \times (23.725/2)}{94}$$

$$= 176.340 \text{ tons} = 176\ 32/94 \text{ tons}$$

The above formula was the official standard used for computing tonnage of merchant vessels at the time of the American Revolution.[4]

The body plan and lines of vessel 44YO88 depict a boxy, bluff-bowed hull with a very fine run aft (Plate 3). The hull is very flat floored with slack bilges and fairly flat sides. The depth of preservation, slightly over 11 feet in the stern and 9 feet in the bow, nearly coincides with the level of the original waterline, thus precluding accurate projection of tumblehome (inward sloping of the sides above the waterline).

The stumps of both masts were still stepped, providing precise locational information (Plates 1 and 2). The foremast was stepped in an exactly vertical orientation, with its centerline 62′ 7-3/8" forward of the stern perpendicular. The mainmast was raked aft 1.89°, or 1-3/16" aft per yard of mast length, and its centerline was 30′ 11" forward of the stern perpendicular.

The description of the hull remains will start with the keel, exactly as construction would have proceeded. A detailed, straightforward description of the hull will be followed by an analysis of the vessel as well as a consideration of her role in the battle (See Chapter 5).

Keel: The keel is 68′ 2-1/2" in overall length and is made of oak, with no visible scarphs (Plates 1 and 2). The keel measures 14-3/8" in sided dimension and 13 1/4" molded. The original cross-sectional shape of the keel may well have been 14-3/8"square; however, the bottom of the keel exhibits signs of wear which appears to have reduced the molded dimension somewhat. This wear, is particularly evident in the bow, just aft of the stem post scarph. Both the heel and the head, at the bottom of the keel are only 10-1/4" but whether this dimension represents shaped taper or merely wear is open to conjecture. At the heel, at the point where the stem post is fayed on, keel width is once again 14-3/8".

There is no false keel, or shoe, although two bolts penetrate horizontally through the keel at 14" and 3′ 9" forward of the heel. These bolts may have secured a now-missing shoe at some earlier phase of the vessel's career.

The rabbet is let into the keel 1-1/4" below the top. At all measurable points, this dimension remains constant.

Stern post: The stern post assembly is fayed to the keel with a shiplap scarph (Plate 1 and Figure 6). The assembly consists of an inner and outer post, both of oak. The post assembly is raked aft at an angle of 11°. The inner post is 14-3/8" molded at the bottom, tapering to 13" at the top of the preserved surface. A pine fish plate, covering three bolts of 1-1/4" diameter, extends 10-7/8" up from the bottom of the inner post and 6-1/2" down onto the keel. Two bolts penetrate the keel, while the third passes through the post. The fish plate was let into both timbers and protected the bolts that most likely secured a mortise-and-tennon arrangement which further secured the stern post.

An oak filler piece, 4-3/4" at the bottom and tapering to 1-1/4" at 3' 4-3/4" up from the top of the keel, is fitted between the inner and outer posts. At the after edge of this fitting, the outer post is 14-3/8" molded. However, it is only 1-3/4" aft of this joint that the outer post steps down 6-5/8" to form the shiplap scarph to the keel. A single bolt of 1" diameter is present 1-3/4" forward of the after edge of the outer post. The outer post is 14-3/8" molded at the bottom and tapers to 2-3/8" molded at the top of the preserved surface. Sided dimensions for the outer post are 14-3/8" at the bottom and 12" at the top. The inner post is the same up to the rabbet; forward of that point, the inner post is 10-3/4" sided.

Between the after edge of the fish plate and the forward edge of the outer post scarph, a pair of scribed lines divide the exposed keel surface. The top line extends from the forward edge of the fish plate to the outer edge of the rabbet. The rabbet is inlet into the inner post 1-1/4" aft of the forward surface. The rabbet is 2-1/4" deep and is vee-shaped at the uppermost, visible, preserved surface. The rabbet rakes aft at an angle. Draft numbers are inlet directly into the inner post. These are scribed Roman numerals with "VII" being the lowest. The bottom line of the "VII" is 6' 10-3/4" from the bottom of the keel. (This slight deviation from 7 feet is probably due to wear on the bottom of the keel.) The uppermost preserved draft number, "X", is considerably smaller than the other three. "VII," "VIII" and "IX" are all 8-3/8" in height, with the bottom lines being exactly one foot apart. The "X", however, while keeping its bottom line one foot above the one below, is only 2-3/8" high because of the placement of a gudgeon strap above the numeral.

Stem post: Details on stem construction are not as complete as those for the stern, because of the difficult working conditions in the bow and because disassembly of the bow was not possible. However, most features of the stem construction were recorded (Plate 1 and Figure 7).

The stem post is constructed of two pieces of oak fayed together with two filler pieces interposed. The lower segment of the post is fayed to the keel with its aftermost edge 2' 5-7/8" aft of the head. The actual molded dimension of the bottom of this timber is 1' 4-3/4" . This section is 10' 2-3/8" in straight-line measurement, with a sided dimension of 1' at the top. The bottom is situated 1-3/4" lower than the projected keel top.

Securing this union are two iron bands and a fish plate. The aftermost band is 1" forward of the after edge of the stem section. The band is 2-1/4" wide and extends 14 -3/8" from the bottom of the keel, 5-3/8" of which is on the stem post. This band is secured to the stem with three iron bolts of 1" diameter.

Forward of this band 8-1/4" is a pine fish plate which protects three iron bolts, 1-1/4" in diameter. Two of these bolts penetrate the stem in the upper 5" of the plate. The plate is 14" in height and terminates at the bottom (badly-worn) surface of the keel. A seam appears within the inlet recess of the plate, 9" from the top. Between this seam and the bottom of the keel is the third bolt. The scarph arrangement secured by this plate can only be speculated. Just 2-1/2" forward of the plate is a second, longer iron band. Although this band is also 2-1/4" wide, it is 1' 10-3/4" in length and begins at the bottom of the keel, with 14" of its length extending above the bottom of the post. Four bolts of 1" diameter are fastened through the band into the stem with three more of the same size passing into the keel. The head of the keel is only 8-3/8" wide forward of this band.

The second upper timber in the stem is fayed to the lower timber 5' 4-3/4" above the bottom of the keel. It joins along a 38° angle on a surface 3' 10-3/4" in length. Of the total length, 10-3/4" is a filler piece at the forward, upper end. A stopwater is present at the bottom end of the filler and is 1" x 1" in size.

The upper timber is preserved to 8' 11-7/8" above the bottom of the keel. The width of the stem at the preserved level, at the after facet is 11-3/4". This piece extends 1' 3-3/8" forward and narrows to 9-3/8" sided. At this point the timber drops 6" to the lower stem section, forming a step which extends 2-3/8" horizontally before terminating with a sided measurement of 8-3/8". A second step is formed here with a 10-3/4" drop to the gripe. At a point 3' 9-5/8" down the seam between the gripe and stem is the second filler, a 1' 6" by 2-1/4" piece of oak.

The rabbet leaves the keel and rises along the two timbers forming the stem at a point 3' 7-1/4" from the head of the keel. The rabbet rises in a curve that is becomes more acute as it rises. It terminates at the top of the post only 1-1/4" forward of the after facet of the stem. The rabbet is 2-1/4" deep at this point.

The gripe is a solid timber of oak with the beginnings of the cutwater worked into its forward edge. At the lowermost end of the gripe is a puzzling arrangement where it joins the keel. A triangular series of lines is found 2' 2-3/8" down the aft edge of the gripe. The grain of the gripe continues into the triangle, indicative of these lines being scribed onto the wood. This triangle extends slightly aft of the forward iron band and overlaps the keel by 13-1/4". This triangle ends over a 1-1/4" gap between the head of the keel and the aft edge of the gripe/cutwater. This gap may have been caused by the wear and tear evident along the bottom of the keel at this point, which gives the impression that the keel is tapering upwards. However, the damage evident along the sides reaffirms the worn and battered theory. The gripe/cutwater is 8-3/8" wide at the top and 10-1/4" at the bottom.

The draft numbers in the bow are also Roman numerals and are scribed in the same way as those on the stern post. They begin at "VI" and end with "VIII", the last preserved numeral. All are inlet into the stem pieces. The bottom of "VI" is only 5' 6" from the projected bottom of the keel. Even allowing for the wear on the keel, these numerals are apparently not as accurately placed as those in the stern. The bottom line in each subsequent numeral, however, is exactly one foot above its predecessor. These numerals are not all exactly the same height, "VI" and "VII" being 7" in height and "VIII" being 7-1/8".

To this point, construction has been fairly standard and straightforward. The next set of timbers, however, apparently make 44Y088 unique. The arrangement of the transverse timbers and cant frames is previously undocumented.

Stem and stern chocks: Bolted directly to the stern post and stem post assemblies are a series of transverse horizontal timbers; in the bow these serve the function of an apron and are, therefore, designated apron chocks. The stern timbers replace the sternson and have been designated transom chocks (Plates 1 and 2 and Figure 8). In both bow and stern all of the chocks are fashioned from oak.

The apron chocks begin 11-3/4" forward of the first floored frame, S61 (Plates 1 and 2 and Figure 8). The lowest chock butts against the deadwood, then the chocks follow the curve of the stem directly to the topmost preserved level. There are seven chocks in this arrangement, all of which are unique in shape. (Note that the uppermost chock is not shown in this drawing due to its almost complete deterioration.)

The uppermost chock illustrated, chock "B", is the widest. As the chocks descend, they angle inward to accommodate the cant frame arrangement. The thickness of the chocks, a relatively consistent 9-5/8", was established by probing the gaps between them. Every chock except "F" is through-bolted with 1-1/4" diameter iron bolts running directly into the stem assembly. "F" is held only by treenails. Treenails are also present in the other chocks, but serve to secure the hood ends of the exterior planking. The chocks are slightly curved to permit the bow to sweep aft into the run of the hull. Taken as a whole, this arrangement resembles a segmented apron which extends forward of the first floor.

In the stern the chock construction technique is mirrored almost exactly, with only minor variations. Four transom chocks are preserved, all through-bolted directly to the stern post assembly with iron bolts 1-1/4" in diameter.

The lowermost chock, Transom "D", overlaps the top of the upright portion of the timber assumed to be the stern knee (the complete timber could not be examined without further disassembly of the hull).

Although the general configuration of the transom chocks is similar to those in the bow, the shapes of the stern chocks are quite different. All four angle inward as they descend but they are much narrower than the bow timbers due to the sharper lines of the stern. In addition to one iron through-bolt each, all four transom chocks contain numerous treenails which attach the hood ends of the outer planks as they head into the rabbet. The average thickness of the chocks, as in the bow, is 9-5/8".

In the stern cant frames radiate from the transome chocks, but only two actually butt them. This is a result of the more vertical position of the stern post and the more tapered nature of the chocks.

Interior bracing: Only two other transverse timbers survived within the hull (Figure 5). In the bow, the lowermost breast hook was still attached, just at the uppermost level of bow preservation. This timber, shaped from a single crook of oak, measured 12' 6" from end to end across its curve. The width at the widest point, slightly to starboard of the centerline, is 14-3/8".

A small filler was fitted between the breast hook and apron chock "A". The breast hook was fitted directly against the frames and bolted into them with a total of seven iron bolts, all 1-1/4" diameter. The ceiling planking bevelled into the underside of the breast hook. This timber was crudely sided but was, at its thickest point, 1' 6" in depth.

In the stern, an oak crutch, also made of a single oak compass timber, was still attached, just below the level of preservation. The crutch measures 10′ 7-1/8" from end to end across the curve. It too was fitted directly against and bolted to the frames with seven 1-1/4" diameter iron bolts. As in the bow, the ceiling strakes were bevelled into the underside. A small filler was present between the after edge of the crutch and the top of transom chock "D", 3-1/2" below the uppermost preserved surface. The width of the crutch was 11-3/4" on the centerline, and again the sided dimension was crude and uneven, with an average thickness of 11-3/8".

Deadwood: In the bow a piece of deadwood, "DW5", is discernable between the lowest apron chock, "G", and the first floor, S61 (Plate 1 and Figure 8). It is 1′ in length. The deadwood drops 1′ 1-1/4" aft of S61 and descends aft at an angle all the way to S47. At S61 the deadwood is 9-5/8" thick and is still over the stempost assembly. At S47, well into the run of the hull the deadwood is 6" thick and rests directly on the keel. The width is consistent with the width of the keel and is 14-3/8" throughout. No vertical or horizontal seams are visible. Thus "DW5" appears to be one solid piece of oak.

In the stern the deadwood is comprised of least five oak segments, including the knee of the stern (Plate 1 and Figure 8). There are probably additional segments that were not readily discernible with the hull still intact. The uppermost piece of deadwood, "DW1", starts 1′ 4-1/4" forward of the lower end of transom chock "D" and is 14-3/8" in width. At this point it steps down 1′ 4-3/4" onto the horizontal arm of the stern knee, "DW6". The knee is scarphed to the after face of transom chock "D" and extends up behind it for 10-3/4" . Only 1′ of the knee is visible running downward and the it is secured by two 1-1/4" diameter bolts slightly to starboard of the centerline.

"DW1" runs forward 2' 11-3/8" to S11, the aftermost floor timber. One 1-1/4" diameter bolt is present on the centerline, 7-3/4" forward of S11. Forward of S11 the deadwood steps down 4-1/4" and runs to S13. Forward of S13 it steps down again 10-1/4" . Before reaching S15 a vertical seam is visible that extends down 1' 7-1/8" where it butts a horizontal seam. The next piece forward, "DW2", is 3' 8-1/2" in length and is also 14 3/8" in width. It extends from 1-1/4" aft of S17 to 1-1/4" forward of S19. It has an angled step down between S17 and S19 and overlies "DW3".

"DW3" is 15' 7-3/4" in length, running from S15 forward to S29, slightly aft of the mainmast. It is 14 3/8" wide throughout. At S15 it is 7-3/4" thick and tapers gradually as it moves forward to a thickness of 11-3/8" at S29.

"DW4" is 5' 5-3/8" in length and extends from 1-1/4" forward of S19 to 4-1/4" aft of S24. At S19 it is 10-3/4" thick and angles downward as it runs forward where it terminates with a thickness of 5/8". This piece is also a consistent 14 3/8" wide.

Framing: Frames are denoted S1-S68 on the starboard and P1-P66 on the port (Plates 1 and 2 and Figure 8). S1 and P1 are the aftermost frames with the numbering running forward to the bow. The framing of 44YO88 appears to be somewhat non-standard. In the central portion of the hull, the framing pattern is similar from bow to stern, with the first futtock always aft of its associated floor. The standard convention of reversing the first futtock and floor at the midships frame does not hold true for this vessel. In the extreme ends of the hull the cant frame arrangement also departs from convention (Figure 8). These frames are laid out in a radial pattern, butting against the apron chocks and transom chocks. All of the framing timbers are oak and, while they have well-molded surfaces, are sided very crudely.

Seven sets of starboard frames were found to be bolted together (Figures 9, 10, 11, 12, 13, and 14). These are most likely the master frames. These frames would have been erected first. With ribbands attached to these frames the other frames could then be raised and faired in to create the desired hull shape. All the bolts used in these frame sets were .10' in diameter. The bolted frame pairs are S57/S56, S51/S50, S45/S44, S37/S36, S31/S30, S23/S22, and S17/S16. The placement of these frame pairs shows a somewhat ambiguous pattern (Plates 1 and 2). There are four frames between S17/S16 and S23/S22, then six frames between S23/S22 and S31/S30. There are four frames between S31/S30 and S37/S36 and again it drops back to four frames between S37/S36 and S45/S44. There are four frames between both of the last two paired frame sets, S45/S44 to S51/S50 an S51/S50 and S57/S56.

S37/S36 is the only pair with a bolt running through the floor into the first futtock. The other two bolts in this pair secure the second futtock to the first futtock (Figure 12). S57/S56 has two bolts, both securing the second futtock to the third futtock. S51/S50 has only two bolts as well, fastening the second futtock to the first futtock (Figure 14). S45/S44 has three bolts, all running between the second and third futtocks (Figure 13). S31/S30 has three bolts. Two secure the second futtock to the first futtock. The third fastens the third futtock to the second futtock (Figure 11). S23/S22 has two bolts attaching the second futtock to the third futtock (Figure 10). S17/S16 has three bolts. One attaches the second futtock to the first futtock. The other two fasten the second futtock to the third futtock (Figure 9).

Starting in the bow at S61, the first floor, first futtocks S60 and S58 butt directly against the keel and deadwood (Plate 2). However, the next first futtock, S56 is offset 10-3/4" from the starboard edge of the keel. This offset is carried through on all first futtocks with only minor variations in distance from the keel. This offset ends with S18. At this point S18, S16, S14, and S12 again butt the keel/deadwood arrangement.

The floor timbers are shorter towards the bow and stern with the midships floors extending the farthest outboard before being scarphed to the second futtock. All futtocks are scarphed with chocks and fastened vertically with treenails, 1-1/8" in diameter. These scarphs are not uniform in dimension. The futtocks do not line up and are offset on the lower preceeding futtock, reflecting the crudity of the sided dimensions. In the bow and stern floors extensive use was made of fillet pieces (Plates 1 and 2 and Figures 9, 10, 11, 12, 13, and 14). These fillets, triangular chocks under the floors, are present in S61, S59, S57, S55, and S53 in the bow. There are no floor fillets in the run of the hull. The fillets resume in the stern with S23 and continue aft with S21, S19, S17, S15, S13, and S11. Although these fillets do not, in all cases, fay to the underside of the floors in the vessel's present condition, they probably did when the ship was built. Putrification, known to have occurred before the vessel was lost, most likely deteriorated these pieces to their present configuration. These fillets are all secured to the floors with oak treenails, 1-1/8" in diameter.

In contrast to these fillets in the bow and stern floors, top fillets are present on the first futtocks in the center portion of the hull (Plates

1 and 2 and Figures 9, 10, 11, 12, 13, and 14). These top fillets are affixed to the heels of the first futtocks. They provide a smooth plane in line with the upper sided surface of the floors, for the bilge ceiling to be laid to. These top fillets are present on futtocks S54, S52, S50, S46, S44, S40, S38, S36, S32, S30, S28, S26, S24, S22, and S20. Futtocks S48, S42, and S34 do not have fillets, the timber used in these cases being sufficiently thick in the molded dimension. Floor S31 has a small shim, 5/8" thick, attached to the upper surface to ensure a smooth plane for the ceiling.

Each floor and the futtock immediately aft are considered a frame set (Figure 15). Centers are taken from the center of these two members combined, including any space in between. Room and space has been calculated for the floor/first futtock and the space aft of this set. Room and space varies from 2′ 6" to 2′ 1". Frame centers are 2′ 4-1/4" on average with a range of 2′ 6".

Cant Frames: The cant frame arrangement on this vessel is a radial pattern (Figure 8). In the bow on the port side, P61, P62, P63, P64, P65, and P66 comprise the cants. P61 butts against deadwood, "DW5", and is partially fitted against the forward face of P60/S61, the forward most floor. The heels of P63, P65, and P66 are fitted against the apron chocks. P64 and P62 do not butt the apron chocks. P65 has a notch allowing it to fit over the protruding port upper corner of apron chock "F". These frames are not fastened to the apron chocks and are so tightly fitted together that no longitudinal fasteners could be discerned. The sided dimensions on these frames seems somewhat cleaner than it does on the starboard frames. Treenails, 1-1/8" in diameter, secure these cant frames to the planking with iron bolts, 1-1/4" in diameter running into the frames from the breasthook.

On the starboard side of the bow there is one more cant frame than on the port side. S62, S63, S64, S65, S66, S67, and S68 make up the cant arrangement on the starboard. S63, S65, and S67 do not abutt the apron chocks. S62 butts deadwood, "DW5", and is fitted tightly against S61 towards the lower end. S66 is notched to fit around the protruding upper starboard corner of apron chock "F". As on the port side these frames are held to the planking with 1-1/8" treenails and no fasteners were found either between the frames or between the apron chocks and the frames. Iron bolts, 1-1/4" in diameter were in the frames there they had secured the breasthook. On both the port and starboard sides the two forwardmost frames, P66 and S68 are fitted tightly against apron chocks "A", "B", "C", "D", and "E" with their heels resting on the top of apron chock "F".

The cant frames in the stern are similar but are not as radial in their layout due to the sharper curve of the stern (Figure 8). Most of these cants butt against deadwood "DW1". Only two of the cants actually butt against the transom chocks, P1 and S1. On the port side P1, P2, P3, P4, P5, P6, P7, and P8 make up the cant grouping with P9 being the aftermost floor. P1 is tightly fitted against transome chocks "A", "B", "C', and "D". P2 is slightly below the lower end of "D" and is fastened at the heel to the heel of S3 with a treenail. This joint is over the crook of the knee but is not affixed to the knee. P3, P5, and P7 do not reach the deadwood. P4, P6, and P8 are all fitted down to the port edge of "DW1". These frames are fastened to the planking with treenails, 1-1/8" in diameter, with iron bolts from the crutch running into the frames. No horizontal longitudinal fasteners were discerned in any of these frames.

On the starboard side, as in the bow, there are more cants than there are on the port side. One of these, S10, is probably present due to the greater depth of preservation on the starboard side. S1, S2, S3, S4, S5, S6, S6, S7, S8, S9, and S10 compose this cant group. S2, S4, S6, and S10 do not reach the deadwood. S3 is butted against P2 and S5, S7, S8, and S9 all have their heels fitted against the starboard edge of "DW1". S1 is fitted against transom chocks "A", "B", "C", and "D". These frames are all attached to the planking with treenails, 1-1/8" in diameter, and have iron pins from the crutch running into them.

Keelson Assembly: The keelson assembly consists of four components with an overall length of 56'10-5/8" (Plates 1 and 2). It extends from S61, The forwardmost floor, to S13, the floor adjacent to the aftermost floor. It has a consistent width of 14 3/8" and sweeps upward in both the bow and stern. As it sweeps upward it tapers considerably. All upper edges are chamfered to prevent splitting.

The largest component is "C'. "C" is 50' 4-3/4" in length and extends from S57 aft to 3-5/8" beyond the after edge of S15. "C" is only 3-1/2" thick at the forward end which falls in the center of S57. As it sweeps downward amidships it reaches a thickness of 1'6-5/8" at S31, just forward of the main mast. Here it begins it upward sweep toward the stern and tapers back down to 4-1/4" in thickness at S15. This component is pine, one of the few timbers on the vessel not made of oak.

Fayed to the top of component "C" is a thin strip of oak, designated component "B". "B" is 4-1/4" thick throughout and is 46' 1-3/4" in length. "B" extends from just aft of S53 in the bow to the center of S15 in the stern where it is secured with two 1-1/4" diameter through bolts.

Component "A' is scarphed to the forward end of "B" at floor S51 and extends forward 12' 4-1/4" to the center of floor S61. It is secured here by one 1-1/4" diameter iron through bolt. The forward edges were notched to accept small bilge ceiling planks that covered the apron chocks. At the scarph over "B", "A" is 11-3/8" thick forward of "B" and 7-1/4" thick at it's extreme aft end. "A" is secured here by two iron through bolts, both with a diameter of 1-1/4". "A" sweeps upward as it runs forward with a slight curve. At the aft end is 14 3/8" wide and narrows slightly as it runs forward. S61 is angled to accept it at the forward end. This component is oak and has the mortise for the foremast 4' 6" aft of its forward end. Two iron pins run athwartships through "A", one at the corner of the "A/B" scarph and the other slightly forward of the mortise. Both of these pins are 1" in diameter.

The final component in the keelson assembly is "D", a piece of oak that forms the mortise for the main mast. "D" is 4' 10-3/4" in length and 6" in thickness throughout. It is 14-3/8" wide and is situated between S32 and S28. The forward edge of the mainmast mortise is 1' 9" aft of the forward edge of component "D".

The keelson is through bolted at every floor from S61 aft to S51. All of these bolts are 1-1/4" in diameter. Since component "B" was not removed only these frames were actually examined. In all likelihood, however, this pattern would have continued throughout the keelson assembly's length.

Five deck stanchion steps are placed along the keelson assembly. Four of these are on component "B" and the fifth is on "D". The forwardmost stanchion step is centered 4' aft of the after end of "A", over S47 and S48. It is composed of two C shaped pieces of oak, each secured by three square-shanked spikes with 1/4" x 1/4" shanks. Although each step varies slightly all are made up of two C shaped pieces held in place with three square shanked spikes. The second step is centered 9' 6" aft of the first step and the third, on component "D", is centered 9' 6" aft of the second. The fourth step is centered 7' 6" aft of the third step and the fifth step is centered 7' aft of it. The fourth and fifth steps are both affixed to component "B".

Mast steps and masts: Both the foremast and mainmast are stepped directly into the keelson assembly with simple mortises (Plates 1 and 2 and Figures 16 and 17). Both masts are pine and are secured in their steps with chocks and shims. Both masts are octagonal and taper down toward the heels. Both have iron bands around the bottom and had coins present in their steps in the finest tradition of the sea.

The foremast has no rake and is 62' 7-3/4" on centerline, from the stern perpendicular (Figure 16). The is octagonally sided with facets being 6-3/8" at the top preserved surface and 6' at the iron band. The band is 2-3/8" wide and is 1' 3" above the mast heel. Diameter of the mast is 1' 2-3/4" at the top and 1' 2-3/8" at the band. 3" below the band the mast is shaped down to fit the step with the tenon width being 4-7/8" and the length 1' 2- 3/8". The mortise is 6" deep on the aft end and 5-3/8" deep on the forward end. It is 1' 7" in length including the space for the two oak chocks present in the forward edge of the mast. A heavy residue of pitch was present on the bottom of the step, along with the remains of a silver coin. Unfortunately the coin was too badly deteriorated for identification.

The mainmast is centered 30' 11" forward of the stern perpendicular (Figure17). It is raked 1.89 degrees (1' 3/16" rake per yard of length). The octagonal shape has facets measuring 7" at the uppermost preserved surface tapering to 6-1/4" at the band. The band is 1' 3" above the heel and is 2-1/2" in width. Diameter of the mast at the top is 1' 4-7/8" tapering to 1' 3-7/8" in diameter at the band. Directly below the band the mast is shaped down to form the tenon. The tenon is 6-1/4" wide at the top and 6" wide at the bottom. Tenon length is 1' 2-3/8". The mortise depth is 7-3/8" and is the same both fore and aft. Length of the mortise is 1' 8- 1/2". There is one oak chock on the forward face of the mast and an oak shim on the after face. The after face of the tenon is bevelled forward with the shim worked in. A small depression was present on the mast heel and held a badly bent copper coin. By size and weight it would appear to be an English half penny. At this point conservation of the coin is still in progress.

Deck Structure: A minimum of articulated deck structure is present in the starboard after quarter (Figure 18). Two deck beams and the remains of three lodging knees are present from S18 to S30. Fragments of a third beam are disarticulated but present at S30. All the other timbers were slightly displaced but still resting on the deck clamp which is still firmly affixed to the frames. The deck beams were in notches, inlet 1-5/8" into the clamp. All of the deck support timbers are of oak.

The oak clamp is 4-3/4" wide on the top with a 9-3/4" vertical dimension. The lower edge was 5/8" in width with a chamfered edge adjoining the vertical surface. The lodging knees that are still overlapped, TT1006 and TT1007 both have wedges fitted into the top of the crook. They are both through bolted to beam TT1000 in a radial pattern and the remains of a similar pattern were present towards the remains of beam TT1008. The knees are also through bolted to frames S19 through S29. All iron bolts were 1-1/4" in diameter. TT1006, the inner knee, has two notches cut into it to accept a pair of ledges. A single nail is toed into each notch to secure the ledge. These notches are different in size. The forward notch is 4-1/2"x 2-3/4" and the after notch is 2-5/8"x 3-5/8". Both nails are square shanked with 1/4"x 1/4" shanks. These notches are 7-1/4" apart.

The aftermost knee, TT1003 is badly worn and is the outer knee in a pair that is missing the inner knee. It is also bolted to the frames and shows a radial bolting pattern to the after side of beam TT1004. Only fragments of the inner knee for this pair are present.

The remains of one other lodging knee, TT1010, was found disarticulated from the hull. It was inboard of frames S34, S35, S36, and S37. Only the longitudinal arm of this knee was present.

The beams are all badly deteriorated with TT1004 being in the best condition. It was 9-5/8" wide by 9-3/4" thick, preserved length being 3' 2-1/2". Two square shank spike holes are present on the upper surface. The first was 1' 7-1/4" from the preserved outboard end. The second was 10-3/4" inboard of the first. Both of these holes were 1/2"x 1/2". No deck planking was found with this structure. However, numerous deck planks were found within the hull and all were pine.

Main Wale: The main wale assembly is partially preserved along the starboard side of the hull. It is composed of three pieces, "W1", "W2", and "W3". A small fillet is preserved below the lowermost strake, "W3", and gives a smooth lay to the sacrificial planking. All the components of this assembly are oak.

"W1" is present from S11 to S49. It is 10-3/4" wide and 5" thick. From S11 to S19 it is composed of two pieces running longitudinally with felt caulking in between. Each of these pieces is 2-1/2" thick. "W2" extends from S8 to S56. It is 1' wide and 5" thick. "W3" extends from S8 to S59. Both of these strakes extend beyond the afore mentioned frames but have been faired back into the hull at those points. The fillet piece also tapers to a feathered end at those points. At it's widest dimension the fillet is 5-1/2". At it's thickest point it is 1/2".

Bilge ceiling: The bilge ceiling was completely intact on the starboard side prior to removal. From the keelson to the clamp sixteen strakes and a limber board were present at midships. As the hood ends tapered down in the bow and stern, several strakes were dropped. The ends were bevelled into the underside of the transverse bracing timbers. In the stern the strakes ran into the crutch with shorter pieces covering the cants in the lazarette area formed by S11 stepping down to the deadwood.

Three short ceiling strakes were fitted to the forward end of the keelson, covering the lower apron chocks. These fitted into the inlet notches on the forward edges of keelson component "A". All ceiling planking is oak and is secured to the frames with oak treenails, 1 1/8" in diameter. Iron spikes with 1/2" x 1/2" square shanks are also present. These spikes were used in pairs at the butt ends of each plank. They were also present in a few other locations that appear to be entirely random. The seams, while not caulked, were extremely tight and had no vent spaces or gaps. The average thickness of the ceiling was 2 1/2" although this varied considerably, particularly where complex curves were found.

The ceiling planks featured numerous graffitos and construction marks The limber strake was composed of 12 sections, 10" in width. These planks were extremely tight and had finger wells on the after ends. At S25 to S27 a collar was fitted around the lower end of the pumpwell. This was spiked to the floors (See pump well section). Other than this collar all the planks in the limber strake were unfastened except for the two on the extreme fore and aft ends. These were secured with two square shanked spikes at each end. These spikes were 1/2" x 1/2".

Exterior Planking and Sheathing: All exterior planking is oak, spiked and treenailed to the frames. This is straight run planking. It rises to the bow with the use of steelers and diminishing hood ends. In the stern the planking runs to the stern post assembly with steelers in the quarter. All hood ends are spiked with 1/2" x 1/2" square shanked spikes. Liberal use of treenails further secured the ends to the transom chocks and apron chocks. These treenails are 1 1/8" in diameter.

The hull is covered with sacrificial planking made of pine, 1-1/4" thick. This is laid over a felt and tar undercoat. The sacrificial planking is secured with small tacks, 1/4" x 1/4". The sheathing covers the keel, stern post and stem post as well as the hull planking. Draft numbers, identical to the ones in the posts, are scribed into the sacrificial planking. The rudder was also sheathed with the gudgeon and pintle straps left exposed.

Rudder: The rudder is still shipped, although it is displaced upward 6". It is over to port 9 degrees (Figures 6 and 19). The rudder consists of six pieces of oak, with two gudgeon and pintle arrangements intact. At the heel the rudder measures 3' 6" and tapers to 2' 7" at the upper most preserved surface of all components. It is a consistent 9-3/4" in thickness and the heel is perfectly horizontal.

Rudder component "A" is the bearding piece, separate from the stock. "A" is 7-1/8" wide at the heel and tapers to 4-3/4" at the upper pintle. "A" is 5' 7-3/4" in overall length and is not found above the upper pintle. The bevelled edge tapers from 4-3/4" to 4-1/2" as this piece goes upward. "A" also forms the cavity that houses the lower gudgeon and pintle arrangement. The bottom of the lower pintle shaft is butted directly against "A" since the rudder is upwardly displaced. "A" serves as a woodlock in this instance and prevents the rudder from being completely unshipped.

The rudder stock, "B", is the largest timber in the rudder. It is 1' 5/8" wide at the heel and the top. "C" is 8-3/8" wide at the heel tapering to 4-3/4" at the upper end. "D" is 9" in width at the heel and 10-3/4" wide at the top. A narrow rubbing plank, 2-3/8" in width covers the trailing edge of the rudder. It is slightly rounded on its sides and bottom. Five iron bolts hold the entire rudder assembly together. These bolts are all 1-1/4" in diameter and run horizontally fore and aft.

The two remaining pintles are located 2' 7" and 6' 4-3/4" above the heel of the rudder. The lower pintle was cleaned of all concretion and measured in detail in situ. The shaft of the pin is 10-7/8" in length and 2-1/4" in diameter. The head of the pintle is 3-5/8" in thickness and 4-3/4" in length. It steps down to the strap which is 3" wide. The strap angles down slightly as it runs aft. The strap is secured to the rudder with nine iron spikes. These spikes have heads with a 1" diameter and square shanks, 1/2"x 1/2". The strap for the upper pintle is the same width but has only seven spikes securing it to the rudder. The lower strap is 2' 10-3/4" in length, the upper strap is 2' 8-3/4" long.

Two gudgeons are still intact, as are the remains of a third strap. The lowermost gudgeon is 5' in length and 3/4" thick. Its strap is 4'1" long and 3" wide. It is secured by nine iron spikes, three in the post and six in the hull. These are all 1" in head diameter with 1/2" x 1/2" square shanks. The strap angles upward and bends out to conform to the curvature of the hull. The top of the gudgeon is 2' 6-1/4" above the heel of the keel.

The second gudgeon top is 6' 2-5/8" above the heel of the keel and has a strap 3'10-3/4" in length. The strap is 3" wide and is secured with nine spikes. These spikes are the same as the spikes in the lower strap, but in this case four are in the post and five are in the hull.

The top of the third strap is 10′ 3-5/8" above the heel of the keel. It too is 3" wide and is secured by six spikes identical to the other two sets. Three of the spikes are in the post and three in the hull. This strap is 2" 3-5/8" in length and also angles upward, bending out forward of the post to conform to the hull.

Pump well: The pump well structure was examined in situ, by Thomas J. Oertling of the Institute of Nautical Archaeology. His description of the remains is as follows:

> The well was constructed in the following manner: a rectangular chock was nailed to the top rider of the keelson to which the spacer boards were nailed such that their outboard sides were flush with the sides of the keelson. Presumably a similar chock was nailed to the underside of the deck to provide an attachment point for the upper ends of the board. The boards of the fore and aft walls were notched to fit over the keelson/rider assembly and extended outboard of the keelson about 5-6 inches. Each plank had two nails fastening it to the side of the keelson/rider assembly. The fore and aft walls were held in place at the rider keelson by two pieces of quarter round (2 x 3 inches) placed behind the aft wall and before the forward wall and each nailed into the top of the rider keelson. The six major planks of the well were preserved to a height of ca. 5′ 7" above the top of the rider keelson. As the table shows, the fore and aft walls were narrower at the top than at the bottom.
>
> The lead tube found in the starboard chamber was without a doubt a part of the pump tube...

Please see appendix A for Mr. Oertling's report and tables.

FOOTNOTES

[1] National Endowment For The Humanities, Grant Application, 1981. Yorktown Shipwreck Archaeological Project files, Virginia Department of Historic Resources, Richmond, Virginia.

[2] Ibid.; John D. Broadwater, personal communication, May, 1976.

[3] Warren Reis, "The Phantom Pyramid", soft ware program, 1982. Virginia Department of Historic Resources, Richmond, Virginia.

[4] David Syrett, Shipping in the American War, 1775-1783 (London: Althone Press, 1970), pp. 110-114.

CHAPTER V

ANALYSIS AND CONCLUSIONS

In the final analysis the most significant aspect of the Yorktown Shipwreck Archaeological Project was the documentation of the hull remains. Several unique construction features and the exceptional state of preservation provide an unparalleled view of an eighteenth century collier brig. The recovered data provides valuable new insight into eighteenth century ship design and construction.

The hull of 44 YO88 is solidly built with extremely heavy construction. Bluff bows give way to a full midships section with a fine run aft. With a calculated tonnage of 176 32/94 tons it is convenient to compare YO88 with the 170 ton collier depicted in David Steel's Elements of Naval Architecture.[1] The remains of YO88, with the deck beams still articulated, has a projected depth of hold of 9′ 10" compared to 10′ on Steel's collier. YO88 is also slightly beamier, 23′ 7 1/4" vs. 22′ 11" and shorter by 2′ 7" (75′ 9" for Steel vs. 73′ 1 3/4" for YO88). The intact remains of the main wale, the top of the sacrificial planking and the draft numbers allow for an accurate placement of the waterline, which gives a projected draft of 9′ 6". This is 1′ 6" less than the draft shown by Steel. The broader beam on YO88 probably accounts for this difference. A comparison of body plans shows a remarkable similarity between the two vessels but does not provide an exact match. The bluff bows, full body and fine run aft seen in Steel's collier are, however, readily apparent in the lines generated for YO88 (Plate 3).

Moving away from the overall hull shape to the individual timbers the case for collier classification grows even stronger. The keel, unscarphed oak, is 14 1/2" in width and 13 1/2" in depth. The keel is badly worn along the bottom and was probably 14 1/2" by 14 1/2" when the vessel was laid down. A relatively shallow keel is essential in a vessel designed to sit flat on the bottom, as colliers were. The absence of a shoe, or false keel is attributable to damage and loss rather than to a lack of this timber when the vessel was new.

The stern post is a two-piece structure with a ship lap scarph to fay it to the keel (Plate 1 and Figure 6). The stern post /keel joint is secured by a fish plate covering three iron through bolts. The outer post rapidly tapers as it rises. Although preservation stops at 10′ 2 1/2" above the fayed joint it is possible to ascertain the termination of the upper end. At the most this post would only have risen another 6". This value was discerned by projecting the fayed seam between the inner and outer posts. The angle of this joint would cause the post to terminate at 10′ 8 1/2" above the heel of the outer post. At this point a transom arrangement of some type would have been attached and the construction of the stern gallery begun. However, due to the height of preservation there is no evidence of how this was accomplished. The apparent filler piece between the two posts was probably just that, a filler rather than a structural member.

The stem post assembly is somewhat more complex and not as straight forward as the stern post. The stem itself is composed of two pieces with a third piece, the gripe, bolted to its forward edge. A somewhat unusual feature is the ridge fashioned on the leading edge of the gripe. It is possible that a small piece was affixed here as a separate cutwater but this is purely speculative (Plate 1 and Figure 7).

The scarph arrangement for the stem/keel joint is not known, although a lapped joint of some type appears most likely. This joint is secured by two iron straps and a fish plate. The small piece fitted between the gripe and the stem is another filler, similar to the filler piece in the stern post. The gap at the heel of the gripe was most likely caused by repeated groundings. The purpose of the triangular series of lines is not known, but appears to be some form of construction marking. The wood grain continues across these lines indicating that these lines were merely scribed.

The construction features that are most unusual are found in the extreme ends of the vessel (Plates 1 and 2 and Figure 8). The chocks fastened to the inside faces of the stem and stern post are quite different from documented construction techniques of the day. They are an integral part of the framing pattern in the bow and stern. In the bow these chocks are used in place of an apron. Unlike an apron, which was usually two pieces with the grain running vertically, the chocks are short, transverse timbers and they are not attached to one another. Instead they are individually bolted directly to the stem post and bo not butt against the forward end of the keelson.

In the stern the chocks are also fastened directly to the post and are not fastened together. Here the chocks probably served as a form of transome chock or an additional inner stern post. These pieces overlap the top of the stern knee where as in the bow they butt against a section of deadwood slightly forward of the first floor (Figure 8). These transverse chocks in the vessel's ends are completely unique. No previous archaeological work has revealed similar structure in a vessel and contemporary writings make no mention of this technique.

There were only two other transverse timbers remaining in the hull (Figure 5). In the bow a breasthook was still in place and was bolted directly to the frames. In the stern the crutch was similarly affixed to the frames. Both the breasthook had the crutch had filler pieces behind them on the centerline and were quite standard in configuration. These pieces served to provide transverse rigidity to the hull and were both hewn from oak. The through pins fastening them to the frames were 1 1/14" in diameter. The underside of each of these timbers had been rabbeted to receive the ends of the bilge ceiling strakes.

The framing of the vessel is very heavy and tightly spaced (Plates 1 and 2). The sided dimension of the frames is extremely crude. However this is not due to any lax production methods on the part of the builders. "The quality of a ship, either in construction or finish, was in accordance to the value of its cargoes; the richness of the trade in which she was employed."[2] This quote from Chapelle's The History of American Sailing Ships fits the collier hypothesis flawlessly. It was quite common for frames to be sided in the rough and ready manner found on YO88 in order to leave the maximum amount of wood in each timber. Only models and ships draughts feature neat, cleanly sided frames.[3]

The pattern of floor/first futtock is interesting in that it never changes. The first futtock is always aft of the floor throughout the vessel. Generally the relationship between floor and first futtock would have had the first futtock forward of the floor forward of the midships frame and aft of the floor aft of the midship's frame.[4] Documented exceptions do however exist.

A revenue cutter, the Kraken, found and recorded in Kalmar Harbor, Sweden, had all of the first futtocks on the starboard side aft of the floor. On the port side, however, all of the first futtocks were forward of the the floors.[5] The Kraken was lost in 1651. Another interesting feature of the Kraken was the complete lack of transverse longitudinal fasteners between the floors and first futtocks on either side.[6] The first futtocks were also lapped about 1' 6" up from the centerline. This technique was extremely common and continued in the Royal Navy into the first half of the eighteenth century. In merchant vessels this practice continued well into the nineteenth century.[7]

The English vessel Sparrowhawk, lost off Cape Cod in 1626, also had offset first futtocks, again not fastened to the floors.[8] The first documented mention of offset first futtocks is by Sir Henry Mainwaring in his 1621 marine dictionary.[9] A second reference may be found in fragments of a manuscript by Thomas Fagge, Esq. that has been dated to c. 1693.[10] The latest example of this framing technique was found on a German merchantman lost off New Jersey in 1836.[11] Initial examination of a site in North Carolina at Rose Hill also shows evidence of this framing method. The Rose Hill site is tentatively dated to the mid-eighteenth century.

YO88 exhibits all of these characteristics with two exceptions. The frames on both port and starboard all have the first futtock aft of the floor throughout the vessel and one bolted frame pair, S36/S37, has one bolt fastening the floor to the first futtock. (Figure 12).

There are seven bolted frame sets or pairs on YO88. These pairs are actually form one frame and are the master frames for the vessel. With the exception mentioned above these frames were only bolted longitudinally in the upper futtocks (Figures 9, 10, 11, 12, 13, and 14). During construction these frames were probably raised first, following standard English shipbuilding technique. Flexible battens, called ribbands, would have then been attached to these master frames and the remaining frames faired into the shape created. It is possible that some planking would have been affixed as these frames were being raised but there is no way to say for certain. If this is indeed the case, then this would be an example of whole moulding on an extremely large scale. Whole moulding was generally confined to small vessels and ships' boats.[12]

The use of fillet pieces in the frames is not at all unusual. They were often used in place of appropriately sized floor timbers, the wood for which was not always available. Fillets below the floors provide a secure piece to attach the garboard strake. A Dutch East Indiaman excavated in Cape Town, South Africa in 1978 was found to have pine fillet pieces.[13] These fillets were found to be in suprisingly good condition. The fillets on YO88 were substantially larger but showed signs of putrification.[14] This was confined to the upper edges of the fillets where they would have been alternately wet and dry. The lower edges of the fillets that would have remained wet showed no signs of putrification. The change in wet and dry states would have provided the ideal conditions for putrification to occur.

The top fillet pieces on the heel ends of the first futtocks in the midships section of the vessel were present to fill the space left by the use of compass timbers in the frames. The compass timber added strength to the hull and the addition of reverse fillets would have enabled the bilge ceiling to be laid on in a smooth continuous line.

The framing in the bow and stern is the most unusual feature in the vessel. Rather than true cant frames such as were used in the nineteenth century YO88 has a radial frame pattern in the bow and stern. This may well be an example of a transitional phase in framing patterns for bow and stern construction. Prior to the use of cant frames, i.e. frames canted off the perpendicular to the centerline in the vessel ends, square frames were run throughout the length of the vessel and the outside molded surface was bevelled to form the shape of the bow and stern.[15] No mention was made of cant frames in Thomas Sutherland's The Shipbuilder's Assistant of 1711 or in his later work, Britain's Glory, or Shipbuilding Unveiled of 1717.[16] Models from the period do not show cant frames and very little is known of the evolution in their design which culminated in the nineteenth century with a conventional arrangement used by most ship builders. YO88 is the only vessel excavated to date that has the radial pattern frames coupled with the short transverse chocks described earlier in the text.

YO88 has frames that start to angle towards the ends, starting with the second futtock of S61 in the bow (Figure 8). As the bow frames continue forward from this point they abutt the short transverse chocks bolted to the stem. They show no fasteners either between themselves or to the chocks. Apron chock "F" resembles a small floor timber, extending outboard of the chocks above and below it (Plate 1).

In the stern the canted frames begin with the second futtock of S11. Aft of S11 the canted frames have a more standard appearance and butt against the deadwood (Figure 8). Only two stern frames are actually butted against the chocks, these being S1 and P1. Again no fasteners were discernable either between the frames or from the frame to the chocks or deadwood.

This somewhat unusual arrangement warrants far more study to gain a better understanding of the transition from massive square, bevelled frames to the later cant frames with hawse pieces, knight's heads, and fashion timbers. Archaeological remains offer the best opportunity for this endeavor.

The keelson assembly has several interesting features, the principle one being the use of pine for the main component, "C". Pine may have been selected for its workability or due to the lack of a suitable piece of hardwood at the time of the vessel's construction. The thin oak strip affixed to the top of "C", section "B", would have functioned as a shoe on the bottom of the keel (Plate 1). This piece would have protected the keel bolt heads and prevented damage to the softer pine. The oak would also have increased the strength of the entire keelson assembly and provided a hard surface for the deck stanchions to be mounted on. The forward section of the keelson, "A", is also oak and sweeps upward toward the bow. It contains the mortise for the foremast and secures the forward end of the keelson. Component "D" is present to provide a strong step for the main mast. The use of several pieces in the construction of the keelson assembly would have provided for both strength and flexibility, two features essential to a vessel carrying a heavy, loose cargo.

Although no deck stanchions were found, the steps for their heels were still fastened on the top of the keelson. The stanchions were removable to facilitate the loading and unloading of cargo. The "c" shape of the steps would have allowed for easy removal. This was plainly evident from the wear pattern left in the wood's surface (Plate 1). The irregular shape of these pieces and the crude workmanship is indicative of the wear and tear and subsequent frequent replacement these pieces underwent.

The remaining deck structure is slightly puzzling in that there was no evidence of hanging knees. Enough of the structure was still articulated that if hanging knees had been present originally they would still have been in place (Figure 18). The absence of hanging knees may well be a function of the vessel's original task as a collier. This task would have entailed hauling large cargoes of loose loaded coal. The lodging knees were heavily fastened and were obviously adequate to support the deck structure in conjunction with the deck clamp.

The bilge ceiling was composed entirely of heavy oak planks with no vent spaces, another indicator of the vessel's function as a collier. The extremely thick ceiling was an additional structural component adding to the strength of the hull. The ceiling covered the chocks in the bow and was bevelled into the underside of the breasthook. In the stern it covered the frames and formed the lazerett with the deadwood providing the bottom of this area (Figure 8).

Exterior planking was found to be entirely of oak in a straight strake arrangement. This planking was also relatively thick in consideration of the vessel's size and again would have added considerably to the strength of the hull. The sacrificial planking over the hull was pine, as found on other vessels from this period. The tar and wool felt under coating is also quite common. This planking was designed to protect the hull from the ravages of marine borers such as the teredo worm (toredo navalis). Nail holes in the hull were not discernable to the point of being able to establish how many times the vessels had been resheathed.

The rudder is fairly typical except that the heel is horizontal rather than swept upward heading aft. Although displaced upward 6" by the vessel's sinking the rudder is otherwise exactly as it would have appeared during the vessel's active career (Figures 18 and 19). The rudder was also entirely sheathed in pine for protection from the worm. It is worth noting that the heel of the rudder is 3' 6 1/2 ". When multiplied by three this renders a value of 10' 7 1/2". The beam of Y088 is 23' 7 1/4". There was a shipwright's convention in some yards of the period that three times the heel of the rudder's length equaled half of the maximum beam.[17] Two times 10' 7 1/2" would give a beam of 21' 3", which, while not an exact match, is still close enough to consider interesting and partially validating. Y088 most likely had a simple tiller affixed at the rudder head in keeping with the simple design of the vessel.

The pumpwell and box are quite typical and are located just aft of the main mast. The box consists of three chambers with the two outboard chambers extending into the sump in the bilges (Figures 20 and 21). The box was constructed of oak and probably had the pump mechanism on the weather deck. A section of lead pipe was found in the starboard sump with saw marks across the top end. This would seem to indicate that the pump mechanism had been salvaged previously. (For a complete description and analysis of the pumpwell and box see Appendix A).

Mast placement on Y088 is that of a brig, with a slight chance that a snow rig could have been employed. If a snow rig is to be considered it is purely speculation since no archaeological evidence was found to support this theory. Fore- and mainmast placement for snows and brigs were virtually identical and the level of preservation at Yorktown precluded any hope of finding snow rigging remains.[18] The positions of the masts relative to the stem and stern perpendiculars coincides with the contemporary formula for a brig of similar tonnage.[19] While not a precise science these formulae are an excellent reference and dramatically support the brig rig conclusion. The two coins found in the mast steps were too deteriorated to be dated. The copper coin from the mainmast was found in a small augered recess in the heel of the mast and by size and weight is an English half penny.

In addition to the physical characteristics of the hull another clear indicator of the vessel's collier lineage was present in the bilges. Samples taken throughout the bilge directly against the keel yielded a large percentage of coal residue. With 45 samples taken all indications are that the vessel carried coal on numerous voyages in large quantities. Analysis of this coal residue has revealed that it most likely came from coal seams in the British Midlands.[20]

The vessel remains at Yorktown are physically conclusive. Her hull shape, construction and rigging are clearly indicative of a collier brig. Coupled with the coal in her bilges and the preference of the Navy Board for hiring colliers the case for YO88 being a collier is almost perfect. Throughout the project however two questions were always left begging. What was the vessel's identity and what specific function did she serve in support of Cornwallis' troops?

When Cornwallis brought his forces to Yorktown he was placing himself in a position that was tactically untenable. With the river at his back it was essential that he strongly fortify the landward side of Yorktown. He set to this task by constructing a series of earthworks and star forts in a layered defense.[21] These positions were prepared by the Royal Engineers attached to his command.[22] Unlike modern emplacements which rely on sandbags and barbed wire these positions required wooden supports, stakes and floor boards.

To produce these structural members local trees were cut and brought to Yorktown. This timber was then taken aboard various ships in the harbor and rendered into the needed pieces.[23] This was one type of direct support Cornwallis could still use his supply vessels for in the prevailing tactical environment.[24] By working on these timbers aboard the anchored merchantmen the already crowded waterfront was kept free for ferrying troops and unloading supplies.

Y088 had dozens of locally available logs in her hold.[25] These pieces were all directly atop the sand ballast and several showed signs of partially completed adze work. One large log was found with an end buried in the ballast and propped on the sill of the companionway in the forward bulkhead. This log was partially adzed into a square and the chips from the work were directly beside it on the ballast. The adze itself was lying against the bulkhead. In addition to the partially worked logs numerous timbers were found in a completed state including three that had been shaped as "duck boards". "Duck boards" would have been placed in the bottom of a trench to provide solid footing for the troops in that position. These were identical to boards used in other land fortifications during the war and were notched to lay over one another.[26]

The identity of the vessel has finally been established with a fair degree of certainty. It was ascertained once size and construction details were established, but the impetus for vessel specific identification came from four small pewter buttons recovered in 1987. These buttons were from the uniform of the 43rd Regiment of Foot, a unit that joined Cornwallis at Portsmouth, Virginia in the spring of 1781.[27]

On July 7, 1781 100 men of the 43rd were transported from Portsmouth to Yorktown on board the 150 ton brig Betsy.[28] One Betsy, a 30 ton schooner, was known to have been at Yorktown during the siege.[29] Lloyds Register reveals, however, that in 1780 a brig Betsy, 180 tons, was hired into the service of the crown for transport duty. She was single decked and sheathed in wood.[29] All of these details match the remains of the Yorktown vessel. The calculated tonnage for Y088 is 176, and the orderly in the 43rd listed her at 150 tons but variations in rated tonnage were often in excess of 20 tons.[30] She disappears from the Register in 1782. Since all papers pertaining to the loss of the vessels at Yorktown were lost in transit to England no claim was filed on the Betsy.[31] The captain and owner of the Betsy was John Younghusband.[32] Two cask heads recovered in 1987 from the captain's stores in the lazerette bear the inscription "JY". Without actually finding the name Betsy inscribed on the hull this accumulation of evidence is sufficient for 44YO88 to be declared the Betsy. The Betsy was built in 1772 at Whitehaven as a collier.[33] At the time of her scuttling she was nine years old. The outstanding condition of the hull remains reflects her relative youth and the quality of her construction. That she was scuttled is without question. Between frames S24 and S23 was a square hole in the bilge ceiling and the exterior planking. This hole was cut by someone intimately familar with the ship since it was positioned perfectly between two frames. Although there is no documentation available to reveal the exact date of her sinking her position relative to the other shipwrecks and to the beach indicates that she was among the first vessels scuttled on the sixteenth of September.

The information on vessel construction and hull shape provided by the investigation of site 44YO88 have added immeasurably to the existing body of knowledge on eighteenth century merchant vessels. The amount of detail recorded and the accuracy of the information more than justify the time and effort that the project required. Without the use of the cofferdam this information would not be as complete or as accurate and to this end the cofferdam succeeded. Although cost prohibitive in the current economic environment the use of a protective enclosure in hostile conditions has proved to be a viable method for precise data acquisition. With the removal of the cofferdam in the summer of 1990 the Yorktown Shipwreck Archaeological Project came to a close. Additional research on various other aspects of the excavation will continue. This will be undertaken by several of the professionals who made this project an internationally recognized success.

FOOTNOTES

[1]David Steel, Naval Architecture (London: 1805), plate XXII.

[2]Howard I. Chapelle, The History of American Sailing Ships (New York: Bonanza Books, 1982), p. 276.

[3]R.C. Anderson and W. Salisbury, "The Framing of Models and Actual Ships", Mariner's Mirror 40 (Winter, 1954): 156-159.

[4]William A. Baker," More on the Framing of Models", Mariner's Mirror 40 (Winter, 1954): 80-81.

[5]William A. Baker, "The Development of Wooden Ship Construction; A Brief Historical Survey to the Nineteenth Century", paper presented at 1955 New England Section of the Society of Naval Architects and Marine Engineers, Boston, 1955. Published 1955, Norman A. Hamlin, ed., p. 24.

[6]Ibid., pp. 24-25.

[7]John Fincham, A History of Naval Architecture (London: Whittaker and Co., 1851), p.73.

[8]Hobart H. Holly, "Sparrowhawk, A Seventeenth Century Vessel in Twentieth Century America", American Neptune volume XIII (1953): 56.

[9]Sir Henry Mainwaring, First English Marine Dictionary, 1621, cited in Baker, "The Development of Wooden Ship Construction", p. 24.

[10]Anderson and Salisbury, "The Framing of Models and Actual Ships", p. 155-156.

[11]Gordon P. Watts, Jr., personal communication, October, 1989.

[12]Howard I. Chapelle, American Small Sailing Craft (New York: W.W. Norton Company, Inc., 1951), p. 11.

[13]R.A. Lightly, "An Eighteenth Century Dutch East Indiaman, Found at Capetown", International Journal of Nautical Archaeology 5 ( ): 310.

[14]Eri Weinstein, personal communication, January, 1990.

[15]Baker, "More on the Framing of Models", p.81.

[16]William Sutherland, The Shipbuilder's Assistant (London: 1711) ; Britain's Glory, or Shipbuilding Unveiled (London: 1717).

[17] Geoff Scofield, personal communication, April, 1989.

[18] David Steel, The Elements and Practice of Rigging and Seamanship, 2 vols., (London: 1794), II: pp.208-209.

[19] Ibid., p. 209 ; John D. Broadwater, personal communication, December, 1990.

[20] Coal Analysis of Samples 1-45, Site 44YO88, report prepared by The British Coal Institute for the Yorktown Shipwreck Archaeological Project, 1989, p. 2-4.

[21] Charles E. Hatch, Jr., ed., Colonial Yorktown's Main Street and Military Entrenchments (New York: Publishing Center for Cultural Resources, 1980), p. 105.

[22] Ibid.

[23] John O. Sands, Yorktown's Captive Fleet (Charlottesville: The University Press of Virginia for the Mariner's Museum, 1983), p. 62.

[24] Ibid.

[25] "U.S. Forest Service Report On Wood Samples From Site 44YO88", unpublished, prepared for the Yorktown Shipwreck Archaeological Project, 1988.

[26] David Lyon, personal communication, December, 1988.

[27] "Order Book of the 43rd Regiment of Foot, April-August, 1781", manuscript copy, Virginia Department of Historic Resources, n.p.

[28] Ibid., entry 7 July 1781.

[29] Sands, Yorktown's Captive Fleet, p. 184.

[30] Llyod's Register, 1772-1782. Reprint ed.(London: Gregg Press, n.d.).

[31] David Syrett, Shipping and the American War, 1775-1783 (London: Althone Press, 1970), pp. 110-113.

[32] Llyod's Register, 1772-1782.

[33] Ibid.

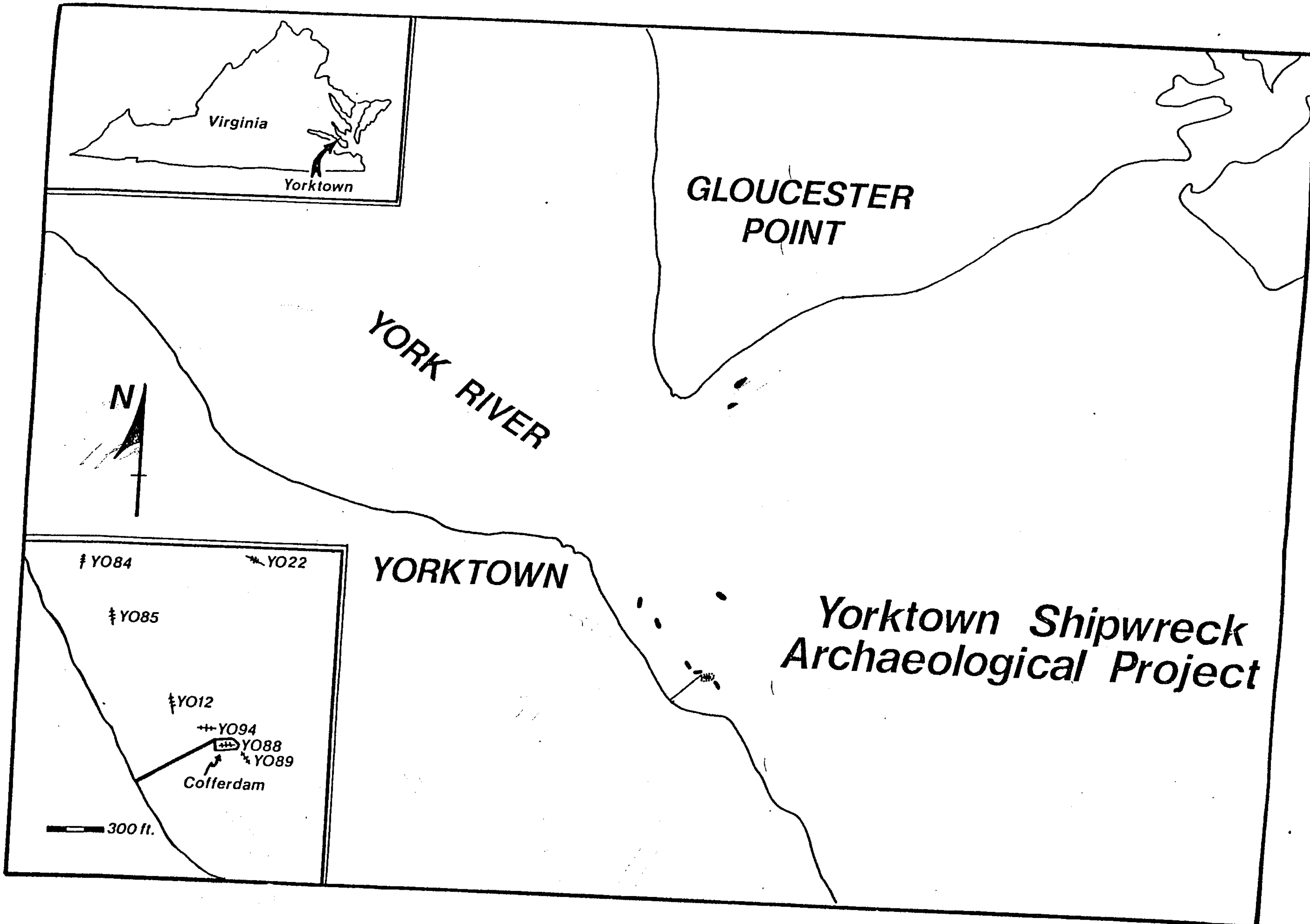


FIGURE 1. SITE LOCATION

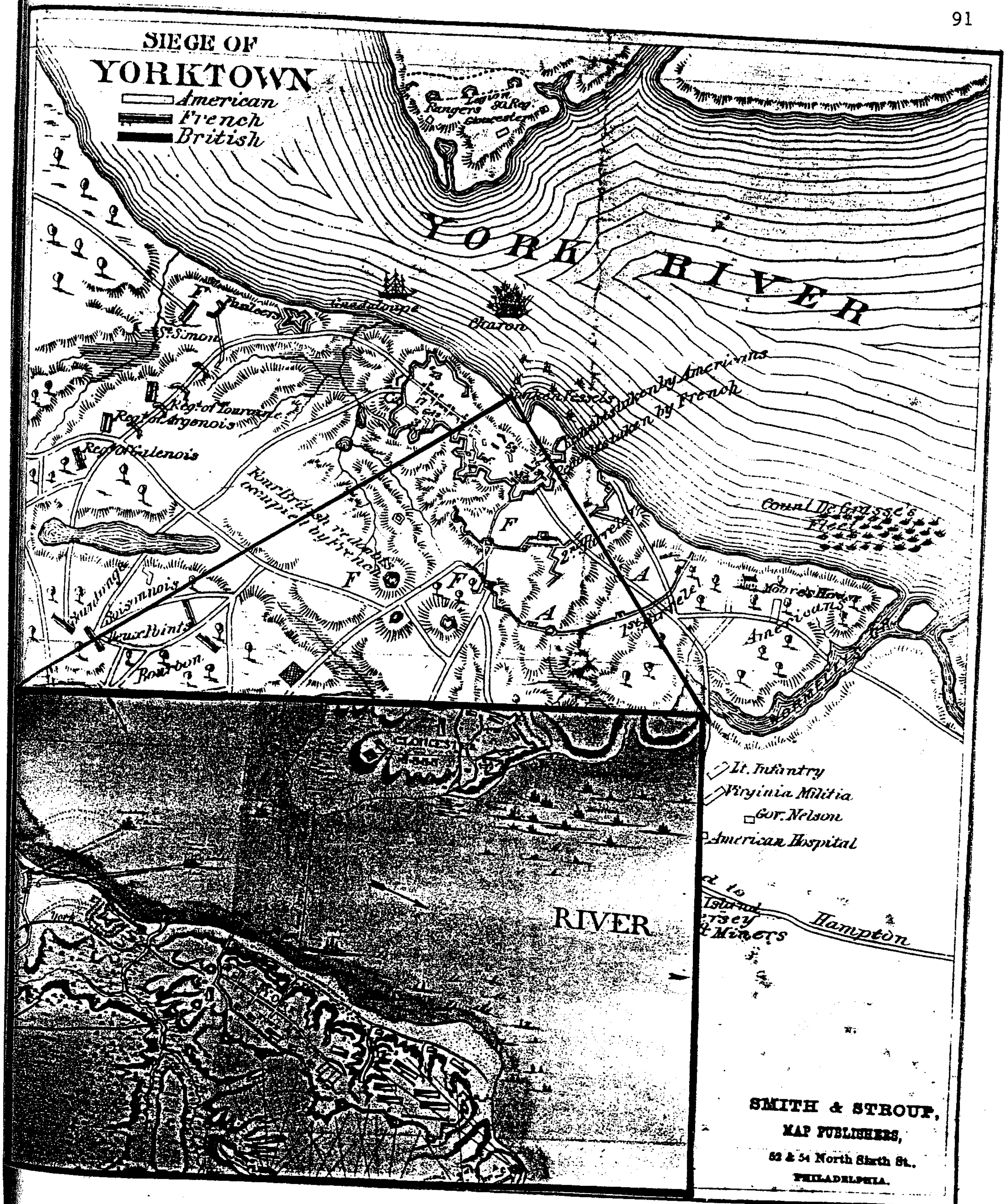


FIGURE 2. 1781 MAP OF YORKTOWN

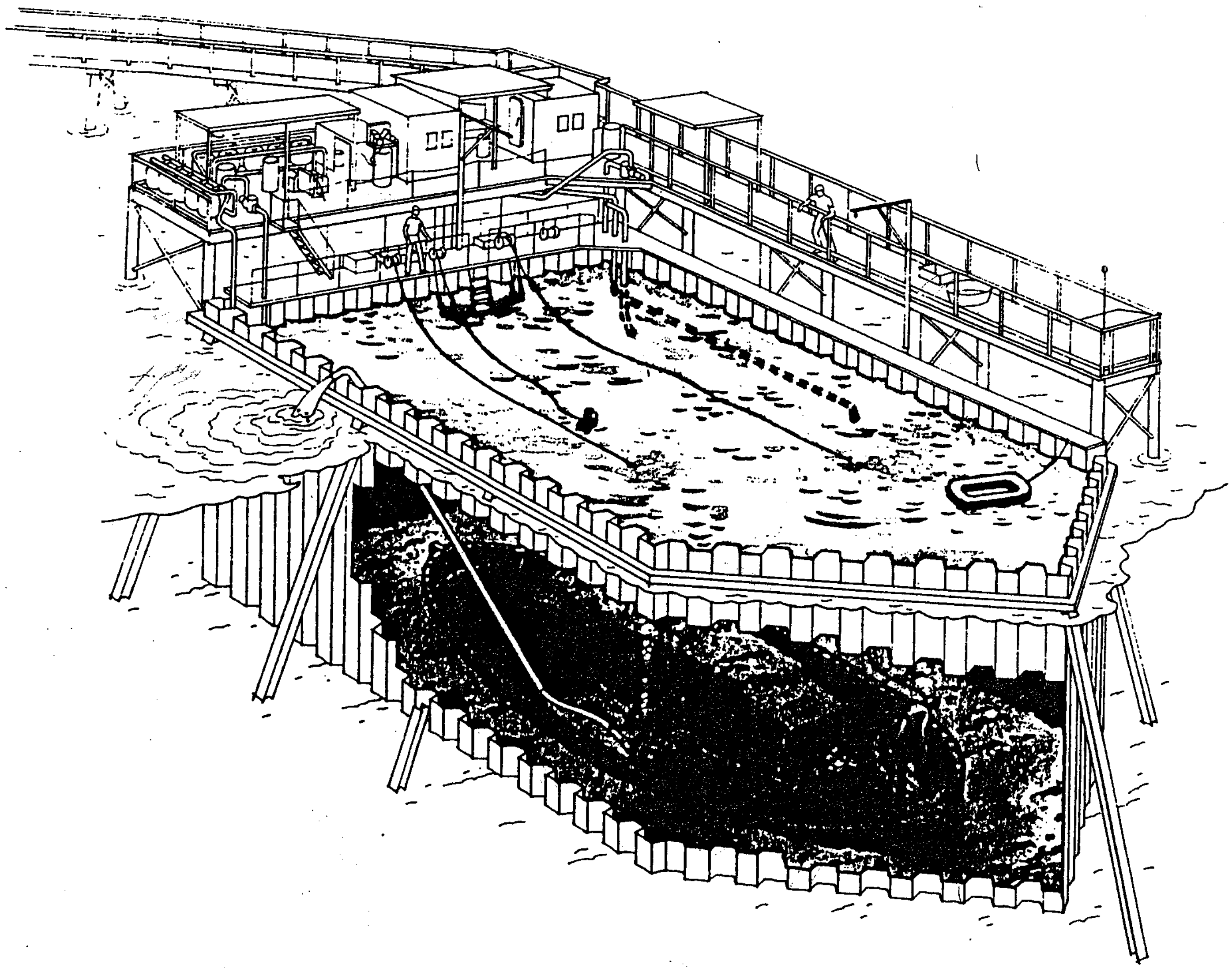


FIGURE 3. ARTIST DEPICTION OF YORKTOWN COFFERDAM
(PIERRE MION, © 1988 NATIONAL GEOGRAPHIC)

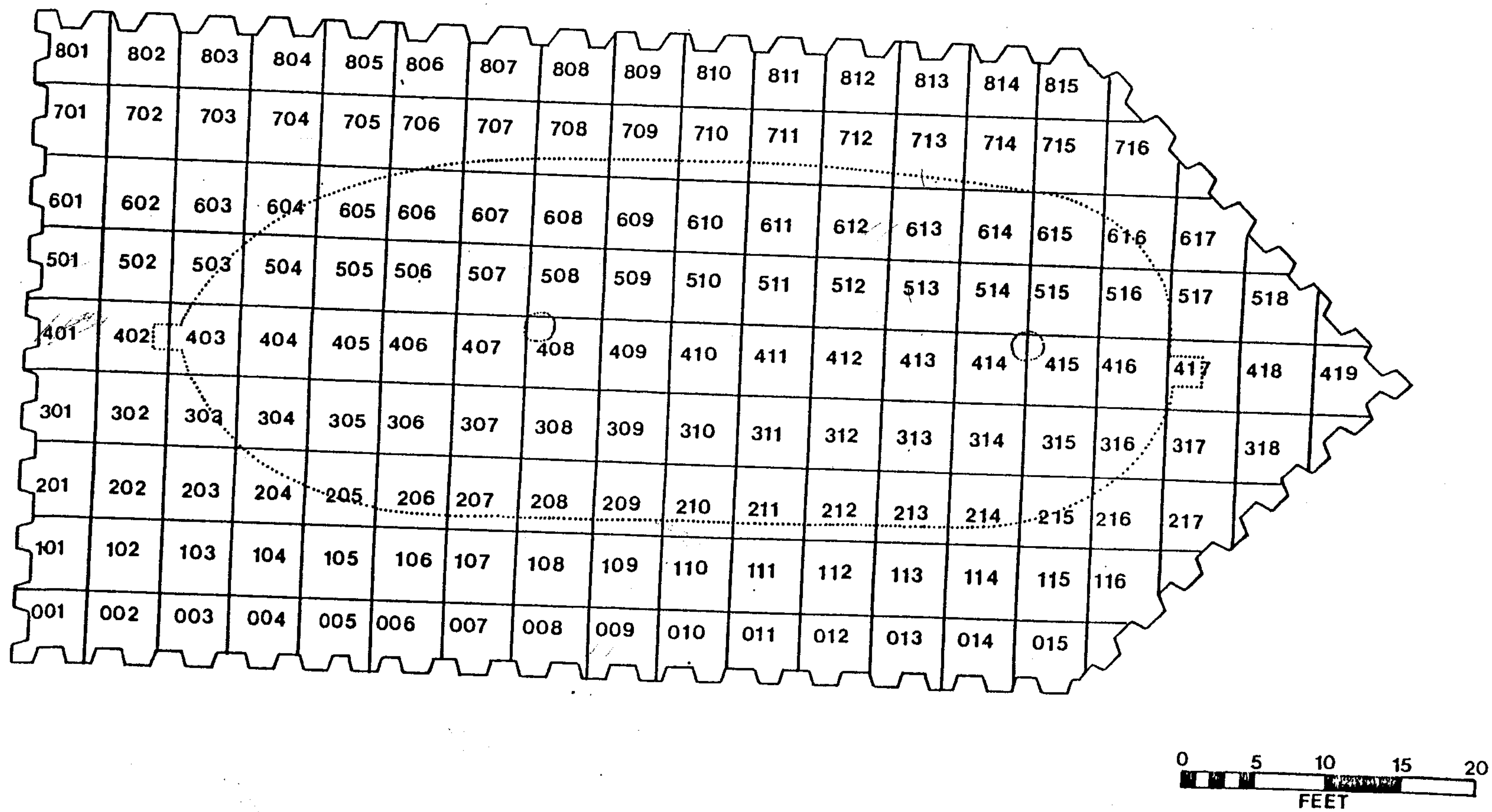


FIGURE 4. 44YO88: SQUARE DESIGNATION

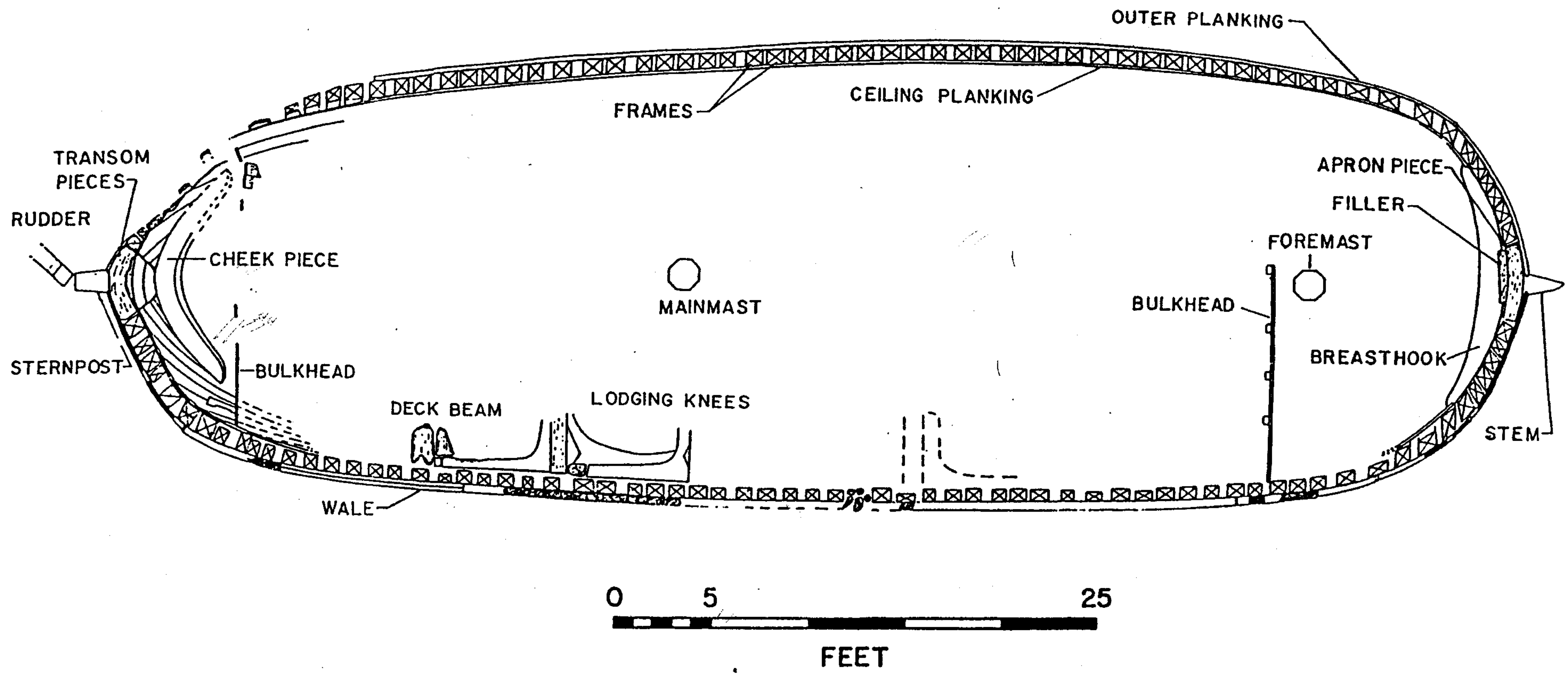


FIGURE 5. 1983 SITE PLAN, 44YO88

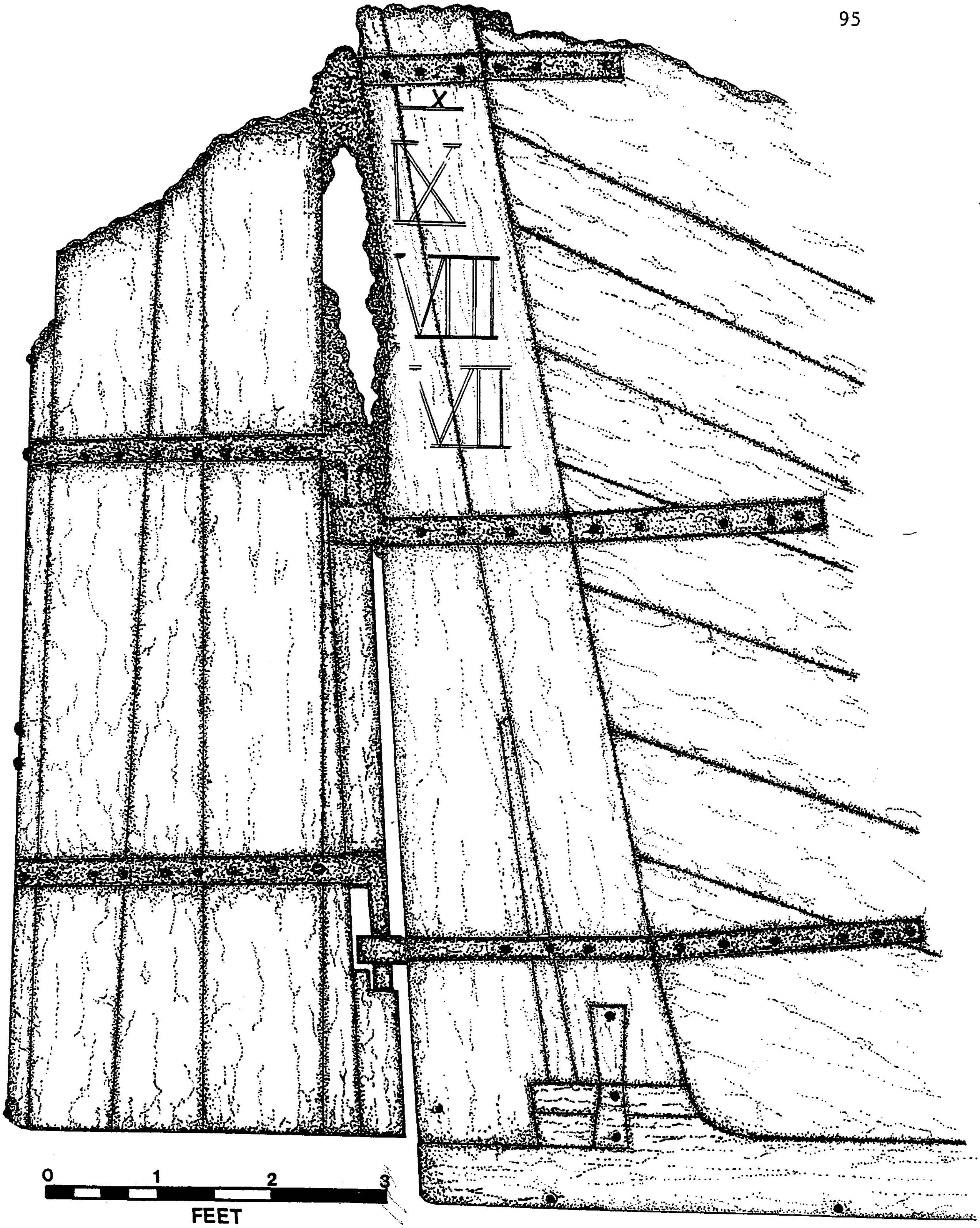


FIGURE 6. STERN AND RUDDER, EXTERIOR

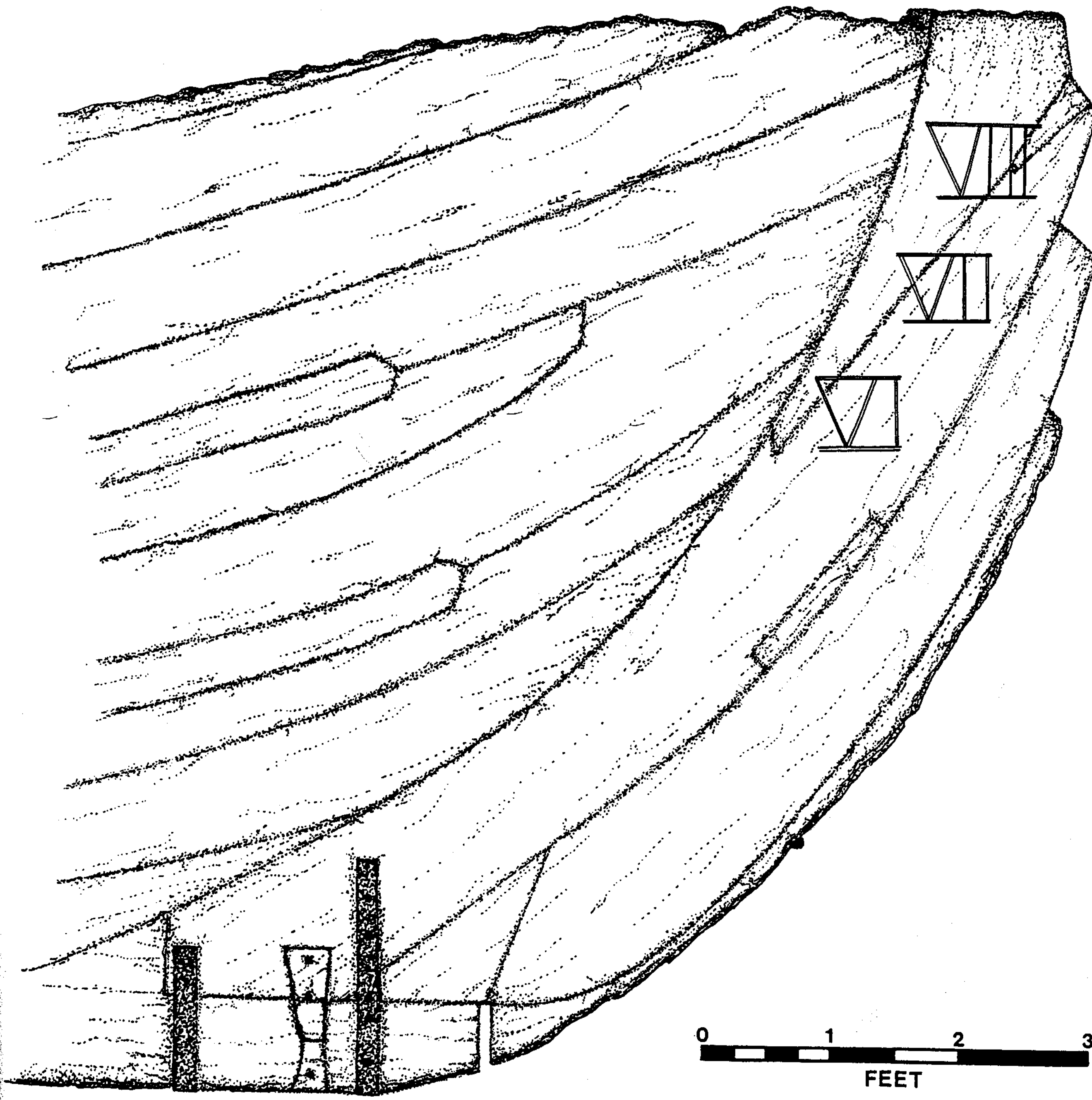


FIGURE 7. STEM POST, EXTERIOR

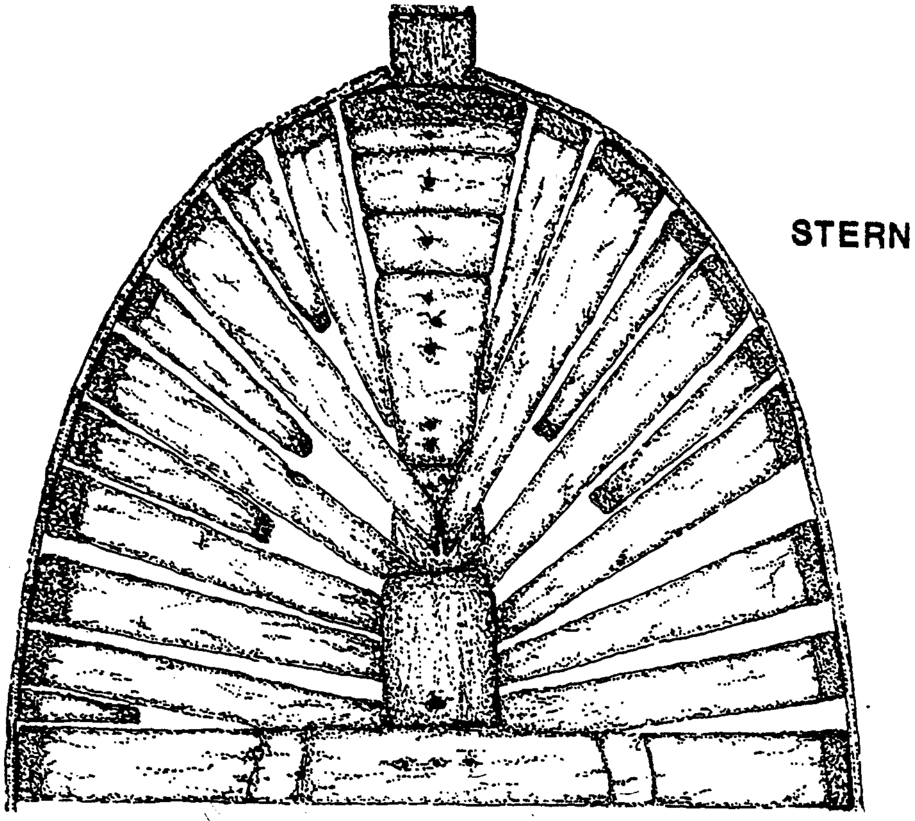
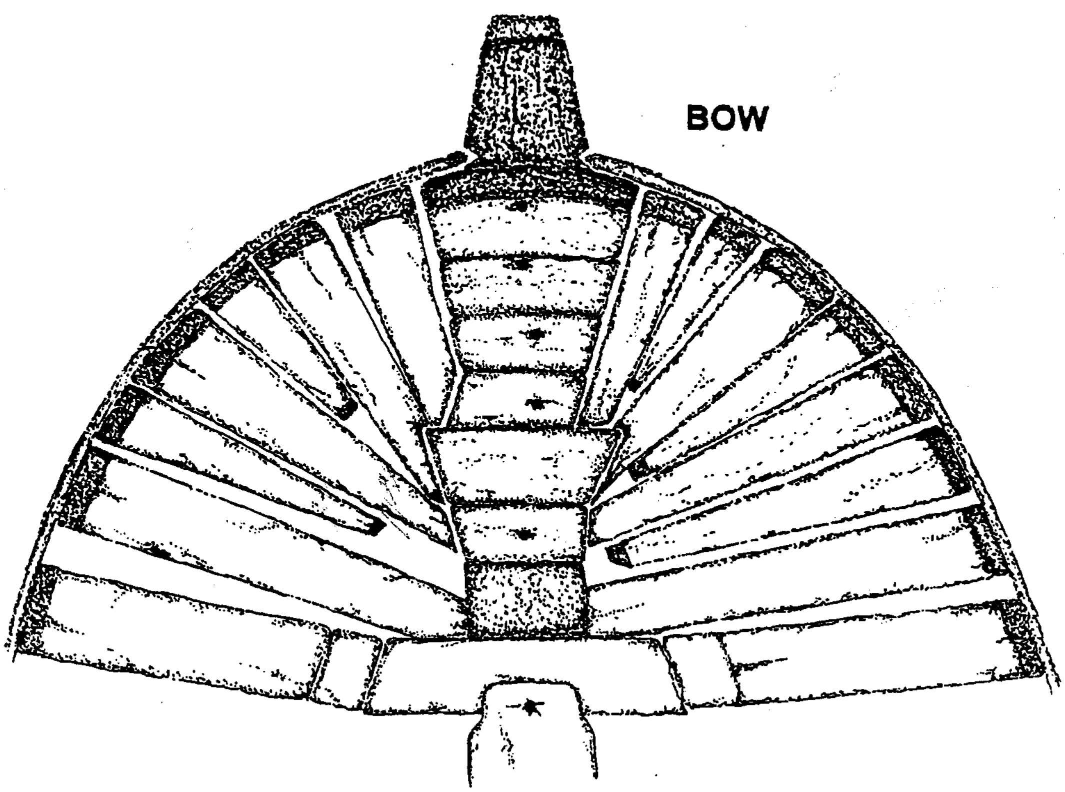


FIGURE 8. BOW AND STERN CANTS AND TRANSVERSE CHOCKS



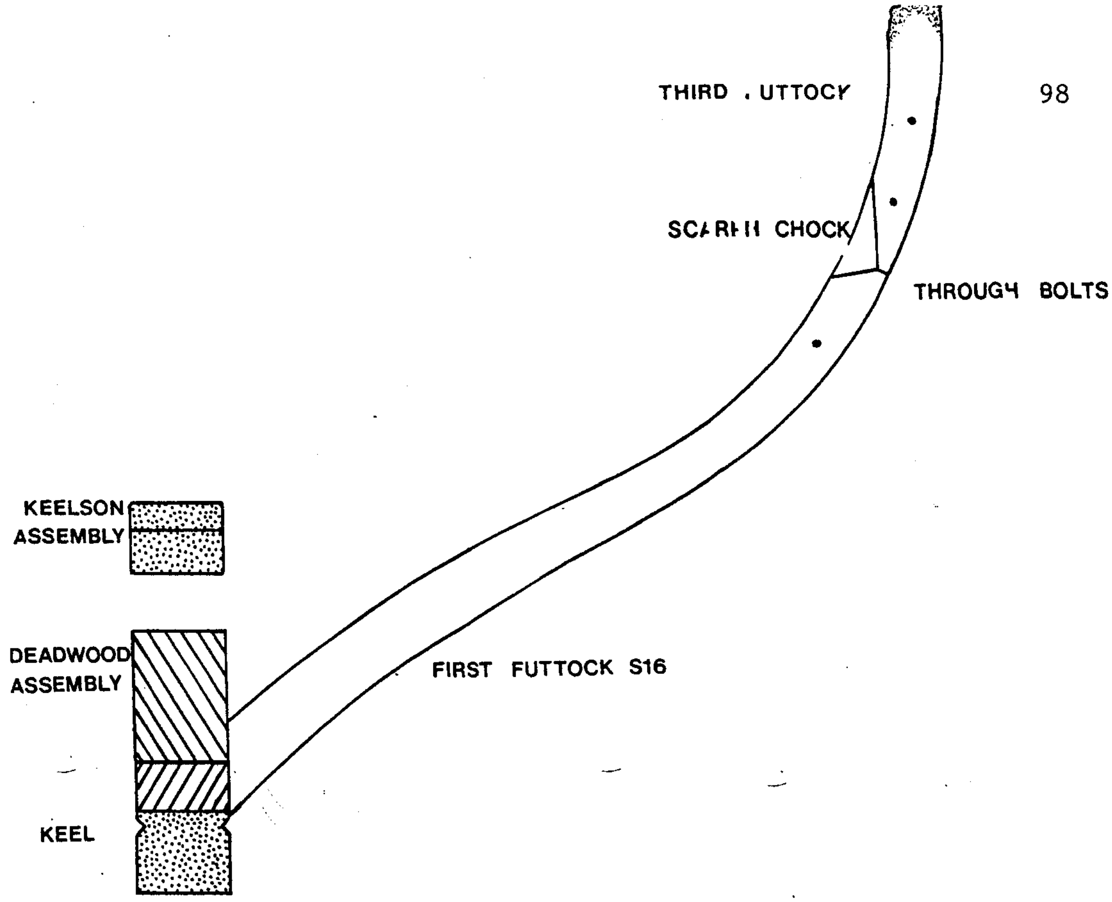
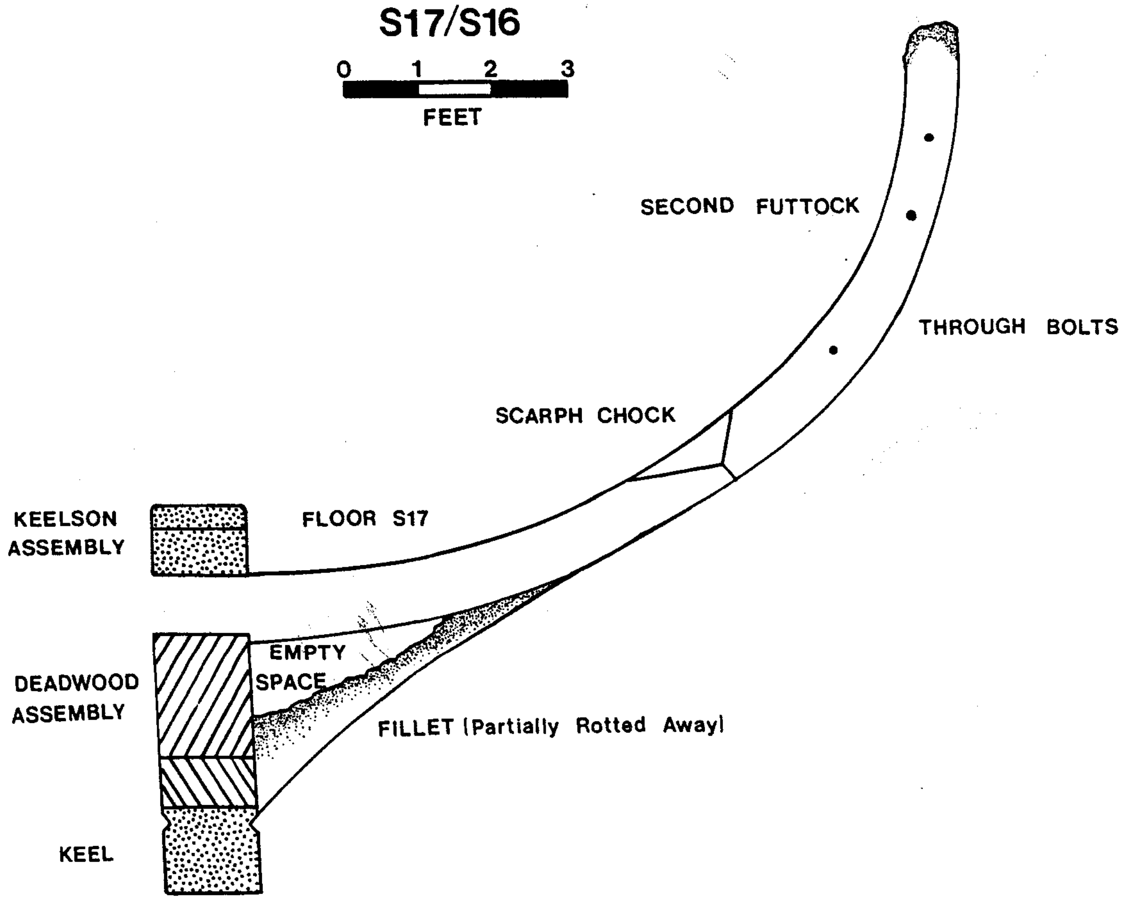


FIGURE 9.

Bolted Frame Pair S17/S16

0 1 2 3
FEET



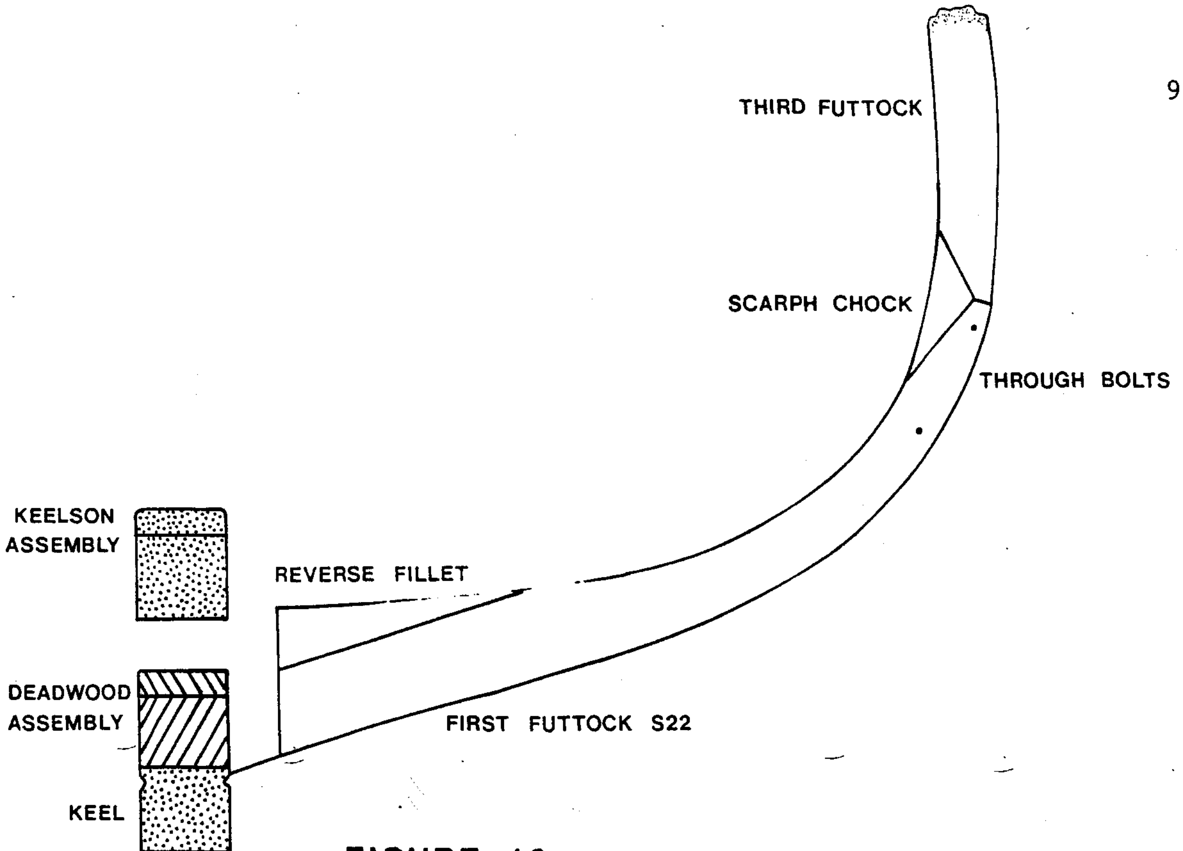
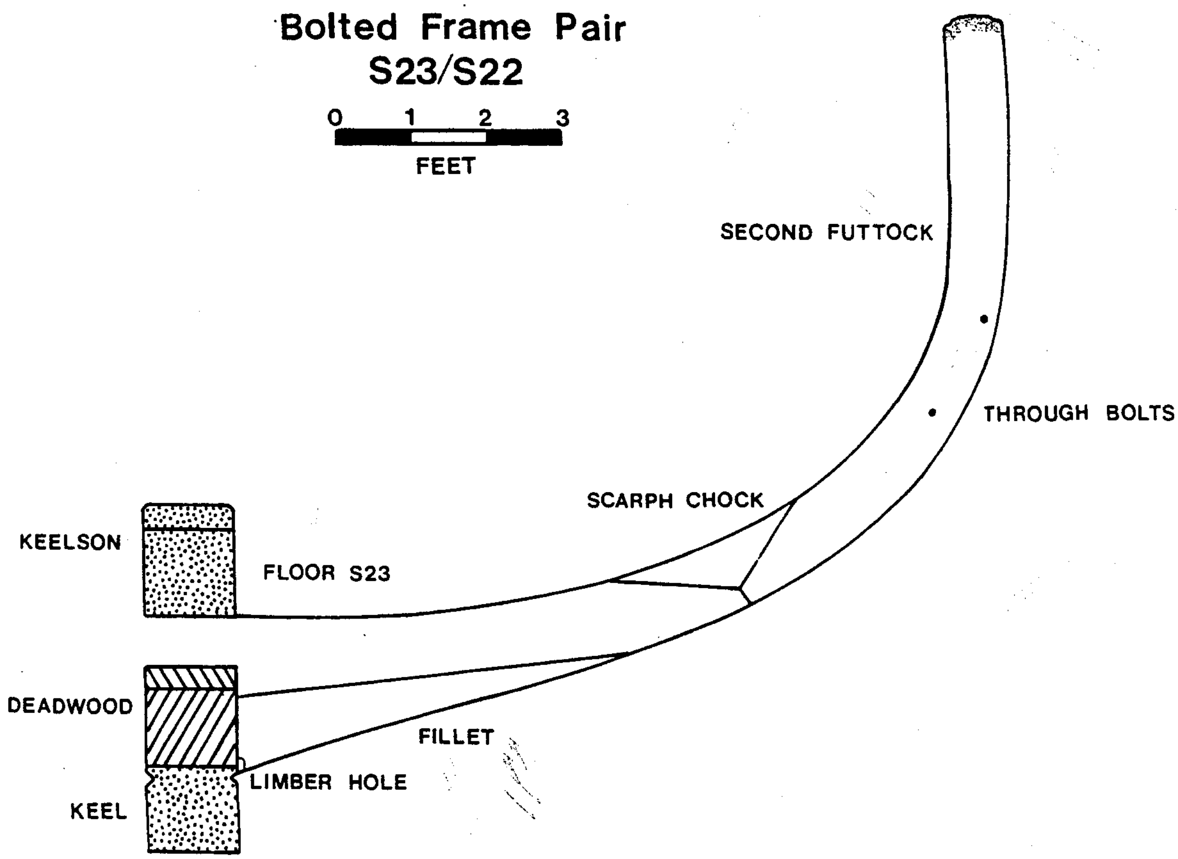


FIGURE 10.

Bolted Frame Pair S23/S22



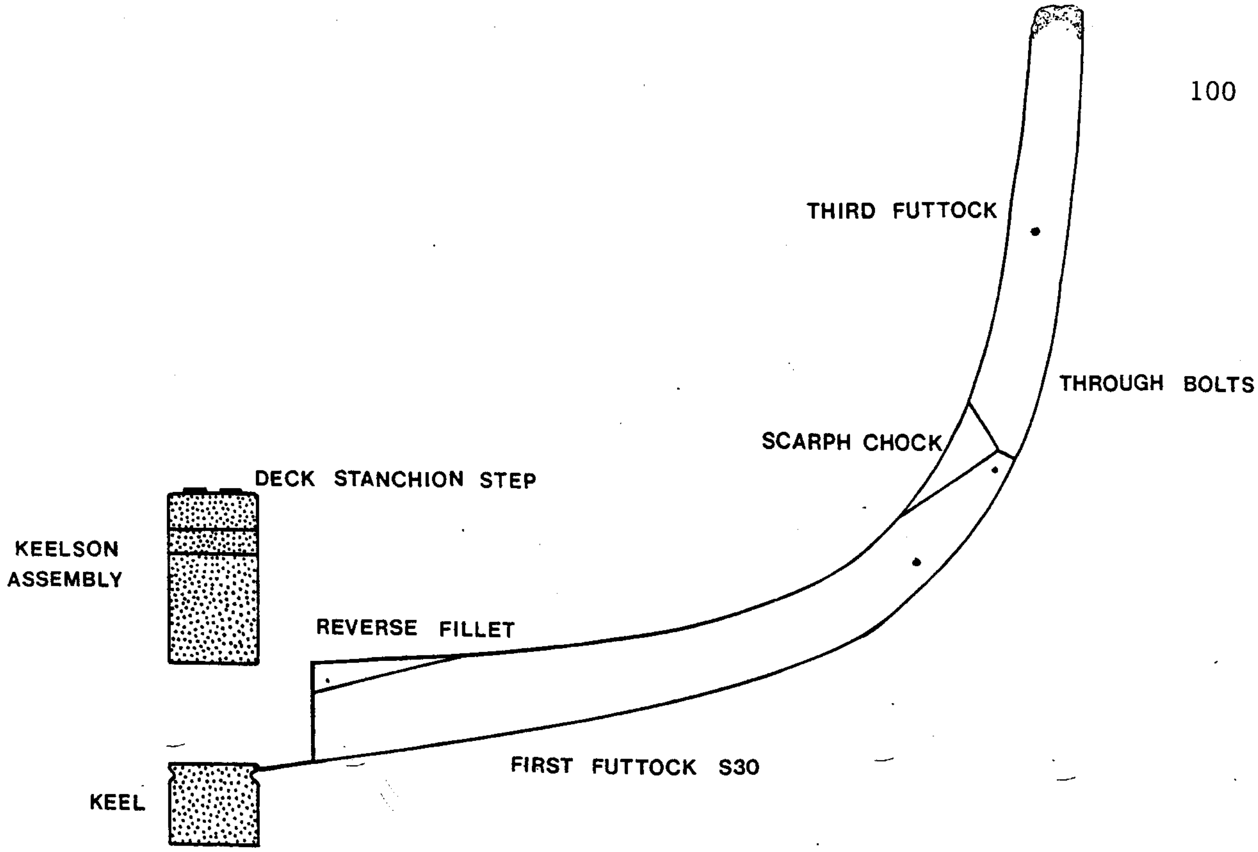
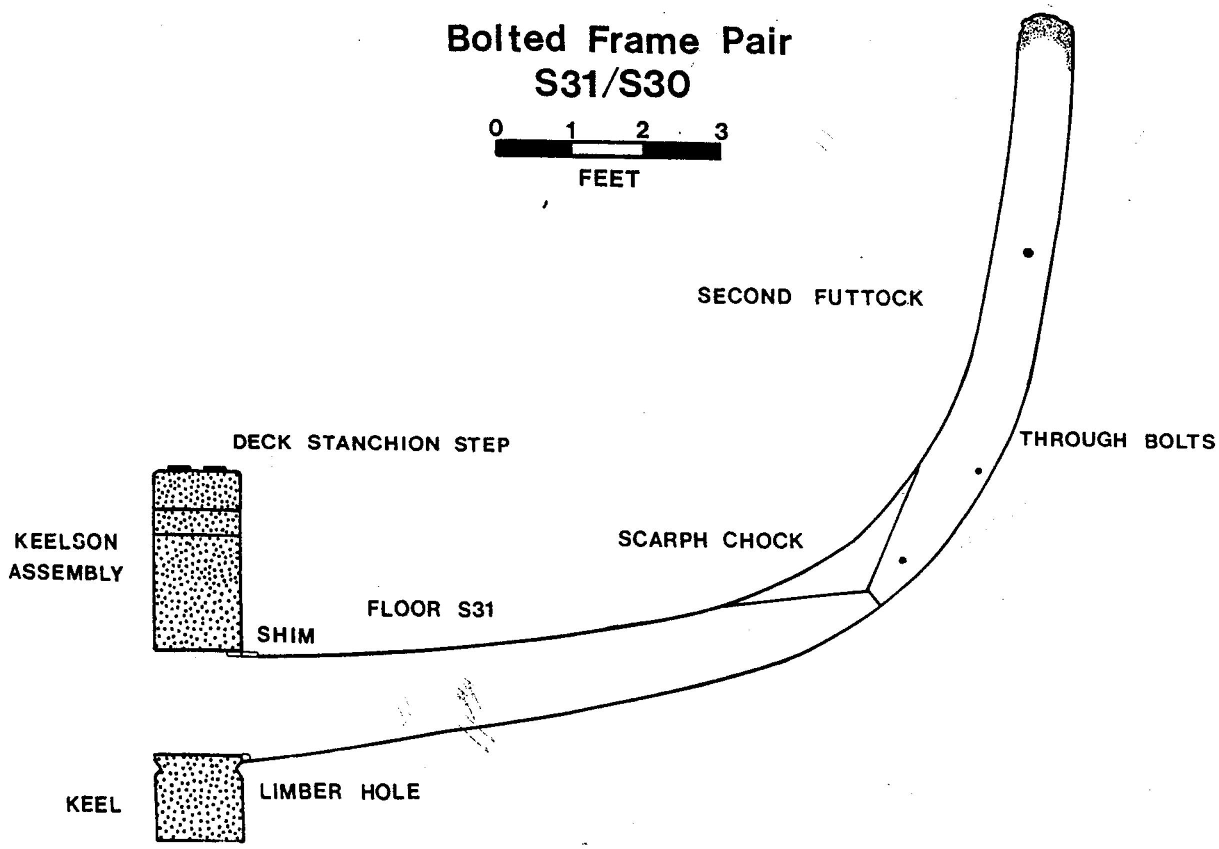


FIGURE 11.

Bolted Frame Pair
S31/S30

0 1 2 3
FEET



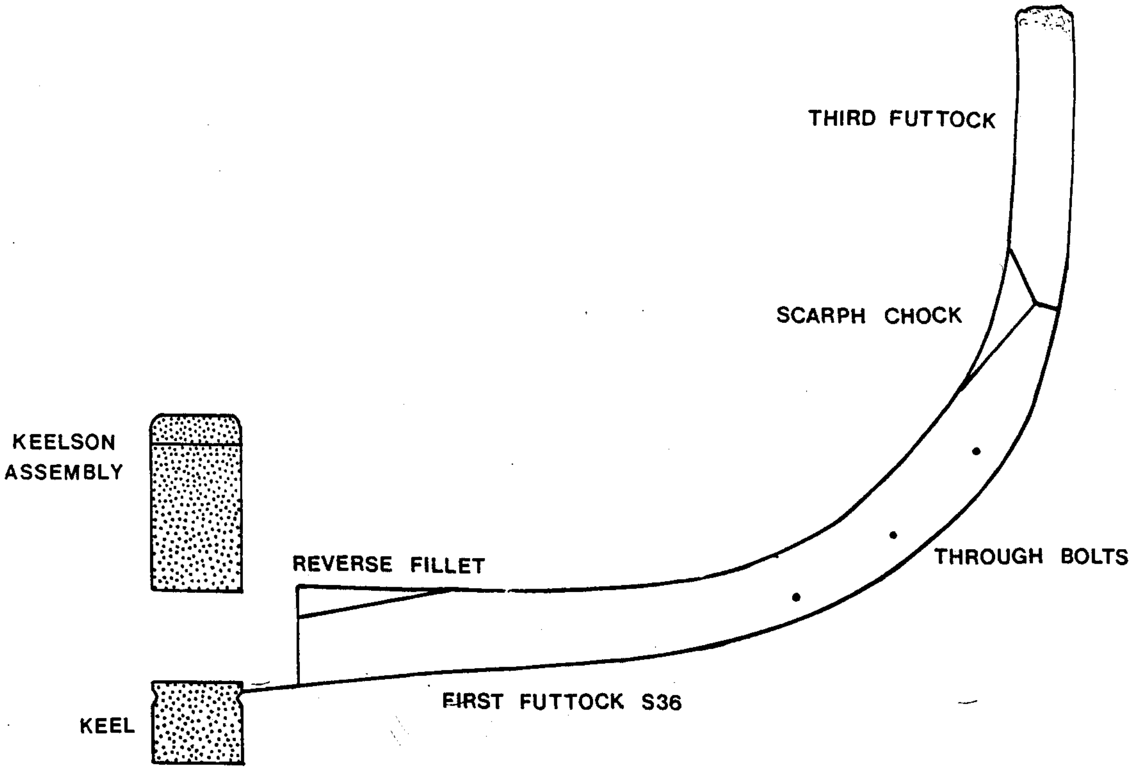
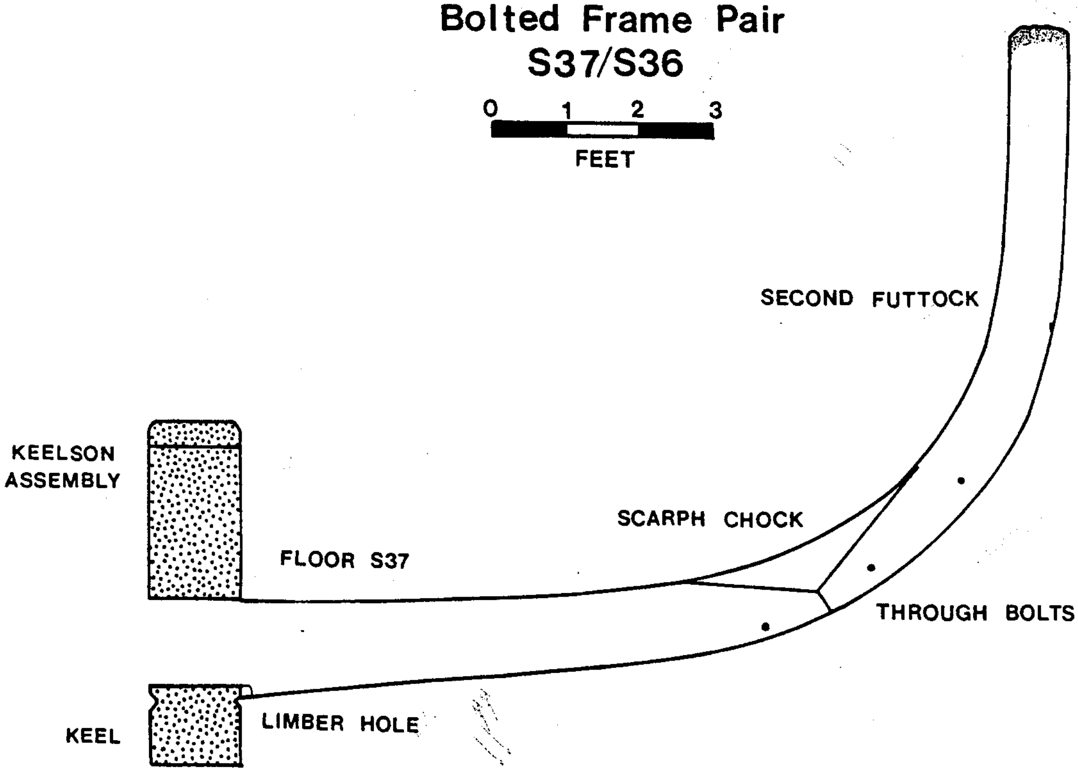


FIGURE 12.

Bolted Frame Pair S37/S36

0 1 2 3
FEET



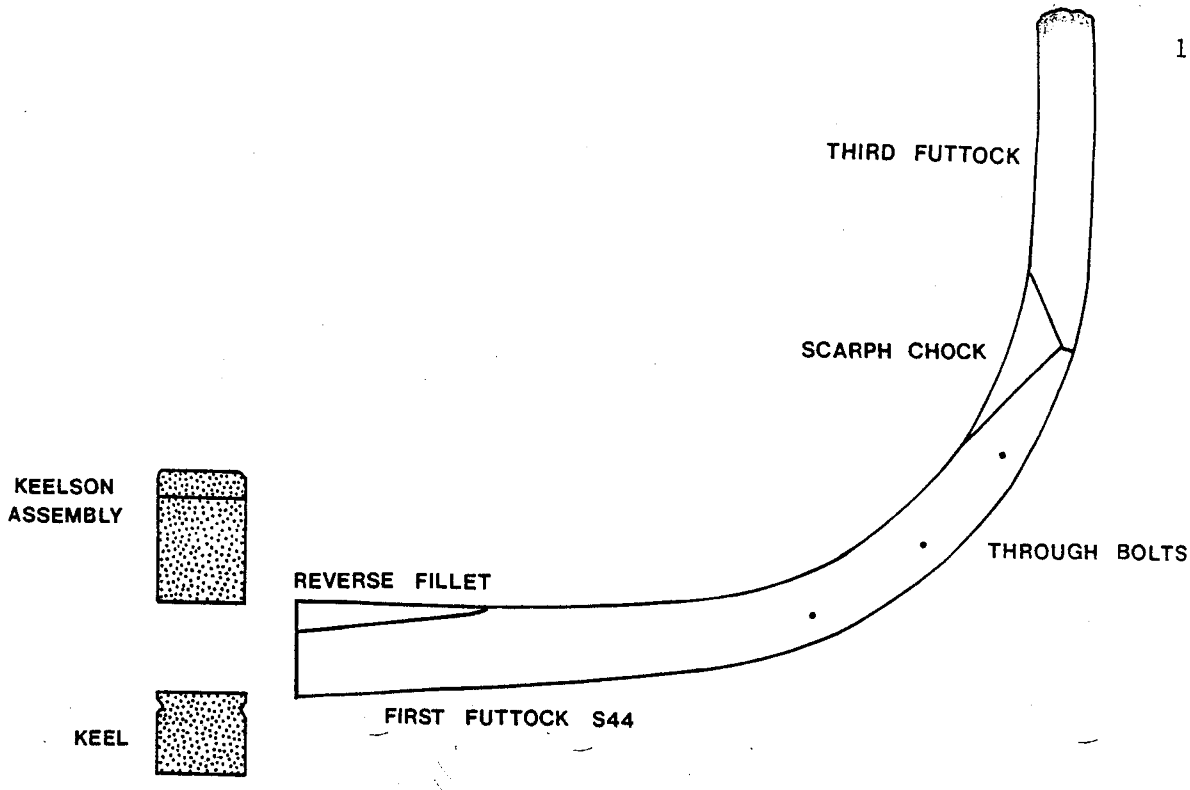
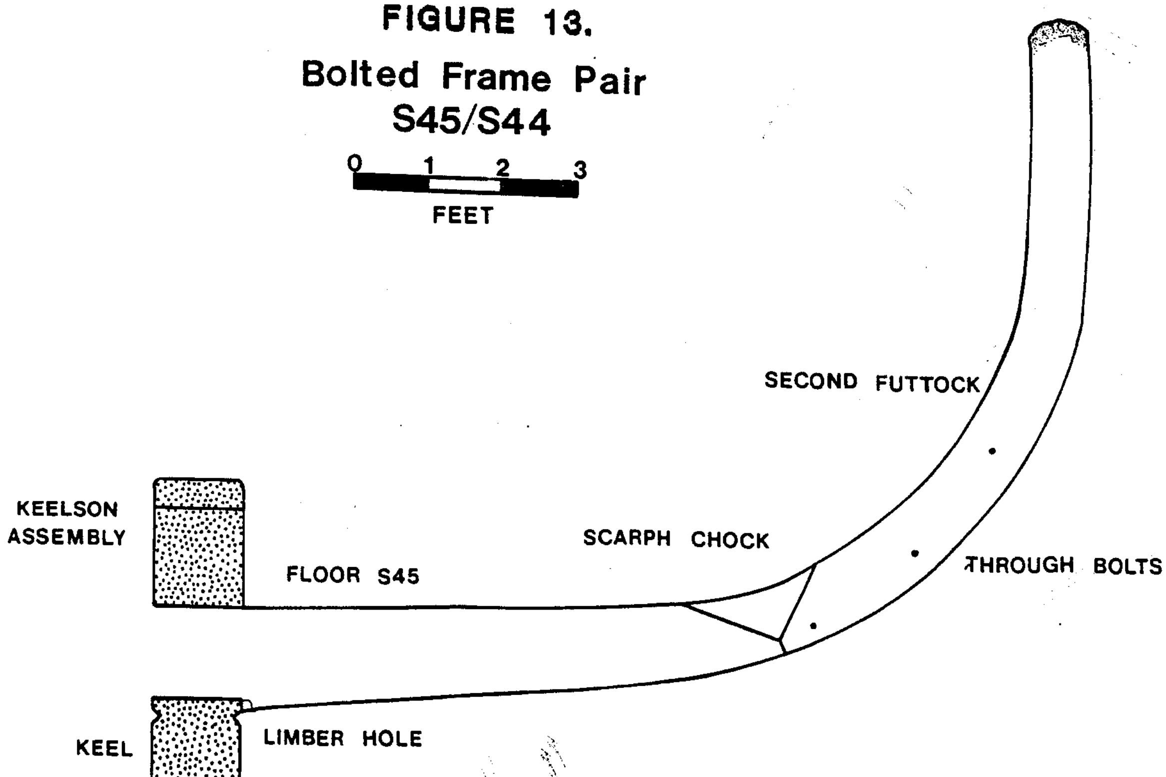


FIGURE 13.

Bolted Frame Pair S45/S44



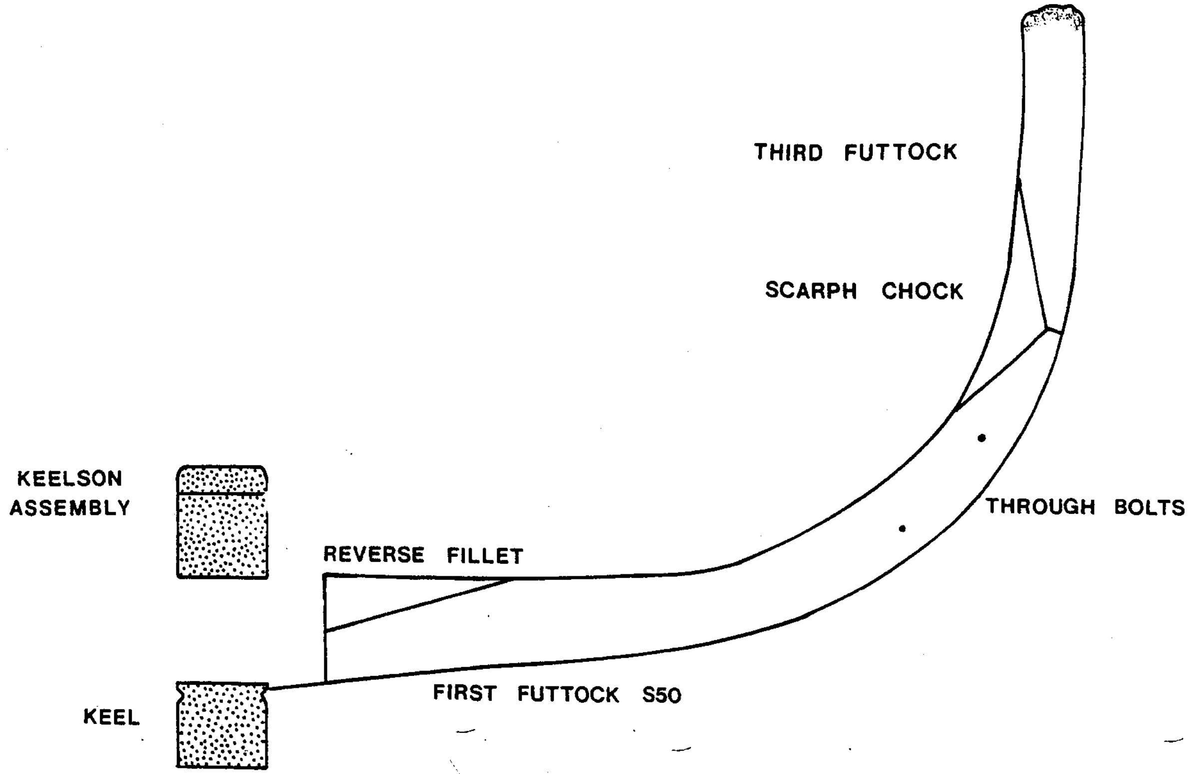
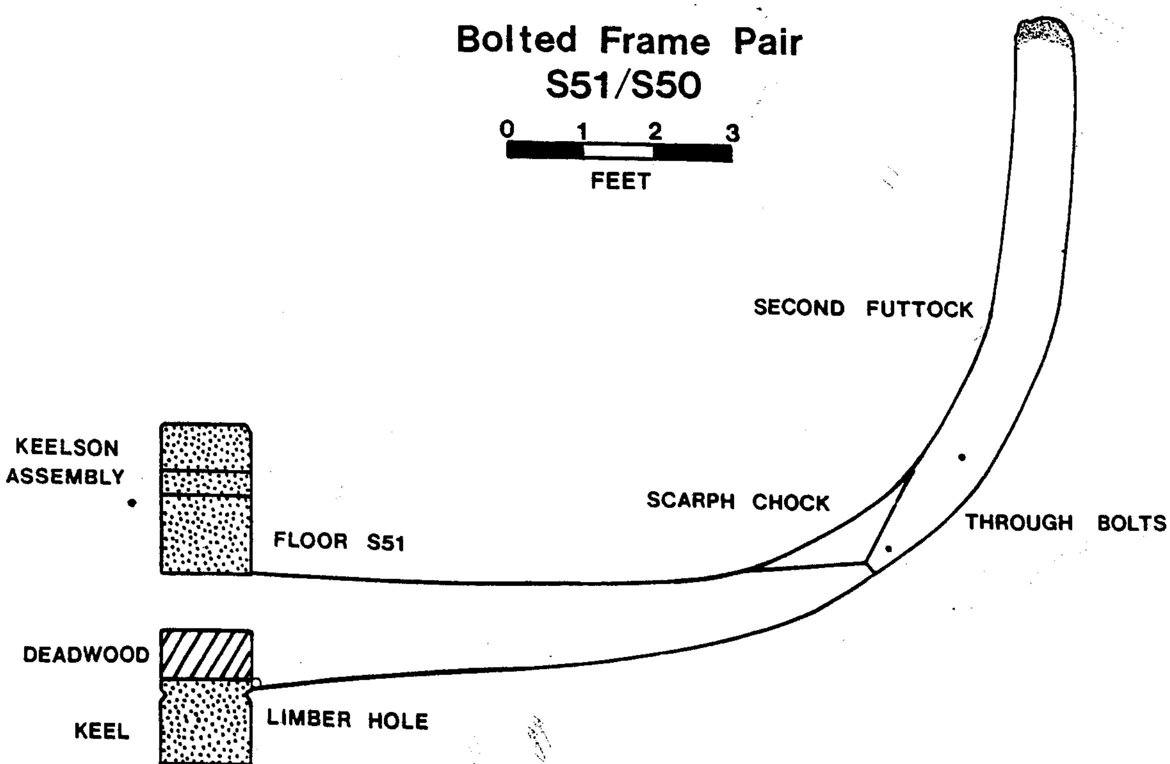


FIGURE 14.

Bolted Frame Pair S51/S50

0 1 2 3
FEET



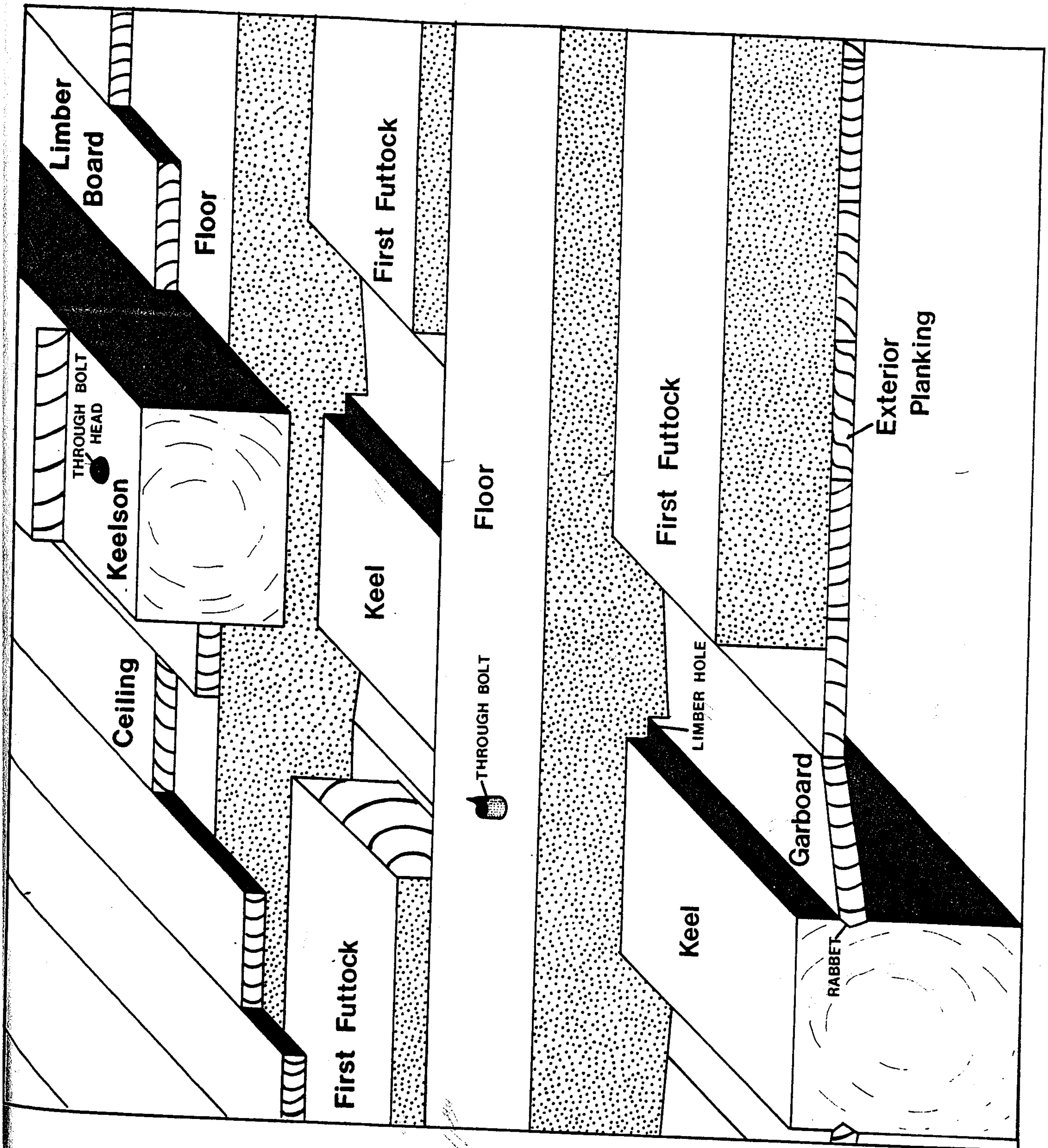


FIGURE 15. FRAMING PATTERN, SCHEMATIC

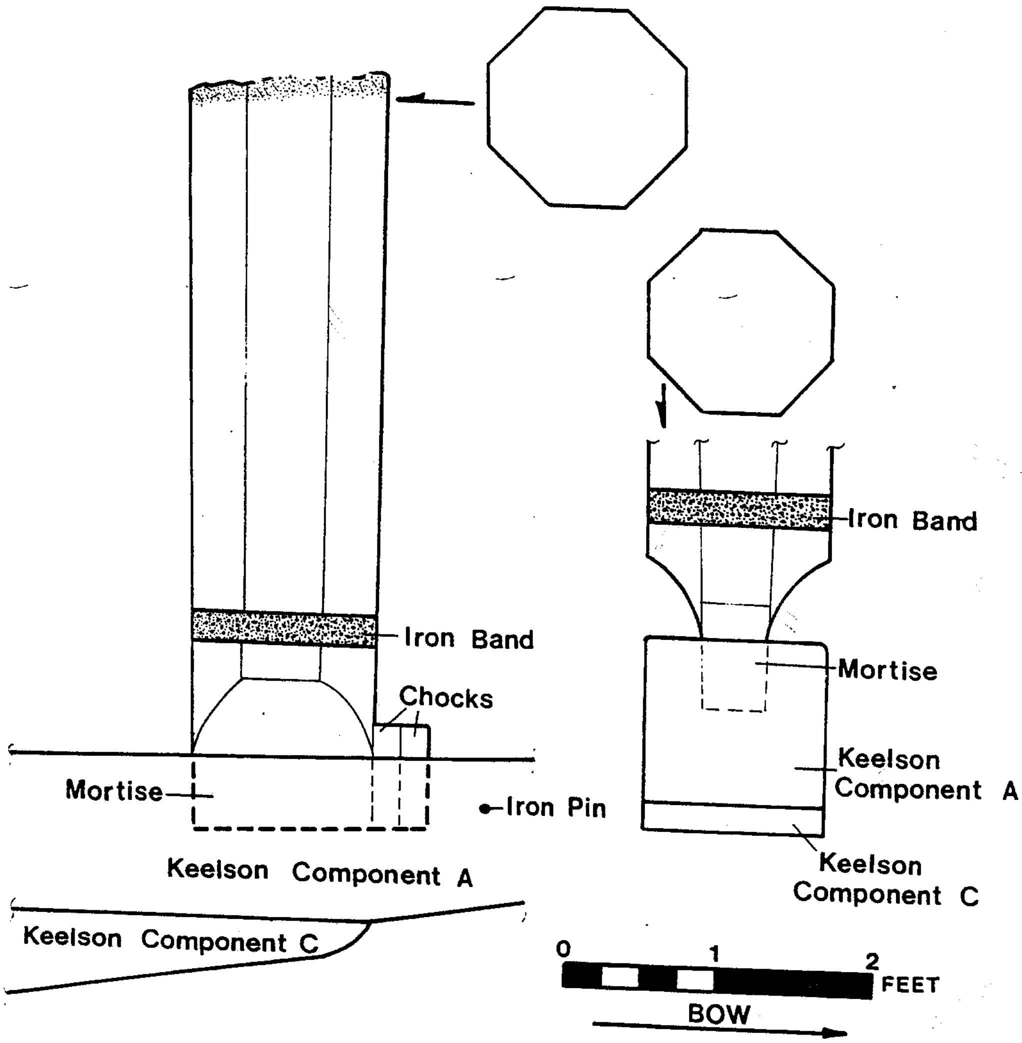


FIGURE 16. FOREMAST

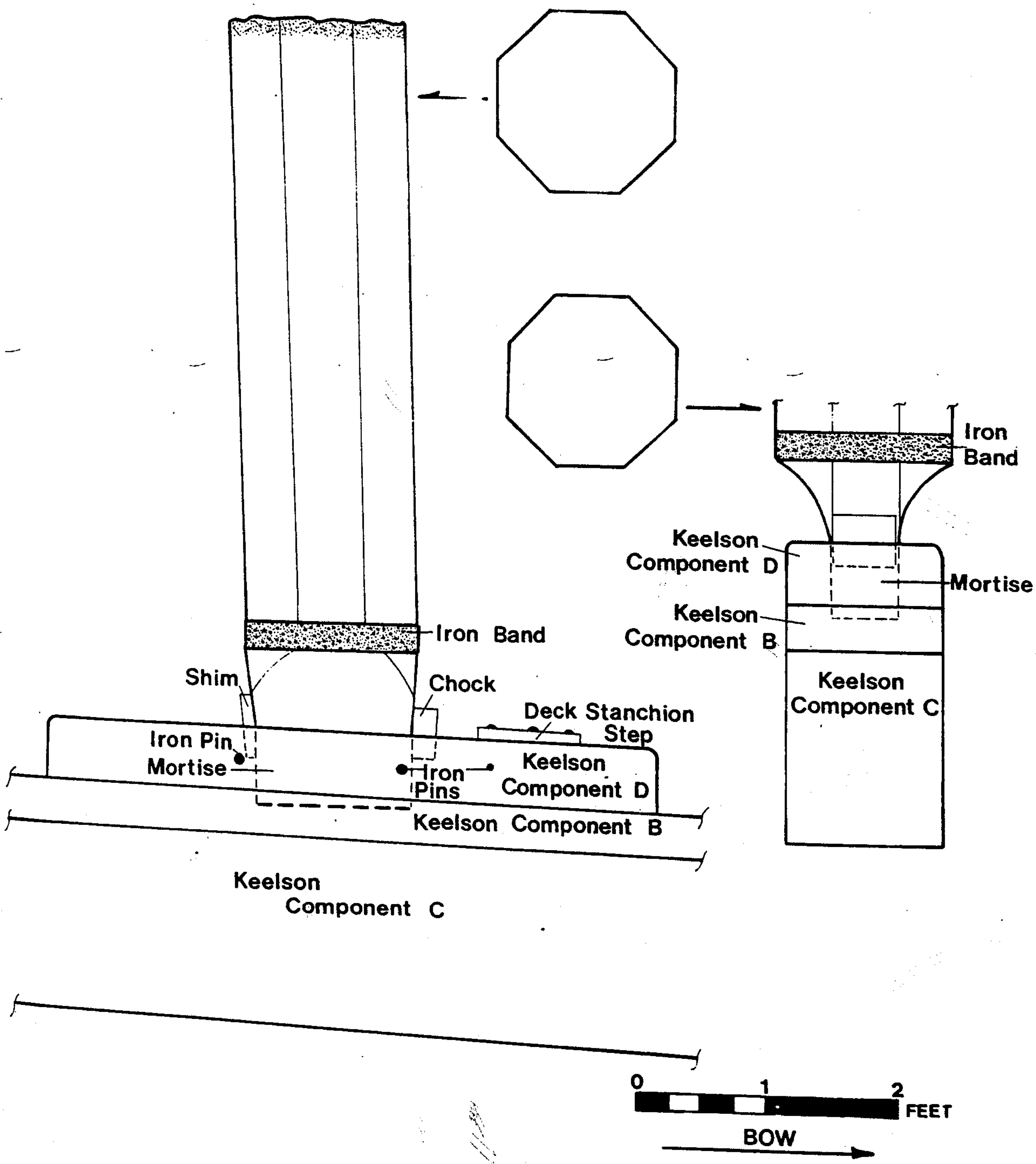


FIGURE 17. MAINMAST

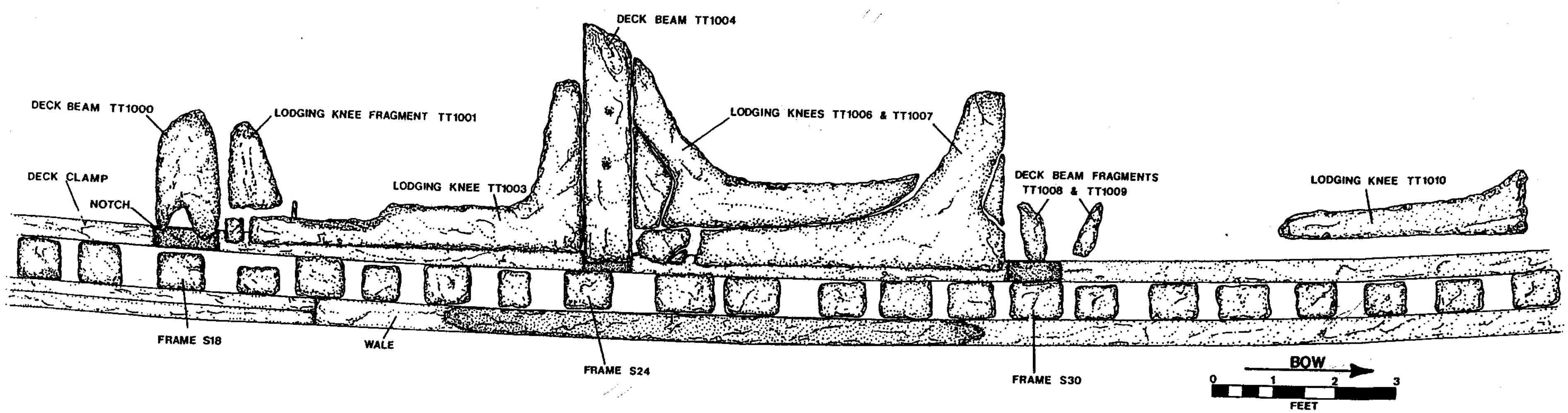


FIGURE 18. REMAINING ARTICULATED DECK STRUCTURE

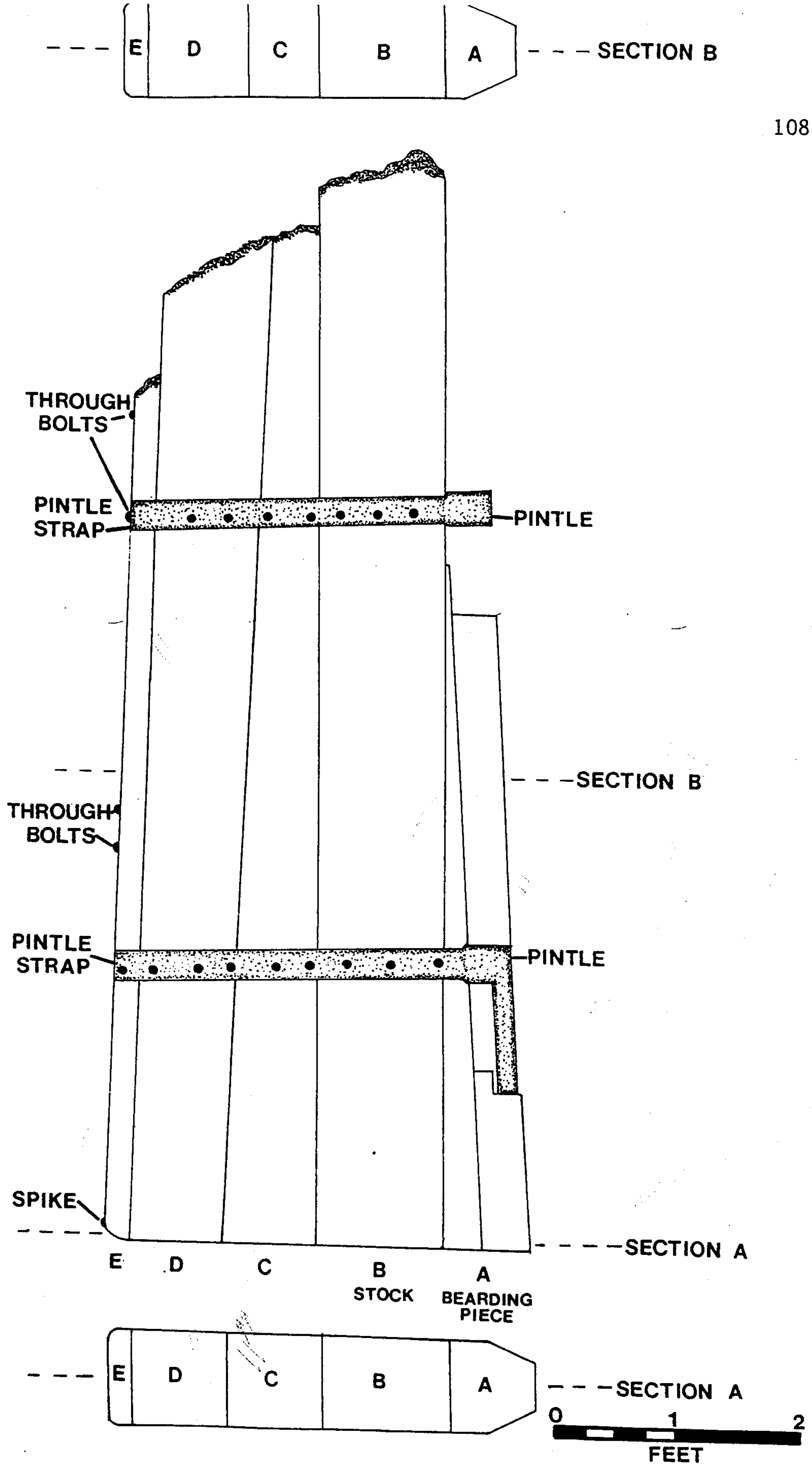


FIGURE 19. RUDDER, CONSTRUCTIONAL DRAWING

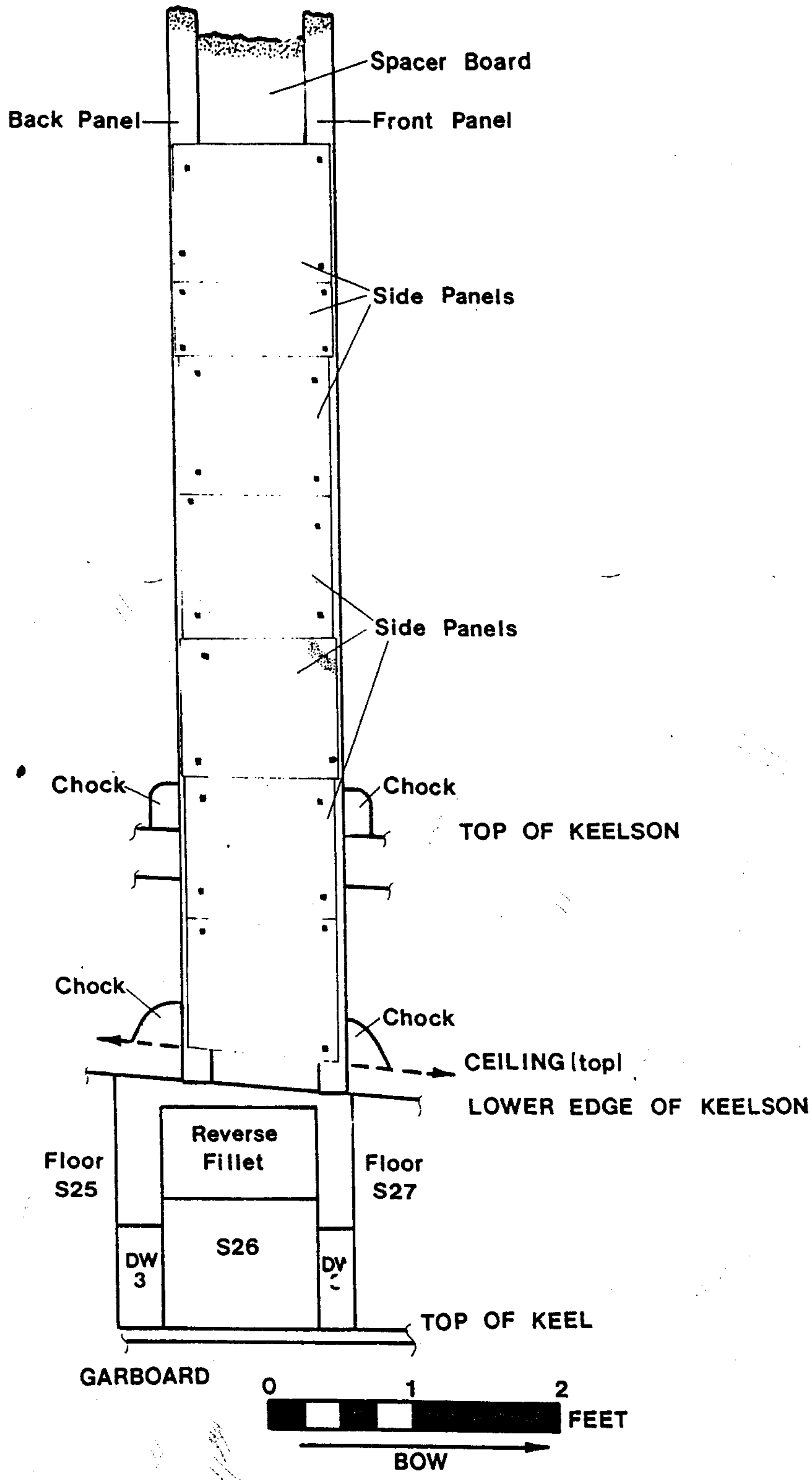


FIGURE 20. PUMPBOX, STARBOARD PROFILE

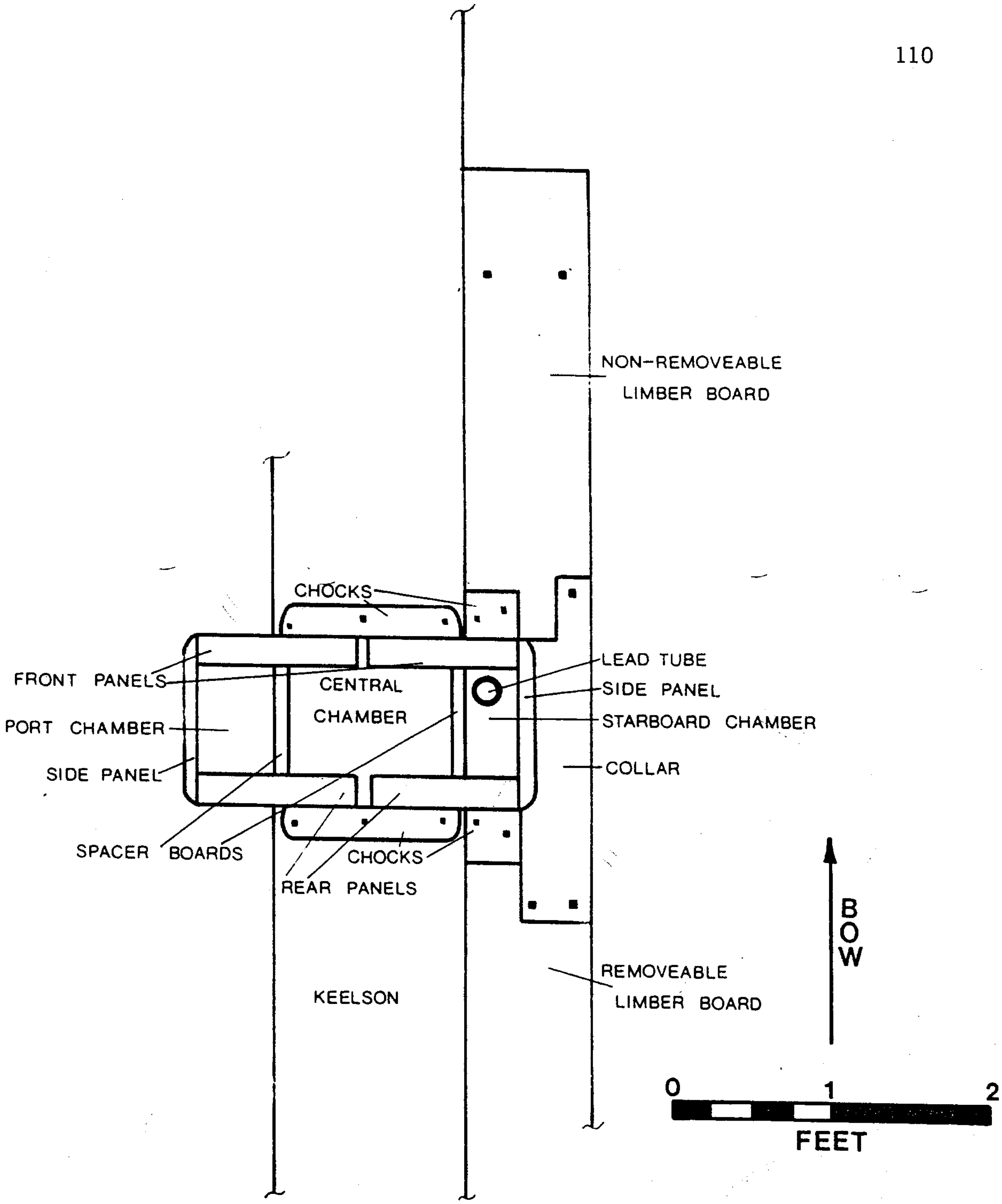


FIGURE 21. PUMPBOX, PLAN VIEW

BIBLIOGRAPHY

Primary Sources

Books

Chadwick, French Ensor, ed. The Graves Papers and the Documents Relating to the Naval Operations of the Yorktown Campaign, July to October, 1781. New York: Naval Historical Society, 1916.

Chalmers, G. Estimate ofthe Comparative Strength of Great Britian. London: 1784.

Chapman, Frederick Henrik af. Arcitectura Navalis Mercatoria 1768. London: Adlard Coles, Limited, 1968.

Ewald, Johann. Diary of the American War: A Hessian Journal. Translated and edited by Joseph P. Tustin. New Haven: Yale University Press, 1979.

Fincham, John. A History of Naval Architecture. London: Whittaker and Co., 1851.

Lever, Darcy. The Young Officier's Sheet Anchor. London: 1815.

Lloyd's Register, 1770-1782. Reprint ed. London: Gregg Press, n.d.

Murray, Mungo. A Treatise on shipbuilding. London: A. Miller, 1754.

--- References and Explanations of Four Prints Exhibiting Different Views of a Sixty Gun Ship. London: A. Miller, 1754.

Popp, Stephan. A Hessian Soldier in the American Revolution: The Diary of Stephan Popp. Translated by Reinhart J. Pope. N.d. : privately printed, 1953.

Ross, Charles, ed. Correspondence of Charles, First Marquis of Cornwallis. London: John Murray, 1859.

Shoepf, Johann David. Travels in the Confederation. Translated and edited by Alfred J. Morrison. New York: Beergman, 1968.

Steel, David. Naval Architecture. London: 1805.

--- The Elements and Practice of Rigging and Seamanship. 2 vols. London: 1794.

Sutherland, William. Britain's Glory, or Shipbuilding Unveiled. London: 1717.

--- The Shipbuilder'Assistant. London: 1711.

Tarleton, Banastre. A History of the Campaigns of 1780 and 1781 in the Southern Provinces of North America. London: T. Cadell, 1787.

Articles

Dohela, Johann Conrad. "The Dohela Journal, 1781." William and Mary Quarterly, 2d ser., no. 22 (1942): 229-274.

Tucker, St. George. "Diary of the Siege of Yorktown." William and Mary Quarterly, 3d ser., no. 5 (1948): 375-395.

Manusript Collections

Court Records, County of York. "Claims for losses of York County in the British Invasion of 1781." York County Courthouse, Yorktown, Virginia.

Governor's Papers. Virginia State Library, Richmond,Virgina.

Orderly Book, Ensign Dennis. Colonial National Historic Park, Yorktown Virginia.

Order Book, 43rd Regiment of Foot, April 17, 1781 - August 15, 1781. Yorktown Shipwreck Archaeological Project Records, Department of Historic Resources, Richmond, Virginia.

Project Files, Yorktown Shipwreck Archaeological Project, Department of Historic Resources, Richmond, Virginia.

Vessel Log, Emerald, N. d.. Private Collection.

Newspapers

Richmond Times Dispatch

Interviews

Broadwater, John D. Interveiw with author. Yorktown, Virginia. December, 1990.

Lyon, David. Interveiw with author. Yorktown, Virginia. December, 1988.

MacGregor, David R. Interveiw with author. Yorktown, Virginia. December, 1987.

Neubauer, Joseph R. Interveiw with author. Gloucester Point, Virgina. December, 1988.

Scofield, Geoff. Interveiw with author. Morehead City, North Carolina. April, 1989.

Watts, Gordon P., Jr. Interveiw with author. Yorktown, Virginia. October, 1989.

Secondary Sources

Books

Albion, Robert Greenhalgh. Forests and Sea Power: The Timber Problem of the Royal Navy, 1652 - 1862. Cambridge: Harvard University Press, 1926.

Burgess, Anthonyand H. Graham Wood. Steamboats Out of Baltimore. Cambridge, Maryland: Tidewater Press, 1969.

Brown, Marley R. III, and Kathleen J. Brandon, ed. Towards a Resource Protection Process: Management Plans for James City County, York County City of Poquoson, and City of Williamsburg. Williamsburg, Virgina: Colonial Williamsburg Foundation, 1985.

Chapelle, Howard I. American Small Sailing Craft. New York: W.W. Norton Company, Inc., 1951.

--- The History of American Sailing Ships. New York: W.W. Norton Company, Inc., 1935.

Clark, T.H. and C.W. Stearn. The Geological Evolution of North America: A Regional Approach to Historical Geology. New York: Ronald Press, 1960.

Coker, Samual P. The Maritime History of Charleston. Charleston: Coker Press, 1985.

Davis, Burke. The Campaign That Won America: The Story of Yorktown. New York: Dial, 1970.

Davis, Ralph. The Rise of the English Shipbuilding Industry in The 17th and 18th Centuries. Newton Abbot, England: David and Charles Press, 1972.

Dodds, James and James Moore. Building the Wooden Fighting Ship. New York: Facts on File, 1984.

Flinn, Michael W. The History of the British Coal Industry. 2 vols. Oxford: Clarendon Press, 1984.

Goldenberg, Joseph A. Shipbuilding in Colonial America. Charlottesville: University Press of Virginia, 1976.

Hatch, Charles E., Jr. Colonial Yorktown's Mainstreet and Military Entrenchments. New York: Publishing Center for Cultural Resources, 1974.

Johnson, Gerald H. Guidebook to the Geology of the York-James Peninsula and the South Bank of the James River. Williamsburg, Virginia: The College of William and Mary, 1969.

Johnston, Henry P. The Yorktown Campaign and the Surrender of Cornwallis, 1781. New York: Harper and Brothers, Franklin, 1881.

Keegan, John. The Price of Admiralty : The Evolution of Naval Warfare. New York: Viking, 1989.

Larabee, Harold A. Decision at Chesapeake. New York: Clarkston N. Potter, 1964.

Leviton, Jeffrey S. Marine Ecology. Englewood Cliffs, New Jersey: Prentice-Hall Incorporated, 1982.

Longridge, C. Nepean. The Anatomy of Nelson's Ships. Watford, Hertfordshire, England: Model and Allied Publications, Argus Books Limited, 1977.

Lynch, Barbra A. The War at Sea: France and the American Revolution, A Bibliography. Washington , D.C. : U.S. Government Printing Office, 1976.

MacGregor, David R. Merchant Sailing Ships 1775 - 1815, Their Design and Construction. Watford, Herts, England: Model and Allied Publications, Argus Publications Limited, 1980.

Mahan, Alfred Thayer. The Major Operations of the Navies in The War of American Independence. London: Sampson Low, Marston, 1913.

Middleton, Arthur Pierce. Tobacco Coast: A Maritime History of the Chesapeake Bay in the Colonial Era. Newport News: The Mariners' Museum Press, 1953.

Murray, Grover. Geology of the Atlantic and Gulf Coastal Province of North America. New York: Harper and Brothers, 1961.

Nef, John U. The Rise of theBritish Coal Industry. 2 vols. Oxford: Clarendon Press, 1984.

Noel Hume, Ivor Noel. Here Lies Virginia: An Archaeologist's View of Colonial Life and History. New York: Knopf, 1968.

Parry, J.H. Trade and Dominion. London: 1971.

Sands, John O. Yorktown's Captive Fleet. Charlottesville: University Press of Virginia, 1983.

Smith, Adam. An Inquiry into the Nature and Causes of the Wealth of Nations. New York: 1932.

Syrett, David. Shipping and the American War, 1775 - 1783: A Study of British Transport Organization. London: Althone, 1970.

Tilley, John A. The British Navy and the American Revolution. Columbia: The University of South Carolina Press, 1987.

Articles

Anderson, R.C. and W. Salisbury. "The Framing of Models and Actual Ships." Mariner's Mirror, 40, (Winter 1954):156 - 159.

Baker, William. "The Developement of Wooden Ship Construction; A Brief Historical Survey to the Nineteenth Century." New England Section of the Society of Naval Architects and Marine Engineers, 1955.

--- "More on the Framing of Models." Mariner's Mirror, 40, (Winter 1954): 80 - 81.

Holly, Hobart H. "The Sparrowhawk, a Seventeenth Century Vessel in Twentieth Century America." American Neptune, volume XIII (1953): 56 - 54.

Lightly, R.A. "An Eighteenth Century Dutch East Indiaman Found at Capetown." International Journal of Nautical Archaeology vol. 5 no. 3: 310 - 318.

Maclean, J.D., Jr. "The Formation of the Yorktown Formation in the York-James Peninsula of Virginia, with Notes on Assosciated Mullusks." Bulletins in American Paleontology, vol. 36 no. 160 (1956): 225 - 294.

Theses and Unpublished Works

Bass, George F., Ivor Noel Hume, John O. Sands, and Richard J. Steffy. "The Cornwallis' Cave Shipwreck." Report submitted to the Virginia Historic Landmarks Commission, 1976.

British Coal Institute. "Coal Analysis of Samples 1 - 45, Site 44Y088." Unpublished, prepared forthe Yorktown Shipwreck Archaeological Project, 1989.

Carron, Joseph Michael. "Geomorphic Processes of a Drowned River Valley: Lower York River Estuary, Virginia." Master's thesis, The College of William and Mary, 1986.

Reiss, Warren, "The Phantom Pyramid." Computer program, Virginia Department of Historic Resources, 1982.

Steffy, Richard J. "The Charon Project: A Preliminary Report. Unpublished report, 10 August, 1980, Texas A & M University, College Station, Texas.

U.S. Forest Service. "Report on Wood Analysis of Samples from Site 44Y088." Unpublished, prepared for the Yorktown Shipwreck Archaeological Project, 1988.

Yorktown Naval Weapons Station, Historic Preservation Plan, U.S. Army Corps of Engineers, Draft Copy.

APPENDIX A

"Report on the Pump Well Structure of YO-88"

by Thomas J. Oertling

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August 11, 1988

Yorktown Shipwreck Archaeological Project

"Report on the Pump Well Structure of YO-88"

by Thomás J. Oertling, Research Associate, Institute of Nautical Archaeology

In May of 1988, I was invited by John Broadwater, director of the Yorktown Shipwreck Archaeological Project, to come to Yorktown to record and dismantle the pump well structure of the vessel (YO-88) currently being excavated in a cofferdam off the Yorktown beach. This was accomplished between July 11-16.

The pump well, the wooden structure protecting the pump tubes from shifting cargo and ballast, was still in situ on the ship's centerline. It was well built and reflected the quality with which the rest of the ship was built. Situated 2' 5" aft of the mainmast mortise the well was composed four vertical boards forming the fore and aft walls and two thinner spacing planks placed between the walls thus dividing the well into three chambers. The sides were composed of many short planks nailed to the outboard edges of the fore and aft walls. (See Table for timber sizes) A length of lead tube was found <u>in situ</u> in the bottom of the well on the starboard side.

The well was constructed in the following manner: A rectangular chock was nailed to the top of the rider keelson to which the spacer boards were nailed such that their outboard sides were flush with the sides of the keelson. Presumably a similar chock was nailed to the underside of the deck to provide an attachment point for the upper ends of the board. The boards of the fore and aft walls were notched to fit over the keelson/rider keelson assembly and extended outboard of the keelson about 5-6 inches. Each plank had two nails fastening it to the side of the keelson/rider keelson. The fore and aft walls were held in place at the rider keelson by two pieces of quarter-round (2 x 3 inches) placed behind the aft wall and before the forward wall and each nailed into the top of the rider keelson. The six major planks of the well were preserved to a height of ca. 5' 7" above the top of the rider keelson. As the table shows, the fore and aft walls were narrower at the top than at the bottom.

The lead tube found in the starboard chamber was without doubt a part of the pump tube. The tube was formed by rolling a sheet of lead around a mandril and soldering a seam along its length. The seam is still clearly evident. The upper end of the tube, as it was found in the well had an angled cut, a sign that the pumps were salvaged by being pulled up and cut into manageable pieces. The lower end of the tube was a finished end, as evidenced by the way the soldered seam falls into the tube, as though the mandril did not extend that far.

Lead pumps and pump tubes are perfectly in keeping with this time period. This metal was easily obtained and worked, and so, was very common. Tubes of any diameter could be made, as described, by cutting a sheet of lead in width to the desired circumference, rolling it so the ends met, and soldering the seam (Diderot, 1966: Vol. 12, 787; and Vol. 29, plombiere, pl. II, fig. 27). These tubes were durable, did not rust, and were not prone to splitting as wood might.

There are several examples of lead pumps in the archaeological record. Most appropriately, a pair of lead pump tubes, now in the Mariner's Museum (#RS2 and 3), was recovered from the York River at Yorktown, Va., in the 1930's (Ferguson, 1939). There is a reservoir box on top of a piston tube, with a drainage port at one side of the box and no top on the reservoir box. The second section of lead tube has a lower fitting which is an expanded section of tubing, and the third section is a length of tube that connected with the second, according to museum staff.

A photograph of these pipes just after their recovery shows enough lead tubing to account for at least three if not four pumps. Two bottoms and one top are shown and each with enough tubing attached to account for a separate pump (Ferguson, 1539: fig. 5). The photograph also shows two different lower fittings, but only one is in the Museum collection.

Another pair of pumps at the Museum (#RS 6 and 7) was purchased in St. Thomas, B.W.I., by agents of the Museum because they looked very similar to, but were smaller than, the tubes recovered from the York River. The difference between the two sets is that the piston cylinders are made of copper. No information is available on the history of these pumps, and no seams were seen on the lead tubing of these pumps.

An earlier example of a lead pump is from the *San Jose*, sunk off Florida in 1733, which was possibly an English-built ship purchased by the Spanish. The pump consists of a reservoir box, a dale, and a piston cylinder, all of lead. The latter contained a bronze gravity valve set permanently into its tapering lower end. The tapered end probably fit into a wooden tube.

No trace of the pump mechanism was found on the site as it was most certainly salvaged from the ship sometime after the battle. It was, in all likelihood, a lead or copper pump fixed to the deck and probably with lead dales which carried the (often foul-smelling) bilge water to the side of the ship.

Diderot, Denis, 1966, Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers. Stuttgart-Bad: Cannstatt, Frommann.

Furguson, Homer L., 1939, "Salvaging Revolutionary relics from the York River." The William and Mary College Quarterly Historical Magazine, 2nd Ser., 19: 257-51.