SHELBURNE SHIPYARD STEAMBOAT GRAVEYARD: ARCHAEOLOGICAL INVESTIGATION OF FOUR STEAMBOAT WRECKS

A Thesis

by

CAROLYN KENNEDY

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Chair of Committee,	Kevin J. Crisman
Committee Members,	Cemal Pulak
	Anthony Stranges
Head of Department,	Cynthia Werner

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ABSTRACT

Steamboats became commercially viable in the early nineteenth century, and by the 1830s were arguably the most popular form of long-distance travel around North America, especially on inland waterways like Lake Champlain. Due to this popularity, demand for faster, larger boats drove shipwrights to experiment with new designs that differed greatly from traditional ship construction. Unfortunately, steamboat plans from this period are mostly missing or incomplete, and therefore our knowledge of their changing shapes and features must be derived from archaeological data. A survey of Lake Champlain's Shelburne Shipyard revealed the remains of four nineteenth-century steamboats. The four hulls, labeled Wrecks 1 through 4, were recorded for comparative study during a field school that took place in the month of June, 2014. Researchers from Texas A&M University and the Lake Champlain Maritime Museum spent three weeks recording the remains in order to identify the individual boats, develop preliminary site plans for each wreck, and compare the differing construction patterns. Though Wreck 1 (*A.Williams*) proved to be from 1870, the other three were nearly contemporaneous, all built in the 1830s. Despite their close launch dates, Wrecks 2, 3 and 4 (*Winooski* [1832], *Burlington* [1837] and *Whitehall* [1838]) displayed very different construction methods. This study examines the archaeological findings of the Shelburne Shipyard steamboats along with historical background information in order to illustrate how shipwrights were straying from traditional, heavy-timbered ship designs to make lighter and longer hulls in an effort to make faster vessels.

DEDICATION

For my grandfather, Stanley Roussel, who inspired in me the love of boats and Lake Champlain.

ACKNOWLEDGEMENTS

This project was made possible by the guidance, support and encouragement of several individuals and organizations. First and foremost I would like to thank my committee chair, Dr. Kevin Crisman, for introducing me to this historically and archaeologically rich site. It has been my great honor and pleasure to work alongside Dr. Crisman throughout this project. His love for Lake Champlain's shipwrecks is inspiring, and I could not have asked for a better mentor.

I am indebted to my committee members, Dr. Cemal Pulak and Dr. Anthony Stranges for their helpful insight and general guidance throughout the writing process. I sincerely thank both of them for reviewing in a tight time frame, and being flexible with digital edits while I continue to work in the field.

Many thanks are owed to the institutions that made this project possible, including the Institute of Nautical Archaeology, the Center for Maritime Archaeology and Conservation, and the Department of Anthropology. I appreciate these organizations' decision to fund my project, and for their ongoing support for future field work. I would also like to thank the State of Vermont's Division for Historic Preservation for granting permission for this archaeological investigation.

I am deeply grateful to the Lake Champlain Maritime Museum staff for their assistance and support throughout every phase of this project. Archaeological director Christopher Sabick worked with us through all of the phases of the project, devoting much of his time and energy to the planning, field school and writing stages. His

guidance and participation made him an invaluable asset to this work. Our divemasters, Ron Adams and Robert Wilczynski, ensured the safety of all our divers, and to them we owe many thanks. I would like to sincerely thank Paul Gates, conservation technician for the museum, who was our site photographer and also hauled our dive tanks back and forth every morning and evening to the dive shop for refills. I also thank the Waterfront Diving Center in Burlington, Vermont, for their help with refilling tanks and providing the project and divers with gear.

Thanks also go to my friends and colleagues from Texas A&M University who participated in the 2014 field school: Mara Deckinga, Nathan Gallagher, Rebecca Ingram, Stephanie Koenig, Varvara Marmarinou, Carrie Sowden and Grace Tsai; and our volunteer, Dan Bishop. This team surpassed all expectations in data collection, especially considering the short timeframe within which we were on site. The stellar group dynamic and work ethic of these individuals is unmatched, and I truly hope to work with them all again on future projects.

This project was made possible by the agreement of the property owners living adjacent to the site. Marge Aske, Mark Brooks and Connie Porteous generously allowed our divers to stage directly off their shorefront properties, and use their docks for surveillance. Their enthusiasm for the work being done for this project is highly appreciated, and many thanks are owed to their ongoing support. Thanks to Mary Griswold, owner of the Shelburne Shipyard, for allowing our team to use the marina's facilities. Finally, thanks to Mary Fitzpatrick for renting us her house in Ferrisburgh, Vermont, for the duration of the project, a wonderful place to come home to every day.

I am forever indebted to Arthur Cohn who has guided and mentored me even prior to my acceptance into Texas A&M University on all aspects of nautical archaeology. Art has ingrained in me the importance of shipwrecks as resources of our shared cultural heritage, and also the need to study and share our results with everyone. I would like to thank Art here specifically for his role in the 2014 project, in which he gave three lectures to the field school students on different aspects of diving and ethical issues relevant to nautical archaeology based on his personal experiences (which are extensive).

Finally, thanks to my family for their constant support throughout my academic career. Their encouragement and enthusiasm over this project has been infinite, and I will be forever grateful to them for enabling me to pursue all of my academic goals.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER I

INTRODUCTION

The first successful trial of a steam-propelled watercraft occurred in 1807, when Robert Fulton and Chancellor Livingston's *North River Steamboat*, later to be re-named *Clermont*, was launched from New York City and traveled up the Hudson River to Albany in 30 hours.[1] Fulton's success on the Hudson River inspired two entrepreneurs on nearby Lake Champlain to realize the advantages of steam transportation. Within two years of *North River Steamboat*'s first voyage, brothers John and James Winans, launched the second steamboat in North America, *Vermont*. The boat was 120 ft. (36.6 m) long, 20 ft. (6.1 m) wide and traveled at a speed of 8 mph (12.9 km/h). *Vermont* carried passengers the length of Lake Champlain for six years until it sank near Isle aux Noix, Quebec, in 1815.[2]

The profitable career of *Vermont* boded well for the preceding steamboat business on the lake, which promptly took off "full steam ahead." Lake Champlain was one location in North America where steam-powered vessel construction gained stride in the first few decades of the nineteenth century, since the main form of transportation around the area was via water. The decades between 1809 and 1850 witnessed the launch of seventeen new steamboats, each reportedly with improvements in engine technology and hull design over those of its predecessors.

Contemporary observers noted these rapid changes in steamboats, but detailed descriptions and plans of vessels from this period are largely missing. There is no

reliable evidence to tell us exactly what form the improvements took. Luckily, archaeological remains of steamers from this time survive beneath various bodies of water around the country and provide clues to these fast-paced changes; however, few places provide more evidence than Lake Champlain. Three wrecks, *Phoenix* (1815), *Water Witch* (1832) and *Champlain* II (1868) have been archaeologically recorded in recent years. *Phoenix,* as will be seen below, was investigated as the subject of a dissertation by George Schwarz of Texas A&M University in 2009 and 2010.[3] *Champlain* II was the focus of an M.A. Thesis by Elizabeth Baldwin of Texas A&M University in 1997.[4] *Water Witch,* built by Jahaziel Sherman, provides a unique example of a steamboat-turned-schooner. While Sherman's boat was originally built with powerful engines, the hull was not well designed for passenger transport, and was therefore converted to a cargo-carrying canal schooner in 1836.[5] Tragically this wreck, along with *Phoenix*, took with it the lives of several people.

A study by the Champlain Maritime Society (CMS) documented the remains of steamboat hulls in Shelburne Bay in 1983. The results of these findings, published by CMS project director, Jack Chase, in 1985 provided initial clues to the wrecks remaining in the area.[6] Ultimately, the CMS report proved helpful, however not fully accurate. In 2013, a study planned for June 2014 targeted four steamboat hulls sunk near Shelburne Shipyard in the town of Shelburne, Vermont as examples of changing hull designs.

The archaeological investigation of Shelburne Shipyard was sponsored by Texas A&M University (TAMU), the Institute of Nautical Archaeology (INA), the Center for Maritime Archaeology and Conservation (CMAC) and the Lake Champlain Maritime

Museum (LCMM). A group of ten graduate and undergraduate students from TAMU participated in a field school directed by Kevin Crisman and Carolyn Kennedy. The objective of the 2014 field season was to carry out a reconnaissance survey of the four wrecks, gathering information on the overall dimensions of each, as well as the dimensions and configurations of elements such as keels, endposts, frames, keelsons, engine bed timbers, planking and other significant features associated with the wrecks. This project aimed to be as noninvasive as possible, with minimal disturbance to sediment overlying the hulls. By the conclusion of the field work, the four hulls were identified, and preliminary site plans were prepared for each wreck.

The first objective of the survey was to determine the identity of the four wrecks. Historical evidence indicated that these vessels were all built prior to 1850, the period of steamboat construction that was the focus of this research. Unfortunately, the sources used to identify the wrecks were not perfectly reliable. Based on their lengths, only two out of the four matched their presumed identities, while the other two hulls belonged to entirely different steamboats. Additional research revealed the options for the wrecks' identities were few, based on their lengths. Within a few days of discovering initial mistakes, the real identities were determined with a high degree of probability. Three of the wrecks were of steamboats built in the 1830s: *Winooski* (1832-1850), *Burlington* (1837-1854) and *Whitehall* (1838-1853); and one had a much later date: *A. Williams* (1870-1893).

In order to better understand the remains in Shelburne Shipyard, dive teams of two were each assigned a wreck to record with the ultimate goal of preparing

preliminary site plans for all four wrecks. Therefore, while all the divers noted the obvious differences between hulls, they were only truly analyzed post field investigation, when plans could be compared to see where and how they differed. The plans revealed something suggested by certain historical sources: that these hulls, three of which were built less than a decade apart, had significant differences in construction that reflected the dynamic period of hull design experimentation during which they were built.

The following thesis will present the historical information used in the process of identifying the four steamboats, followed by an archaeological report of the data gathered for each wreck. The purpose of this thesis is to analyze and compare the wrecks, in particular the three near-contemporaneous wrecks, and examine the nature of the dynamic experimentation in steamboat construction occurring in this very narrow time frame.

CHAPTER II

HISTORICAL BACKGROUND

History of Steamboat Companies on Lake Champlain

It was not long after Fulton's *North River Steamboat* made its triumphal maiden voyage up the Hudson River in 1807 that two steamboat enterprises started building steam-propelled vessels for travel on Lake Champlain. The lake's first steamboat, *Vermont,* was a private pursuit by brothers John and James Winans in 1809. Four years after their success the first of the lake's steamboat consortiums, the Lake Champlain Steamboat Company, was established in 1813.[7] The Company's first boat, *Phoenix*, was built in 1815 immediately following the end of the War of 1812.

Phoenix is among the most famous of Lake Champlain's steamboats due to the story of its sinking. Late on the night of 5 September 1819 *Phoenix* was on a regular run from Whitehall, New York, to St. Jean, Quebec. The boat was under the command of Richard W. Sherman, son of the steamer's regular captain, Jahaziel Sherman, while the older man was at home due to sickness. Leaving the steamer in the hands of its pilot, R.W. Sherman went to bed just after leaving port at Burlington, Vermont. At 1 a.m., a passenger making his way to the pantry for a late-night snack noticed a fire had broken out. His shouts roused the passengers and crew who immediately awoke Sherman. The young captain quickly organized the panicked crowd, and managed to get the majority of people into the steamer's two boats. Unfortunately, eleven people were left on board the burning vessel, Sherman included. After ordering remaining passengers and crew to

jump overboard and grab hold of anything buoyant, Sherman himself swam away from the burning vessel. Ultimately six individuals drowned.[8] The story of the burning of *Phoenix* circulated around the Champlain Valley and around the United States and Canada, and the young captain was praised for keeping his head during the desperate situation. Both Shermans were held in high esteem throughout their careers on the lake.[9]

Phoenix was built in 1815, and sank in 1819. Its wreck is currently the earliest archaeological example of a steamboat in North America. The remains of the vessel were discovered in 1978, and a survey of the hull took place in 1980 by the Champlain Maritime Society (CMS) under the direction of Arthur B. Cohn. Another CMS team directed by Jack Chase and Donald Mayland carried out limited artifact recovery from the wreck in 1983. Most recently, George Schwarz reexamined *Phoenix* as part of his Texas A&M University doctoral dissertation research in 2009-2010.[10] Schwarz's report on the archaeology of *Phoenix* was useful for comparison with the Shelburne Shipyard wrecks as it is our current earliest archaeological example of steamboat construction on Lake Champlain.

The fire that resulted in *Phoenix*'s demise sparked some debate over the safety of steam engines. Despite the fact that a candle left burning in the kitchen most likely was the cause, many people worried that the engine had triggered the fire.[11] Though the concern over the *Phoenix* tragedy was significant, steam propulsion still gained popularity on Lake Champlain. Between 1815 and 1833, six separate entities built and operated steamboats on Lake Champlain. These included the Lake Champlain Steamboat Company, the Champlain Ferry Company, the St. Albans Steam Boat Company, Messrs.

Henry H. Ross and Charles McNeil, and Jahaziel Sherman. The most powerful among them was the Champlain Transportation Company (CTC), established in 1826. The CTC launched its first steamer, *Franklin*, in 1827, and this boat was bigger, faster and grander than the other companies' vessels. The CTC sold many stocks due to the success of *Franklin*, resulting in a substantial financial base.[12] Within its first year, the CTC formed a partnership with the Lake Champlain Steamboat Company, the oldest company still operating at the time. The partnership was favorable to the CTC but the Lake Champlain Steamboat Company struggled financially. In 1833 the older company sold all of its property to the CTC, including the steamboats *Phoenix II* and *Congress*, and all of the land at Shelburne Harbor, for a total value of $47,000.[13] By 1835, the CTC had either bought or bankrupted all of their other competition and claimed an unofficial Lake Champlain passenger steamboat monopoly.[14] The shipyard at Shelburne Harbor was one of the company's most important assets.

Shelburne Harbor is located in a protected bay in Lake Champlain on the eastern side of Shelburne Point, Vermont (Figure 1). The area is an excellent location for a shipyard due to its protection from prevailing winds and waves. This area served as the location of the CTC's shipyard starting in 1833, and thereafter all of their steamboats were built and retired in this harbor, making this harbor home to the remains of many archaeological examples of Lake Champlain steamboats.

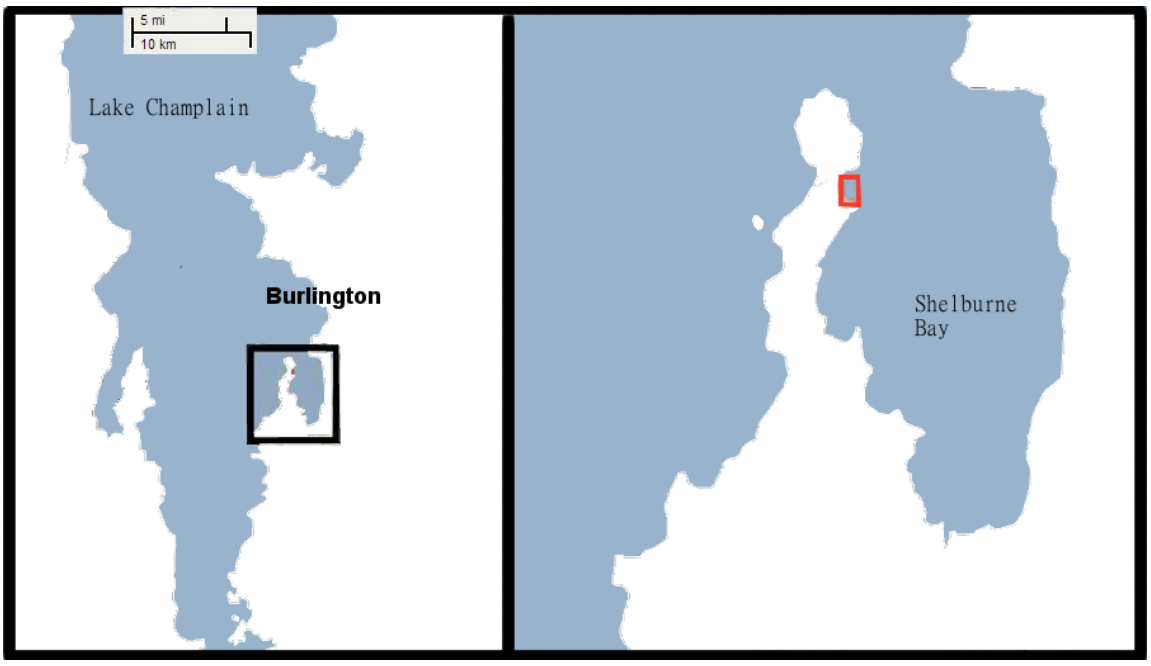

Figure 1. Left: Location of Shelburne Bay in Lake Champlain. Right: Location of Shelburne Shipyard in Shelburne Bay. (Adapted from Google Maps, 2014.)

Mistaken Identities

In anticipation of a planned archaeological investigation of Shelburne Shipyard scheduled for June 2014, Kevin Crisman and Carolyn Kennedy began researching the site's history in 2013. A Bing satellite image (located by Lake Champlain Maritime Museum archaeologist, Christopher Sabick) showed four shallow wrecks in close proximity to each other near the southern shore of the harbor (Figure 2). Other wrecks of both steamboats and sailing vessels are believed to be sunk around the shipyard area, but in 2014 we elected to concentrate on the four visible hulls. Strictly speaking, the identities of the wrecks were not needed for the purposes of the archaeological recording process; however, determining the names and dates of the individual wrecks was important in order to discuss trends in steamboat development to compare earlier and

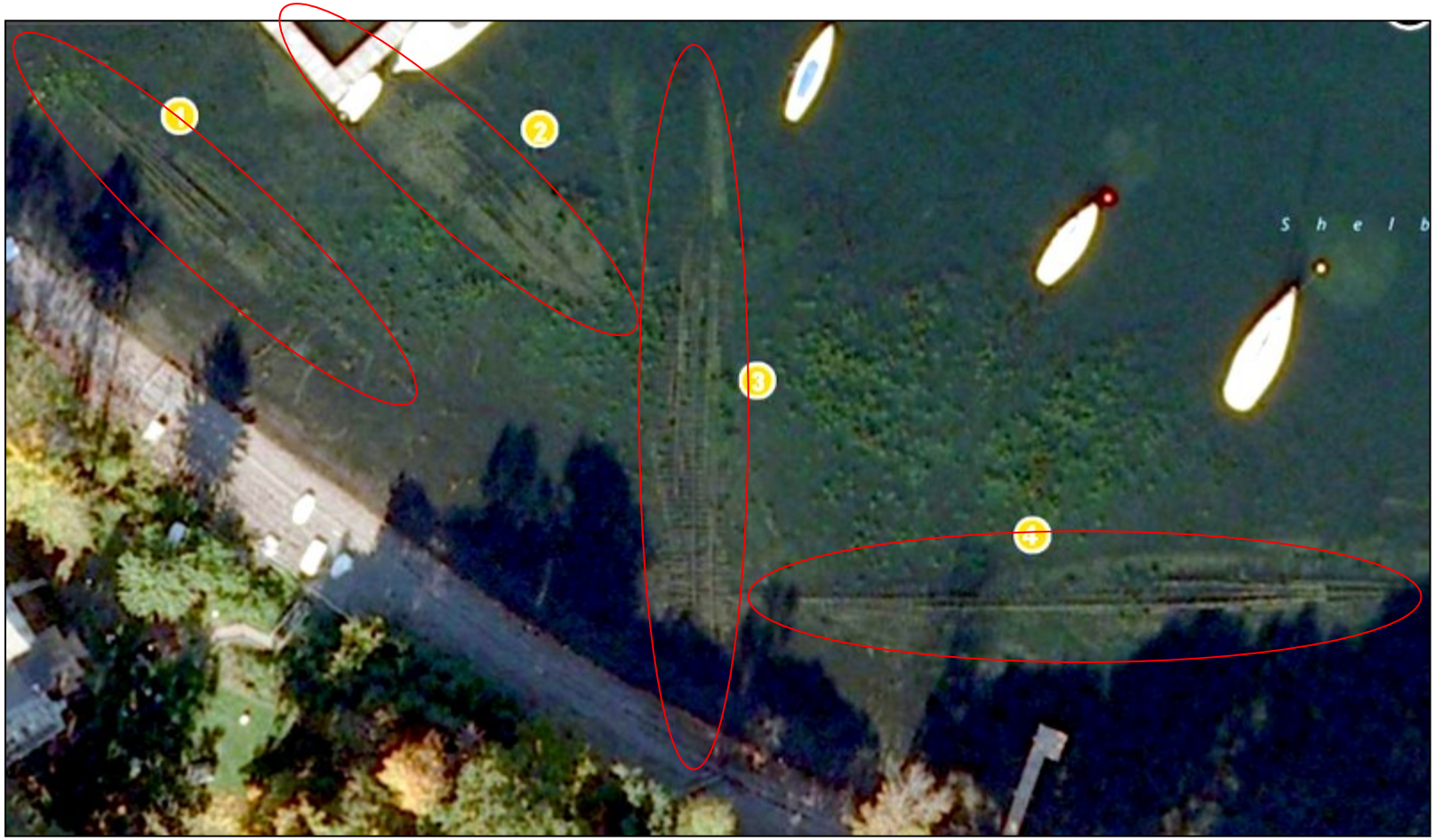

Figure 2. Satellite image of four steamboat wrecks in Shelburne Shipyard. (Bing Maps, 2013.)

later designs. Further, knowing the wrecks' names indicated to us the names of their builders and owners, allowing further study of variation in designs.

Historical research prior to the archaeological project began with two general sources: *The Steamboats of Lake Champlain 1809-1930*, by Ogden Ross (1997), and the Champlain Maritime Society (CMS)'s 1983 survey of the site.[15] The Champlain Transportation Company (CTC) commissioned Ross to record the company's history since its beginnings, therefore his book includes basic information of all of the steamboats owned and operated by the CTC. Jack Chase wrote up the results of the CMS's 1983 survey of Shelburne Shipyard for publication in 1985, which included the preliminary surveys of 12 steamer wrecks along the eastern shore of Shelburne Point.[16] Both Ross and Chase offered suggestions as to which steamboats these old hulls represented. Neither, however, had fully cited the sources that provided the basis of their assumptions. The wrecks were tentatively identified using an old map showing the locations of abandoned steamboats near the CTC shipyard in combination with an early photograph of the steamboat graveyard from circa 1859-60 (Figures 3 and 4). Though a bit misleading, these sources were the first clues to what remained beneath the lake's surface at Shelburne Shipyard.

Figure 3. Shelburne Shipyard ca. 1859-60 facing south toward Pine Point. This photograph shows the rotting hulls of many retired vessels, at least four of which appear to be steamboats. (K.Crisman personal collection.)

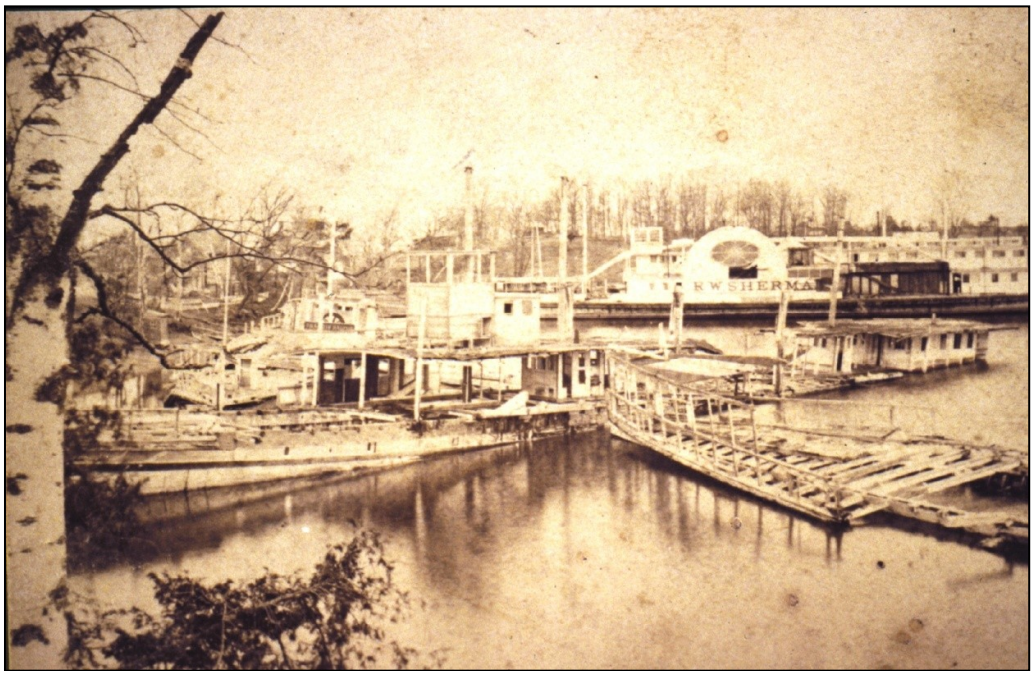

Figure 4. Photograph of Shelburne Shipyard ca. 1859-60 facing north. The two steamer hulls in the foreground are *Burlington* (left) and *Whitehall* (right). (K.Crisman personal collection.)

According to Ross and Chase, twelve steamboats were retired in the Shelburne Shipyard and its vicinity, ranging in retirement dates from 1838 to 1893. These steamboats were *Franklin* (1827-1838), *Winooski* (1832-1850), *Whitehall* (1838-1853), *Burlington* (1837-1854), *Saranac* (1842-1855), *Francis Saltus* (1844-1859), *R.W. Sherman* (renamed *America*, 1851-1866), *United States* (1847-1873), *Canada* (1853-1870), *Adirondack* (1867-1875), *A.Williams* (1870-1893), and a final steamer, *Herald* (unknown), was included only in Chase.[17] Out of these twelve, five were located on a map dated to "as early as 1880" in the precise location the Bing satellite image showed the four submerged hulls (Figure 5).[18] The map identified *Franklin, Burlington, Whitehall, Francis Saltus* and *A. Williams* as five abandoned where the four hulls are present today.

The Bing satellite image revealed only four visible wrecks in the vicinity we planned on surveying, however the anonymously drawn map found in Chase indicated five steamers retired there. An effort was therefore made to match the five steamboats shown in Figure 5 to the four steamboats visible in Figure 2. In one of the photographs dating to ca. 1859-60 (Figure 4), one of the partly-dismantled steamboats in the background has a name board on the pilot house which reads '*Francis Saltus*', indicating this steamer was retired in the Shelburne Shipyard (Figure 6). Ross noted that "the Company took no more chances with the *Francis Saltus*. As soon as her status was settled, she was turned over to the hands of the wreckers and her hulk now lies under the waters of the Shelburne Bay not far from the final resting place of the old *Franklin*."[19]

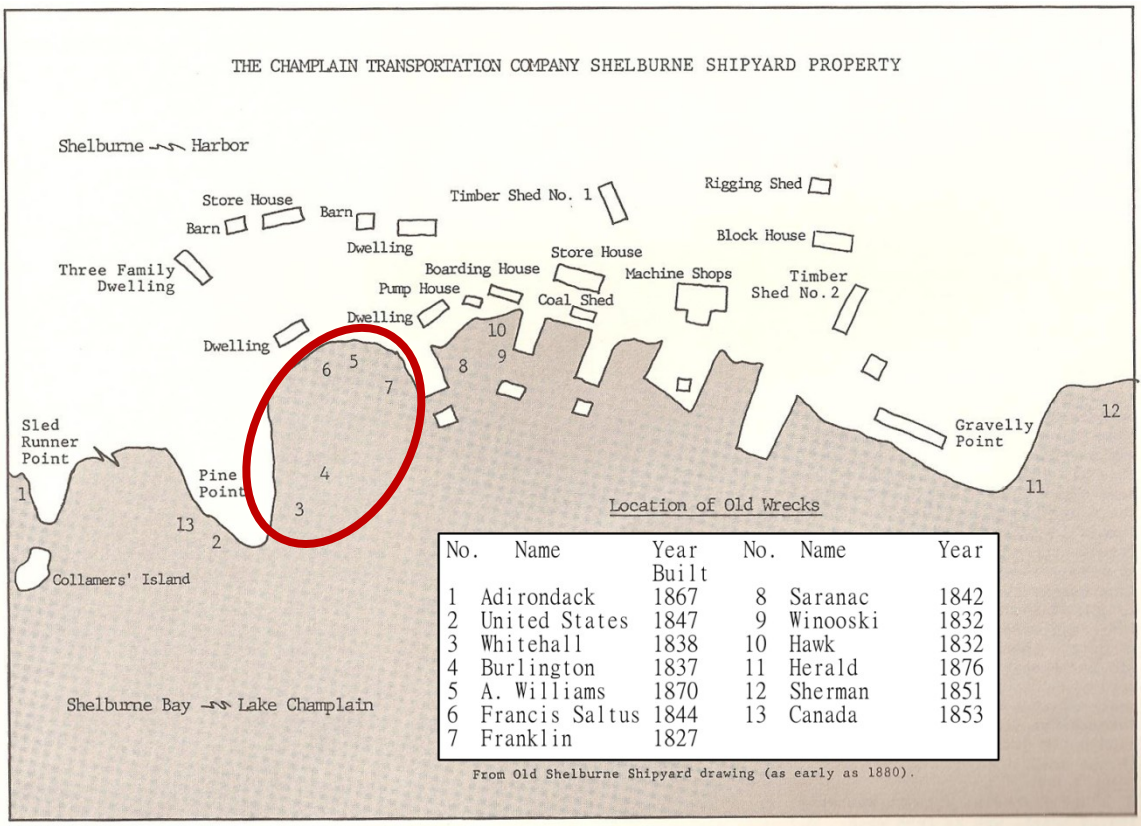

Figure 5. The location of retired steamboats along CTC property. The location of the 2014 archaeological investigation is marked in red. (Chase, 1983: 57.)

With historical sources placing *Francis Saltus* and *Franklin* together, and photographic evidence of *Francis Saltus* in the area in question at the time of its retirement, it seemed obvious that those two steamboats must be among the four shown in the Shelburne Shipyard satellite image (Figure 2, Wrecks 1 and 2). The other two wrecks in the satellite view were located where the 1880 map placed *Burlington* (Wreck 3) and *Whitehall* (Wreck 4); these corresponded to the two wrecks shown in the foreground of one of the c. 1858-60 photos (Figure 4). *A. Williams* was assumed to be sunk elsewhere in the harbor, especially since its retirement date of 1893 post-dated the supposed 1880 date of the map. Accordingly, prior to the field work historical research

on the four steamboats we expected to find: *Franklin, Francis Saltus, Burlington* and *Whitehall.*

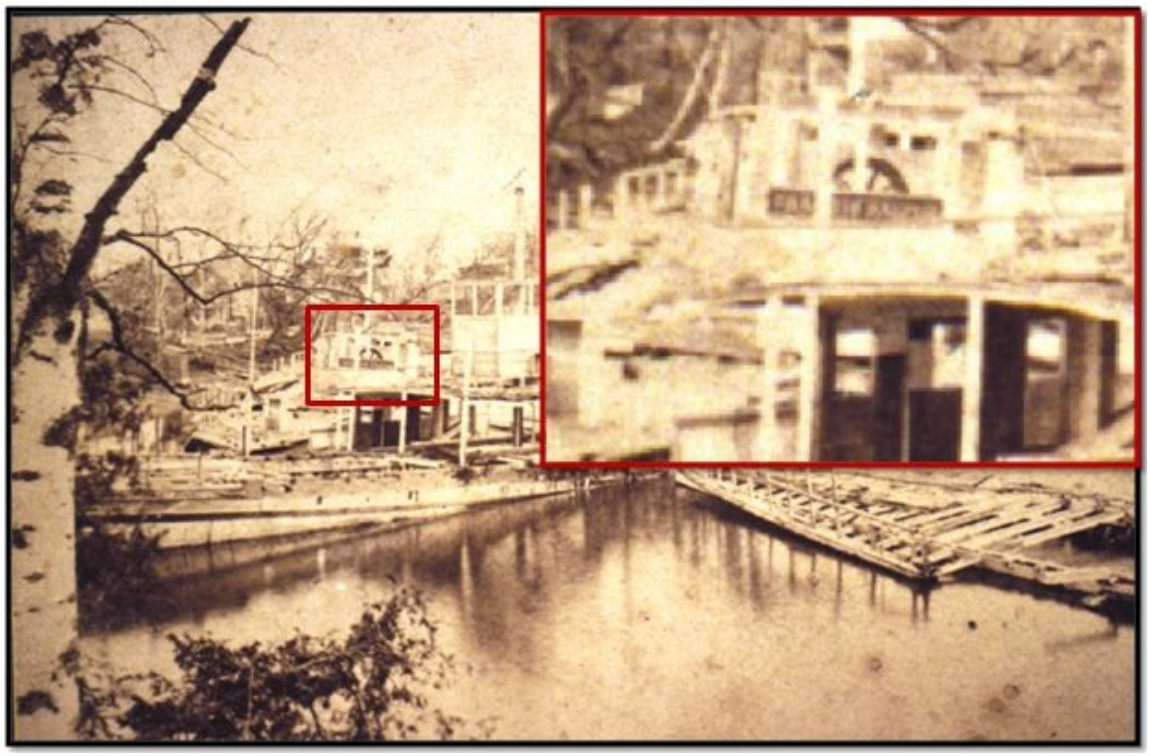

Figure 6. The nameplate of *Francis Saltus* is visible on steamboat in background of ca. 1859-60 photograph. (K. Crisman personal collection.)

Franklin

The Champlain Transportation Company (CTC) built *Franklin* in 1827, only twenty years after Fulton's *North River* inaugurated the steamboat age in North America. It was the CTC's first steamer, and their pride and joy. In its first year *Franklin* became the first steamboat on Lake Champlain to achieve a speed of 10 miles (16.1 kilometers) per hour. Not only was *Franklin* the fastest, but it was also the largest steamboat built

on the lake up to this point, measuring 162 ft. (49.4 m) in length and 22 ft. (6.7 m) in beam, giving it a 7.36:1 length-to-beam ratio.[20] The engine had a 75 horsepower engine, the first ever assembled by Elijah Root, chief engineer for the CTC for 55 years from 1827 to 1882.[21]

Franklin established the CTC's reputation for finely decorated, expensive and beautiful steamboats (Figure 7). The first advertisement printed in the *Burlington Free Press* described the steamer as "built of the best materials and in the best manner […] Her cabins are spacious and well lighted, with 84 births for passengers, and no expense has been spared in procuring furniture of the most costly and fashionable description."[22] The CTC maintained its record for producing very expensive steamboats throughout Lake Champlain's steamboat days, up to and including the launching of the lake's final steamer, *Ticonderoga,* in 1906.[23]

Franklin was reportedly retired in Shelburne Shipyard in 1838 when it was replaced by the CTC's newest and more impressive steamer, *Burlington*. No records have been located that identify the exact location of the hull of *Franklin*, though as noted earlier, historical sources placed it adjacent to the wrecks of *Francis Saltus, Burlington* and *Whitehall.* [24]

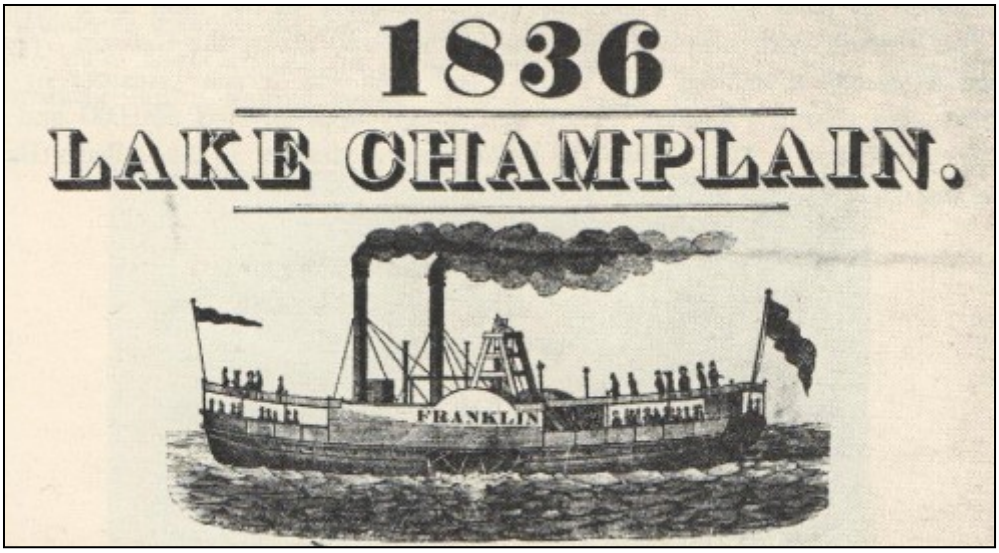

Figure 7. The steamboat *Franklin* as advertised by the Champlain Transportation Company. (Ross, 1997: 52.)

Burlington and Whitehall

Between the years 1826 and 1836, the CTC bought out or bankrupted all of its competitors and developed a monopoly on steam transportation on the lake, acquiring during this decade many working steamboats built by their competitors. Since these takeovers provided the CTC with new steamers, the company had no reason to build any new boats for nearly ten years after launching *Franklin* in 1827. By 1836, however, many of the existing boats were ready for retirement and so the CTC made plans to build a new boat at Shelburne in 1837.[25] The resulting steamboat, *Burlington*, was the pride of the CTC, and its career epitomized the golden days of steam on Lake Champlain.

Burlington was launched on 20 June 1837 from Shelburne Harbor with only a short notice advertising the upcoming event in the local newspaper: "We are informed that the new Steam-Boat building at the Harbor, will be launched at 4 o'clock, on

Tuesday afternoon."[26] The boat was launched with its lower hull complete, and its upperworks were finished over the course of the summer. In October, *Burlington* made its maiden voyage, a run the full length of the lake from Whitehall to St. Jean. Prominent citizens from Vermont, New York and Canada were invited to participate in the event. Among the passengers was Canadian politician, Thomas S. Brown, who said that *Burlington* was "a perfect specimen of all the arts employed in her construction, she does honor to Lake Champlain on which she floats, and to her liberal proprietors, who to gratify their customers, have spared no expense in adding tasteful decorations to strength and speed" (Figure 8).[27]

Brown was not the only one to praise *Burlington*. According to many others in the Champlain valley, including the CTC, *Burlington* was the world's finest steamboat of its time. The *Plattsburgh Republican* enthused, "We have no hesitation in saying that the "Burlington" is the most commodious and elegant boat that floats upon the waters of this or any other country."[28] Nobody, however, described *Burlington*'s elegance better than the English novelist Charles Dickens, who took passage aboard the steamboat in 1842 during his travels through North America:

> There is one American boat – the vessel which carried us on Lake Champlain, from St. Johns to Whitehall, which I praise very highly, but no more than it deserves, when I say that it is superior even to that in which we went from Queenstown to Toronto, or to that in which we travelled from the latter place to Kingston, or I have no doubt I may add, *to any other in the world*. The steamboat, which is called the *Burlington*, is a perfectly exquisite achievement of neatness, elegance and order. The decks are drawing rooms; the cabins are boudoirs, choicely furnished and adorned with prints, pictures and musical instruments; every nook and corner of the vessel is a perfect curiosity of graceful comfort and beautiful contrivance. Captain Sherman, her commander, to whose ingenuity and excellent taste these results are solely occasion; not the least among them, in having the moral courage to carry British troops at a time (during the Canadian rebellion) when no other conveyance was open to them. He and his vessel were held in

> universal respect, both by his own countrymen and ours; and no man ever enjoyed the popular esteem who, in his sphere of action, won and wore it better than this gentleman.[29]

Coming from an author famous for eloquent writing and distaste for all things American, *Burlington* could receive no higher praise.

Figure 8. The steamboat *Burlington* in a poster made by the Champlain Transportation Company for advertisement purposes. (Ross, 1997: 62.)

In 1835, just as news of *Burlington*'s construction was circulating the Champlain Valley, steamboat entrepreneur and CTC competitor Peter Comstock began building a new Lake Champlain steamboat at Whitehall, New York. The CTC decided to pay off

Comstock and buy his new steamboat, eliminating any competition to *Burlington*. The company first approached Comstock in 1836, and by 1838 had closed the deal when the CTC took over construction of the steamboat *Whitehall* while it was still on the stocks and paid Comstock $22,500. After the company's takeover Comstock was put in charge of the construction and was asked to lengthen the hull by 30 ft. (9.1 m) for a total length of 215 ft. (65.5 m), making it the longest steamboat to thus far grace the waters of Lake Champlain (Figure 9).[30]

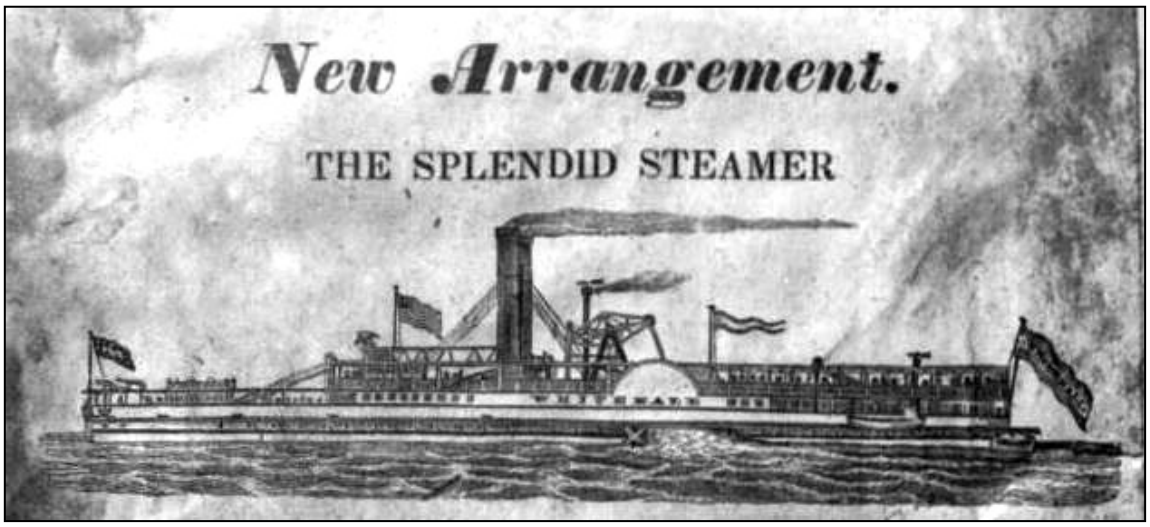

Figure 9. The steamboat *Whitehall*. (Champlain Transportation Company Papers (CTCP), Collection "A": Miscellaneous Papers 1838. Carton 8: Folder 55-87.)

Once built, *Whitehall* ran the same line as *Burlington*, only in reverse. The original schedule had *Burlington* leaving the town of Whitehall every Tuesday, Thursday and Saturday and leaving from St. Jean's every Monday, Wednesday and Friday. *Whitehall* held the opposite schedule, meaning when *Burlington* left Whitehall, *Whitehall* left St. Jean's and vice versa. The two steamboats ran this way for fifteen

years until their retirement, *Burlington* in 1854 and *Whitehall* in 1853. Both were retired side by side in Shelburne Harbor, and completely dismantled by 1855.[31]

Francis Saltus

During the reign of *Burlington* and *Whitehall* on the lake, various other steamboats made their appearance as well. Among these were *Saranac* (1842) and *Francis Saltus* (1844). While the former was built by the CTC at Shelburne, *Francis Saltus,* another potential CTC competitor, was constructed in Whitehall. Having successfully forced the CTC to buy him out on a previous occasion, Peter Comstock began building the rival steamboat of similar size to *Burlington* and *Whitehall*, no doubt expecting the CTC to pay him off again. The CTC, however, refused to bend to Comstock's plans or blackmail again, and instead decided to compete with him. Comstock completed his steamboat and launched *Francis Saltus* from Whitehall in 1844 (Figure 10).

Within only a year, Comstock sold *Francis Saltus* to Messrs Grant, Coffin and Church, a firm out of Troy, New York.[32] Throughout its early career, *Francis Saltus*' proprietors avoided buyout by the CTC, and the boat was a thorn in the powerhouse company's side because the company's competitors owned it. After a series of sales that included a short period of ownership by the CTC in 1848, the Plattsburgh and Montreal Railroad Company operated *Francis Saltus* in 1854. The railroad company ran the steamer in direct competition with the CTC's boats, generating legal battles between the two companies. Finally, in 1859, the CTC won its case against the railroad company

and claimed ownership once again of *Francis Saltus*, which they immediately retired and dismantled in Shelburne Harbor.[33]

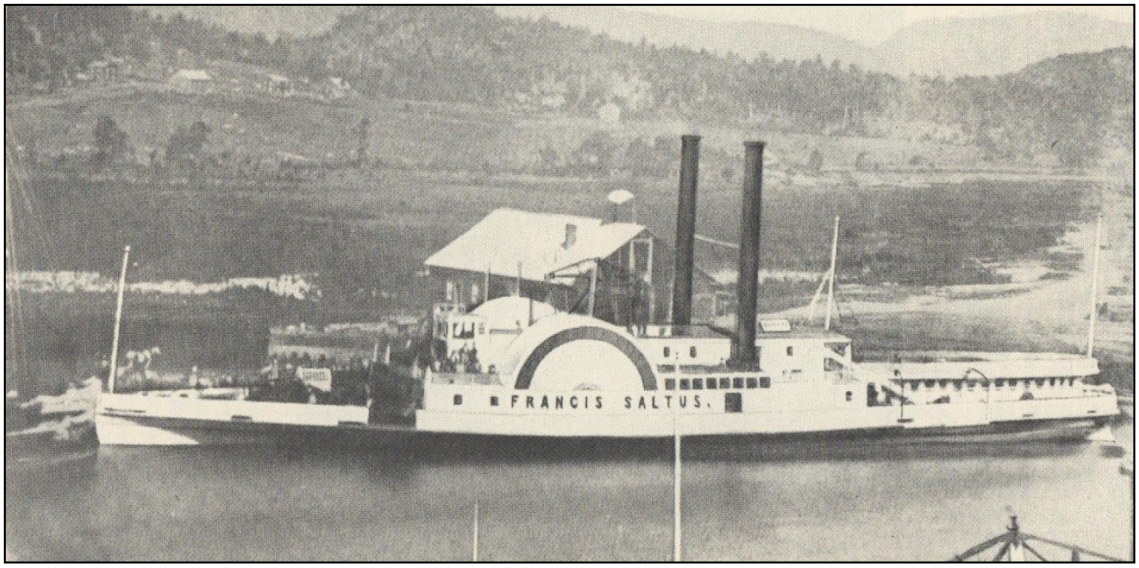

Figure 10. Comstock's steamboat *Francis Saltus*. Photograph taken at Whitehall, date unknown. (Champlain Transportation Company Papers (CTCP), Collection "A": Miscellaneous Papers 1838. Carton 8: Folder 63.)

Confirmed Identities

When the combined TAMU-INA-LCMM archaeological team began work at Shelburne Harbor in June 2014, the four wrecks were numbered 1 through 4. The wreck closest and parallel to shore was labeled Wreck 1. Wreck 2 was located parallel to, but off shore of Wreck 1, under a floating dock. Wreck 3 had sunk with its bow pointed in toward the shore. Wreck 4 was sunk parallel to the shore, with its bow pointing at Wreck 3 (see Figure 2). After the divers secured baselines on all four wrecks and determined their total lengths, it quickly became clear that two of the wrecks did not correspond to

the lengths of the steamboats they were thought to be (Table 1). While Wrecks 3 and 4 matched the historical descriptions and ascribed locations of *Burlington* and *Whitehall*, Wrecks 1 and 2 could not possibly be *Franklin* or *Francis Saltus*. The lengths of Wrecks 1 and 2, from stem to stern, each averaged around 130 ft. (39.6 m), but *Franklin* and *Francis Saltus* were 162 ft. (49.4 m) and 185 ft. (56.4 m) respectively.[34] Documentation of the wrecks continued, and we considered alternate possible identities. The complete list of CTC steamers provided by Ross made it easy to narrow down the possibilities of the identities of the two mystery hulls based on their lengths. These lengths were compiled by F.H. Wilkins for *The Vermonter* in 1916 in a table that can be referred to in Appendix E.[35] Only two steamboats whose final resting places could possibly be Shelburne Shipyard fit the correct lengths: Wreck 2 was tentatively identified as *Winooski* at 136 ft. (41.5 m) and Wreck 1 as *A. Williams* at 132 ft (40.2 m).[36]

Wreck Number	Name	Wreck Length		Historical Length	
Wreck 1	*A.Williams*	123 ft. 2 in.	37.5 m	132 ft.	40.2 m
Wreck 2	*Winooski*	133 ft. 2 in.	40.6 m	136 ft.	41.5 m
Wreck 3	*Burlington*	158 ft. 1 in.	48.2 m	185 ft.	56.4 m
Wreck 4	*Whitehall*	214 ft.	65.2 m	215 ft.	65.5 m

Table 1. The four wrecks identified and both wreck and original steamboat lengths listed.

Prior to identification, Wreck 1 was observed to have the most engine bed timbers by far of all of the wrecks, separating it from the other wrecks. Furthermore, within the first week a diver recovered a ceramic plate fragment from Wreck 1 with the maker's mark 'Burgess & Campbell' on the underside (Figure 11). Research revealed that this British company operated between the years 1879 and 1895.[37] Finally, LCMM Director Emeritus Arthur Cohn discovered a photograph dating to the mid-1890s portraying a stripped-down steamboat hull floating directly over where Wreck 1 was sunk, that was hand-labeled '*A.Williams*' (Figure 12). These combined clues strongly suggested that Wreck 1 was indeed the 1870-built steamer *A. Williams* (Figure 13).

The case for identification of Wreck 2 was more circumstantial, but still compelling. At 133 ft. 2 in. (40.6 m) long this wreck matched only the historical lengths of a few steamers. The heavy framing timbers, similar to those of *Phoenix* (1815), were a sign of an earlier construction date, which led us to believe this wreck dated to earlier than Wreck 3 and Wreck 4 (*Burlington* [1837] and *Whitehall* [1838]). Within this narrow timeframe, only *Winooski*, at 136 ft. (41.5 m), came anywhere near that length, and therefore Wreck 2 was tentatively identified (Appendix E).

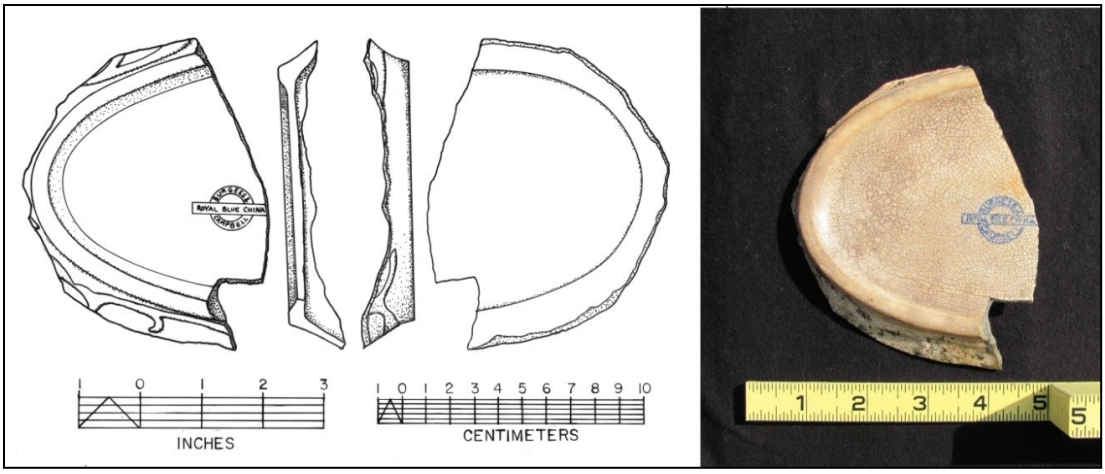

Figure 11. Ceramic plate or serving-platter fragment with maker's mark 'Burgess & Campbell'. This plate helped date and identify Wreck 1. (Drawing and photo by Nathan Gallagher.)

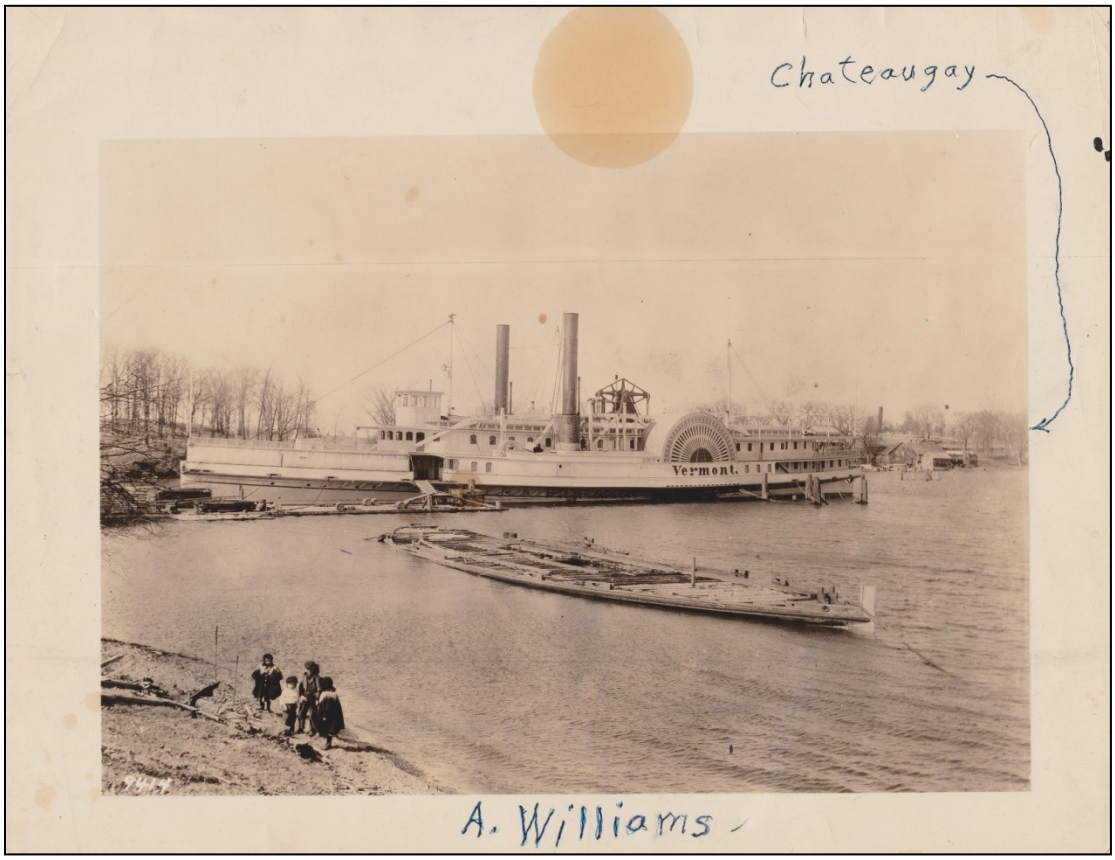

Figure 12. Stripped down hull of *A. Williams* floating directly above current location of Wreck 1. (Personal collection A. Cohn.)

Figure 13. Steamboat *A.Williams*, built in 1870. (Ross, 1997: 134.)

Winooski

Winooski was originally built by the Champlain Ferry Company in 1832-1833 as a passenger ferry boat from Burlington to Port Kent, New York, though most of its 18-year career was spent under the ownership of the CTC. In 1835, the Champlain Ferry Company sold *Winooski* along with their land at Shelburne Shipyard to the CTC.[38] This was the same year that the CTC bought out all the other steamboat companies on Lake Champlain, resulting in their ownership of a total of seven steamboats, including the only vessel the company had built up to that point, *Franklin*. Three of the seven, *Winooski*, *Franklin* and *Phoenix* (II), were used in the CTC's regular Whitehall-to-St. Jean passenger service, with *Winooski* originally operating a separate, shorter ferry line between Burlington and Port Kent. *Phoenix* (II) was taken out of commission in 1836,

to be replaced by *Winooski*. According to an announcement in the *Burlington Free Press*, the CTC refitted *Winooski* over the winter of 1835-1836 and "added thirty two feet (9.8 m) in length to the *Winooski* – have also added new and powerful machinery giving her increased speed, and have otherwise fitted her up to take her station in line, in a style of comfort and neatness which, it is hoped, will satisfy the public. She has a dining cabin forty two feet (12.8 m) in length, and also ample accommodations for ladies."[39] This increase in length brought the steamboat up to its reported overall length of 136 ft. (41.5 m).

Winooski lasted two seasons in the Whitehall-to-St. Jean service, for *Burlington* replaced the older boat late in 1837. What happened to *Winooski* during the following years, especially after *Whitehall* entered the scene, is unknown. Presumably *Winooski* returned to service on a shorter ferry line. In 1842 *Winooski* was retired for the first time, but this appears to have been temporary.[40] Exactly when and why *Winooski* came back into service is unknown, however two sources agree upon a final retirement date of 1850.[41] Once *Winooski* was transferred to CTC ownership the 1835-1836 modifications to the hull were made by Lavater S. White, the builder of *Burlington*, meaning the same man oversaw both the extension of *Winooski* and the construction of *Burlington*.[42] Unfortunately, despite its long career and reputable service, no contemporary images of *Winooski* have been found.

A. Williams

A. Williams was named after Andrew Williams, who built the steamer in partnership with Warren Corbin at Mark's Bay, Burlington, Vermont. *A. Williams*, like *Winooski*, was not built by the CTC. In 1870, a 132-ft. (40.2-m) steamboat was small in comparison to the giants being built by the company.[43] Its small size was advantageous rather than detrimental, however, as operating costs were proportionately lower. The CTC directors recognized the usefulness of a small steamer (and again, probably wanted to get rid of the competition) and offered to buy it, to which Williams and Corbin accepted.[44]

The purchase was more successful than the company had original expected, as the small boat remained in service for 23 years, until 1893. Not only did the hardy little steamer last longer than the average lake steamer, it was also known to "run anywhere on the lake, no matter what the weather was, and […] apparently enjoyed a gale of wind. John Smith, pilot on the "Williams", […] evidently had no thought of anything except to *get there* [*sic*]."[45] *A. Williams* served as both a ferry boat and an excursion boat throughout its career.[46] Largely due to *A. Williams*' success as an excursion boat, the CTC was in a profitable state by the end of the 1880s. From this profit, the company decided to replace *A. Williams* with a new general-purpose steamer, *Chateauguay*, the first steamer on the lake made of iron. After *Chateauguay*'s launch in 1888, *A. Williams* was sent to Shelburne Harbor for use as an occasional excursion boat, and a harbor boat. The little steamboat was kept running until 1893 when it was officially retired and dismantled.[47]

CHAPTER III

ARCHAEOLOGICAL METHODOLOGY

The archaeological investigation of the four wrecks in Shelburne Shipyard was carried out as part of a Texas A&M University (TAMU) field school which ran from June 9 to June 30, 2014. The project was run in cooperation with the Lake Champlain Maritime Museum (LCMM), and supported by the Institute of Nautical Archaeology (INA) and the Center for Maritime Archaeology and Conservation (CMAC). The State of Vermont's Division for Historic Preservation granted the team permission to conduct an archaeological survey of the site. No excavation or recovery was planned, and anything temporarily brought to the surface for closer inspection was returned to its original location. The 2014 field season was the first archaeological work done on these Shelburne Shipyard wrecks since the Champlain Maritime Society undertook a preliminary survey in 1983.

Co-principal investigators, Kevin Crisman, Associate Professor in the TAMU's Anthropology Department's Nautical Archaeology Program and Director of CMAC, and Carolyn Kennedy, a doctoral student in the Department of Anthropology directed the field school. The museum's archaeological director, Christopher Sabick, also guided project organization and operations. The field school included four other TAMU graduate students from the Nautical Archaeology Program (NAP): Mara Deckinga, Nathan Gallagher, Stephanie Koenig and Grace Tsai; one undergraduate student from the Anthropology Program: Varvara Marmarinou; two alumnae of NAP, Dr. Rebecca

Ingram and Carrie Sowden; and one volunteer, Dan Bishop. The dive masters for the project, Ron Adams and Robert Wilczynski, were contracted through the LCMM. The LCMM's conservation technician, Paul Gates, also participated in the project.

Students and co-directors stayed in a rented house located 15 miles from the shipyard in North Ferrisburgh, Vermont (Figure 14). Marge Aske and Mark Brooks, property owners adjacent to the site, granted staging access to the wrecks via their private properties and beaches (Figure 15). The shallow location of the wrecks and their close proximity to shore allowed the divers to enter and exit the water from a pebble beach. Aske, Brooks, and neighbor Connie Porteous also allowed the field school to use their private docks, which was very helpful for surface monitoring of dive activity.

Figure 14. House in North Ferrisburgh used for housing during the field school 2014. (Photo by homeowner Mary Fitzpatrick.)

Figure 15. Staging area on Mark Brooks's beach, adjacent to Marge Aske's property. Brooks kindly allowed the use of his floating dock for divers entering and exiting the water. The pebble beach made this an ideal staging area. (Photo by Paul Gates.)

The project required students to provide their own dive gear, including masks, fins, regulators, Buoyancy Control Devices (BCD), weight belts, and 7-9 mm thick wetsuits or drysuits, as well as gloves and hoods. This full-body coverage was required for multiple reasons. Lake Champlain in June is cold, averaging 55-60 degrees Fahrenheit (12.8-15.6 degrees Celsius), and therefore students needed thick wetsuits. Divers used gloves to protect their hands from the razor-sharp shells of the zebra mussels, an invasive species that attach themselves to shipwrecks. Hoods were required to help prevent ear infections from Lake Champlain's freshwater bacteria, and also as

further heat-loss prevention. The LCMM provided dive tanks throughout the project, and refills were done at the Waterfront Dive Center in Burlington, VT.

Each diver carried a clipboard with mylar on each dive for recording hull measurements and details. Measurements were taken with folding plastic 6-ft. (1.83-m) Rhino Rulers and flexible measuring tapes of 50, 100 and 300 ft (15.2, 30.5 and 91.4 m). The imperial system of English feet and inches was used, rather than the metric system, since early nineteenth-century boat builders used imperial measurements to build their steamboats, and therefore measurement patterns could be more easily seen by using the same system. A digital camera with a waterproof housing and a GoPro videocamera wielded by divers recorded images and videos of the wrecks. Divers used digital goniometers to measure curves.

The first week of the field school focused on orientation, training and checkout dives, while the two following weeks were spent recording. Ten divers were divided into four teams, and each team was assigned a wreck to work on for the duration of the project. Team 1, Stephanie Koenig and Varvara Marmarinou, aided by Christopher Sabick, documented Wreck 1; Team 2, Mara Deckinga and Carolyn Kennedy worked on Wreck 2; Team 3, Dan Bishop, Rebecca Ingram and Carrie Sowden recorded Wreck 3; and Team 4, Kevin Crisman and Grace Tsai, measured Wreck 4. Paul Gates did much of the photography, and, during the last week, assisted Team 2. Divemasters Ron Adams and Rob Wilczynski performed odd jobs, including removing some of the rock pile on Wreck 2 and recording miscellaneous features on Wreck 4.

The first task performed by all teams was to lay a baseline along the keelson or centerline of each wreck. Frames were then numbered using plastic tags prominently numbered with indelible 'Sharpie' pens; and the tags stapled to the wooden frames. At the end of the project, everything was removed except for the frame tags of Wreck 2 and Wreck 4 in anticipation of a second field season to take place in June 2015.

Diving proceeded on an alternating daily schedule, with teams 1 and 3 on one rotation and teams 2 and 4 on another. On days when teams 1 and 3 dived twice, teams 2 and 4 dived once, and vice versa, making for three rotations of divers per day. On this schedule, divers could keep up their energy throughout the week, and it also allowed the group time in the afternoons to transcribe notes. Dives typically lasted approximately one hour each, ranging anywhere from half an hour to almost two hours. Since the site was in shallow water, the main factor in determining bottom times was divers' comfort and temperature. Once the first rotation of divers was out of the water, the second rotation of divers prepared to enter the water. No decompression time was required for such shallow dives; however, breaks were needed for rest, refreshments and for divers to warm up in the sun.

One non-diver was designated as surface monitor for the entire project. A full-time surface lookout was vital at this site due to the proximity to the Shelburne Shipyard Marina and to other private boats moored nearby. Wreck 2 was situated directly underneath a floating dock used by multiple speed cruisers, and therefore divers working on or near that wreck had to be protected in case of boat activity. Dive flags were set up every morning around the perimeter of the dive area, however on multiple occasions

boaters either ignored the flags or did not see them and came near the divers, and therefore had to be asked to leave by surface monitors.

Another concern was the large iron bolts protruding from the wrecks that could potentially rip neoprene and injure divers. Divers were all required to have tetanus shots prior to attending the field school. As previously mentioned, zebra mussels were also a potential hazard to divers, and divers were instructed to take caution when coming into contact with the razor-sharp shells. Other than the potential danger they posed, the mussels so completely covered parts of the wrecks that some features were obscured, and may have skewed some measurements. As the field school progressed, another inconvenience that developed was an increasing layer of algae, fondly nicknamed 'green slime.' The green slime made visibility much worse, and often completely covered the wrecks. This resulted in much time lost by having to fan away the slime.

For the three weeks of the field school, weekdays were designated dive days, and the weekends were reserved for catching up on notes and rest. The typical daily schedule was for students to breakfast and load gear by 7:30 am, reach the site by 8:00 am to 8:15 am, first rotation of divers in the water by 9:00 am, last rotation of divers out of the water by 2:00 pm, pack up and leave the site by 3:00 pm. The afternoons and evenings were reserved for transcribing notes, dinner and rest. Typically, dive teams spent time after dinner planning their next dives and organizing the materials they needed.

Over the course of the three-week project, the four wrecks were recorded for approximately 240 dive hours. Each team recorded their designated wreck and compiled

notes on key features and enough of the wreck to develop preliminary site plans for all four hulls. The results of this documentation will be described in the following four chapters.

CHAPTER IV

ARCHAEOLOGICAL RESULTS: WRECK 1

After careful documentation Wreck 1 was determined with a high degree of certainty to be the steamer *A. Williams*, a boat built in 1870 much later than the other three. As noted earlier, two gentlemen from South Hero, Vermont, Andrew Williams and Warren Corbin, built *A. Williams* in Marks' Bay, Burlington, Vermont.[48] Though it was a smaller boat than what the CTC was used to running, the company purchased the little steamer to replace the recently dismantled, much grander steamer *Adirondack*. *A. Williams* served the CTC for twenty years, from 1873 to 1893, mainly as a ferry boat, but also as an occasional excursion boat. *A. Williams*'s recorded length and beam were 132 ft. (40.2 m) and 22 ft. (6.7 m).

The hull remains were a total of 123 ft. 2 in. (37.5 m) long from stem to stern. The wreck was fairly complete, and even its rudder lay nearby, still attached to the sternpost that had broken off from the keel. The biggest challenge with recording Wreck 1 was due to its proximity to shore and location below the overhanging branches of several large oak trees. A thick layer of leaves from the oak trees had covered portions of the hull and therefore much time was spent clearing the debris. Wreck 1 had a large concrete mooring block on its frames 22 ft. 10 in. (7 m) abaft the stem. The dock adjacent to the wreck served as our dive entry and exit point. This meant that some care was required to avoid stirring up the silt and blinding the dive team studying Wreck 1. Also because of its very shallow location, Wreck 1 was heavily eroded and broken up.

The sternpost was detached, and the forward twenty or so feet were disconnected from the majority of the wreck (Figure 16).

Construction and Materials

Survey revealed that Wreck 1 differed from the other wrecks in several major aspects of construction. Whereas the others all showed very odd features, like irregular frame spacing or sizing, overly heavy construction or bolting, Wreck 1 appeared to be more refined in its construction. Though many pieces were missing or eroded beyond recognition, it still presented a fairly symmetrical and planned hull. In itself, this was a clue that the date of this wreck was much later than the others, suggesting an approach to steamboat construction that was more systematic. Wreck 1 was a total of 123 ft. 2 in. (37.5 m) long from the preserved lower end of the stem to the after end of the keelson. The sternpost was disarticulated and therefore the total original length was likely longer. The rudder was found adjacent to the broken after end of the keelson, still attached to the sternpost, and therefore the wreck is estimated to have been just slightly longer than the current recorded length.

Since this field project intended only to survey the four wrecks and record preliminary observations, wood samples were not retrieved. Differential preservation between frames and stringers hinted that different wood types may have been employed, but there is no confirmation of this. The most common type of wood used for shipbuilding in this period was white oak, however, being a lake steamer and not an

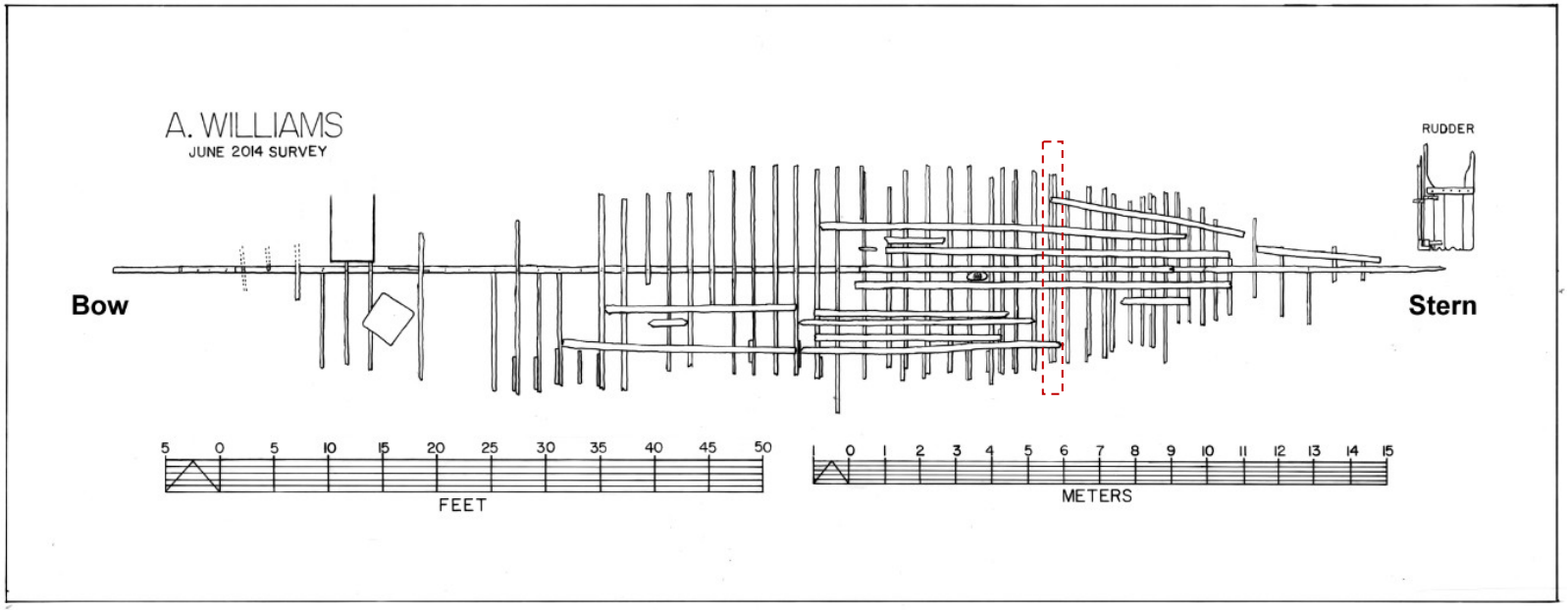

Figure 16. Preliminary site plan of Wreck 1. Frame 42 is a double-floored frame and is outlined in red. (Drawn by Stephanie Koenig, Varvara Marmarinou and Christopher Sabick; inked by Nathan Gallagher.)

oceangoing vessel, it is possible that the expensive white oak timbers were supplemented with cheaper, softwoods like pine or spruce.

The metal bolts present on the wreck were consistently made of wrought iron, as was the lower pintle and gudgeon on the rudder. The upper pintle and gudgeon assembly was remarkable as it was made of a cupreous material, evidenced by the pinkish copper color and lack of iron corrosion products. The presence of copper-alloy gudgeon and pintle on a freshwater steamboat suggested that this wreck was later than the others since copper-alloy marine hardware was more prevalent in the later nineteenth century when it became more affordable.[49]

Another feature that divers noted and recorded was a lead collar found at 78 ft. 7 in. to 80 ft. 6 in. (24 m to 24.5 m) along the main baseline (MBL), in between the keelson and first port bed timber. The lead was identifiable due to its white corrosion product and pliability (Figure 17). This collar likely represented either a seal placed between iron water-intake pipes for the boiler, or one for an overflow drain from the engine's condenser. The opening in the hull planking for the collar was plugged with a large wooden stopper.

Figure 17. Lead collar found on Wreck 1. Top view (left) shows location along the center baseline and perspective view (right) shows wooden stopper. (Photographs by Stephanie Koenig.)

Keel

The keel of Wreck 1, as with all the other wrecks, was mostly buried in the silt. There were some areas where it was partially exposed, at least enough to reveal the top surface. Between 25 ft. 4 in. and 29 ft. (7.7 m and 8.8 m) MBL a hook scarf was visible, with the hook at 27 ft. 2 in. (8.3 m) MBL. The hook scarf was unusual as the joint of the scarf was visible from the top face, meaning the two sections of keel joined by the scarf were laid side by side, rather than being laid one atop the other.

The keel's top (sided) and side (molded) surfaces were visible from 7.5 in. (19 cm) abaft the stem to 68 ft. 3 in. (20.8 m) MBL. The keelson began at 68 ft. 3 in. (20.8 m) MBL and obscured the after half of the keel. Three measurements were taken of the keel's sided and molded dimensions, at points 10 ft., 20 ft., and 30 ft. (3 m, 6.1 m, and 9.1 m) MBL. The sided measurements were consistent at 7 in. (17.7 cm); however the

molded dimensions decreased as the keel extended farther aft. At 10 ft. (3 m) MBL, the molded dimension was 7 in. (17.7 cm). This decreased to 5 in. (12.7 cm) at 20 ft. (6.1 m) MBL, and 4.25 in. (11.4 cm) at 30 ft. (9.1 m) MBL. The shallow keel is representative of American northeastern steamers, whose keels averaged 2 in. to 6 in. (5.1 cm to 15.2 cm) molded.[50] Though ocean-going steamers needed deep keels to steady themselves against the roll of the large ocean waves, lake steamers were not required to have as deep a keel in the sheltered waters of the inland water body. This allowed the vessels to steam into shallower waters, which made dock access easier and reduced the likelihood of running aground.

Stem Assembly

Wreck 1's lower stem assembly was partially preserved, and its after end overlapped the keel by 4 in. (10.2 cm). The keel appeared to be broken off at its forward end. A bolt extending down from the stem 7 in. (17.8 cm) forward of the end of the keel confirmed this theory, as it had nowhere to go except into the keel. This bolt likely marked the original forward end of the keel. The bolt head was located at the level of the keel's underside, and the bolt itself extended up and aft approximately sixty degrees from horizontal (the angle was measured from digital camera images), through the widest remaining part of the inner stem, and the tip was bent aft (Figure 18).

The stem assembly was eroded and only a small piece of the main stem remained. Aft of this small piece was the inner stem, and aft of that the apron. The inner stem began at 11 in. (27.9 cm) MBL, and ended 3 ft. 2 in. (96.5 cm) MBL. This

piece was not examined in detail due to time constraints; however there was a clear curve to the grain of the wood, indicating that it was fashioned from a section of compass timber. The height of the inner stem was unrecorded due to time constraints. The apron overlapped the after end of the inner stem at 2 ft. 10 in. (86.4 cm) MBL, and appears broken at its forward end. It extended aft 3 ft. 2.5 in. where it appears to end in its original location, evident by the clean-cut after end of the timber.

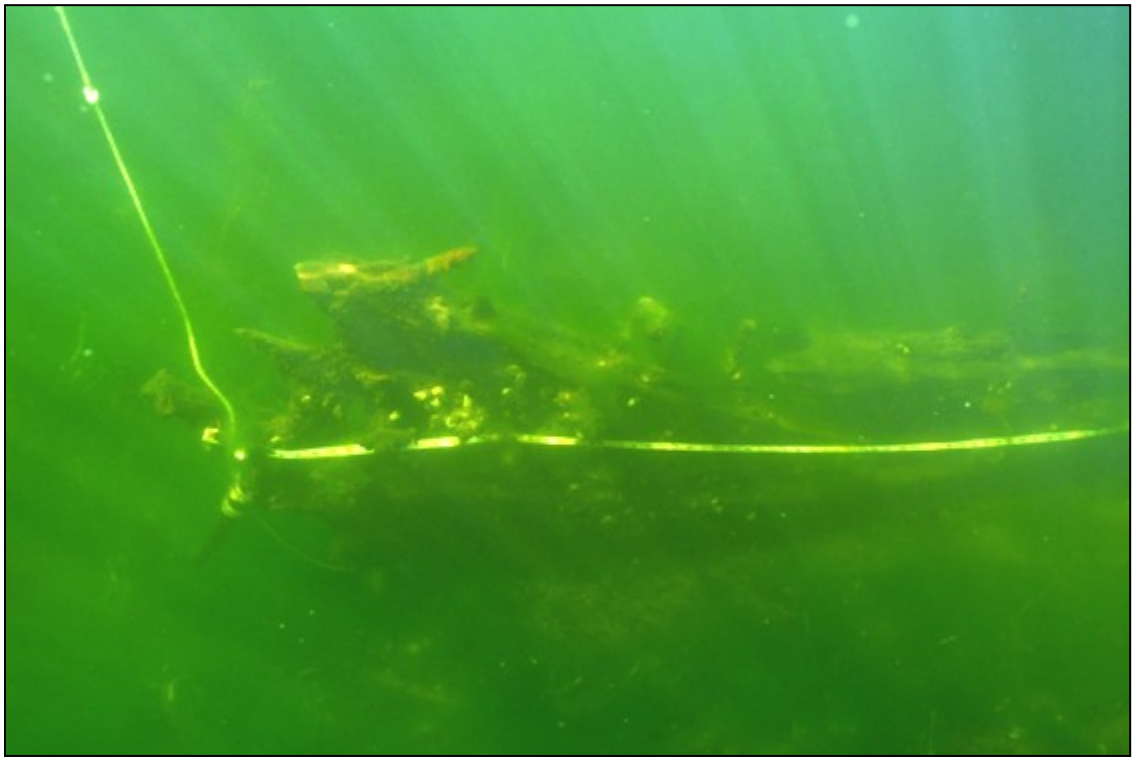

Figure 18. Photograph of bow assembly on Wreck 1. A buoy is tied to the forward end. Note the bolt that exits the topmost timber and angles aft. (Photo by Paul Gates.)

Along the upper portion of the curve of the inner stem were spike heads that extended horizontally, which appeared to be where the hood ends of the planks were

fastened. Their locations were recorded along the baseline as 10 in., 1 ft. 2 in., 1 ft. 5 in., 1 ft. 10 in., and 2 ft. (25.4 cm, 35.6 cm, 43.2 cm, 55.9 cm and 61 cm) MBL, spaced approximately every 3 in. (7.6 cm). The inner stem's wide curve was probably used to create a strong internal joint between the horizontal keel and the near-vertical stem that was typical of steamboats in this era.[51]

Stern and Rudder

In contrast to Wreck 1's attached stem assembly, the stern assembly was broken off and largely missing. The after end of the keelson ended at 122 ft. 7 in. (37.4 m) MBL, only slightly before the after end of the keel located at 123 ft. 2 in. (37.5 m) MBL. The shallow location of the wreck left the stern assembly exposed to ice, decay and human activity. The after end of the keelson appeared to have split, as it tapered to a point. The sternpost, or more likely (due to its narrow molded dimension) the false post, was discovered lying adjacent to the end of the keel, still attached to the rudder.

The rudder was a typical steamboat "barn-door-style rudder," measuring 5 ft. 4 in. (1.63 m) fore-and-aft, 5 ft. 10 in. (1.78 m) tall, and 6 in. (15.2 cm) thick (Figure 19). It was made up of five vertical timbers with a range of widths. The first vertical timber was the rudder post to which were attached two pintles. The rudder post was taller than the succeeding timbers, with a height of 7 ft. 2.5 in. (2.20 m); it was clearly broken at the top. The adjacent three timbers measured 1 ft., 1 ft. 9.5 in. and 6 in. (30.5 cm, 54.6 cm and 15.2 cm) in width. The fifth and furthest-aft timber measured 1 ft. (30.5 cm) fore-

and-aft, and 9 ft. 3 in. (2.82 m) in height. This final timber appeared to have been cut as tall as the rudder post.

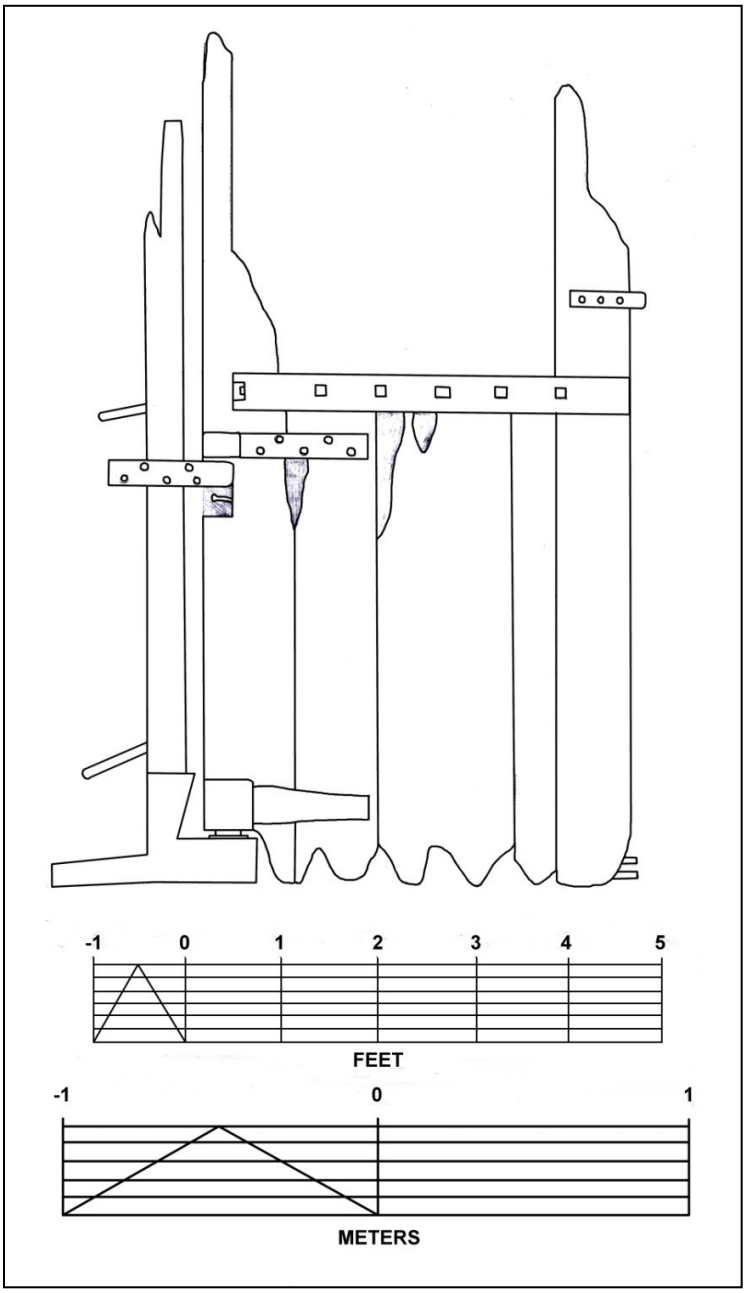

Figure 19. Rudder from Wreck 1 drawn to scale. (Drawing by Stephanie Koenig and Varvara Marmarinou.)

This symmetrical rudder was typical to steamboats in North America's inland waters. For example, a similar configuration was found on the rudder of *Heroine*, an 1832 western river steamboat.[52] On this steamboat the furthest aft timber is made much narrower than the other rudder timbers, and was as tall as the rudder post (Figure 20). Wreck 1's final rudder timber was made taller, like *Heroine*, but unlike *Heroine*'s aft-most timber, Wreck 1's was substantial. This upward projection was attached to the steering mechanism with block and tackle to allow for better control over the entire rudder. By attaching lines to the outer extremity of the rudder, the need for long tillers was eliminated and wheels could be substituted, freeing up space on the deck.[53] Also, being longer and shorter than most rudders, steamboat rudders may have been somewhat difficult to turn, needing more direct leverage.

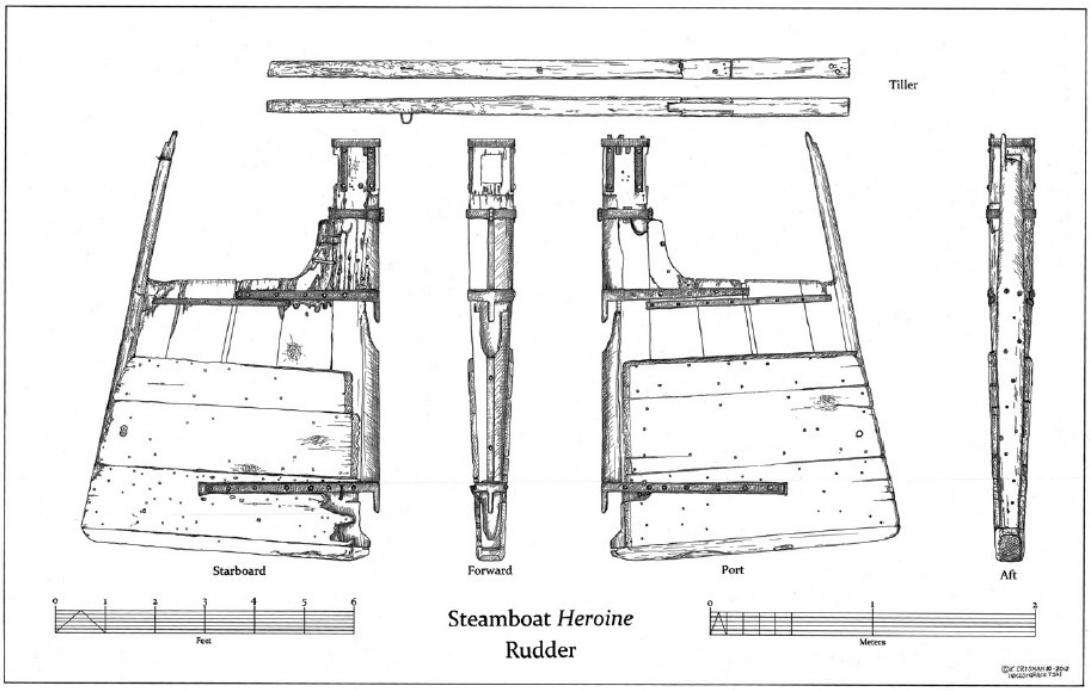

Figure 20. *Heroine*'s "barn-door" shaped rudder. (Crisman, 2013: 146.)

One unique feature found on the rudder was the upper pintle-and-gudgeon assembly. Out of all of the metal hardware on all four wrecks, these were the only pieces cast from a cupreous material. This piece was used as a clue to Wreck 1's identity, since copper became more affordable in the later nineteenth century, thereby suggesting a later construction date.[54] Moreover, the upper pintle and gudgeon assembly was probably compiled of repair pieces since all of the other metal present, including the lower pintle and gudgeon, were made of iron. The pintle straps were 3 in. (7.6 cm) in width, and approximately 20 in. (50.8 cm) in length. The upper gudgeon straps were 3.5 in. wide (8.9 cm), with an unmeasured length.

The lower iron gudgeon and pintle were of a very atypical construction. Instead of simply having iron straps fastened to either side of the sternpost, the lower gudgeon also had a funnel-shaped upward projection into which the sternpost or false sternpost fit. The gudgeon was located at the very bottom of the stern, and was possibly attached to either side of the keel rather than either side of the sternpost. In which case, the gudgeon itself also doubled as a skeg, a projection that protected the forward lower corner of the rudder and prevented it from being torn off in the event of grounding. The gudgeon, or in this case, skeg, projected 9 in. (22.9 cm) abaft the sternpost and was 6 in. (15.2 cm) tall. The adjoining pintle, still in place, was 7 in. (17.8 cm) high at its forward end, and had 3 in. (7.6 cm) straps. There was a gap between the gudgeon and pintle of 1 in. (2.5 cm).

Frames

A total of sixty frames or frame locations were recorded on Wreck 1. Many frames were missing or loose, however patterns of bolts were present at even intervals, marking the location of the missing frames. Very little deadrise was noted in a cross section taken at frame 29, found amidships at 62 ft. 8 in. (19.1 m) MBL (Figure 21). Limber holes are present in the cross-section drawing of Figure 21; however, they were not recorded in detail.

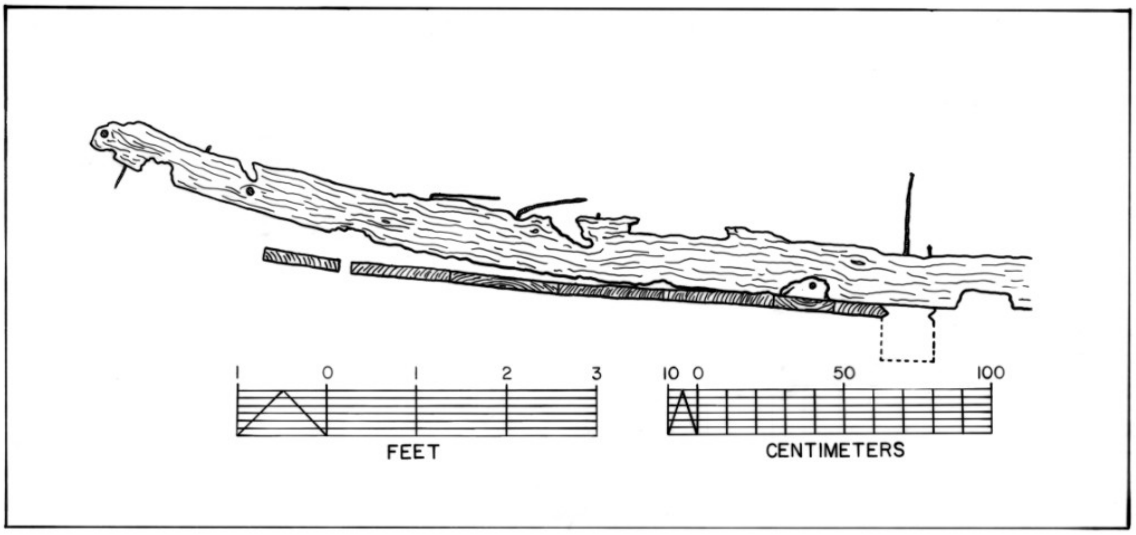

Figure 21. Cross section of starboard side frame 29 facing aft on Wreck 1. (Drawing by Chris Sabick; inked by Nathan Gallagher.)

The frames that were present were similar in size, ranging from 2 in. to 4.5 in. (5.1 cm to 11.4 cm) sided, with an average of 2.9 in. (7.4 cm) sided overall. Most of the intact frames were 3 in. (7.6 cm) sided, and many of those with a sided dimension of 2 in. (5.1 cm) frames were badly eroded. The frames had molded dimensions ranging

from 4 in. to 10 in. (10.2 cm to 25.4 cm), with an average of 7 in. (17.8 cm). Considering the level of erosion present, an average of 9 in. (22.9 cm) molded was likely the original size. These measurements represent deep but narrow frames. Similar frames were found on Wrecks 3 and 4 as well. One hypothesis is that this shape was employed in order to reduce the weight of the hull, while not sacrificing any of the structural stability of larger frames. Long, narrow steamboats with heavy square frames would have had problems with hogging or sagging. Employing narrower frames reduced the total weight, while keeping them deep retained their strength. Even though *A.Williams* was a relatively short boat, at 132 ft. (40.2 m), this method was likely standard for all steamboats by the time it was built in 1870. For example, *Champlain II* (1868) exhibited similarly rectangular sections in its frames, with average sided dimensions of 4 in. (10.16 cm) and molded dimensions of 16 in. (40.64 cm). The much larger steamer (original length of 244 ft. [74.4 m]) would have benefited from the reduced weight this style of frame allowed for, much more even than *A. Williams*.[55]

Bolts entering through the top of the keelson holding the frames in place were fairly uniformly spaced, averaging 23 in. (58.4 cm) apart. Most frames had two bolts holding them in place, however on many frames only one bolt was found. In these cases it was difficult to tell if a second bolt originally existed or not. The frames were spaced further apart at the forward end of the hull, but became closer together between frames 33 and 55 (71 ft. 5 in. to 103 ft. 1.5 in. [21.8 m to 31.4 m] MBL). The heavier framing further aft was to support the weight of the engine and boilers, as seen in the photograph of *A.Williams* (Figure 13), were positioned closer to the stern than the bow.

A frame with doubled floors was present from 86 ft. 4 in. to 86 ft. 10 ½ in. (26.3 m to 26.5 m) MBL, both individual parts being 3 in. (7.6 cm) wide (see Figure 16). This was the only instance of a double-floored frame, and therefore may represent the midship frame. If so, it is in an unusual location in the aftermost third of the length of the hull. Typically, midship frames were located forward of the middle of the vessel. The location of this double frame therefore invokes questions of possible changes in construction trends by 1870. Williams and Corbin, the builders, may have seen some advantage in placing the midship frame, and fullest hull shape, further aft in this steamboat to better support the engine.

Keelson

The keelson on Wreck 1 was missing forward of 68 ft. 3 in. (20.8 m) MBL. It then extends aft to 122 ft. 7 in. (37.4 m) MBL, with a piece missing from 97 ft. 8 in. to 100 ft. 5 in. (29.8 m to 30.6 m) MBL. The keelson tapers to a point at its after end, where it was broken and split. Approximately 7 in. (17.8 cm) square, this timber is relatively small when compared with the bed timbers. The purpose of the keelson was to fasten the frames to the keel and act as a longitudinal support timber, or spine, to the vessel, but there is no indication from the remains that it was used directly in supporting the engine machinery. The single or double bolts securing the keelson to the frames were visible on the top face of the keelson, and were placed in an alternating port and starboard pattern, presumably to avoid the centrally-placed bolts attaching the frame floors to the keel.

Divers were unable to determine whether or not the keelson had been notched to fit over the frames.

Engine Bed Timbers

The keelson was dwarfed by the engine bed timbers. These timbers, also referred to as stringers, were common features of steamboat construction, providing a foundation to support the heavy engine and boiler components. The placement of these bed timbers can be useful for reconstructing and placing the larger engine components. On Wreck 1, bed timbers were located from 68 ft. 3 in. to 102 ft. 11 in. (20.8 m to 31.4 m) MBL. Up to six timbers were found on either side of the keelson, numbered 1 through 6, and designated as P for port and S for starboard. The numbers correlated with their proximity to the keelson, P1 and S1 being the closest, and P6 and S6 the furthest.

Wreck 1 had more bed timbers than any of the other wrecks. P1 and S1 were the largest of them all, averaging 8 in. (20.3 cm) sided. Between 74 ft. 11.5 in. and 92 ft. 1 in. (22.8 m and 28.1 m) MBL, both P1 and S1 were composed of two timbers stacked on top of each other, therefore totaling an average molded dimension of 18 in. (45. 7 cm) between these points. Forward of 70 ft. (21.3 m) and aft of 91 ft. 5 in. (27. 9 m) MBL, P1 and S1 are single timbers that average about 6 in. (15.2 cm) molded.

S2 was located between 71 ft. and 76 ft. 8 in. (21. 6 m and 23.4 m) MBL, and had a maximum sided dimension of 8 in. (20.3 cm), and molded dimension of 7 in. (17.8 cm). This timber was heavily eroded and broken in places. It appeared to be broken at its after end, and therefore its original overall length is unknown. On the opposite side

of the vessel, P2 was completely missing, its location only marked by the placement of bolts equidistant from the keel as those holding S2 in place. Bolts were found ranging from 22 in. to 30 in. (55.9 cm to 76.2 cm) from the keelson on frames 22, 25, 29, 30, 31, 32 and 35, between 49 ft. and 75 ft. (14.9 m and 22.9 m) MBL. The bolts represented the attachment points for the absent P2 timber, indicating the minimum length of P2, 26 ft. (7.9 m). Though bolts for S2 were not recorded forward of 71 ft. (21.6 m) MBL, it is likely that the arrangement of the bed timbers was symmetrical and therefore S2 was probably as long as P2 originally.

Both S3 and P3 were quite long. S3 stretched from 64 ft. 10 in. to 98 ft. 9.5 in. (19.8 m to 30.1 m), totaling 34 ft. (10.4 m) in length. Its maximum sided dimension was 7.5 in. (19.1 cm), and unfortunately its molded dimensions were unrecorded. P3 was located between 64 ft. 6 in. and 99 ft. (19.7 m and 30.2 m), with a missing section between 82 ft. 5 in. and 92 ft. 9 in. (25.1 m and 28.3 m) MBL. P3's maximum sided dimension was 9 in. (22.9 cm), and molded dimension was 7 in. (17.8 cm). There was considerable erosion noted on P3 as the molded dimensions ranged from 2 in. to 7 in. (5.1 cm to 17.8 cm), the thickest part being located at 47 ft. (14.3 m) MBL.

Bolts assumed to belong to P4 were found as far forward as 39 ft. (11.9 m) MBL and continued as far aft as 84 ft. 10 in. (25.9 m) MBL. A small fragment of P4 was found between 46 ft. 6 in. and 47 ft. 5 in. (14.2 m and 14.5 m) MBL, still attached to frame 21. A larger fragment was found just aft of that between 49 ft. 2 in. and 54 ft. 10.5 in. (15 m and 16.7 m) MBL, and finally the largest section remaining extended from 63 ft. to 84 ft. 10 in. (19.2 m to 25.9 m) MBL. The bolts for S4 were not recorded,

but the only remaining section was found between 72 ft. 9 in. and 88 ft. 2 in. (22.2 m and 26.9 m) MBL. The forward end of this timber was clearly split, and the after end also appears broken and therefore probably continued on both ends. The maximum sided dimension for P4 was 6 in., and it survived from 66 ft. 6 in. to 75 ft. 2 in. (20.3 m to 22.9 m) MBL. The maximum molded dimension was 6 in. (15.2 cm), and was recorded between 64 ft. 7.5 in. to 66 ft. 8.5 in. (19.7 m to 20.3 m) MBL. The maximum sided and molded dimensions for S4 was 7.5 in. (19 cm) sided and 7.5 in. (19 cm) molded. Whether S4 was originally larger in cross section than P4 or whether the size difference is due to erosion is difficult to say. Either way, it appeared that this pair of stringers was made slightly smaller than the others.

S5 was not present, and bolts that may have secured the timber were not recorded, therefore it is unsure whether it existed at all. P5 on the other hand was completely intact, since both ends appeared to be only slightly eroded, but not broken. P5 spanned from 64 ft. 6 in. to 81 ft. 9 in. (19.7 m to 24.9 m) MBL, a total of 17 ft. 3 in. (5.3 m) long. Its maximum sided dimension was 6 in. (15.2 cm), and its maximum molded dimension was 5 in. (12.7 cm). P5 therefore had the smallest cross section of all recorded bed timbers. It was also the shortest engine bed timber. Therefore, it is possible that this timber was only originally on the port side, thus explaining the lack of evidence for S5.

Both S6 and P6 had a significant amount of timber present, however P6 was much better preserved. Both appeared to be broken at either end, and therefore their original overall length is unknown. S6 spanned from 84 ft. 9 in. to 104 ft. 1 in. (25.8 m

to 31.7 m) MBL. Its maximum sided and molded dimensions were 7 in. (17.8 cm) and 6.5 in. (16.5 cm) respectively. This timber curved inward toward the keel at its after end. At 91 ft. 5 in. (27.9 m) MBL the distance between S6 and the keelson was 5 ft. (1.5 m). At 97 ft. 1 in. (28.6 m) this distance reduced to 4 ft. 1 in. (1.2 m), and at 102 ft. 9 in. (31.3 m) MBL it was again reduced to 2 ft. 11.5 in. (90.2 cm).

Two separate sections of P6 were found, the forward-most located between 41 ft. and 62 ft. 10 in. (12.5 m and 19.2 m) MBL, and the aft-most section located between 63 ft. and 87 ft. 7.5 in. (19.2 and 26.7 m) MBL. The maximum sided and molded dimensions of P6 were each 8 in. (20.3 cm), but ranging from 0.5 in. (1.3 cm) where the timber had eroded or broken. The curve towards the centerline seen on S6 was also evident on P6, as seen between 69 ft. 2 in. (21.1 m) MBL where the distance between the keelson and P6 was 7 ft. 7.5 in. (2.3 m), and 83 ft. 3 in. (25.4 m) MBL, where this distance reduced to 4 ft. 9 in. (1.4 m). The angling of these timbers may indicate that S6 and P6 were intended to act as longitudinal structural support for the hull in addition to, or instead of, engine support timbers. This is supported also by their extensive length.

Miscellaneous: Cleat

Lying not far off the port side of the bow of Wreck 1 was a large wooden cleat. The piece was 30 in. (76.2 cm) long, 8 in. (20.3 cm) wide and 4 in. (10.16 cm) high, with bolts extending 7.75 in. (19.7 cm) out its lower face. On the upper face of the cleat were two leather pads, approximately 5 in. (12.7 cm) wide by 6 in. (15.2 cm) long. It consisted of two wooden pieces, fastened together. The upper piece was double the

length of the lower piece, with the lower piece fastened to the middle of the upper piece. The shape of the object resembled a wooden cleat, and its proximity to Wreck 1 suggests it may have belonged to this vessel, although it could also be from one of the other vessels dismantled in this location. Further documentation of this piece is needed for scale drawings.

CHAPTER V

ARCHAEOLOGICAL RESULTS: WRECK 2

Wreck 2 was identified as *Winooski* (1832) by its length. This wreck presented a major challenge, as nearly the entire hull was obscured by rocks. Why the rocks were deposited along the length of the steamboat is not known, although it appears to have been done at the time of the sinking or some time thereafter to hold the hull in place. Perhaps the hull served as a platform for shipyard repairs, or for fuel loading. Regardless of their purpose, the rocks obscured many hull features. The majority of Wreck 2's frames were hidden from view directly adjacent to the keelson, and therefore all frame measurements were taken where the frames emerged out from under the rock pile, in many cases several feet outboard of the keelson. Along with the frames, the bottom of the keelson was also obscured along most of its length, and the entire keelson was hidden between 55 ft. 2 in. and 71 ft. 2 in. (16.8 m and 21.7 m) along the main baseline (MBL). The rocks also covered the top of the keelson and stringers in other areas. Furthermore, the rocks, sediments and lake vegetation completely hid the port side of the wreck, and recording was therefore restricted to the starboard side of the wreck structure. From stem to sternpost, the length of Wreck 2 was 133 ft. 2 in. (40.6 m).

The site plan of Wreck 2 shows the frames and engine bed timbers on the starboard side, but on the port side only the bed timbers were visible through the rock pile and accumulated sediments (Figure 22). A second minor challenge was that Wreck

2's stern area was located underneath a floating boat dock. The presence of these boats meant that overhead clearance was reduced to about 5 ft. (1.5 m) and divers had to be wary of the propellers of the speedboats directly overhead (surface monitors kept an eye on boaters and boating activity during the project).

Construction and Materials

Winooski was constructed in 1832 by the Champlain Ferry Company (CFC), at the Lake Champlain Steam-Boat company's property at Shelburne Shipyard. The builders for that company, Messrs. Phillips and White (Lavater S. White, Phillips' first name unknown) were first commissioned in 1824 to build *General Greene*, the company's first and only other steamer.[56] In 1833 when the company was sold to the Champlain Transportation Company (CTC), it appears that White, at least, stayed on as builder for the CTC as he became master carpenter of the CTC's next steamer, *Burlington*.[57] As noted earlier, *Winooski* was originally built to be 104 ft. (31.7 m) long, but in 1835-6 was lengthened 32 ft. (9.8 m) by the CTC, for a new overall length of 136 ft. (41.5 m).[58] The steamer had a breadth of 20 ft. 6 in. (6.2 m) and a depth of 8 ft. 6 in. (2.6 m), and was run by Captain Dan Lyon for the majority of its career. The steamer's main engineer in 1838 was G. Lyman. *Winooski*'s 60 horsepower engine was constructed by Mr. Battle, whose first name and engine shop location are unknown.[59] Though in the CTC archival documents, the first initial resembled a 'U', it may possibly be an 'M'. This is most likely the case since 'Mellen Battle' from Herkimer, New York, received a patent for a rotary steam engine in 1812.[60]

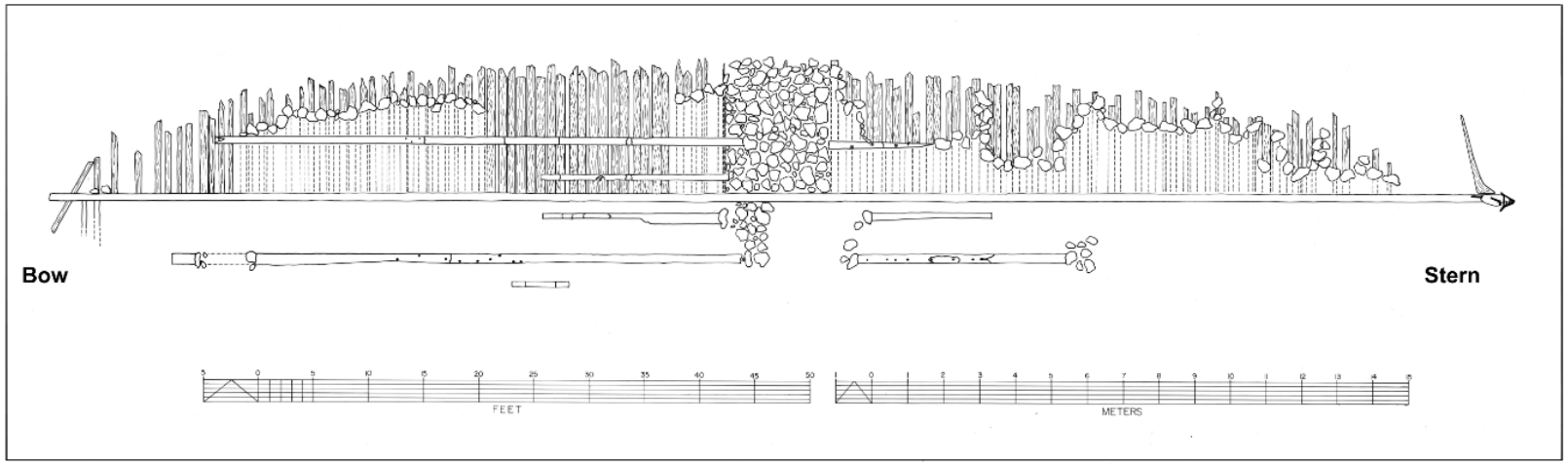

Figure 22. Preliminary site plan of Wreck 2. Where the frame timbers were covered by rocks is represented by dashed lines. The outline of the rock pile is drawn in. (Drawing by Carolyn Kennedy; inked by Nathan Gallagher.)

The construction of this steamboat is reminiscent of the construction of the 17-year earlier steamboat *Phoenix* of 1815 (Figure 23). *Winooski*'s frames, like those of *Phoenix*, were heavy and closely-spaced. The average sided dimension of the frames was 9 in. (22.9 cm) and molded dimension of 9 in. (22.9 cm), with spaces between frame pairs ranging from 4 in. (10.2 cm) to 9 in. (22.9 cm) (therefore giving them an average of 22 in. [55.9 cm] between frame centers). Since most of the frame measurements were taken considerably outboard of the keelson, it was difficult to identify which timbers were floors and which were futtocks.

A section of the hull was cleared for closer inspection near the midship frame, and it became evident that at least two types of wood were used for the heavy frame timbers. The midship frame was of a darker color and resembled oak, while the other frames were made of a distinctly lighter-colored wood. The other frames also showed markedly different grain patterns than the midship frame, indicating that they were made of a different type of wood. Wood samples were not taken from the wreck during the 2014 field season, and therefore the wood species have not yet been identified. The futtocks at the turn of the bilge were made of compass timber, suggesting an abundance of quality shipbuilding timber in the Lake Champlain Valley in 1832, and also that considerable effort and expense was put into the building of *Winooski*.

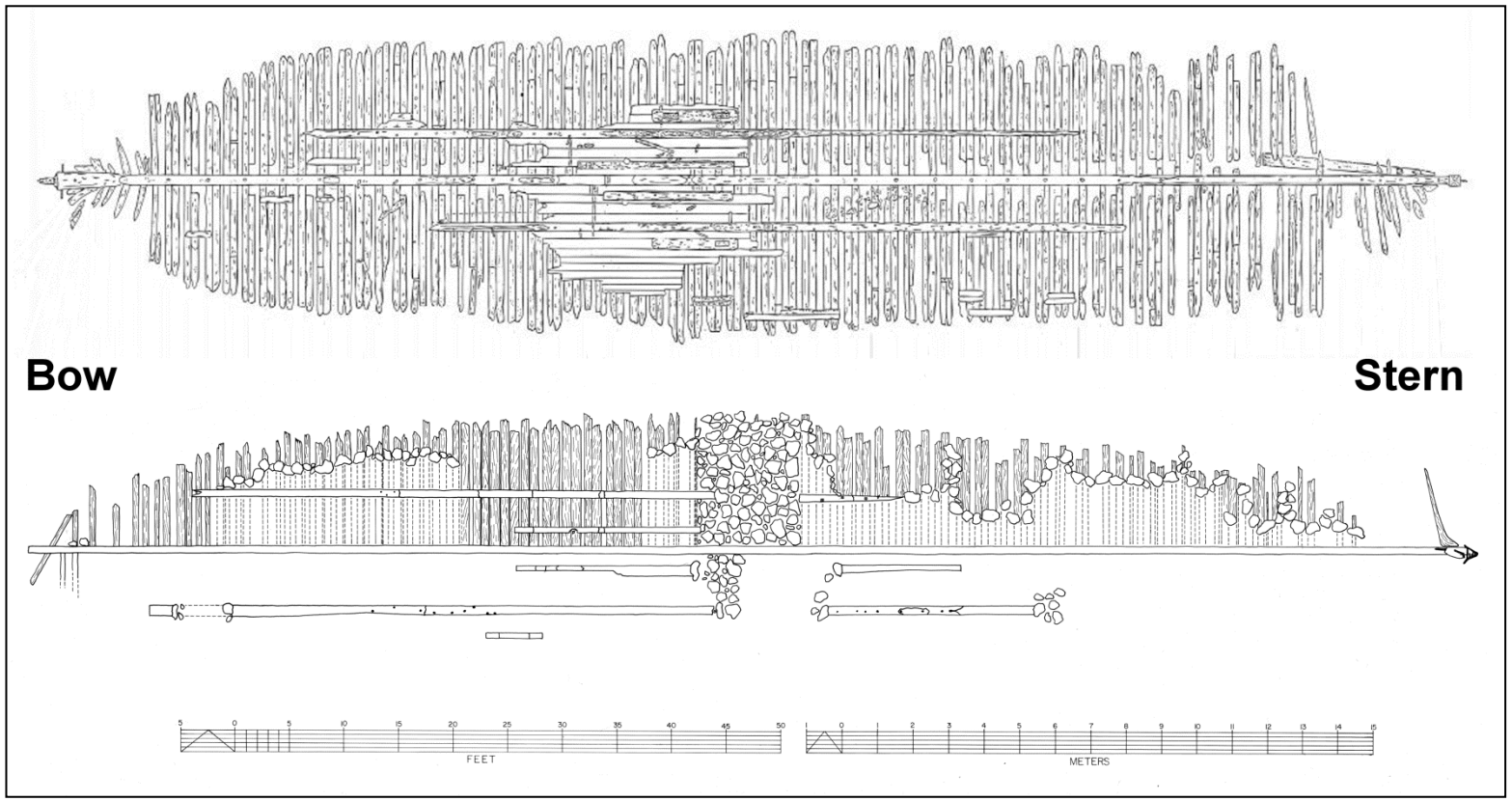

Figure 23. Wreck site plans of *Phoenix* and Wreck 2, scaled and aligned at sternposts. (*Phoenix* site plan Schwarz, 2012: 129.)

Winooski was exclusively fastened with iron fasteners throughout its hull. Bolts of varying sizes and shapes were present along the length of the keelson and stringers, as well as at the bow and stern areas. Unlike *A. Williams*, no cupreous material was discovered among the rudder hardware or fasteners. Also, unlike the later, larger steamers *Whitehall* and *Burlington*, fasteners were not used to excess. Most interestingly, bolt heads do not appear on the top of the keelson above every frame.

Since the work on this vessel aimed at being as low-impact as possible, nothing was removed from the lake floor for closer investigation, and therefore the bolts and spikes were not examined in detail. They were examined in situ, however, and the larger bolts were at least 2 ft. (61 cm) in length (stern deadwood fasteners), and approximately 1.5 in. (3.81 cm) in diameter. The bolt heads were circular, and approximately 2 in. (5.1 cm) in diameter. Many bolts were bent or broken, perhaps from the twisting and turning of the hull as it sunk to the bottom of the lake, as the results of salvage efforts, or possibly due to the weight of the rocks found piled on the hull remains.

Keel

The keel of *Winooski*, like the keels on the other three steamers, had settled into the silty bottom of Lake Champlain. This fact, combined with the presence of the rock pile, made the idea of digging out a portion of the keel for examination unfeasible in the time available in 2014. With the stem and stern post present, we were able to establish the length of the keel as 132 ft. (40.2 m), just under the overall known length of the original vessel of 136 ft. (41.5 m). The only area of the keel visible was near the bow,

slightly abaft the keel-stem scarf. At the forward end of the visible section of keel, or 1 ft. 2 in. (35.6 cm) MBL, its dimensions were 10 in. (25.4 cm) sided and 8 in. (20.3 cm) molded. It is very possible that at this forward location the keel was tapered, since at 4 ft. 2 in. (66 cm) the sided dimension widened to 12 in. (30.5 cm). Unfortunately at this point the bottom of the keel was buried and therefore no molded dimension could be taken for comparison.

Between 2 ft. 6 in. and 3 ft. 11 in. (76.2 cm and 1.2 m) MBL, a length of 1 ft. 5 in. (43.2 cm) there is a notch that ranges from 2.5 in. to 4 in. (6.4 cm to 10.2 cm) deep carved into the upper face of the keel. The purpose of this carved out section is unknown. There was a disarticulated frame resting in the depression, but since it was loose this may not have been its original location. This frame, frame 1, is only 6 in. (15.2 cm) sided, and therefore did not need a groove 1 ft. 5 in. (43.2 cm) wide to be set in. Whether this groove was made for multiple frame timbers to sit in, or whether it serves some other purpose is difficult to determine. Very far forward, at 1 ft. 7 in. (48.3 cm) MBL, a scarf of unknown length was noted in the keel, the joint between the stem and keel. The scarf hook measures 4 in. (10.2 cm) vertically.

Since the keel was buried in the silty bottom, it is likely that the keel timbers are well preserved. Examining these timbers in more detail will be beneficial to our understanding the hull's construction and operational parameters.

Stem Assembly

Wreck 2's stem was not well preserved, having been worn down by wave action, ice, and possibly intentional dismantling over the many years the hull rested in this shallow harbor. The curve of the stem only extended 1 ft. 5 in. (43.2 cm) above the lake floor, and the timber's surviving length was just 2 ft. 3 in. (68.6 cm) forward of the end of the keel. Where the stem joins the keel there is a substantial gap between the keel above and the stem underneath. This gap was probably originally filled with an apron. The forward end of the keel appears broken off or eroded. Forward of the break in the keel, bolts coming from underneath, emerge through the top face of the stem and protrude well above the remaining timbers, probably indicating a missing joint between keel and stem was once there. The stem dimensions on this lower section were measured at 9 in. (22.9 cm) sided and 4.5 in. (11.4 cm) molded.

At the top of the lower stem section, a horizontal iron bolt ran perpendicular to the axis of the keel. The 22 in. (55.9 cm) long fastener extended horizontally across the broken upper face of the stem, extending out 7 in. (17.8 cm) on the port side and 6 in. (15.2 cm) on the starboard side. A similar fastener was present on the stem of *Phoenix* (Figure 24). The purpose of the bolt is unknown; however, it may have been used for securing the hood ends of the planking. Another iron bolt extended downward approximately 1 ft. (30.5 cm) from the forward face of the stem.

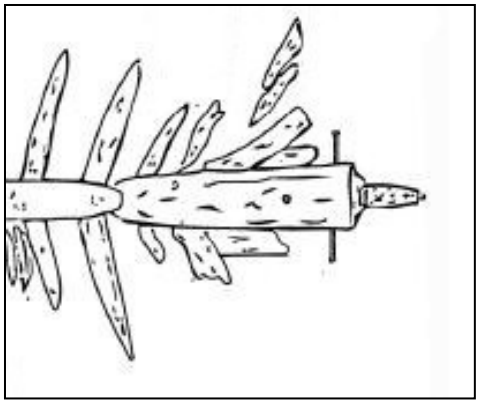

Figure 24. A large iron bolt protrudes from either side of Phoenix's bow. A similar feature was found on Wreck 2's bow.

Many components had fallen away from the bow assembly, as evidenced by the presence of planks and loose bolts around the bow. A timber that may possibly be the upper end of the stem had broken off and fallen directly forward, in line with the keel. The timber totaled 4 ft. 3 in. (1.3 m) long. At 2 feet 4 in. (71.1 cm) above its heel, the molded dimension expanded from 3 in. to 5 in. (7.6 cm to 12.7 cm), suggesting that this was a scarf that likely connected to the lower stem assembly. The sided dimension was consistently 6 in. to 7 in. (15.2 cm to 17.8 cm) over the length of the timber.

On the starboard face of the detached stem multiple iron spikes protruded out from the side, six of them within 6 in. (15.2 cm) of each other; 6 in. (15.2 cm) to either side of this cluster were two more spike heads. This timber will need further examination to determine its shape and if the spikes were for securing the forward ends of the planking.

Stern Assembly

Wreck 2's sternpost was still partially intact and protruded 1 ft. 7 in. (48.3 cm) above the lake bottom. The keel, most of the deadwood, and keelson were completely buried in silt, meaning that the remaining sternpost continued under the sediment to an unknown length.

Forward of the sternpost on the starboard side, a large piece of compass timber lay loose and off at an angle to the centerline of the vessel. This piece looked like a knee, however one leg of the knee extended 7 ft. 6 in. (2.3 m) while the other was only 1 ft. 6 in. (45.7 cm). The shape of Wreck 2's knee with one leg longer than the other resembles the shape of the stern knee of *Ticonderoga,* an 1812 steamboat-turned-warship.[61] Its location and "knee-like" shape suggest that this timber may be Wreck 2's stern knee. Bolts were attached along the length of the piece, indicating that it was likely bolted atop the keel or the deadwood. More study is needed to determine if the bolts present line up with holes in the centerline timbers.

Just forward of the remains of the sternpost was a conglomeration of large bolts and wood. Making sense of these pieces was nearly impossible, though they appeared to be the remains of the deadwood assembly. The bolts were long, measuring between 14 in. (35.6 cm) and 2 ft. (61 cm), and many were bent at odd angles. These may have attached the stern knee and deadwood to the sternpost. A considerable portion of the assembly was buried beneath silt, and requires excavation and further documentation.

An iron gudgeon was fastened to the top of the sternpost. The gudgeon was triangular in shape, with the forward ends flared out slightly to accommodate the ship's

stern shape (Figure 25). Each strap measured 18 in. (45.7 cm) in length, and 3 in. (7.6 cm) in height. The distance between the forward ends of the straps was 18 in. (45.7 cm). The pintle hole in the gudgeon was 2 in. (5.1 cm) in diameter. There is likely another gudgeon attached to the sternpost beneath the exposed example.

Figure 25. Iron gudgeon attached to Wreck 2's sternpost. The basic shape is triangular, but the forward ends flare out to accommodate the shape of the missing stern. The rudder is visible in the background. (Photo by Carolyn Kennedy.)

The rudder was separated from the hull and lay adjacent to the sternpost, its pintles intact. It was also buried in silt, with only 26 in. (66 cm) of the main rudder showing, lying at approximately a 15 degree angle from the lake floor. Light hand-

fanning revealed that the buried lower rudder was well preserved, however less than an inch (2.54 cm) of buried rudder was revealed, and the task of uncovering and recording this feature will have to await the next phase of study.

The total height of the rudder is currently unknown. Seven vertical rudder timbers remained; however, there was a 14 in. (35.6 cm) gap between the forward end of the pintle and the first rudder timber, clearly indicating at least one timber that was no longer extant. The first five remaining timbers made up the majority of the exposed rudder and measured 3 in., 28 in., 7 in., 7 in. and 5 in. (7.6 cm, 71.1 cm, 17.8 cm, 17.8 cm and 12.7 cm) fore-and-aft respectively. The following two timbers made up the after upward projection of the rudder, like that seen on *Heroine* and Wrecks 1 and 3. The total width of the rudder from the forward edge of the pintle to the after end of the rudder was 5 ft. 9 in. (1.75 m).

The after upward projection of the rudder was 9 in. (22.9 cm) wide, fore-and aft, and was composed of two separate timbers measuring 3 in. (7.6 cm) and 4 in. (10.2 cm) with a 1 in. (2.5 cm) gap in between them. The second, taller and wider timber extended 15 in. (38.1 cm) above the main rudder timbers. The first, thinner timber projected up only 11 in. (27.9 cm), where it was held to the second, thicker timber by an iron collar. The strap of the iron collar was 3 in. (7.6 cm) wide. Below this collar were two iron through-bolts, each 1 ft. (30.5 cm) in length, which also fastened the two timbers together. Below the through-bolts, these two timbers were fastened to the main rudder timbers by a 1 ft. 6 in. (45.7 cm) long, 3 in. (7.6 cm) wide iron strap.

The wrought iron upper pintle was located 13 in. (33 cm) below the top of the main rudder timbers. The straps were 3 in. (7.6 cm) wide and 3 ft. (91.4 cm) long. The pintle pin extended 5 in. (12.7 cm) below the iron strap that held it to the rudder planks. The gap between the straps was 9 in. (22.9 cm), clearly the original thickness of the rudder. About halfway along its length the port-side iron strap of the pintle bent outward from some obvious damage. There is likely to be a lower pintle but it is currently buried in sediment and therefore unrecorded.

There were many intrusive elements adjacent to the stern, including a large tree stump, various modern water intake pipes and electrical cords. Some of the loose-lying timbers may have been part of the wreck but were not examined due to time constraints.

Frames

The frames on Wreck 2 were very different from the frames on the other three wrecks examined in 2014. They were significantly larger in sided dimensions, and generally smaller in molded dimensions, making them nearly square in section, whereas the other wrecks had narrow and deep frames in section. The frames were also different in their spacing. Whereas on the other three wrecks, an obvious effort had been made to reduce the number of frames (particularly in the bow and stern), likely in effort to reduce both the overall weight and the weight at the bow and stern, Wreck 2's frames were closely spaced.

Unfortunately, due to the rock pile covering most of the wreck along the keelson, only the broken-off tips of the frames peeking out from under the rocks could be

recorded in 2014. Determining which timbers were floors and which were futtocks was nearly impossible, and so each timber was assigned a number. In total, 113 individual frame timbers were counted, and every fifth timber was tagged for reference. It appeared that some frames were either hidden by the rock pile or missing, and therefore this total number is not accurate, however the frames that are present provide quite a clear picture of the framing pattern.

There was a distinct pattern in the sizes of frames throughout the hull. Frames 1 through 37, from 2 ft. 8 in. to 41 ft. (81.3 cm m to 12.5 m) MBL, averaged 6.5 in. (16.5 cm) sided, frames 38 through 57, between 41 ft. 11 in. and 59 ft. 11 in. (12.8 m to 18.3 m) MBL, averaged 9 in. (22.9 cm) and frames 58 through 113, between 60 ft. 9 in. and 118 ft. 9 in. (18.5 m to 36.2 m) MBL averaged 6.5 in. (16.5 cm) sided. The significant increase in size for frames 38 through 57 indicated the midships area of Wreck 2, which began about one third abaft the bow along the centerline.

The heavier framing in this area was needed to support the heavy engine equipment at the widest section of the steamboat. The spacing between frames also decreased throughout this midship section, going from 5.7 in. (14.5 cm) in the first section, to 2.4 in. (6.1 cm), and back to 5.3 in. (13.5 cm) for the last section. That being said, the frames also increased in size in this section. This meant that the frame centers (including two timbers based on a floor and futtock configuration) maintain an average of approximately 22 in. (55.9 cm) centers throughout the entire hull. This is a tentative number, however, since floors and futtocks were indistinguishable due to the rocks. As evidenced by these numbers, the spacing throughout the framing was not very wide. It

must be pointed out that since every floor and futtock was assigned a frame number, spaces of 1 in. (2.5 cm) or less that probably separated floor from futtock were included in the data used to find these averages. Also, frames between 61 ft. 10 in. and 72 ft. 2 in. (18.8 m and 22 m) MBL were almost completely obscured by the rock pile, and only one frame, frame 60, was recorded in that 10 ft. (3 m) area. This area was therefore not included in the data used to obtain spacing averages.

After the first week of survey, it was determined that the area between frames 38 and 57 must be the midships area, and therefore divemaster Ron Adams was tasked with removing the rock pile from frames 38 to 53. Aft of frame 53 the rocks were piled very high, and therefore Adams stopped at this point. Upon examination of the cleared section, frames 38 through 42 were observed to be spaced very closely, with less than 1 in. (2.5 cm) between timbers. Frames 39, 40 and 41 were virtually touching, and therefore it was assumed that Frame 40, at 43 ft. 6 in. (13.3 m) MBL, was the midships frame. Frame 40, we noted, was of a distinctly darker color from the adjacent frames, which may be significant in terms of timber selection by the builder (Figure 26). Limber holes were not noted, however they were unlikely to be seen beneath the rocks.

One of the goals for the 2015 project will be to take wood samples in an effort to establish the wood types used for the frame floors and futtocks.

Figure 26. Wreck 2 midship timber (tagged frame 40) is darker and larger than the adjacent frames. Also note the compass timber on frame 39. (Photo by Carolyn Kennedy.)

Keelson

The keelson of Wreck 2 was visible from 3 ft. 11 in. (1.2 m) to 55 ft. 2 in. (16.8 m) MBL, and 71 ft. 2 in. (21.7 m) MBL to the sternpost, where it was visibly broken at its end. A 16 ft. (4.9 m) section in the middle of the wreck was completely covered by a large rock pile. This section of the hull may have been filled with rocks first during or after its scuttling, and those on either side spilled from this main pile. The larger pile in this location might have been due to a hatch located in the main deck here. The keelson and its features were obscured here, therefore any break in this area is unknown, but the preserved condition of the timbers under the rocks is probably excellent.

The visible portions of the keelson lacked the bolt patterns found on the keelsons of the other wrecks. On Wrecks 1, 3 and 4, bolt heads were visible on the keelson above every frame, but on Wreck 2 the visible bolts on the top face of the keelson were spaced approximately every 5 ft. (1.5 m). Since the sides of the keelson were largely obscured by rocks, it was difficult to tell whether the visible part was an upper timber atop the keelson, or why the bolts were spaced so far apart. Where the keelson was visible it appeared to be a single timber. The keelson had a sided dimension of 9 in. (22.9 cm) molded at 30 ft. 9 in. (9.37 m) MBL, and at this point appeared to be one solid piece. At the forward end of the keelson, between 4 ft. 8 in. (1.42 m) and 3 ft. 11 in. (1.19 m) MBL it had a maximum sided dimension of 8 in. (20.3 cm) and maximum molded dimension of 4.5 in. (11.4 cm).

Engine Bed Timbers

The engine bed timbers on Wreck 2 were similarly sized and placed as those on *Phoenix* (see Figure 23). Two pairs of bed timbers on each side of the hull were recorded and labeled Starboard 1 and 2 (S1 and S2) and Port 1 and 2 (P1 and P2). S1 and P1 were the shorter, inboard timbers, and S2 and P2 were much longer and further outboard. S2, running parallel to the keelson at a distance of 4 ft. 6 in. (1.4 m) from the starboard side of the keelson, was broken forward of 16 ft. 1 in. (4.9 m) MBL, but continued as far aft as 64 ft. 4 in. (19.6 m) MBL, where it was broken by the rocks piled here. From 64 ft. 4 in. to 72 ft. (19.6 m to 21.9 m) MBL, S2 is completely covered by rocks. Abaft the rock pile, S2 extended from 72 ft. to 81 ft. 7 in. (21.9 m to 24.9 m)

MBL, where it ended in a broken point. The majority of S2 had a second layer of timber, labeled S2A, bolted to its upper face. S2A started from a forward point of 35 ft. 3 in. (10.7 m) MBL, however bolts protruding high above the lower timber (S2) as far forward as 32 ft. 10 in. (10 m) MBL indicated S2A had originally been considerably longer. S2A continued as far aft as 77 ft. 2 in. (23.5 m) MBL, almost the entire length of S2. The lower S2 timber averaged 10 in. (25.4 cm) molded and 9 in. (22.9 cm) sided, ending with a broken point. S2A had average molded and sided dimensions of 5.25 in. (13.3 cm) and 8 in. (20.3 cm). S2A was clearly broken in two locations at which points S2 remained intact; between 42 ft. 6 in. and 47 ft. 5 in. (13 m and 14.5 m) MBL, and between 53 ft. 7 in. and 54 ft. (16.3 m and 16.5 m) MBL. These correlate with break points on S1, possibly indicating the original location of engine machinery.

S1 began at 45 ft. 11 in. (14 m) MBL, and was broken off forward of this point. At 47 ft. 5 in. (14.5 m) MBL S2A began on top of S2, and continued aft to 63 ft. (19.2 m) MBL, where both timbers appeared to be cleanly cut. The rock pile began immediately abaft this cut and therefore may have obscured any continuations. A break in S1A occurred between 53 ft. 9 in. and 60 ft. 8 in. (16.4 m and 18.5 m) MBL, which lined up with the break in S2A between 53 ft. 7 in. and 54 ft. (16.3 m and 16.5 m) MBL. These breaks in the engine bed timbers might have been caused by the removal of the engine or drive train. S1 had an average molded dimension of 8.75 in. (22.2 cm) and an average sided dimension of 7.5 in. (19 cm). S1A had average molded and sided dimensions of 2 in. (5.1 cm) and 6 in. (15.2 cm) respectively.

Another starboard bed timber was visible abaft the amidships rock pile starting from 76 ft. 3 in. (23.2 m) MBL, and continued aft to 86 ft. 9 in. (26.4 m) MBL where it was cut rather than broken. This is possibly a continuation of S1, however was labeled S3 during the field project since the rock pile completely obscured any obvious link between the two timbers. S3 averaged 8.5 in. (19 cm) molded and 7 in. (17.8 cm) sided, very similar to S1.

Most of the features on the port side were not recorded due to the heavy rock and sediment coverage. The bed timbers were tall enough, however, so that their upper faces were visible above the stones. Therefore these timbers were partially recorded on the port side, though in many cases only the sided dimensions were recorded. P2 was located 4 ft. 10 in. (1.5 m) outboard of the keelson's port side at 12 ft. 3 in. (3.73 m) MBL, and continued aft until 81 ft. 2 in. (24.7 m) MBL. Between 14 ft. 4 in. and 19 ft. 10 in. (4.37 m and 6.05 m) MBL P2 was covered by rocks. P2A, a second timber lying atop P2, began at 37 ft. 6 in. (11.4 m) MBL and continued aft until it broke off at 47 ft. (14.3 m) MBL. Immediately abaft the break, a new P2A timber continued aft until 52 ft. 8 in. (16.1 m) MBL. Unfortunately the rock coverage near this area prevented examination of these timbers, and therefore molded dimensions were unrecorded aft of 49 ft. 3 in. (15 m) MBL. Forward of this, average molded dimensions of P2 and P2A were 11 in. (27.9 cm) and 8 in. (20.3 cm) respectively, with a gap between the two of an average of 5 in. (12.7 cm). This gap is likely due to the wave action and decay of the timbers that eroded the bolt holes and loosened the timbers. The average sided dimensions of P2 and P2A were 10 in. (25.4 cm) and 9 in. (22.9 cm) respectively.

The closer inboard port stringer, P1, was located 1 ft. (30.5 cm) outboard of the port side of the keelson. It extended a total length of 40 ft. 11 in. (12.5 m), from 45 ft. 11 in. to 86 ft. 10 in. (14 m to 26.5 m) MBL. Nearly 14 ft. (4.3 m) of P2 was completely covered by the large rock pile located between 62 ft. and 75 ft. 11 in. (18.9 m and 23.1 m) MBL, and therefore any changes in P1 in this section were not observed. Two short sections of a top timber, P1A, are preserved, the first between 47 ft. 8 in. and 48 ft. 9 in. (14.5 m and 14.9 m) MBL, and the second between 49 ft. 8 in. and 52 ft. 2 in. (15.1 m and 15.9 m) MBL. P1A averaged 5 in. (12.7 cm) molded. The average sided dimension for P2 was 7 in. (17.8 cm), however at 55 ft. 4 in. (16.9 m) MBL to where the timber is covered by rocks the sided dimension averaged 11 in. (27.9 cm). The average molded dimension of P2 was 18 in. (45.7 cm).

Miscellaneous: Timber P3

A third timber running longitudinally on the port side was recorded and labeled as P3, however was unlikely an engine bed timber. This 5 ft. 2 in. (1.6 m) long timber was found on the port side, bolted or spiked in place to the ceiling planking and frames 1 ft. 7 in. (48.3 cm) outboard of P2, located between 43 ft. and 48 ft. 2 in. (13.1 m and 14.7 m) MBL. P3 was unlike any of the bed timbers found on Wreck 2, or any of the other wrecks. On both the forward and after end of this timber, the height was 6 in. (15.2 cm) for a length of 15 in. (38.1 cm) At 15 in. (38.1 cm) from the ends, the timber suddenly increased to a height of 8 in. (20.3 cm) for 32 in. (81.3 cm). The ends each resembled one side of flat scarf, however no adjoining timbers were located. Furthermore, 4 in.

(10.2 cm) from either end were found transverse circular holes, approximately 3-4 in. (7.6-10.2 cm) in diameter. The holes were clearly cut for some purpose, however that purpose remains a mystery. Possibly this timber was meant to hold intake/outlet pipes in place.

CHAPTER VI

ARCHAEOLOGICAL RESULTS: WRECK 3

Wreck 3, identified as *Burlington*, was the wreck with the most readily-available historical record. Its construction, launching, and original appearance were documented in a variety of contemporary news accounts, travelogues, and images. It is also prominently featured in a photo taken circa 1859-60; several years after its abandonment by the Champlain Transportation Company (CTC), lying sunk and partially dismantled, perpendicular to the shore with its bow closest to the land (Figure 4). The wreck has not moved since the photo was taken, although part of the bow, the upper hull, and the superstructure are now missing.

Wreck 3 was the second longest of the four wrecks examined in 2014, with an overall length of 158 ft. 1 in. (48.2 m). According to contemporary accounts *Burlington* was originally 185 ft. (56.4 m) in length, indicating that about 27 ft. (8.22 m) of the hull's forward end is gone. During the 2014 survey the zero point on the main base line (MBL) was fixed at the forward end of the broken-off keelson (the tip of the keel extended 20 in. [50.8 cm] forward of the MBL's zero point, and the second port-side engine bed timber [P2] extended 5 ft. 6 in. [1.7 m] forward of the MBL). The overall length of the MBL, from the forward end of the existing keelson to the after end of the sternpost, was 152 ft. 7 in. (46.5 m) (Figure 27).

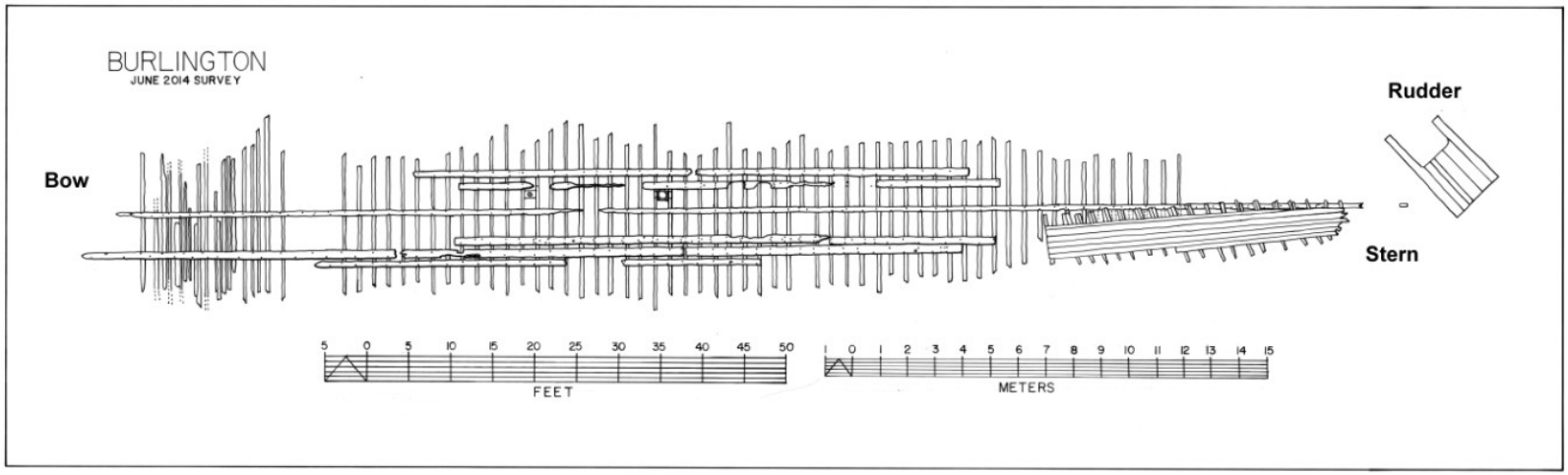

Figure 27. Preliminary site plan of Wreck 3. (Drawing by Rebecca Ingram and Dan Bishop; inked by Nathan Gallagher.)

Construction and Materials

Burlington was built in 1837 by the CTC. The company's chief carpenter at this time was Lavater S. White, and the chief engineer was Elijah Root. These two men supervised the completion of the hull and the installation of the engines and boilers of both *Burlington* and *Whitehall*. *Burlington*'s boilers were manufactured by Thomas Holloway of Pennsylvania, and its engine was made by Ward & Co. in Montreal. Ward & Co., which was renamed Eagle Foundry in 1837, was the most popular marine engine manufacturer in the northeast in the 1830s.[62]

Burlington was launched on 16 June 1837 from Shelburne Harbor, the first CTC steamboat to be built in this location.[63] The boat was completed during the summer of 1837 and its maiden voyage took place in October 1837.[64] Thomas S. Brown, a notable politician of Lower Canada in the 1830s, was invited to board *Burlington* for its maiden voyage and wrote extensively of the grandeur of the steamer:

> The *Burlington* is a most perfect model of "Steamer" architecture, 190 feet long, strengthened by a wooden arch, above which is a wooden frame bracing, similar to that of North River Boats, 25 feet beam, depth of [hold] 9 ½ feet, drawing 4 ½ feet water, (all on board,) 51 feet outside the guards, paddle wheels 24 feet high, [figure] head a full length female, or rather "Lady" [figurehead]; Gentlemen's Cabin below [contains] 120 berths, well lighted; Ladies' Cabin on deck 20 berths; Promenade deck, supported by slender oak pillars, runs the whole length except a short break running across between the forward gangways. The main deck is superior to any thing I ever saw afloat; block [cornices] all around, paneled doors, plated handles, with Pilasters and Doric capitals; carved sashes, and about the quarter deck, the panels are all finished with rich carved moulding; stair cases and bar mahogany. Every thing connected with the upper works is made as light as can be, consistent with necessary strength, and all throughout painted white.[65]

A CTC document from 1838 states that the total length of *Burlington* was in fact 185 ft. (56.4 m), however Brown and others likely rounded up to the nearest round number.[66]

One of the major concerns that arose with building longer steamers was how to keep them from hogging. In *Burlington*'s case, the builders employed a wooden arch as a hogging truss to alleviate weight on the ends.[67] Brown makes no mention of a hog chain truss system (consisting of bow-to-stern wrought iron rods tightened with turnbuckles) included in *Burlington*'s construction, and this relatively new technology may not have been available for steamers by the time of the 1837 launch.

Different types of wood were noted in the structural features of Wreck 3. Oak was clearly used, however a receipt for 160 ft. long cherry boards found in the CTC archives indicates that the deck planking was probably constructed from cherry.[68]

The metal fasteners and rudder hardware were made of iron. A lead collar for a through-hull pipe fitting was located on the wreck, like those found on Wreck 1 and Wreck 4. A lead pipe was discovered nearby Wreck 3, and may have come from the steamboat originally.

Keel

As mentioned above, the keel extended 20 in. (50.7 cm) forward of the forward tip of the keelson. At this forward end the keel was 7 in. (17.8 cm) sided and 3 in. (7.6 cm) molded, though it was heavily eroded in this area.

Wreck 3 had a T-shaped keel, meaning its upper face was wider than the lower majority of the keel. The sided dimensions recorded reflect the size of this upper face, rather than the lower part of the keel, unless otherwise indicated. On average, the upper face was 8 ¼ in. (21 cm) sided. The arms of the T-shaped keel acted like a rabbet, and

the hull planking would have met the keel below the arms. The arms were on average 1 ½ in. (3.8 cm) molded and ½ in. (1.3 cm) sided on both sides, making the lower part of the keel on average 7 ¾ in. (19.7 cm) sided (Figure 28).

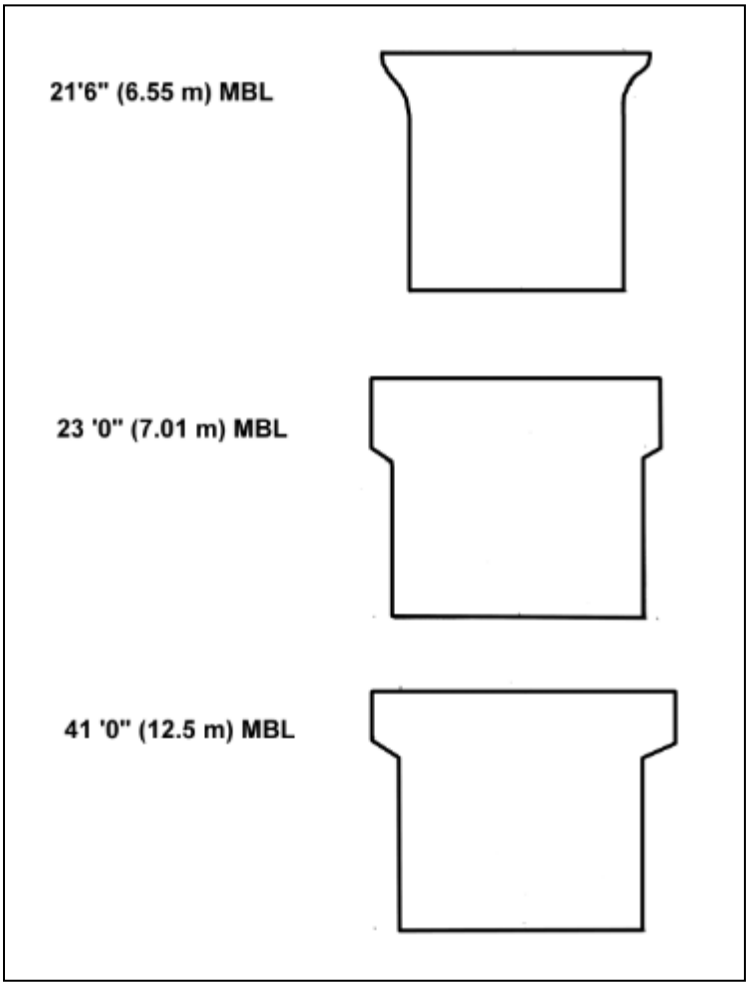

Figure 28. T-Shaped section of Wreck 3 keel. Most likely the first section view is eroded. (Drawing by Dan Bishop and Rebecca Ingram.)

An interesting feature of the keel was observed between 31 ft. 6 in. and 31 ft. 9 in. (9.6 m and 9.7 m) MBL. At this point, and for some distance fore and aft, the keel

was composed of a lower and an upper part. The upper part was 2.5 in. to 3 in. (6.4 cm to 7.6 cm) molded, but no molded dimension was attainable for the lower part due to it being buried in sediment. A gap between the two parts was recorded at 1 in. to 2 in. (2.5 cm to 5.1 cm) molded. For the section in question there was a gap between two timbers which formed the upper level, revealing the timber underneath.

It is unclear what purpose the double keel timbers served for *Burlington*, as this configuration was not found on any of the other steamers. It is possible that due to *Burlington*'s length, White attempted to strengthen the hull longitudinally by having a reinforced keel. Since *Burlington* did not have a hog chain truss arrangement like *Whitehall*, hogging may have posed a serious risk, and it is possible that the CTC was experimenting with doubling up the keel timbers to reinforce the spine of the boat.

Stern Assembly and Rudder

The stern area of Wreck 3 was well-preserved. The sternpost stood nearly vertical on the keel (its surviving length was not recorded in 2014) and the rudder was found lying on the bottom directly adjacent to the sternpost, and even a section of collapsed side frames and planking was preserved near the stern. The sternpost was located at 151 ft 8 in. (46.2 m) MBL, with a molded width of 11 in. (27.9 cm) at the base, and 9 in. (22.9 cm) at the top. The sided thickness was 6 in. (15.2 cm). The post raked aft at an angle of 82 degrees from the keel. Though no total height of the remaining sternpost was taken its original height was over 13 ft. (4 m) based on the rudder dimensions of the rudder post.

The rudder was excellently preserved and clear of debris, and lay just aft and to the starboard side of the sternpost. Like Wreck 1 and Wreck 2, Wreck 3's rudder was "barn-door style", meaning it was nearly square in profile. It was composed of six vertical timbers, the foremost and aftermost of which were taller than the four middle timbers. The fore-and-aft widths of these timbers varied, but they averaged 13.5 in. (34.3 cm) wide, and 7 in. (17.8 cm) thick. The rudder assembly totaled 7 ft. (2.1 m) in length, and the four middle planks were 6 ft. 6 in. (2 m) high. The total height of the rudder post was 12 ft. (3.7 m), and the long aftermost vertical timber extended 4 ft. 3 in. (1.3 m) above the main part of the rudder, giving it a total height of 10 ft. 9 in. (3.3 m).

The upward projection of the aftermost rudder timber included metal hardware fitted to the top 12 in. (30.5 cm) of the piece. The fittings included two metal rings encircling the wooden post, and a topmost ring that had fore-and-aft projections of approximately 3 in. (7.6 cm) each. The purpose of all of these pieces is unknown, and was not found on any of the other rudders. The most likely explanation for their presence is for control over the rudder, as steamboat rudders were often controlled by a block-and-tackle system attached to this after extremity. These may have acted as fastening points for the block and tackle. Two feet three inches (68.6 cm) below the top of the upward projection was a D-shaped metal ring, whose flat side connected through the wooden timber. This piece was 9 in. (22.3 cm) in thickness, and was about halfway between the base and the top of the upward projection. It is possible this piece also allowed for further control of the rudder (Figure 29).

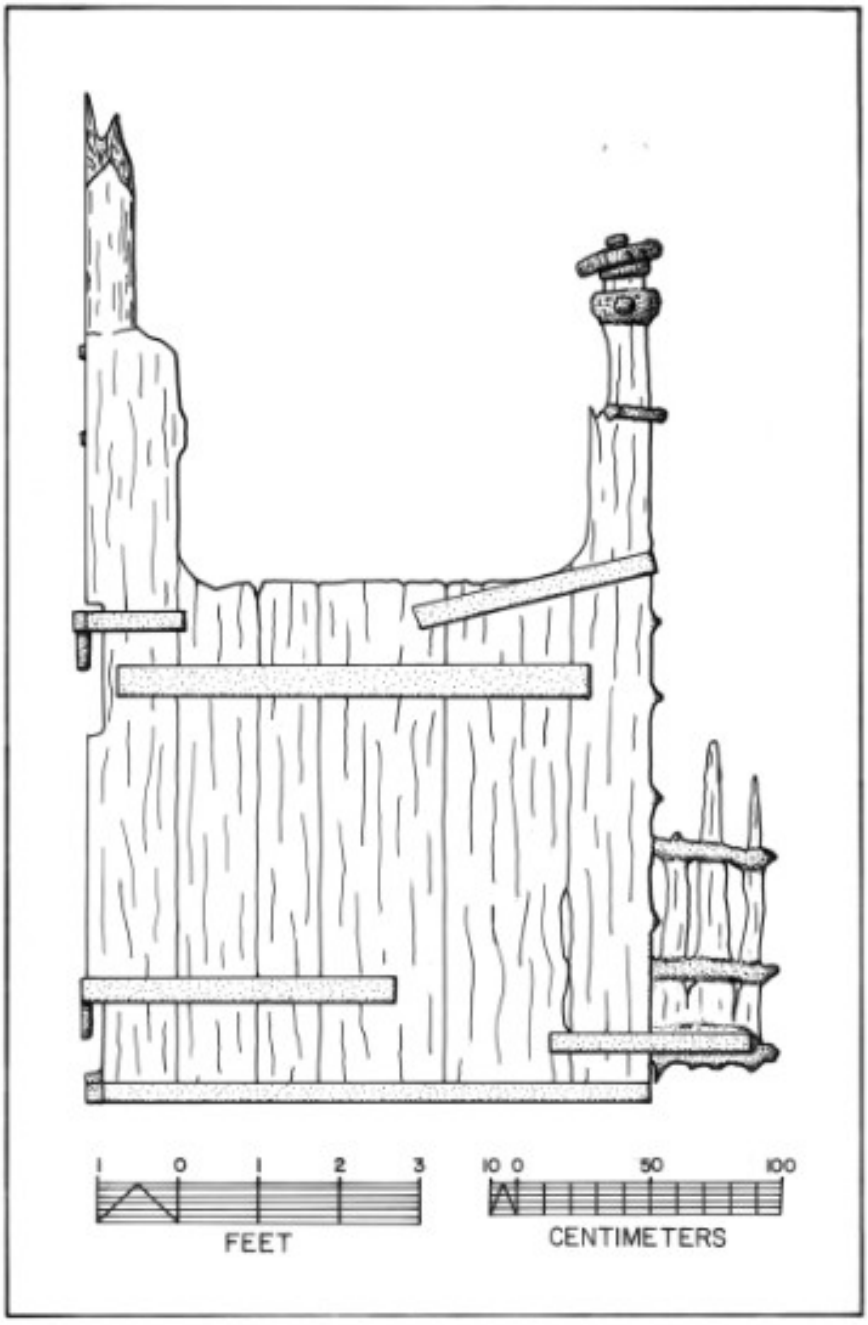

Figure 29. Rudder from Wreck 3. Note the extension on the right-hand side (aft). (Drawing by Dan Bishop; inked by Nathan Gallagher.)

The after edge of the rudder had an unusual projection. Three bolts on the lowermost 40 in. (1 m) of the rudder connected the aftermost rudder timber to three

vertical, eroded wooden timbers. The total length of this extension was 18 in. (45.7 cm) The heights of the three vertical timber pieces comprising the projection were 41 in., 56 in., and 50 in. (1.04 m, 1.42 m, and 1.27 m) fore to aft respectively. An iron strap, 3 in. (7.6 cm) high and 30 in. (76.2 cm) long also secured these three pieces to the main section of the rudder, along with the three bolts.

This rudder extension was curious. The rudder found on Wreck 2 did not have this feature, while the rudder on Wreck 1 had two aft-projecting bolts near the bottom of the aftermost face. One explanation for the rudder extension on Wreck 3 is that it was added retroactively to increase the surface area of the rudder to improve control over the 185 ft. (56.4 m) long steamer.

The metal hardware on the rudder was fashioned from wrought iron. These included through-bolts and external reinforcing straps. The straps ranged from 3-5 in. (7.6-12.7 cm) in width, with the longest strap covering the entire bottom of the rudder. This strap was likely added both to secure the planks together, and also to protect the rudder if it grounded on the lake bottom. A large, 5 in. (12.7 cm) wide strap spanned all six vertical timbers of the rudder, for a total length of 5 ft. 10 in. (1.78 m). Another strap, 3.5 in. (8.9 cm) wide, wrapped around the aftermost timber at the place where it projected above the blade of the rudder, and the straps extended forward for 35 in. (88.9 cm) at a slightly downward angle.

The rudder had two pintles. The pintles themselves were 7 in. (17.8 cm) long, with diameters of 2.5 in. (6.4 cm). The 3 in. (7.6 cm) wide upper pintle straps extended 14 in. (35.6 cm) fore-to-aft, while the 4 in. (10.2 cm) wide lower straps extended 3 ft. 10

in. (1.17 m). The forward face of the rudder post was hollowed beneath the pintles to allow them to be mounted on the sternpost's gudgeons. These hollowed-out spaces were 2.75 in. (7 cm) long and 20 in. (50.8 cm) and 13 in. (33 cm) (top and bottom) high.

Frames

Despite a construction date only five years later than Wreck 2, the framing on Wreck 3 was drastically different. While Wreck 2 exhibited fairly traditional framing, including many timbers with thick, square cross-sections, Wreck 3's frames were unlike frames seen from earlier shipbuilding traditions. Instead of square cross-sections, they had fairly narrow sided dimensions, but deep molded dimensions, like Wreck 1. What can be determined from the unusual frame shapes is that the builders were purposely trying to reduce the overall weight of heavy framing timbers to keep the steamer both light and fast. By keeping the frames narrow, but deep, the builders kept the frames strong but much lighter than was typical of earlier wooden ship frames.

Since Wreck 3 was missing much of its bow, the forward end of the hull is a mystery. The remaining frames at this end of the hull were also quite damaged. The twelve forwardmost frame timbers (including both floors and futtocks) were significantly eroded, and directly abaft these at least three frame assemblies were completely missing, with only remaining bolts and bolt holes to mark their original location. After these missing timbers, the framing presented a fairly clear pattern.

A total of 75 frame timbers were preserved on Wreck 3. On average, sided dimensions were 4.7 in. (11.9 cm) and molded dimensions were 8 in. (20.3 cm), with ranges of 4 to 6 in. (10.2 to 15.2 cm) and 6 to 9 in. (15.2 to 22.9 cm) respectively. The

spacing between the bolts fastening the frames averaged 16.7 in. (42.4 cm), with ranges from 14 to 19 in. (35.6 to 48.3 cm).

The only section where this spacing differed was between the first 12 timbers. Here the spacing was greatly reduced, averaging about 8 in. (20.3 cm) between frame centers. Closer spacing patterns were expected to be found under the heaviest machinery, such as the engine and boilers. These were typically further aft of these frames, over the heaviest bed timbers, so it was surprising to find such closely-spaced timbers well forward of amidships. When aligned with and scaled to a contemporary profile image of *Burlington*, the site plan of Wreck 3 shows these oddly spaced frames directly beneath what appears to be a gap in the main deck (Figure 30). This placement goes against all logical explanation since this area was where the boat was lightest and needing the least amount of structural support. One tentative explanation is that this is the location of a repair or extension, however due to the level of erosion there is very little evidence if this is the case. These frames also do not align with the separation of the keel timbers noted at 31 ft. 6 in. (9.6 m) MBL.

A limber hole cut into the bottom face of frame 27 was located 1.5 in. (3.8 cm) outboard from either side of the keel. The limber hole was 6 in. (15.2 cm) wide at the bottom, and 4 in. (10.2 cm) wide at the top, and had a height of 2 in. (5.1 cm). Though not all frames were examined to compare limber holes, presumably they varied little from this one (Figure 31).

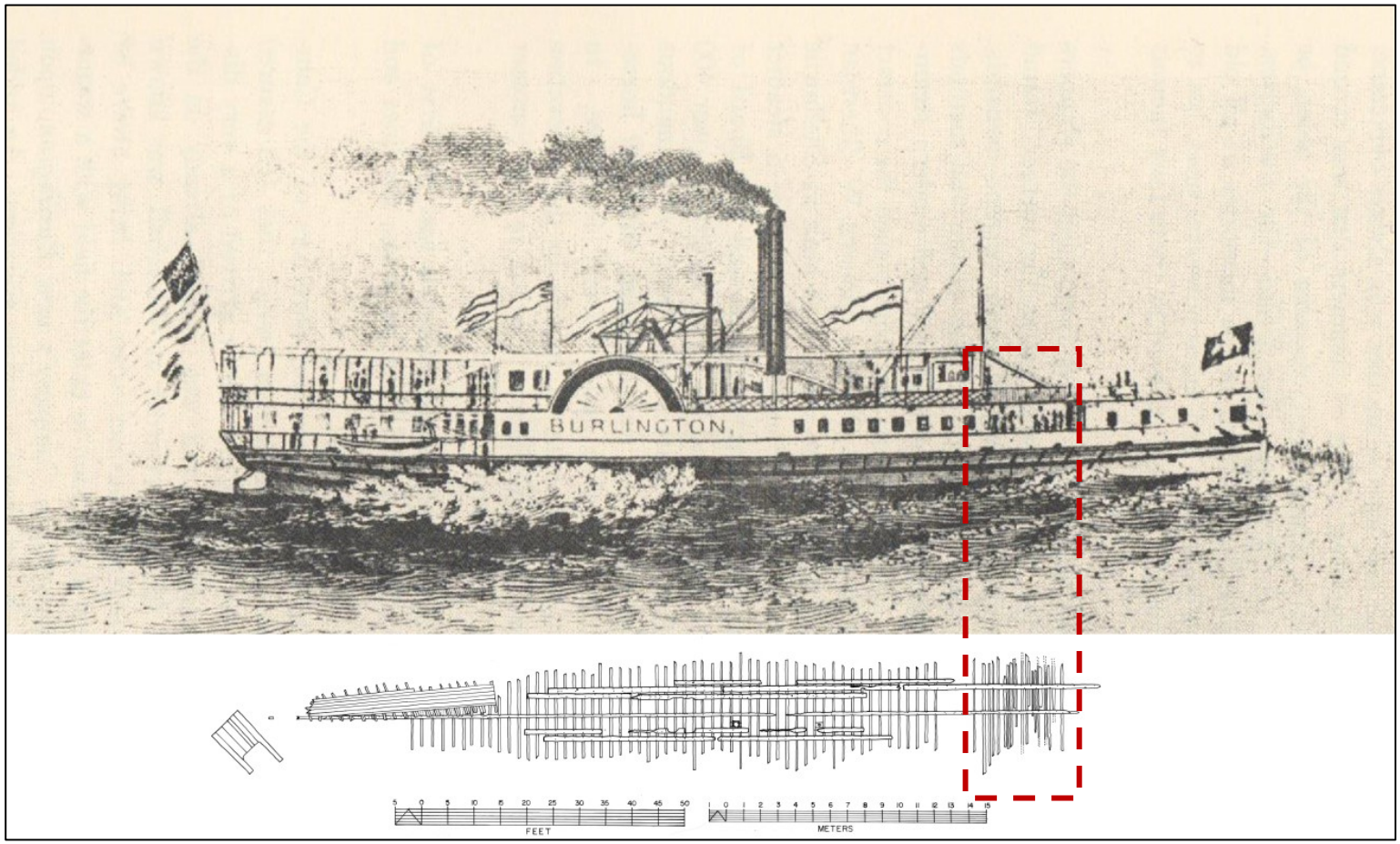

Figure 30. Contemporary profile image of *Burlington* scaled and aligned to site plan of Wreck 3. The atypical arrangement of frames falls directly underneath an area with the least weight to support. (Images scaled to fit by author.)

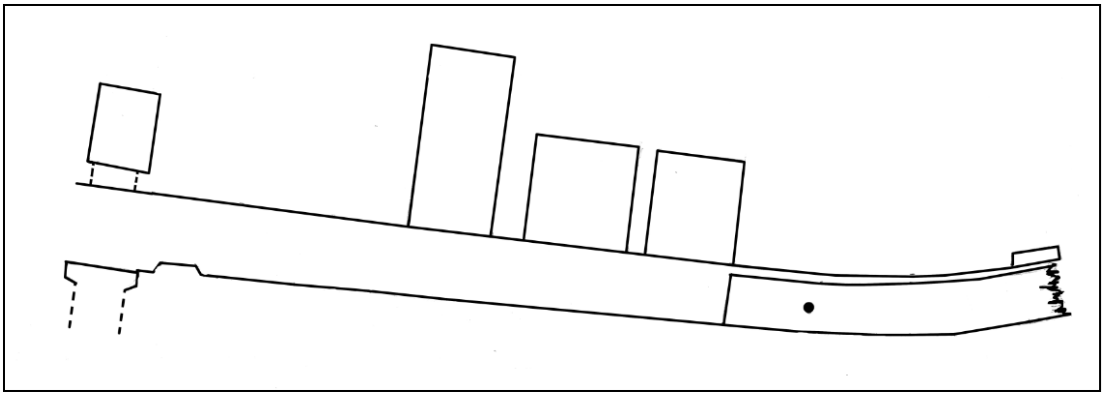

Figure 31. Cross section of frame 45 looking aft. Note limber hole adjacent to T-shaped keel. (Drawing by Carrie Sowden.)

Keelson

Wreck 3's keelson appeared to be missing substantial portions of its forward and after ends (both ends were heavily eroded). It was surprisingly small for a vessel of this size. The average sided dimension was just over 7 in. (17.8 cm), and the average molded dimension is approximately 8 in. (20.3 cm), making the keelson nearly square in section. No notching of the keelson timber to fit down over the frames was observed. The keelson continues aft to 145 ft. (44.2 m) MBL, where its eroded end terminated beneath a deadwood timber. The deadwood timber began at 141 ft. 8 in. (43.2 m) and continued to 147 ft. 1 in. (44.8 m) MBL.

A total of four long flat scarfs connected the keelson timbers. The scarfs averaged 6 ft. 6.5 in. (2 m) long. The first was located between 18 ft. 1 in. and 24 ft. 2 in. (5.5 m and 7.4 m) MBL; the second between 39 ft. 6 in. and 46 ft. (12 m and 14 m) MBL; the third between 80 ft. and 86 ft. 11 in. (24.4 m and 26.5 m) MBL and the fourth between 100 ft. 2 in. and 106 ft. 10 in. (30.5 m and 32.6 m) MBL. It is possible that a

fifth scarf was missed and not recorded, since the remaining length of the keelson would make for an extremely long timber. The scarfs were fashioned with the forward timbers on top of the after timbers, meaning the keelson was laid down from the stern forward. This differs from the laying of *Heroine*'s keelson.[69]

Between 50 ft. 7 in. and 57 ft. 8 in. (15.4 m and 17.6 m) MBL the keelson is deteriorated and eroded into points. There is no obvious reason for this break, however it may mark the location of engine machinery that was salvaged. The keelson was bolted to the frames with a fairly consistent alternating pattern that entered through the top of the keelson, passed through the frame floors and continued into the keel. Presumably the alternating pattern was to avoid the bolts used to secure just the floors to the keel.

The keelson of Wreck 3 had much smaller molded and sided dimensions, 8 in. (20.3 cm) and 7.5 in. (19 cm), than the adjacent engine bed timbers. This differed from the keelson and bed timbers of Wreck 2, suggesting a trend toward a use of multiple and much larger engine bed timbers in the mid 1830s. This change reflects the engineers' intention of relieving the weight of the engine machinery off of the keelson, recognizing the importance of this timber's role in the entire ship's structural integrity. The bed timbers, therefore, were increased in number and size to support all of the weight of the machinery. Another possibility is that the pipes running under the cylinder and boilers required space between the bottom of the machinery and the wooden hull of the ship, and therefore the bed timbers had to raise the entire engine and boiler assembly higher above the hull.

Engine Bed Timbers

As mentioned previously, the bed timbers on Wreck 3 were many and large compared to those seen on Wreck 2. The engine bed timber remains were also surprisingly asymmetrical, with three on the port side and only two on the starboard side. It is possible that a third starboard engine bed timber existed and since broke loose. The bed timbers were lettered P for port and S for starboard, and numbered according to their proximity to the keelson, the closest inboard being 1, and the furthest outboard either 2 (starboard) or 3 (port). Since the bed timbers were such large components of the hull, the dive team recording them decided to designate two secondary baselines, port base line (PBL) and starboard base line (SBL), on P2 and S2 respectively. These baselines were calibrated at certain points with the MBL, and therefore the following figures were based on these calibrations rather than on actual MBL readings.

S1 ran from 39 ft. 4 in. to 103 ft. 6 in. (12 m to 31.5 m) MBL, for a total length of 65 ft. 5 in. (19.9 m). S1 was quite damaged in some sections, specifically between 52 ft. 6 in. and 61 ft. 5 in. (16 m and 18.7 m) MBL, and 77 ft. 11 in. and 88 ft. 8 in. (23.7 m and 27 m) MBL. The damage in these areas may have been caused by the engine machinery being removed. S1 had a second upper timber present from 67 ft. to 81 ft. (20.4 m to 24.7 m) MBL. The maximum molded height of S1 including both timbers was 22 in. (55.9 cm), with an average of 20 in. (50.8 cm). The average molded dimension of the bottom timber of S1 was 9 in. (22.9 cm), and the average sided dimension of S1 was 10.5 in. (26.7 cm).

S2 started forward of S1 at 33 ft. 9 in. (10.3 m) MBL, and has a total remaining length of 66 ft. (20.1 m). The timber's forward end appeared to be broken, indicating that the original timber extended further forward. The after end of the timber ends in a scarf joint but the adjoining timber is now missing. The total length of S2 was clearly longer than 66 ft. (20.1 m) originally.

Unlike S1, S2 did not have a top timber. Its average molded dimension was 10.5 in. (26.7 cm), with a maximum of 12.5 in. (31.8 cm), and its average sided dimension was 11.75 in. (29.8 cm), with a maximum of 13 in. (33 cm). Other than its ends, S2 was in relatively good condition. Only one small break was recorded between 67 ft. 8 in. and 68 ft. 2 in. (20.6 m and 20.8 m) MBL.

Like S1, P1's forward end also began at 39 ft. 4in. (12 m) MBL, and the timber ended at 103 ft. 5 in. (31.5 m) MBL for a total length of 64 ft. 1 in. (19.5 m). P1 and S1 were therefore symmetrically placed at their forward ends. The timber had an average sided dimension of 11 in. (27.9 cm). An upper timber was added to P1 at 54 ft. 4 in. (16.6 m) MBL, bringing the total molded dimension from 9 in. (22.9 cm) (lower timber) to 21 in. (53.3 cm) (both timbers). A flat scarf was recorded on the upper timber between 60 ft. 4 in. and 65 ft. 11 in. (18.4 m and 20.1 m) MBL. The scarf showed that the aft timber was laid down first and the forward timber on top of that.

The upper timber of P1 was heavily damaged aft of 82 ft. 6 in. (25.1 m) MBL, and it was completely broken off at 85 ft. 6 in. (26.1 m) MBL. Aft of this point, just the lower timber remained. In the area where the upper timber was fragmented, the lower P1 timber was also broken. Specifically the lower timber breaks off from 83 ft. to 83 ft.

6 in (25.3 m to 25.5 m) MBL. Aft of the break, the P1 timber was located slightly outboard of the forward timber.

Both S1 and P1 had metal (most likely iron) plating on a portion of their upper surfaces; on P1 the plating was located between 86 ft. 11 in. and 88 ft. 1 in. (26.4 m and 26.8 m) MBL. The plating on S1 more or less matched this location. The plates probably supported the after end of the engine machinery. It is curious that this metal plating is found on the upper face of the lower timber, since the doubling in molded dimension of P1 seems intended to provide a stronger timber for the heavy machinery to rest on. *Burlington* had a walking-beam engine, and would have had an A-frame to hold up the pivoting 'diamond' that served as the connection between the engine's piston and the crankshaft that turned the sidewheels. A-frames for walking-beam engines often include a third, smaller leg that projected aft of the "A" for additional support (Figure 32). This metal plating is possibly where that support leg was attached to the engine bed timbers. Though no such support timber is illustrated in the contemporary image of *Burlington* (see Figure 8) that might be because of the artist's lack of understanding of the supporting A-frame timbers, or possibly it was left out for simplicity.

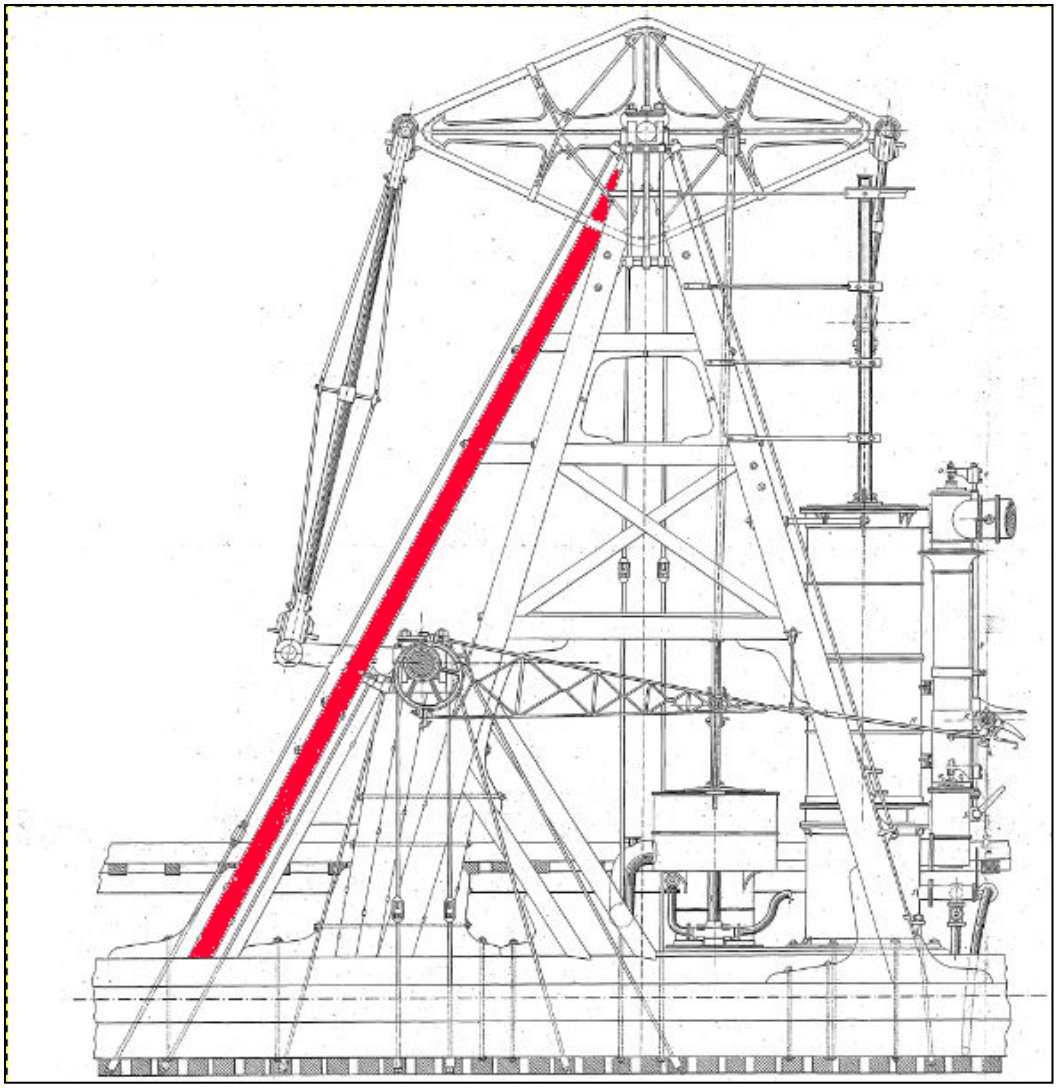

Figure 32. Walking-beam engine of *Francis Skiddy* (1859) with lesser leg highlighted in red. (Atlas du génie maritime, French Department of Defense: Pl. 818. http://www.sheepdog616.org/myGallery/gallery.html)

Inboard of P1 was a semi-detached timber, labeled Unidentified Member 2 (UM 2). This timber was left largely unrecorded. It was approximately 6 ft. (1.8 m) long and lay inboard of P1 from 81 ft. 1 in. to 87 ft. 1 in. (24.7 m to 26.5 m) MBL. UM 2 appeared to be connected to P1 via a bent bolt stemming from P1 at 86 ft. 1 in. (26.2 m) MBL. One of the divers on Wreck 3 noticed that there appeared to be metal plating on

UM2 as well. Since this was discovered towards the end of the project there was unfortunately no time to examine it. More work is needed to better understand the purpose of this timber.

P2 was the longest engine bed timber on Wreck 3, extending from 5 ft. 6 in. (1.7 m) forward of 0 MBL, to 99 ft. 8 in. (30.4 m) MBL for a total length of 105 ft. 6 in. (32.2 m). P2 showed no evidence of an upper timber but had larger overall dimensions than the lower timber of P1. P2's molded dimensions were maximum 13.5 in. (34.3 cm) and average 10.5 in. (26.7 cm). Its sided dimensions were maximum 14 in. (35.6 cm) and average 11.5 in. (29.2 cm).

A break in P2 occurred at 32 ft. 4 in. (9.9 m) MBL and lasted for 6 in. (15.2 cm). Significant damage was present between 37 ft. 4 in. and 42 ft. (11.4 m and 12.8 m) MBL, but no actual break occurred in this section. Finally, another small gap appeared between 66 ft. and 66 ft. 3 in. (20.1 m and 20.2 m) MBL. A small groove in the upper face of P2 was found at 90 ft. 4 in. (27.5 m) MBL. The groove was 4 in. (10.2 cm) long and 1 in. (2.5 cm) deep, and may have been a groove cut for a pipe that transversely crossed the upper face of P2.

The after end of P2 was unusually shaped. At 104 ft. 6 in. (31.9 m) MBL the molded dimension was 13.5 in. (34.3 cm). Aft of this point, the top of P2 sloped down to 9 in. (22.9 cm) molded at 104 ft. 10 in. (32 m) and flattened out to 7 in. (17.8 cm) molded at 105 ft. 2 in. (32.1 m) Unlike the broken ends of the other timbers, P2's after end was purposely carved to create this concave slope. This curved slope may have been shaped this way to fit a pipe or scarf to join with another timber.

P3 was the smallest of the port side engine bed timbers, and was the most damaged. P3 ran from 22 ft. 2 in. to 75 ft. 6 in. (6.8 m to 23 m) MBL, except for a 7 ft. (2.1 m) gap that occurred between 51 ft 6 in. and 58 ft. 8 in. (15.7 m and 17.9 m) MBL. The timbers on both sides of the gap appeared to have been broken from machinery parts being ripped out of the hull. P3, like P2, showed no signs of having a second timber placed on top, and its average dimensions were smaller than the other two engine bed timbers at 8.25 in. (21 cm) molded and 9 in. (22.9 cm) sided; towards its after end these dimensions were slightly larger, at 10 in. (25.4 cm) molded and 10.5 in. (26.7 cm) sided.

All of the engine bed timbers exhibited an alternating bolt pattern, with one bolt per frame. Some frames were secured with two bolts instead of one, with the concentration of double bolts increasing in the middle of each bed timber assembly. The numerous heavy fasteners suggest an attempt to build a more solid hull.

Miscellaneous: Metal Features

A metal cylinder that was likely a through-hull pipe collar was discovered between frames 40 and 41, its inboard edge 13.5 in. (34.3 cm) from the starboard side of the keelson, and 21 in. (53.3 cm) away at its center (Figure 33). The fitting rested at frame level on the exterior hull planking, and had a total height of 16 in. (40.6 cm), though one portion was only preserved to a height of 6 in. (15.2 cm). Its outer diameter was 15 in. (38.1 cm), and its inner diameter was 10.5 in. (26.7 cm), giving the cylinder wall a thickness of 4.5 in. (11.4 cm). The cylinder was held in place by iron fasteners, and a small, 1 in. (2.5 cm) thick wooden timber pressed up against the inboard side of

the cylinder. Two iron fasteners attached the cylinder to frames 40 and 41 fore-and aft, and the small wooden plank was also attached to these frames by diagonal metal fasteners. The iron fasteners were located 16 in. (40.6 cm) and 24 in. (61 cm) from the keelson.

No hull planking was preserved directly below the cylinder, however some was found adjacent to it. The lack of planking may be from damage during sinking, or the decaying process since then, however, this cylinder was likely the base of an intake or outflow pipe for the boilers or condenser where there would be no hull planking.

A circular metal plate was found between frames 31 and 32, at 47 ft. 1 in. to 48 ft. 7 in. (14.4 m to 14.8 m) MBL. The plate was 6 in. (15.2 cm) in diameter and sat 0.25-0.50 in. (0.6-1.3 cm) proud of the planking, its center 22 in. (55.9 cm) starboard of the side of the keelson. The piece lay 6 in. (15.2 cm) forward of the forward face of frame 32, and 4.5 in. (11.4 cm) abaft frame 31. The plank that it rested on was heavily eroded, and had a preserved thickness of less than 1 in. (2.5 cm). A small portion on the starboard side of the plate was broken off, and the fasteners in that section were also missing. A total of seven metal fasteners of 0.25 in. (0.6 cm) diameter held the plate to the plank beneath it.

At the center of the plate was a 1 in. (2.5 cm) square hole that continued through the plank underneath. This hole, like the cylinder or collar, may have been an intake pipe location. Identification of the purposes of these two metal components requires more research on engine designs and parts.

Figure 33. Metal cylinder or pipe found on Wreck 3. (Photo by Paul Gates.)

CHAPTER VII

ARCHAEOLOGICAL RESULTS: WRECK 4

Wreck 4 was the largest of the four wrecks examined in 2014. The remaining hull totaled 214 ft. in length, and lay parallel to the shore with its bow nearly touching the forward end of Wreck 3. This wreck was the most imposing of the four, with massive longitudinal timbers and a huge number of long, iron bolts protruding high above its entire length. The length of Wreck 4 presented its own challenge. Despite the challenge, team four was able to gather a large amount of data, which was enough to make a fairly detailed site plan (Figure 34).

Construction and Materials

Construction of the steamboat *Whitehall* began in the town of Whitehall, New York, in 1836, but it was finally launched in 1838, one year after *Burlington*. The vessel was begun as an independent venture by Peter Comstock, and he had already started building the steamer when ownership passed to the Champlain Transportation Company (CTC). *Whitehall*, like *Burlington*, had its engine constructed by Ward & Co. in Montreal. Its boilers were contracted out to Howell and Coffee of Burlington, Vermont.[70] When the company took over, they asked Comstock to increase the total length of the steamer by 30 ft. (9.1 m) by first cutting the vessel in half.[71] This was fairly common practice in North American steamboat construction.[72]

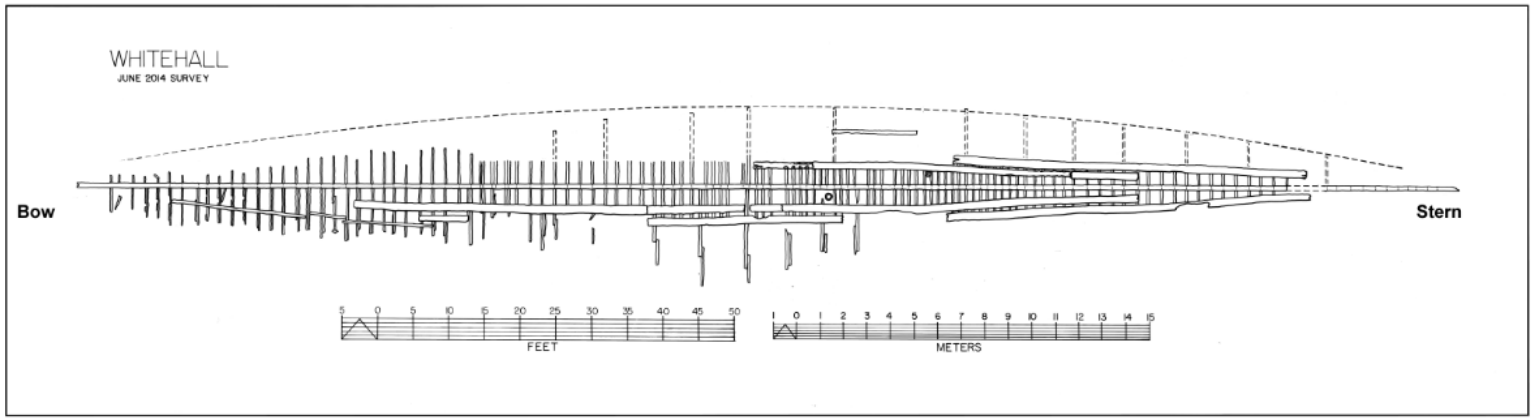

Figure 34. Preliminary site plan of Wreck 4. (Drawing by Nathan Gallagher, Kevin Crisman and Grace Tsai.)

The archaeological investigation shows that this addition was probably placed between frames 26 and 33, however the lower hull was well-buried in silt at this point and no visible modification of the keel was observed. Frames 26 through 29 were accompanied by extra bolts, indicating double floors, and frames 30 through 33 were all double floors. The double-floored section was 12 ft. (3.7 m) long. The floors may have been doubled to reinforce the retroactively fitted section of keel.

Due to time restrictions, divers were unable to take wood samples from Wreck 4. Despite the lack of wood samples, it was clear that at least two different types of wood were used. It is likely that oak was used for some frames that provided the shape to the vessel, but that a cheaper and more readily-available type of wood was used for the majority of frames. The fasteners were consistently made of iron, and no copper or copper alloys were found on this wreck.

The main base line (MBL) on Wreck 4 was laid 17 ft. 9 in. (5.4 m) aft of the forward end of the stem, due to the conveniently located hog chain at this point. The MBL extended as far aft as the sternpost for a total baseline of 196 ft. 3 in. (59.8 m). Including the 17 ft. 9 in. (5.4 m) section forward of the hog chain, the total length of Wreck 4 was 214 ft. (65.2 m).

Keel

The keel of Wreck 4 was mostly buried in silt; however, measurements were attainable near the stem where the keel was exposed. Directly aft of zero on the MBL, the keel was recorded to have a molded dimension of 3 in. (7.6 cm). A slight 1.5 in. (3.8

cm) gap was present between the upper face of the keel and the bottom of the frame, likely due to years of erosion and wave action separating the timbers. Forward of zero on the MBL, the molded dimension of the keel ranged from 7.5 in. to 9 in. (19.1 cm to 22.9 cm), where the keel began to turn upward, forming the gripe. The larger dimensions found further forward were to help the keel timber support the stem assembly. The more likely molded dimension for the majority of the keel's length was the 3 in. to 4 in. (7.6 cm to 10.2 cm), seen abaft the hog chain. The smaller molded dimension accords to Stevenson's observations of American steamers in which "the keel generally projects from two to six inches from the bottom of the hull."[73]

A cross-section view of frame 86 (124 ft. 10 in. [38 m] MBL) revealed information about the keel at this location as well (Figure 35). The keel fit into a notch cut into the underside of each floor, and was 12 in. (30.5 cm) sided. On the top face of the keel, a groove was cut along the center longitudinally measuring 2.5 in. (6.4 cm) wide and 1.25 in. (3.2 cm) deep. The purpose of the groove was most likely a water course, similar to a limber hole. Unfortunately the presence of tightly-fitting garboard planks prevented the recording of the keel's molded dimension at this point.

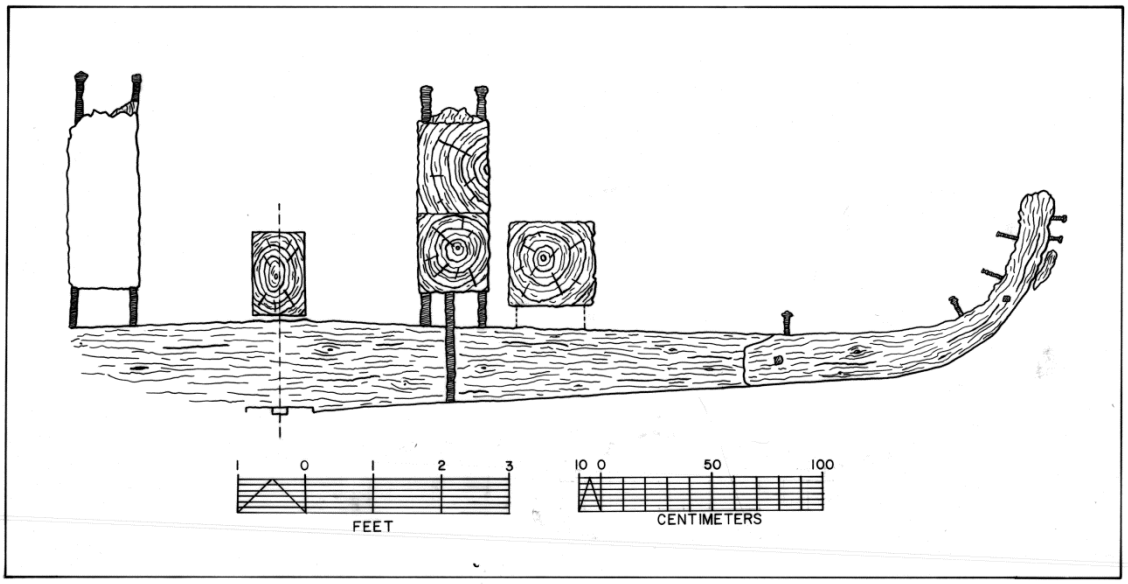

Figure 35. Section at frame 86, port side looking aft. Planking and keel not shown. (Drawing by Kevin Crisman; inked by Nathan Gallagher.)

Stem Assembly

The keel-stem assembly forward of the hog chain rose slightly from the lake bottom. Though it did angle upwards, the keel was still very flat and exhibited almost no curve. Whether this was original to the building or due to warping over 170 years of being underwater is hard to say. A contemporary portrait of *Whitehall* only shows the hull above the waterline, however it is clear from that image that the stem was straight and vertical or near vertical (Figure 36). The ca. 1859-60 photograph of Shelburne Harbor also shows Wreck 4 as having a vertical stem (see Figure 4). Since the stem of Wreck 4 is no longer attached, it is hard to determine how the keel and stem were fastened together, and at how sharp of an angle. Contemporary steamboats often had fairly sharp angles between keel and stem.[74] A slight upward curve was evident in the

forwardmost 2 ft. (61 cm) of the surviving keel. At this point the curve was visible in both the keel and apron timbers. The bottom of the apron curved up more drastically than the top of this timber, creating a point, and also opening up a gap between the apron and keel. Though this gap may be due to erosion of the bottom of the apron, it may also have been where stem timbers were originally joined to the keel and apron (Figure 37).

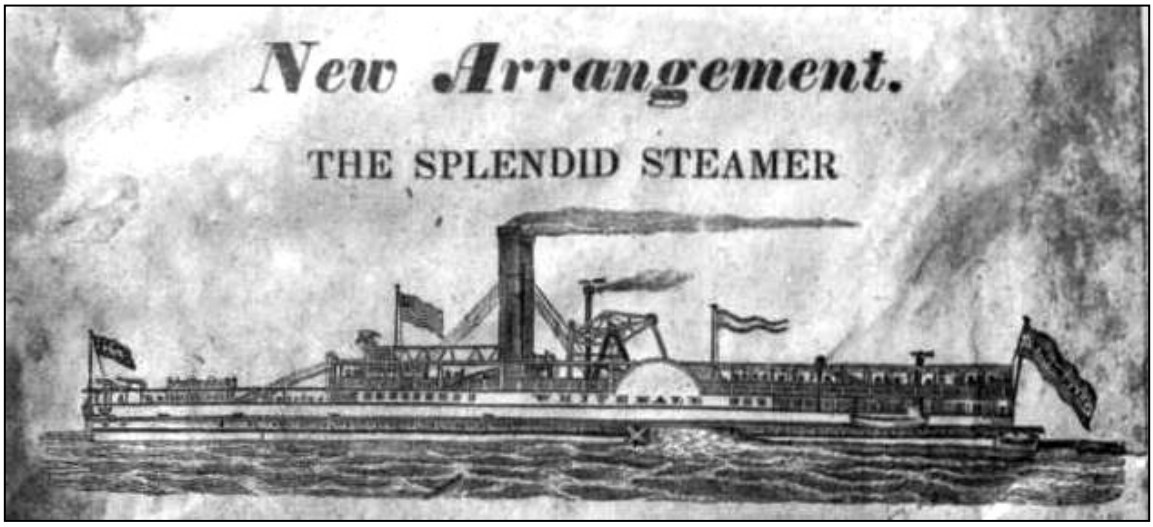

Figure 36. Portrait of *Whitehall*. Note the vertical stem. (Champlain Transportation Company Papers [CTCP], Collection "A": Miscellaneous Papers 1838. Carton 8: Folder 55-87.)

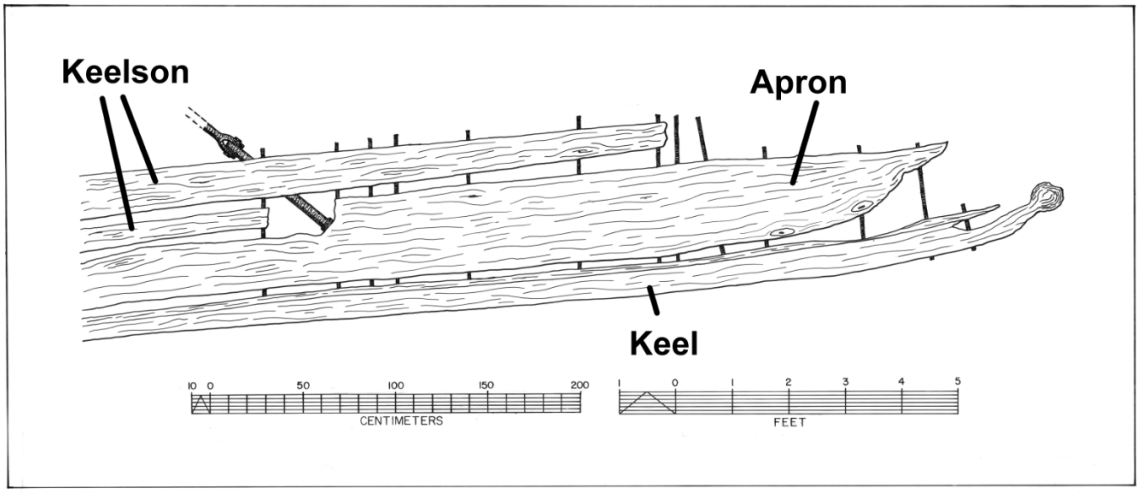

Figure 37. Bow section of Wreck 4. Note the attachment of the hog chain through the keelson. (Drawing by Kevin Crisman and Nathan Gallagher.)

Stern Assembly

The stern assembly of Wreck 4 was not extensively recorded due to time constraints, and the small size of the 2014 team. Deadwood starts directly after the keelson ends, at 178 ft. 10 in. (54.5 m) MBL. Specific measurements were not taken, but the deadwood here dwarfs the keelson forward of it. From this point to the stern there were an incredible number of iron bolts, clearly meant to hold the deadwood and frames in place (Figure 38). The sternpost was still attached to the deadwood at its base, and survived to just above the lowest gudgeon. The lowest gudgeon was made of iron, and still firmly attached to the sternpost. The upper part of the sternpost had disappeared, however an inner sternpost appeared to be firmly attached to the stern deadwood above the lower gudgeon. Wreck 4 was the only wreck out of the four examined that did not have an accompanying rudder present. It is possible that the rudder is in the area, as there were quite a number of timbers strewn around the main part of the wreck.

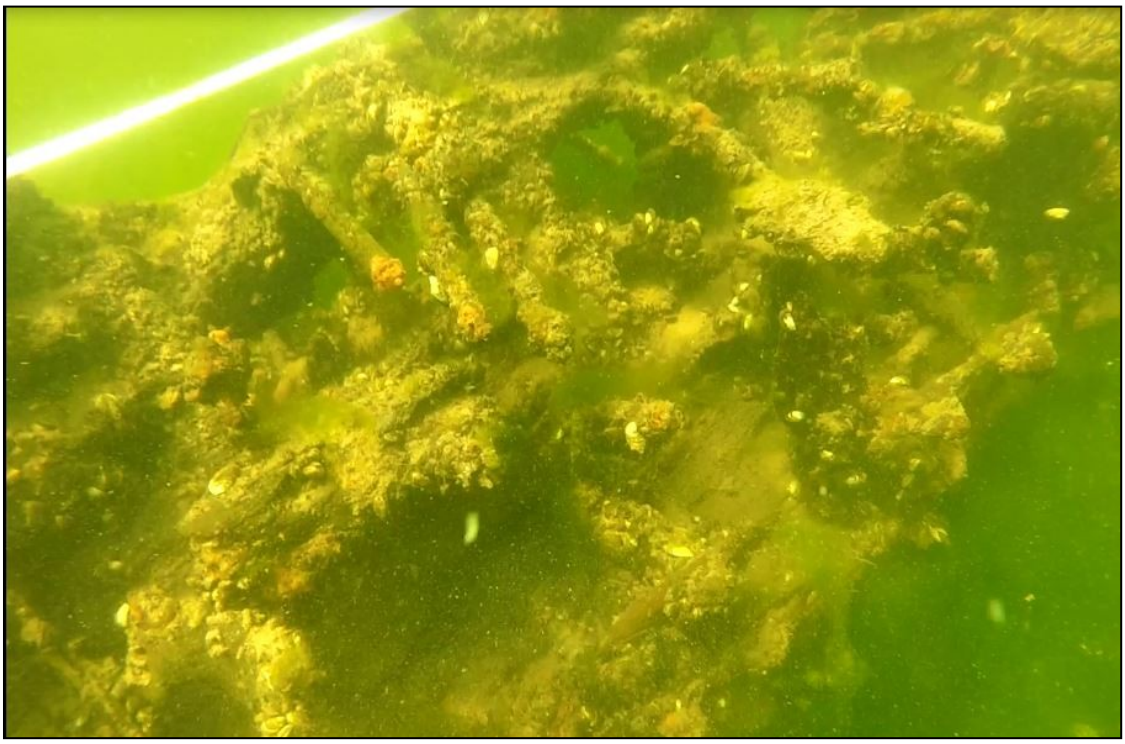

Figure 38. Bolts around frame 130, presumably to hold deadwood in place. (Photo by Kevin Crisman.)

Keelson

The keelson on Wreck 4 was unlike those on the other three wrecks, as this keelson was composed of two, and possibly three, stacked timbers. This was evident as far forward as the stem assembly, and continued at least as far aft as 169 ft. 4 in. (51.6 m) MBL, directly forward of the sternpost. It should be noted that divers recording the keelson observed the topmost of three keelson timbers ended furthest forward at 152 ft. (46.3 m) MBL, and the second timber ended several feet after that at 169 ft. 4 in. (51.6 m) MBL. The lowest keelson timber continued to 182 ft. 11 in. (55.8 m) MBL, where it was followed by a gap of 2 ft. 6 in. (76.2 cm), possibly marking the location of where

the hog chain was originally attached to the stern end of the keelson. Aft of this gap, deadwood timbers began at 185 ft. 5 in. (56.5 m) MBL and continued to the inner sternpost at 196 ft. 3 in. (59.8 m) MBL.

The keelson was fragmented and missing in multiple locations, but was especially damaged between 45 ft. 1 in. and 74 ft. 4 in. (13.7 m and 22.7 m) MBL. Throughout this section the keelson was originally composed of two stacked timbers. The upper keelson timber was missing between 45 ft. 1 in. and 47 ft. 10 in. (13.7 m and 14.6 m) MBL, and disappears again at 54 ft. 7 in. (16.6 m) MBL. It reappeared at an unrecorded location as it was observed again near 120 ft. (36.6 m) MBL. The lower keelson timber was also missing in some places, specifically between 53 ft. 3 in. and 53 ft. 10 in. (16.2 m and 16.4 m) MBL, 63 ft. 6 in. and 63 ft. 8 in. (19.4 and 19.4 m) MBL, and for a large portion between 70 ft. 6 in. and 74 ft. 4 in. (21.5 m and 22.7 m) MBL. At frame 86 the keelson's molded and sided dimensions were 15 in. and 9.5 in. (38.1 cm and 24.1 cm).

Two keelson scarfs were observed during the recording process, though undoubtedly more were present. The furthest forward scarf was located between 15 ft. 4 in. and 20 ft. 1 in. (4.7 m and 6.1 m) MBL, and the second between 24 ft. 3 in. and 27 ft. 9 in. (7.4 m and 8.5 m) MBL. In both cases, the timbers were laid stern to bow. In the first scarf, the upper timber was damaged and as a result left a gap in the scarf.

The bolting pattern along the top of the keelson was consistently a pair of iron bolts, entering from the top of the keelson, through the frame floor, and presumably entering the keel underneath. Since the keel was buried underneath the frames, this

cannot be confirmed, but was typical for boatbuilding practices. The shipwrights who built Wreck 4 were not sparing in their use of bolts, and as a result the wreck resembled a Frankenstein among the four shipwrecks.

Frames

Like Wreck 1 and Wreck 3, Wreck 4 exhibited the same narrow sided dimensions and large molded dimensions in its frames. Much like Wreck 1, Wreck 4's frames were not uniformly spaced. Instead of even spacing patterns, there was a very distinct decrease in the spaces between frames towards the midships area on Wreck 4, and a much more obvious attempt to space them out on either end of the hull. Spacing between the frames was found to be greater from frames 1 to 44, at 21 in. (53.3 cm) between centerline bolts, then there is a transition section from frame 44 to 49, with 17 in. (43.2 cm) centers. From frame 50 to 95, the spacing between frames narrows to 12 in. (30.5 cm) centers. The spaces between frames widens again between frames 96 and 99, which is another transitional area, resuming a spacing of 17 in. (43.2 cm), and frames 100 to 130 the spacing widens to 20.5 in. between centers. Wreck 4's builders clearly recognized the need for added strength in the midships area, where the engine machinery was placed, and therefore nearly doubled the frames in this area, and also increased the sided dimensions.

Due to the immensity of Wreck 4 and the large number of frames and engine bed timbers to record over a very short period, sided dimensions were taken for the first 30 frames, then of only every fifth frame until frame 65. Sporadic measurements were

taken aft of frame 65, and these measurements show little variation from the regularly recorded dimensions. Unfortunately time constraints prohibited further recording, however it is fair to say that the frames recorded give a good representation of the overall sided dimensions as they were observed to be fairly consistent along the entire length of the wreck. This can also be observed by recordings taken with a GoPro camera. The average sided dimension of the frames recorded was 2.5 in. (6.4 cm). Some of the frames had extremely narrow sided dimensions, as small as 1.25 in. (3.2 cm), probably due to erosion. The frames had much narrower sided dimensions directly adjacent to the keelson, and the sided dimensions increased further outboard.

Molded dimensions were generally not taken as the focus for recording Wreck 4 was to create a plan view of the site; however, a cross section of frame 86 was recorded and shows the molded dimension for the length of the frame (see Figure 35). The molded dimension of the floor is 16 in. (40.6 cm) on top of the keel, and it narrows to 9 in. (22.9 cm) where it joins the first futtock. The futtock in this instance is attached to the forward face of the frame by one square-head bolt entering through the futtock. In general, there appeared to be no repeating pattern for the futtocks to be placed forward or aft of the floors. The frame is fairly flat for 9 ft. 7 in. (2.9 m) from the port side of the keelson, after which point it curved up in a hard turn of the bilge. The molded dimension is relatively large, especially in relation to the sided dimension. This was typical for the majority of the frames on Wreck 4.

Engine Bed Timbers

Each dive team used different shortcuts for labeling timbers. Remaining consistent with the three other wrecks, the engine bed timbers will be labeled either "P" or "S" for port and starboard side, followed by a number indicating their relative proximity to the keelson, 1 being the closest and 4 being the farthest outboard.

The engine bed timbers on Wreck 4 were massive, reaching molded dimensions of stacked timbers of almost 4 ft. (1.2 m) high. Their impressive height and lengths dwarfed those of the other three wrecks. These bed timbers stretched longer than those on the other wrecks, extending almost the entire length parallel to the keelson (see Figure 34). Both pairs also exhibited a pronounced curve along their lengths, with their ends curving in towards the keelson, and the middle section farthest away from the boat's centerline.

The starboard side bed timbers were missing forward of 95 ft. (29 m) MBL. S1 began at 94 ft. 4 in. (28.8 m) MBL, and was heavily eroded. At its forward end it also retained a large number of bolts, probably originally used for securing machinery parts. Since the forward end of S1 was broken, the curve towards the keelson at the forward end is not evident. The current forward end of S1 is located 26 in. (66 cm) away from the keelson's starboard side, until 121 ft. 9 in. (37.1 m) MBL, after which it begins to angle in towards the keelson, and finally ends only 9 in. (22.9 cm) from the starboard side of the keelson.

S1 averaged 13 in. (33 cm) sided; however it tapered at its after end to 9 in. (22.9 cm) sided. The molded dimension was large, at a maximum of 16 in. (40.6 cm), and was

increased by the addition of a second, upper timber at 103 ft. 3.5 in. (35.5 m) MBL. From this point to 139 ft 6 in. (42.5 m) MBL S1 had a combined molded average of 36 in. (91 cm), and a maximum molded dimension of 43.5 in. (1.1 m) to the top of the bolt heads. The section of frame 86 shows two stacked timbers, but possibly evidence of a third timber that had broken loose at some point. The bolt heads protruded high above the second timber, leaving plenty of space for a third timber, and had wooden remnants still attached to the iron bolts in some places (see Figure 35). The lower timber of S1 continues aft to 148 ft. 8 in. (45.3 m) MBL.

The forward end of S2 is broken off, but the remaining timber is present from 122 ft. 8 in. to 173 ft. (37.4 m to 52.7 m) MBL. It was placed on average 2.25 in. (5.7 cm) to starboard of S1, following the same curve inward towards the stern. S2 showed no signs of having a second timber placed on top of it. The average sided and molded dimensions of the single S2 timber were 12.25 in. and 11.75 in. (31.1 cm and 29.8 cm) respectively. Both S1 and S2 ended symmetrically with their port side pairs, and ended in clear cuts rather than splintered timbers, indicating that these were their original end points.

A third, smaller timber S3 was found 4 ft. (1.2 m) outboard of S1 at 106 ft. (32.3 m) MBL. The timber was 11 ft. 8 in. (3.6 m) long and had an average sided dimension of 6.25 in. (15.9 cm). No molded dimension was recorded. Outboard and running parallel to S3 was another broken up timber of similar dimensions, S4. The broken up pieces of timber were found between 111 ft. 11 in. and 119 ft. 10 in. (34.1 m and 36.5 m) MBL, and again between 122 ft. 10 in. and 125 ft. 10 in. (37.4 m and 38.4 m) MBL. At

118 ft. 9 in. (36.2 m) MBL, S4 was found 1 ft. 11 in. (58.4 cm) to starboard of S3 with a sided dimension of 5 in. (12.7 cm). These small longitudinal timbers most likely had little role in supporting the engine parts, and therefore cannot really be described as engine bed timbers. S3 and S4 more likely acted as traditional stringers, and were employed to strengthen the long hull longitudinally.

Like the starboard side, the port side of Wreck 4 had two major engine bed timbers, P1 and P2, which ran nearly the entire length of the keelson. While the forward ends of S1 and S2 were missing, P1 and P2 survived much farther forward. Molded dimensions were not taken regularly for the port side stringers, however they were observed to be close to the same height as the starboard stringers.

At its forward end at 38 ft. 9 in. (11.8 m) MBL, P1 measured 12 in. (30.5 cm) sided and 10.5 in. (26.7 cm) molded. Throughout its length, P1 had an average sided dimension of 13 in. (33 cm), and a maximum sided dimension of 16.5 in. (41.9 cm). The port side of P1 was rounded rather than square cut at its forward end. This might have been simply because the builders did not bother squaring this outer surface and left the original curve of the timber. The total length of P1 was 110 ft. 3 in. (33.6 m), ending at 149 ft. (45.4 m) MBL. It was mostly intact over its entire length, except for a small break from 93 ft. 2 in. to 93 ft. 6 in. (28.4 m to 28.5 m) MBL. At 80 ft. (24.4 m) MBL a second, upper timber was added to P1. A third timber was added on top of P1 at 98 ft. (29.9 m) MBL, just aft of the break at 93 ft 6 in. (28.5 m) MBL. This individual third timber was 11 in. (27.9 cm) sided by 11 in. (27.9 cm) molded. Though the total height of P1 was not recorded here, at frame 86, the bolts of P1 had a total height of 44 in. (1.1 m)

(though the top timber was missing at this point) (see Figure 35). Whether these additional top timbers continued to the end of P1 is unclear.

Like the starboard engine bed timbers, P1 and P2 bowed away from the keelson at their midsections. P1's forward end started at 16 in. (40.6 cm) outboard of the port side of the keelson, reaching a distance of 28 in. (71.1 cm) outboard at 93 ft. 5 in. (28.5 m) MBL. This distance was maintained until 122 ft. 8 in. (37.4 m) MBL. After this point P1 angled in towards the keelson and ended only 8 in. (20.3 cm) outboard of the port side of the keelson.

P2 followed the same curve as P1, remaining on average 2.5 in. (6.4 cm) to port. P2 was originally believed to be three separate engine bed timbers; however, once drawn on a site plan it was clear that the three separate timbers lined up perfectly, and was in fact one long timber with two large sections missing. The first section of P2 starts at 47 ft. 11 in. (14.6 m) MBL, and continued aft to 54 ft. 9 in. (16.7 m) MBL. This is the shortest section of P2. The second section extends from 80 ft. to 107 ft. 5 in. (24.4 m to 32.7 m) MBL. The third section started at 122 ft. (37.2 m) MBL and exhibited a 2 in. (5.1 cm) square, right-angled bevel on the upper face of its outboard side. This third and final section of P2 ended at 173 ft. (52.7 m) MBL, parallel to S2. There was a large hole in P2 from 154 ft. to 159 ft. (46.9 m to 48.5 m) MBL, which could have been where machinery was placed. P1 and P2 were bolted together transversely at 135 ft. 5in. and 133 ft. 2 in. (41.3 m and 40.6 m). P2 averaged 13.3 in. sided and its molded dimension was 15 in. at 122 ft. 8 in. (37.4 m) MBL (this was the only molded dimension recorded).

From 13 ft. 3 in. to 32 ft. 5 in. (4 m to 9.9 m) there was a smaller, longitudinal timber identified as P3 that had molded and sided dimensions of 1.3 in. and 5 in. (3.3 cm and 12.7 cm) respectively. Like S3, P3 was found outboard of P2; however, P3 was distinctly angled towards the keelson at its forward end, progressing from 1 ft. 7 in. (48.3 cm) outboard of the keelson at its forward end, to 4 ft. 4 in. (1.3 m) from the keelson at its after end. P3 resumed at 34 ft. 2 in. (10.4 m) MBL and continued aft with a sided dimension of 5 in. (12.7 cm) to 50 ft. (15.2 m) MBL.

Another thin port stringer, P4, extended from 47 ft. 11 in. to 54 ft. 9 in. (14.6 m to 17.6 m) MBL. P4 exhibited similar dimensions to P3, though none were definitively recorded. P4 was located to the port side of P3, its forward end overlapping P3's after end by only a couple of feet, and continuing parallel to the angle of P3. Like S3 and S4, P3 and P4 probably were not used to support the heavy engine machinery, but were instead longitudinal stiffeners.

Hog Chain

Possibly the most exciting discovery from the entire field season was realizing that Wreck 4 was built with a hog chain. Hog chains replaced or supplemented hog trusses in holding up the ends of long steamers to prevent hogging. They were iron rods, rather than actual chains, which were attached to the keel at the bow, traveled up and over the main deck, supported by stanchions, and back to the keel just before the stern. In this way they acted like a suspension bridge by distributing the weight of the ends of the vessel to the stanchions in the middle of the hull. The rods were threaded to accept

turn buckles that allowed tightening or loosening of the truss. Wreck 4 is the earliest archaeological example of a hog chain employed on a steamboat to date. Wreck 3 showed no signs of one; *Burlington* was reported to have hog trusses, but no mention is made of a hog chain. James Renwick, an American who published an essay on steamboat construction, described the issue of steamboats' tendency to hog, their lengths being up to eight times their beams. Contemporary with the launching of *Whitehall*, Renwick's essay described attempts to use trusses or diagonal ceilings "to lessen the danger arising from this source."[75] At the time of this publication, Renwick made no mention of hog chains. Stevenson on the other hand, who first published on American steamboats in 1837, described "iron rods, fastened to the timbers of the vessel, [extending] fore and aft from the upper part of the beams forming the engine framing. These iron ties give support to the bow and stern, which if not braced up in the manner described, invariably sink or settle down in the course of a few months, owing to the slim [build] and great length of the hull. Screws and nuts are generally provided, by which the ties can be tightened up, should any yielding take place in the wood-work of the vessel."[76] While Renwick's essay made no mention of hog chains, Stevenson had obviously learned of these devices by 1837. Most likely hog chain technology was only just beginning to spread throughout the northeast right around the time of *Burlington* and *Whitehall*'s conceptions. *Whitehall*, especially after its 30 ft. (9.1 m) extension, had almost a 10:1 length-to-beam ratio and required extra reinforcement. Perhaps it was lengthened because the CTC had learned of the new technology that would allow for

such a long, narrow hull. The hog chain on *Whitehall* was likely employed along with hog trusses, evidence of which will be discussed below.

The remains of the wrought iron hog chain found on Wreck 4 were located at the bow and were composed of multiple elements. The part that secured the hog chain to the wooden structure was a 2 in. (5.1 cm) diameter iron rod that extended through a narrow hole in the upper keelson timber and terminated in an opening cut into the top of the apron. By fitting snugly to these two heavy timbers the builders ensured the hog chain would not be pulled loose. Just above the upper keelson timber, a connection between the lower rod and upper rod was formed by two links, one on the end of each rod. The total height of this link was 5.5 in. (14 cm), and the total width of the bolt securing the link was 4.5 in. (11.4 cm). The upper iron rod was 33.5 in. (85.1 cm) long, and had a 1.5 in. (3.8 cm) diameter. This section of rod ended in a turnbuckle. The turnbuckle was used to tighten or loosen the hog chain to adjust to the movements of the vessel. The turnbuckle was 17 in. (43.2 cm) long, 6 in. (15.2 cm) wide, with a 2 in. (5.1 cm) space in the middle for the iron rod to fit in. The iron rod entered the bottom of the turnbuckle and protruded 7.25 in. (18.4 cm) into the open space. Exiting out the top of the turnbuckle was a 3 in. (7.6 cm) long broken rod of a 1.5 in. (3.8 cm) diameter that entered the top of the turnbuckle by 1 in. (2.5 cm) (Figure 39). No remains of a hog chain were found at the stern of Wreck 4; however, a break in the keelson between 182 ft. 11 in. to 185 ft. 5 in. (55.8 m to 56.5 m) MBL may mark the location of where the hog chain was removed from the retired hull in 1855.

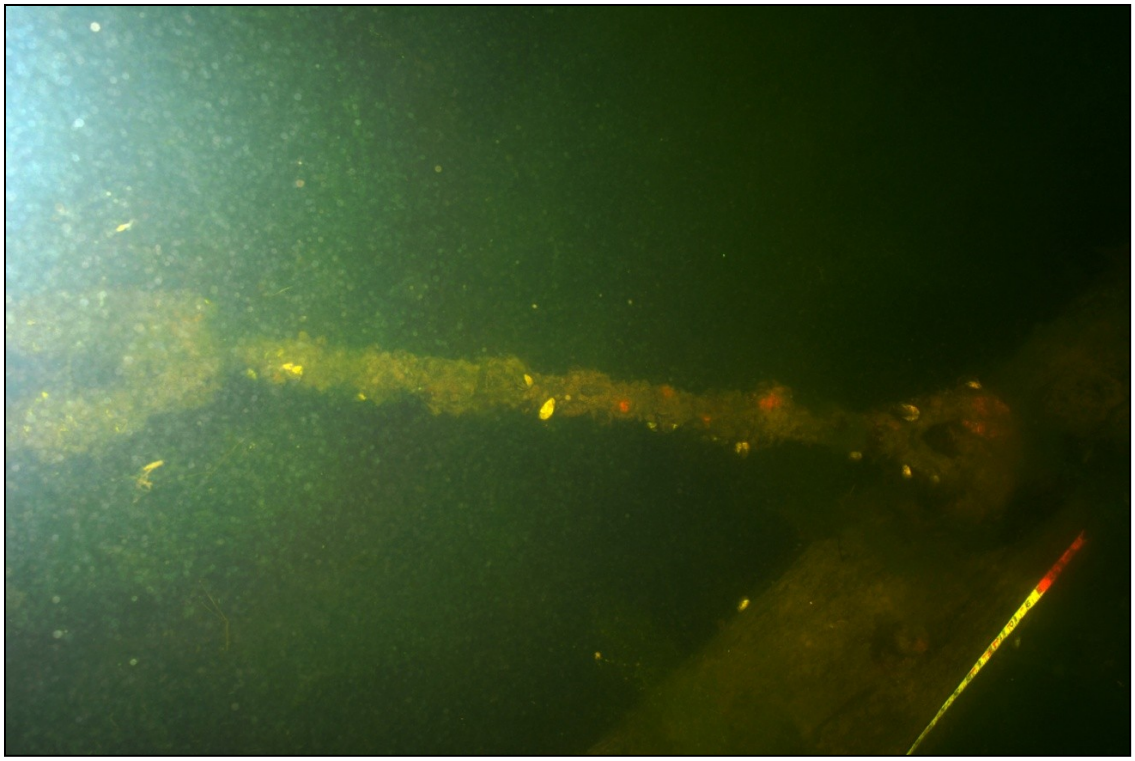

Figure 39. The remains of the hog chain above the keelson. The turnbuckle is not fully included in this photograph. (Photo by Paul Gates.)

Miscellaneous: Truss Structure

A significant arrangement of timbers was found off the starboard side of Wreck 4 near the stern. With little time left to record the structure, the measurements and sketches achieved are preliminary. The overall appearance of the structure assembly was timbers arranged in a triangular shape. The structure was unattached to any of the intact wreck, and so its original location can only be conjectured, however the assembly bore a remarkable resemblance to representations of hogging trusses from Bard Brothers' portraits of steamboats, including that of *Illinois* (Figure 40).[77]

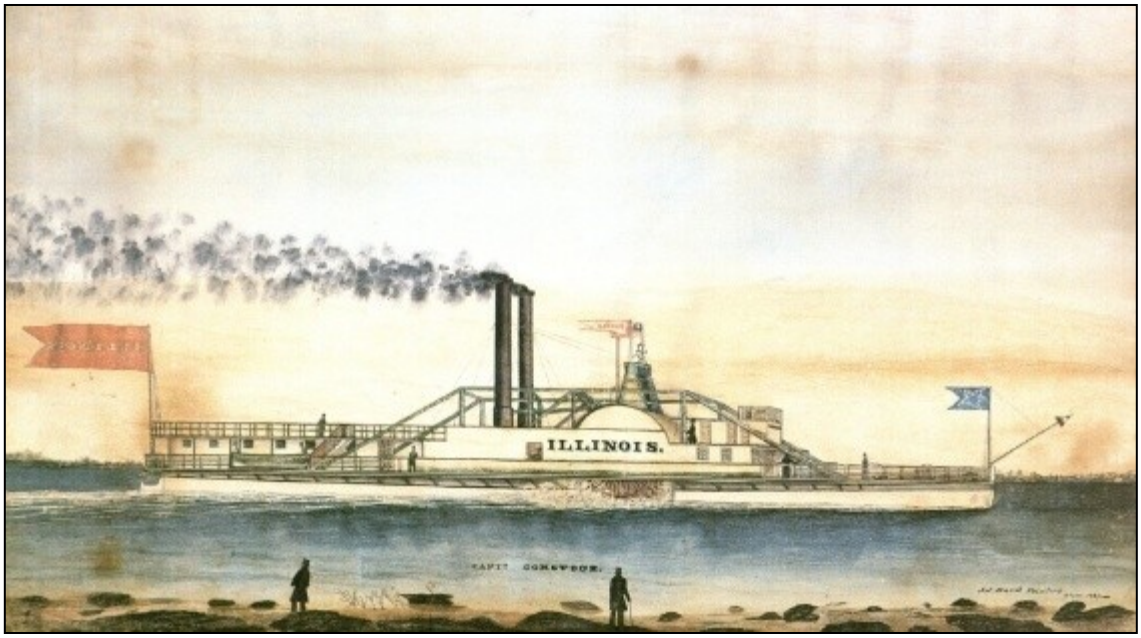

Figure 40. *Illinois* has an obvious truss structure, which may resemble the assembly of timbers found adjacent to Wreck 4. (Bard Brothers Painting in Mariner's Museum, 1997:18.)

The assembly was made up of one large base timber, timber A, 10 in. by 8 in. (25.4 cm by 20.3 cm) in section, and four smaller timbers, timbers B, C, D and E, attached at their bases at different points along timber A, meeting in a point away from timber A, forming a triangular structure. Though the entire structure was lying flat on the lake bottom, the original orientation was likely with timber A on the bottom, and the point of the triangle on the top. Two thick, short 'mounting timbers' were present on the bottom of both ends of timber A that appeared to be part of the structure that timber A was originally mounted upon. Timber A was 28 ft. 6 in. (8.7 m) long total, and with the ends of the 'mounting timbers' protruding slightly on either side the total length of the assembly was 29 ft. 4 in. (8.9 m). The total height with the 'mounting timbers' was 26 in. (66 cm). Timbers B, C, D and E each measured 4 in. (10.2 cm) square. Timbers B

and E were attached to either end of timber A and formed the outside perimeter of the triangular shape. Timber C was attached to timber A 10 ft. 11 in. (3.3 m) from the base of timber B, and 17 ft. 7 in. (5.4 m) from timber E. Timber D was attached to Timber A at a 90 degree angle, though its location along Timber A was unrecorded. Unfortunately the lengths of timbers B, C, D, and E were not recorded, nor was the height of the triangle. Two timbers were fastened to timbers C, D, and E, running parallel to timber A. These timbers also were not measured.

Despite the missing measurements, a diver's sketch provides an overall impression of the structure. This curious assemblage of timbers will be further investigated in an upcoming field season.

Miscellaneous: Metal Through-Pipe Collar

Whereas only one metal cylinder was found on Wreck 3, two were found on Wreck 4. The cylinders, which were probably metal through-pipe collars, both appeared to be made out of a non-ferrous metal, possibly lead, and were very similar in size and appearance to the one found on Wreck 3. One was found on the port side, between the keelson and P1, its forward face at 105 ft. 3 in. (32.1 m) MBL. The outer diameter was 13 in. (33 cm). The second lead collar was found on the starboard side, in between the keelson and S1 between 118 ft. 10 in. and 119 ft. 11 in. (36.2 m and 36.6 m) MBL. This one had a 13.5 in. (34.3 cm) exterior diameter, and 9 in. (22.9 cm) interior diameter. It rested directly against S1, 13 in. (33 cm) outboard of the starboard face of the keelson. These two lead collars, like the one found on Wreck 3, were most likely attached to the

intake and discharge pipes that allowed water to be pumped into the boiler, and expelled out from the condenser.

CHAPTER VIII

CONCLUSIONS

The intent of this archaeological project was first to determine the identities of the hulls in Shelburne Shipyard and second to measure and otherwise record enough data from them in order to make preliminary site plans for each one, and then compare their basic structural features. This was an ambitious goal due to the limited time available to spend with the wrecks. The field school, through which all of the archaeological data was collected, included 8-9 divers over a period of 12 days working on the site. Though the dive site was relatively benign, with an average 10 ft. (3 m) depth, some of the obstacles encountered included boats using the docks floating above the wrecks, zebra mussels, weed and green algae growth, and cold water. Despite these challenges, divers obtained detailed measurements of key features, including the stems, sternposts, frame cross sections, and rudder details of the wrecks. The data collected for these site plans were used for a cross-comparison of the four wrecks to analyze changing design plans throughout the 1830s, and compare those designs to a steamer built over 30 years later, seeing which innovations were kept, and which were improved upon.

The wrecks in Shelburne Shipyard were ideal subjects for the study of 1830s steamboat development; however, they were not all the vessels that we expected to find. Prior to the archaeological investigation, historical research led us to believe that the four wrecks seen in the satellite image of Shelburne Shipyard were the hulls of *Franklin* (1827), *Burlington* (1837), *Whitehall* (1838) and *Francis Saltus* (1844). In reality, the

archaeology proved that our expectations based on historical evidence were false. As it turned out, only two out of the four we expected to find were really present in this part of Shelburne Shipyard: *Burlington* and *Whitehall*. The other two hulls, which had stems and sternposts intact, were much shorter than the originally proposed steamers, and therefore were different boats. Additional research indicated that the only two steamers that fit the dimensions of Wrecks 1 and 2 were *A. Williams* (1870) and *Winooski* (1832). Knowing the identity of the wrecks now allows us to examine the changing designs over a finite period of time.

Wreck 1 had a total length of 123 ft. 2 in. (37.5 m). This length revealed that it could neither be *Franklin* or *Francis Saltus*, as originally expected. A ceramic serving plate with a maker's mark dating to 1879-1895 and a cupreous metal fitting were two clues that dated Wreck 1 to the second half of the nineteenth century, when copper and copper alloys were becoming more commonplace on ships. Finally, a photograph dating to the 1890s of a steamboat hull stripped of machinery and upper decks labeled "*A. Williams*" provided compelling evidence of the identity of Wreck 1. The basic structural features of Wreck 1 reflected the later date of its construction, as the frames had narrow sided and deep molded dimensions, and the framing pattern was regular with relatively wide spacing between frames. Wreck 1 also had up to six engine bed timbers per side, the most of the four wrecks examined.

Wreck 2 showed the greatest contrast to Wreck 1. Like Wreck 1, the total length of 133 ft. 2 in. (40.6 m) from stem to sternpost was much smaller than that of either *Francis Saltus* or *Franklin*. This length narrowed the options for its identity

significantly. In fact, only one steamboat in the historical record that could have retired in Shelburne Harbor fit the length of Wreck 2, and that was *Winooski*, built in 1832. Wreck 2 had an added challenge of being almost entirely covered in rocks. The purpose of the rocks is unclear, though they were obviously purposely deposited on the hull. Unlike Wreck 1, the frames on Wreck 2 were large and closely-spaced. Only two engine bed timbers were found on either side of the keelson, and they were smaller than the bed timbers on the other three wrecks we examined. Overall, the remaining hull components resembled the site plan of *Phoenix* (1815). The resemblance was remarkable since the two vessels were built 17 years apart. Even more remarkable was how much more Wreck 2 resembled *Phoenix* than Wreck 3 or Wreck 4, both of which were built in the same decade as Wreck 2.

Wreck 3 was the second longest of the four wrecks, and was positioned with its bow facing shore. Unfortunately because of this positioning, the bow that had been in especially shallow waters was missing, perhaps weakened by erosion or human activity, and therefore left no stem to record. This also made it difficult to confirm the original length of the boat; however, the remains of Wreck 3 totaled 158 ft. 1 in. (48.2 m) long. Since multiple historical sources confidently placed *Burlington*'s final resting place where Wreck 3 lay, it was unlikely to be any other vessel. The missing length of *Burlington*'s original 185 ft. (56.4 m) undoubtedly belonged to the absent bow. The framing on Wreck 3 was much narrower than that seen on Wreck 2, indicating an attempt to relieve some of the weight on the long, narrow hull and make the vessel lighter and faster. There were at least three bed timbers per side, and they were larger

than those found on Wreck 2. Wreck 3, built only five years after Wreck 2, showed significant advancement in hull design.

Wreck 4 was the most imposing of all four wrecks, with a total remaining length of 214 ft. (65.2 m). Both its bow and stern were present, and so the only Lake Champlain steamer that fit this length was *Whitehall*, with an original length of 215 ft. (65.5 m). Built only a year later, Wreck 4 included some of the advancements found on Wreck 3, including narrow frames and multiple large bed timbers, but at a greater scale. The molded-to-sided ratio of the frames was 5:1, and the bed timbers were stacked three timbers high, reaching a height of almost 4 ft. (1.2 m). The framing pattern also showed the frames more widely-spaced towards the ends of the vessel to relieve the weight on either end and prevent this approximate 10:1 length-to-beam, torpedo-shaped hull from hogging. The fears of hogging were real, and Wreck 4 proved this by also having the first-known archaeological example of a hog-chain truss. A wooden structure found lying to the starboard side of Wreck 4 may also be some type of truss, likely used in addition to the hog chain, demonstrating the builders' attempts to incorporate extra reinforcement.

Developments in Steamboat Design

The 1830s was a decade brimming with experimentation and accelerated progress for both the engine makers and the shipwrights, not only on Lake Champlain, but everywhere. Out on the western rivers, steamboats were becoming sleeker and shallower, able to carry as much as possible over the shallow waters of rivers like the

Mississippi. On the Great Lakes, steamboats were becoming larger in every respect, with more horsepower to propel the immense hulls. Lake Champlain shipwrights were combining both styles to meet the needs of the unique waters of the lake. Following suit of the river steamboats, the lake's steamers had very high length-to-beam ratios. This helped them go faster, and speed was highly desired.[78]

When Stevenson wrote his chapter on steam navigation on the lakes and rivers of North America in 1837, he remarked upon the rapid increase in the number of steamboats in operation in only 30 years; the learning curve among shipwrights was steep. Some improvements were widely accepted by shipwrights on the lakes and rivers, however Stevenson described that on the whole, hull design and construction of steamboats were completely lacking in any general guidelines among steamboat engineers.[79] The failure of engineers and shipwrights to record their designs is indicative of the experimental phase taking place in the 1830s as the changes occurred too quickly to record plans.

Designs for the Lake Champlain steamers were highly influenced by their close neighbors, the Hudson River steamboats. As the site of the first successful steamboat, the Hudson continued to be a frontrunner in new steam technology. Shipwrights on the Hudson were constantly vying for faster, sleeker boats. Races took place daily, and with each race improvements upon existing steamers were made. When new boats were constructed, these changes were kept and improved upon constantly.[80] As a result, many changes that appeared on the boats themselves were recorded only in the minds of the shipwrights, rather than through actual design plans. Even if designs were recorded on

paper, in many cases they have been lost over the years. For these reasons, archaeological examples of steamboats are incredibly valuable sources of information for this dynamic period of steamboat development.

When *North America* was launched in 1827 the Hudson River steamer broke all kinds of records and was noted by both North Americans and Europeans.[81] This boat marked the beginning of a new period of steamboat design. *North America* was one of the first steamers to employ a walking-beam engine to great success. In fact, this and several other early walking-beam steamboats had two walking-beam engines, one engine to propel each of the side wheel paddlewheels. Though the double engine was soon realized to be more redundant than useful, the walking-beam style engine became the single type of engine found on either Hudson River or Lake Champlain henceforth. This type of engine was an efficient, easily managed, low-pressure engine and could attain impressive speeds.

The introduction of walking-beam engines quickly made clear the need for substantial structural support of the heavy machinery parts associated with them. The top-heavy engines along with the boilers placed a lot of weight on a wooden-hulled, flat-bottomed steamer. To support this weight, shipwrights started incorporating heavier and more multiple longitudinal stringers that acted as engine bed timbers. The Shelburne Shipyard wrecks are excellent examples of this development.

Also seen on the Shelburne wrecks were measures taken to avoid hogging. Increasingly long and narrow hulls were a big concern for shipwrights. These designs were best for faster boats, but presented the risk of hogging. A ship was likely to hog

when the strain on the ends of the vessel were too great, causing the ends to droop. In serious cases, the drooping ends could break the back, or break the keel, of the boat, and sink it. The wrecks at Shelburne Shipyard belong to this era of technological advancement, and the archaeological analysis of the remaining hull timbers shows the experimental stage of this time.

The changing engine bed timbers on all four wrecks represent the changing priorities in the minds of the shipwrights throughout the nineteenth century. The importance of supporting the heavy engine parts became paramount. To combat the forces of these heavy timbers weighing down the hull, the sizes of the frames were adjusted to keep the steamers streamlined.

Since historical documents dating to this dynamic period of steamboat design have been largely lost, or never existed, archaeological remains dating to the early years of steam are especially valuable. Shelburne Shipyard therefore provides a unique case study into the development of hull design during this period due to the three wrecks from 1830s-built steamboats found here, and the one from 1870. The three steamers built in the same decade exhibited very distinct differences in design, despite being nearly contemporary. Wreck 1, built in 1870, displayed many of the changes seen in Wreck 3 and Wreck 4, demonstrating that many of the experiments that took place in the earlier decades, for example larger and more numerous engine bed timbers, and narrower, deeper frames, were continued 30 years later.

The above information is the result of a three-week-long field season, with 10 people looking at over 700 ft. (213 m) of steamboat hulls over the course of 12 days on

site. The amount of data retrieved was nothing short of astounding considering the limitations of diving and project runtime; however, there still remain many opportunities for learning more from this site. A project planned for June, 2015, will return students to the site as part of a second Texas A&M University, Institute of Nautical Archaeology, Center for Maritime Archaeology and Conservation and Lake Champlain Maritime Museum field school. The primary goal for the 2015 field season is to more fully record Wreck 2 (the second earliest archaeological example of a steamboat in Lake Champlain). The numerous rocks covering the wreck prohibited full documentation of the timbers, especially directly adjacent to the keelson and on most of the port side. With a longer field season of four weeks planned for 2015, the plan is to remove the rocks in selected areas in order to record the well-preserved timbers underneath. A secondary goal is to document Wreck 4 in more detail. Due to the immensity of this wreck, many details remain to be recorded. A return to the truss structure lying off the stern is planned, and further documentation of the floor and futtock pattern is also desired. Finally, a tertiary goal is to fully photograph the wrecks and piece them together in a photogrammetry software program, AgiSoft PhotoScan, to create detailed full site plans for each wreck.

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APPENDIX A: WRECK 1

Wreck 1 Frame Measurements						
Frame No.	Start	End	Sided (in.)	Molded (in.)	Space between forward edge (inches)	# bolts
1	6'3"	N/A	N/A	N/A	N/A	2
2	7'10.5"	N/A	N/A	N/A	19.5	1
3	8'11.5"	N/A	N/A	N/A	13	1
4	10'5"	N/A	N/A	N/A	17.5	2
5	11'11"	12'1"	2	7.5	18	1
6	14'6.5"	N/A	N/A	5.5	19.5	N/A
7	16'10.5"	17'1"	2.5	7	28	1
8	19'3"	N/A	N/A	N/A	16.5	2
9	21'5"	21'7"	2	5.5	26	2
10	23'9"	N/A	N/A	9	28	2
11	25'11"	N/A	N/A	N/A	28	2
12	28'2"	28'5"	3	12	28	2
13	30'7"	N/A	N/A	N/A	29	2
14	32'9.5"	N/A	N/A	N/A	26.5	1
15	35'0.5"	N/A	N/A	N/A	27	1
16	37'1"	N/A	N/A	N/A	24.5	2
17	39'1"	N/A	N/A	N/A	24	2
18	41'1"	N/A	N/A	N/A	24	1
19	43'0.5"	N/A	N/A	N/A	23.5	2
20	44'10.5"	45'2"	3.5	6	22	2
21	46'9.5"	47'2"	4.5	6	23	2
22	48'11"	49'2"	3	8.5	25.5	1
23	50'11.5"	51'2"	2.5	5	24.5	1
24	52'11.5"	53'2"	2.5	N/A	24	1
25	54'11"	55'2.5"	3.5	8	23.5	1
26	56'11"	57'2"	3	5.5	24	1
27	58'10"	59'0"	2	8	23	2
28	60'9"	61'1"	3	4.5	23	2
29	62'8"	62'10.5'	2.5	8.5	23	2

30	64'7.5"	64'11"	3.5	5	22.5	1
31	66'6"	66'8.5"	2.5	6.5	22.5	2
32	68'11"	69'2"	3	7	29	1
33	71'5"	71'8"	3	6	30	2
34	72'10"	73'2"	4	8.5	17	N/A
35	74'11.5"	75'2"	2.5	8.5	25.5	N/A
36	76'11"	77'3"	4	9	23.5	N/A
37	78'9"	79'0"	3	4	22	N/A
38	80'9"	81'0"	3	7.5	24	N/A
39	81'9"	82'0"	3	7	12	N/A
40	83'0"	83'3"	3	8.5	15	N/A
41	84'8"	84'11"	3	9	20	N/A
42	86'4"	86'7"	3	9	20	N/A
	86'7"	86'10.5"	2.5	9		N/A
43	87'10.5	88'0.5"	2	8.5	15.5	N/A
44	89'10"	90'0.5"	2.5	8	23.5	N/A
45	91'3"	91'5"	2	6	17	N/A
46	91'10"	92'1"	3	6	7	N/A
47	93'5.5"	93'8.5"	3	7	19.5	N/A
48	94'7"	94'10"	3	7.5	13.5	N/A
49	95'9"	95'11"	2	8.25	14	N/A
50	96'10"	97'1"	3	8.5	13	N/A
51	97'11.5"	98'2"	2.5	7	13.5	N/A
52	98'11"	99'2"	3	8.25	11.5	N/A
53	100'3"	100'6"	3	9	16	N/A
54	101'5"	101'8"	3	8	14	N/A
55	102'9"	103'1.5"	4.5	6.5	16	N/A
56	105'0.5"	105'2.5"	2	8.5	27.5	N/A
57	107'6"	107'8"	2	8.5	29.5	N/A
58	110'2"	N/A	N/A	N/A	32	N/A
59	112'5.5"	112'8.5"	3	10	27.5	N/A
60	115'0"	115'3"	3	8	30.5	N/A
Average:			3.0	7.1	23.1	

Table A-1: Frame data transcribed from notes, including sided and molded dimensions and averages.

Wreck 1 Keelson Measurements		
Baseline (ft.)	Sided (in.)	Molded (in.)
0	N/A	N/A
5	N/A	N/A
10	7	7
15	7	5
20	7	5
25	7	5
30	7	5.5
35	6.5	6
40	7	N/A
45	7	N/A
50	6.5	N/A
55	6.5	N/A
60	6.75	N/A
65	N/A	N/A
70	3	0.5
75	7	7
80	7.5	7.5
85	7	7
90	7	5.5
95	7.5	3
100	N/A	N/A
105	7.5	6.75
110	4.5	7.5
115	5	7.5
120	7	7
E	0.5	1
Average	6.3	5.5

Table A-2. Keelson sided and molded dimensions taken every 5 feet along the baseline.

APPENDIX B: WRECK 2

Wreck 2 Frame Measurements								
Frame No.	Sided (In.)	Molded (In.)	Space aft of frame (In.)	Calculated Baseline Measurement (Forward)	Measured Baseline Forward	Stbd. Rocks from Baseline	Stbd. Length	Port Rocks from Baseline
1	6	4.5	N/A (Loose, on an angle)	130'6"	130'6"	N/A	3'2"	
2	5		14	128'0"			3'3"	
3	7		19	126'5"			5'8"	
4	6		16	124'3"			4'0"	
5	6	7	5	122'5"	122'5"		6'7"	9"
6	6		7	121'6"			5'8"	
7	5		5	120'5"			6'1"	
8	6.5		7.5	119'7"			6'4"	
9	9		2	118'5"			7'6"	
10	6	4.5	5	117'6"	118'0"		6'11"	13'0"
11	6		4	116'7"			8'6"	
12	5		8	115'9"			8'7"	
13	7		2	114'8"		5'5"	9'4"	
14	4		7.5	113'0"		6'5"	7'3"	
15	5	7.5	3	112'11"	113'3"	6'5"	8'9"	12'5"
16	5.5		16	112'4"		6'4"	9'6"	
17	5.5		10	110'6"		8'0"	9'0"	
18	4		4.5	109'3"		7'9"	9'8"	
19	6		6.5	108'6"		7'5"	10'7"	
20	7	6.5	3	107'6"	~108'0"	7'10"	10'0"	13'0"
21	6		6	106'8"		7'9"	10'4"	
22	8		1.5	105'8"		7'6"	9'5"	
23	7		6	104'10"		7'11"	10'0"	
24	7		2	103'9"		8'6"	10'6"	
25	7	7	6	103'0"	~103'5"	8'2"	11'0"	11'10"
26	7		1	101'11"		8'8"	10'8"	
27	7		6	101'3		9'3"	10'10"	
28	7		0.5	100'2"		8'7"	9'7"	
29	7		5	99'7"		9'0"	11'0"	

30	8	5	2	98'6"	97'3"	9'0"	9'11"	11'9"
31	5.5		6	97'8"		8'9"	10'3"	
32	8		4	96'9"		9'0"	10'6"	
33	6		4	95'9"		9'1"	11'7"	
34	8		0	94'11"		8'8"	10'2"	
35	8	5	7	94'3"	94'5"	8'8"	10'3"	12'0"
36	7		3	93'0"		7'11"	11'7"	
37	8		3	92'2"		N/A	11'4"	
38	9.5		0.5	91'3"		N/A	11'4"	
39	8		1	90'5"		N/A	11'5"	
40	10	5	1	89'8"	89'0"	N/A	10'5"	Rock pile devoid in this area
41	10		1	88'9"		N/A	11'7"	
42	10		4.5	87'10"		N/A	10'6"	
43	7.5		0	86'8"		N/A	11'7"	
44	8		7	86'0"		N/A	10'9"	
45	9	6	0	84'9"	85'4"	N/A	11'6"	Rock pile devoid in this area
46	9		5	84'0"		N/A	11'2"	
47	9		0	82'10"		N/A	11'5"	
48	10		4	82'1"		N/A	11'2"	
49	9		0	80'11"		N/A	12'3"	
50	10	7	5	80'2"	79'9"	N/A	11'1"	Rock pile devoid in this area
51	8		0	78'11"			11'3"	
52	9		3	78'3"			11'5"	
53	10		0	77'3"			11'7"	
54	9		7	76'5"			10'10"	
55	8	7	0	75'1"	75'5"	9'1"	12'2"	4'3"
56	9		5	74'5"		11'1"	11'2"	
57	6		4	73'3"		9'5"	12'3"	
58	2		11	72'5"		10'0"	12'4"	
59	6		1	71'4"		9'11"	10'0"	Very obscured by rock
60	1	6	64	70'9"	70'5"	10'8"	11'10"	12'0"

61	4		48	65'4"		11'6"	12'1"	
62	7		9	61'0"		11'8"	12'1"	
63	7		0	59'8"		8'6"	11'0"	
64	8		8	59'1"		8'6"	10'3"	
65	7	7.5	0	57'9"	57'6"	4'1"	11'0"	7'0"
66	9		5	57'2"		4'1"	9'11"	
67	7		0	56'0"		6'10"	10'4"	
68	8		6	55'5"		5'11"	9'8"	
69	8		0	54'3"		3'10"	10'10"	
70	7	7	8	53'7"	54'4"	3'1"	7'4"	6'0"
71	7		0	52'4"		4'2"	10'7"	
72	8		7	51'9"		5'0"	10'7"	
73	6		0	50'6"		4'10"	9'5"	
74	8		7	50'0"		5'7"	10'7"	
75	7	5	0	48'9"	48'10" (48'8")	4'1"	9'7"	4'8"
76	8		8	48'2"		9'4"	10'5"	
77	7		0	46'10"		8'6"	10'0"	
78	8		6	46'3"		3'3"	9'11"	
79	7		0	45'1"		3'2"	9'5"	
80	7	7	9	44'6"	44'5"	3'10"	9'3"	9'0"
81	5		0	43'2"		3'9"	7'9"	
82	7		8	42'9"		4'3"	7'10"	
83	7		0	41'6"		2'11"	8'11"	
84	8		8	40'11"		6'2"	9'10"	
85	7	7	0	39'7"	39'0" (39'2")	6'0"	8'3"	10'0"
86	8		9	39'0"		8'1"	9'6"	
87	5		4	37'7"		8'2"	8'4"	
88	6		7	36'10"		8'11"	9'2"	
89	7		7	35'9"		6'9"	8'0"	
90	7	7	8.5	34'7"	34'7"	6'6"	8'11"	10'0"
91	6.5		8	33'3.5"		6'11"	9'4"	
92	8		8	32'1"		6'4"	8'9"	
93	3		4.5	30'9"		6'7"	8'4"	
94	6.5		8	30'1.5"		6'4"	8'9"	
95	5	5	3	28'11"	30'2"	6'9"	7'10"	15'0"
96	7		9	28'3"		6'6"	7'4"	
97	4		7	26'11"		6'11"	7'10"	
98	3		7	26'0"		8'7"	9'2"	

99	4		5	25'2"		6'5"	6'11"	
100	7	4.5	10	24'5"	25'4"	5'5"	7'0"	8'0"
101	4		3	23'0"		6'4"	7'0"	
102	8		0	22'5"		6'8"	7'0"	
103	9		2	21'9"		3'1"	6'6"	
104	8		8	20'10"		5'9"	5'9"	Completely obscured by rocks
105	6	7	0	19'6"	20'8"	3'2"	6'4"	10'0"
106	6		3	19'0"		2'1"	7'7"	
107	2		4	18'3"		2'5"	4'11"	
108	6		0	17'9"		2'7"	5'10"	
109	4		19	17'3"		4'11"	4'11"	Completely obscured by rocks
110	4	6	7	15'4"	15'7"	2'5"	6'4"	5'0"
111	7		25	14'5"		2'4"	6'3"	
Avg. 1-37	6.5							
Avg. 38-57	8.9							
Avg. 58-111	6.3							
Avg. All	6.8	6.1						

Table B-1. Frame measurements from Wreck 2.

Wreck 2 Starboard Engine Bed Timbers Measurements										
	S2		S2A		S1		S1A		S3 (Continuation of S1)	
	Molded (M)	Sided (S)	M	S	M	S	M	S	M	S
113 ft. 8 in.	6.5	8.5								
106 ft. 9 in.	10.5	8.5								
102 ft. 10 in.	13	8.5								
97 ft. 11 in.	8.5	10	3.5	7						
90 ft. 8 in.	10.5	9								
87 ft. 3 in.					9.5	6				
85 ft. 11 in.							4	6		
81 ft. 5 in.	12	9	7	9						
75 ft. 1 in.					8	9				
72 ft. 6 in.							1	5.5		
70 ft. 2 in.							2	6		
61 ft. 2 in.	9	9								
57 ft. 9 in.	13	9								
56 ft. 11 in.									9	8
53 ft. 1 in.	3	3								
46 ft. 5 in.									8	6
Averages	10.4	8.9	5.3	8	8.8	7.5	2.3	5.8	8.5	7

Table B-2. Starboard side engine bed timbers sided and molded dimensions recorded at points along the baseline, and their averages.

Wreck 2 Port Engine Bed Timbers Measurements									
	P2			P2A		P1		P1A	
	Molded (M)	Sided (S)	Gap	M	S	M	S	M	S
120 ft. 11 in.		11							
113 ft. 8 in.									
106 ft. 9 in.		11							
100 ft. 11 in.		8							
98 ft. 6 in.	At least 12 in.	11							
97 ft. 11 in.	12								
95 ft. 11 in.	12	11							
88 ft. 2 in.	12	9	4	5	9				
87 ft. 3 in.						9	7		
86 ft. 2 in	9		7	10					
85 ft. 6 in.						25	7	Begins - 5?	7
84 ft. 5 in.						20	6.5	Ends	
83 ft. 11 in.	11	9	5	10	9				
83 ft. 6 in.						24	6	Begins	
81 ft. 0 in.								Ends	
80 ft. 6 in.				End					
76 ft. 9 in.						16	11		
71 ft. 5 in.		10			10				
71 ft. 2 in.							11		
57 ft. 3 in.							8		
51 ft. 10 in.						15.5	6		
46 ft. 5 in.						16	7		
Averages	11.2	10	5.3	8.3	9.3	17.9	7.7		

Table B-3. Port side engine bed timbers molded and sided dimensions recorded at points along baseline, and averages.

APPENDIX C: WRECK 3

Wreck 3 Frame Measurements				
Frame Number	Sided (in.) over keel	Molded (in.) over keel	Gaps between frames (by keelson)	MBL (center)
1	4	6		3'3"
2	6	7	13	4'2"
3	4	8	6	4'11"
F4	7.5	6		
4	2	8	12	6'3"
5			3	6'9"
5A	3	7	3.5	7'3"
6	4	4.5	11	8'2"
F6				
7	4	8	5	9'2"
8	3.5	7	11	10'4"
F8				
9	5	8	9.5	11'4"
9A	4	8	3	12'0"
10			3	
11	4	8	11	13'9"
12	6	7	8.5	14'10"
13	4	8	3.5	15'6"
14	7	7	8	16'6"
15A	4	7.5	17	18'5"
15				19'0"
16	Frame not preserved			
17	Frame not preserved			
18	Frame not preserved			
19	4	8		25'9"
20	4	8	18	27'6"
21	4	8	17	29'3"
22	4	7.5	17.5	31'0"
23	4	7.5	17.5	32'9"
24	4	8	18	34'6"
25	4	8	18	36'3"
26	4	8	17.5	38'1"
27	3.5	8	17.5	39'10"

28	5	8	18	41'7"
29	4	8.5	16.5	43'4"
30	4	8	17.5	45'1"
31	4.5	8	17	46'11"
32	5	8	18	48'9"
33	5	(Eroded)	17.5	50'6"
34	5	7	15	52'3"
35	4	9	16.5	54'1"
36	5	6	16.5	55'10"
37	5	7	15	57'6"
38	4.5	7	17.5	59'6"
39	5	8	17	61'1"
40	4	8	17.5	62'11"
41	4	9	17	64'7"
42	5	8.5	16.5	66'6"
43	4	8	15	68'1"
44	5	7.5	17	70'1"
45	6.5	9	17	71'8"
46	6	9	15	73'6"
47	5.5	9	15.5	75'2"
48	5	9	16	76'11"
49	5	9.5	17	78'8"
50	6	(unrecorded)	19	80'8"
51	4	(damaged)	16	82'2"
52	4.5	(damaged)	17	83'10"
53	4	7.5	18	85'9"
54	5	8	17	87'6"
55	6	9	17	89'3"
56	5.5	8.5	15	90'11"
57	5	9	17	92'10"
58	5.5	9.5	15.5	94'6"
59	5.5	9	16	96'3"
60	5.5	9	15.5	98'0"
61	6	9	15	99'8"
62	5	(buried)	16	101'6"
63	6	8	16	103'3"
64	5	9	15	105'0"
65	5	9	16	106'9"
66	6	9	16	108'9"

67	5	10	15.5	110'4"
68	4	8.5	16.5	112'0"
69	4.5	8	18	113'10"
70	5	8	17	115'8"
71	4	7	15.5	117'4"
72	5	6.5	19	119'5"
73	4	(unrecorded)	(can't measure)	121'4"
74	4	(unrecorded)	(can't measure)	123'5"
75	4	6?	(can't measure)	125'6"
Averages	4.7	8.0	16.7	

Table C-1. Wreck 3 frame sided and molded dimensions and location along the main baseline.

Wreck 3 Keel Dimensions (in.)				
Baseline Location	Molded	Sided	Lip Molded	Lip Sided
0 ft.	3	7		
21 ft. 6	7	8	2	0.5
23 ft.		8.5	2	0.5
41 ft.		9	0.5	0.5
54 ft. 5 in.	7.5	9.5	1.5	0.5
124 ft.		7.5		
Averages	7.3	8.3	1.5	0.5

Table C-2. Wreck 3 Keel sided and molded dimensions where attainable along the main baseline.

Wreck 3 Keelson and Engine Bed Timber Dimensions												
	Keelson		S1		S2		P1		P2		P 3	
Baseline	Molded (M)	Sided (S)	M	S	M	S	M	S	M	S	M	S
- 1 ft.									8.5	10		
1 ft.					9	11						
3 ft.	8.5	7.5										
5 ft. 5 in.			9	11								
13 ft.			8	10.5	11	10						
18 ft.	8	8										
23 ft. 2 in.											5.5	7
30 ft.					9	13						
31 ft. 2 in.									8	12		
32 ft. 4 in.									8	12		
34 ft.					12	?						
35 ft.			18	10								
39 ft. 7 in.							8.25	11	12	11	9.5	9.5
40 ft.	8	6.5	22	10			9				8	9
45 ft.					11	12			11.5	10.5		
47 ft.	8	7										
55 ft.					12.5	11.5						
57 ft.			9	10.5								
64 ft.					11.5	12.5						
66 ft. 7 in.					6.5	11.5			13	14		
70 ft.	8	7	9	11								
74 ft. 9.							21	11	13.5	10	10	10.5
90 ft.	8	7										
95 ft. 6 in.							9	10.5				
99 ft. 5.25 in.							9.25	12.25	8	14		
103 ft.							9	10.5				
104 ft. 6 in.									13.5	13.5		
117 ft.	7.5	7.5										
130 ft.	8	7.5										
142 ft.	8.5	7.5										
Averages	8.1	7.3	13.4	10.5	10.3	11.6	10.9	11.1	10.7	11.9	8.3	9

Table C-3: Wreck 3 Keelson and engine bed timbers measurements taken along the main baseline.

APPENDIX D: WRECK 4 MEASUREMENTS

Wreck 4 Frame Measurements									
Frame No.	Frame bolt location along MBL	Sided Floor (port)	Sided Futtock (port)	Futtock Fore or Aft	Sided Floor (stbd)	Sided Futtock (Stbd)	Futtock Fore or Aft	Length from KS (Stbd) (in.)	Spaces between frame centers (bolts)
1	4'4"	4.25			5.5	3.5	?	9	
2	5'11"	6			2.25			12	19
3	7'9"	2.25			1.75			13	22
4	9'7"	3.5	2.5		2.5			9	22
5	11'3.5"	2.5	2.75		2.5			13	20.5
6	13'0.5"	2	1.75		2.5			17	21
7	14'9"	3	2.5		2.5			11	20.5
8	16'5.5"	2.5	2	fore	N/A				20.5
9	18'5"	3	2.5		2.5			14	23.5
10	20'2"	3.4	3.4		3			11	21
11	21'9.25"	2.5	2.5		2.5			20	19.25
12	23'6.5"	2.5	2.5		2.25			14	21.25
13	25'3.5"	3.5	2.75		2			25	21
14	27'0.5"	3	2.5		2			27	21
15	28'10.5"	3.25	3		2			28	22
16	30'6"	4	3.5		1.5			28	19.5
17	32'4"	4	4		1.75			40	22
18	34'1.5"	4	4		1.5			41	22.5
19	35'10"	3.5	4		1.5			44	20.5
20	37'6.5"	3.5	3		1.5			44	20.5
21	39'5"	3.5	3		1.75			39	22.5
22	41'1"	3	3		1.5			50	20
23	43'	1.75			1.25			47	23
24	44'8.5"	2	2.5		1.25			47.5	20.5
25	46.6"	3			1.25			31.5	22.5
26	48'2"	6	2	Aft	1.5			55	20
27 (lone bolt)	49'4.5"				1.25			61	
27	49'11.5"	3.5	3.5	Aft	1.5			59	21.5
28 (lone bolt)	59'2"							55	

28	51'8.5"	3.5	4.5	Aft				53	21
29	53'7.5"	4.5	3.5	? (not drawn)					23
30	54'10" / 55'3.5"	6	3.5	Fore					20
31	56'6.5" / 57'1"	6	4.5	Aft					21.5
32	58'4" / 58'9.5"								20.5
33	60'2.5" / 60'7"								21.5
34	61'9"								14
35	63'7.25"	4		None					22.25
36	65'4"	4.5	5	Aft					20.75
37	67'1"	5.5	5	Aft					21
38	68'10.75"								21.75
39	70'7"								20.25
40	72'4"	3.5		None					21
41	74'2.5"								22.5
42	75'10"								19.5
43	77'7.5"								21.5
44	79'4.5"								21
45	80'10"	5	4.5	Aft					17.5
46	82'3"								17
47	83'7.5"								16.5
48	84'11"								15.5
49	86'4.5"								17.5
50	87'3.5"								11
51	88'4"								12.5
52	89'4"								12
53	90'5"								13
54	91'4.5								11.5
54A	92'4"								11.5
55	93'5"	5	6	Aft					13
56	94'4.5"								11.5
57	95'4.5"								12
58	96'4"								11.5
59	97'4.5"								12.5
59A	98'4.5"								12

60	99'5"	5	5	Aft					12.5
61	100'5.5"								12.5
62	101'4.5"								11
63	102'5"								12.5
64	103'5"								12
65	104'5"								12
66	105'3.5"								10.5
67	106'2.5"								11
68	107'2.5"								12
69	108'2"								11.5
70	109'0.5"								10.5
71	110'0"								11.5
72	111'0"								12
73	111'11"								11
74	112'11"								12
75	114'10"								23
76	115'10"								12
77	116'9"								11
78	117'9.5"								12.5
80	118'9"								11.5
81	119'10"								13
82	120'10.5"								12.5
83	121'10"								11.5
84	122'10"	3			3				12
85	123'9"								11
86	124'10"	4	4.75						13
87	125'10"								12
88	126'10.5"								12.5
90	127'9.5"								11
91	128'10"								12.5
92	129'10"								12
93	130'10.5"								12.5
94	131'11"								12.5
95	132'10"								11
96	134'4.5"								18.5
97	135'6.5"								14
98	137'1"								18.5
99	138'5.5"								16.5
100	140'0"								18.5

101	141'7.5"								19.5
102	143'5"								21.5
103	145'4.5"								23.5
104	146'10.5"								18
105	148'7.5"								21
106	150'4"								21.5
107	152'2"								22
108	153'11"	2.5			2.5				21
109	155'7"								20
110	157'4"								21
111	159'11"								29
112	160'11"								12
113	162'8"								21
114	164'5"								21
115	166'1.5"								21.5
116	168'0"								22.5
117	169'6.5"								18.5
118	171'7.5"								25
119	173'4"								20.5
120	175'3"								23
121	176'8"								17
122	178'8"								24
123	180'5"								21
124	182'1.5"								20.5
125	183'9"								19.5
126	185'4"								19
127	186'7.5"								15.5
128	187'11.5"								16
129	189'6"								18.5
130	190'10.5"								16.5
Avg. (total)		3.7	3.4		2.1	3.5			
Avg. frame 1-44									21.0
Avg. frame 45-49									16.8
Avg. frame 50-95									12.1
Avg. frame 96-99									16.9
Avg. frame 100-130									20.3

Table D-1: Wreck 4 frame measurements and location along the baseline. Averages of spaces between frames show an effort was made to keep the ends lighter by decreasing the number of frames.

Wreck 4 Keelson and Starboard Engine Bed Timbers Measurements													
Baseline	Keelson				Space between KS and SST1	Starboard Stringer 1			Space between SST1 and SST2	Starboard Stringer 2		Space between SST 1 and SST3	SST3
	Sided (in.)	Molded top (in.)	Molded bottom (in.)	Gap (upper/ lower timbers)		Sided (in.)	Molded top (in.)	Molded bottom (in.)		Sided (in.)	Molded Bottom (in.)		Sided (in.)
0													
4'0"	9	9	7										
31'0"	9	9	4.5	2.5									
40'0"		8.5	4	3									
45'1"		ends											
47'10"		resumes											
53'3"			ends										
53'10"			resumes										
54'7"		ends											
63'6"			ends										
63'8"			resumes										
70'6"			ends										
74'4"			resumes										
94'4"					26								
95'0"						12		12					
99'5"													
102'5"					26	13		16					
103'3.5"					26		Starts						
104'5"													
106'0"													Starts

113'10"												54.5	6.5
117'9.5"												48	6
118'10"					26								
121'9.5"					23								
122'8"	9.5				22.5	13		35.5	2.5	12	13		
123'10"	9				22	12							
127'9.5"													
132'10"	9.5	9	8	(17 total)	13.5	13.5		36	1.5	13.5	12		
139'6"							End						
139'9"					10.5	15		15	1.5	13	12		
148'8"					7.5	13		16	3.5	11.5	12.75		
148'10"	9		16		9	13		16	24 (between KS and SST2)				
149'0"													
153'10"						Ends			21				
157'3"	9								19.5	12.5	10.5		
166'0"									14	11.5	10.5		
169'7"	9					9			10.75				
169'10"		ends											

172'7"									23.5 (between KS and SST2	11.5	11		
Average	9.1	8.9				12.6				12.2	11.7		

Table D-2. Wreck 4 Keelson and starboard engine bed timbers measurements taken at points along the baseline.

Wreck 4 Port Engine Bed Timbers Measurements											
Baseline	Space Between KS and PS1	Port Stringer 1			Space between PST1 and PST2	Port Stringer 2		Space Between KS and PST3	Space Between PST1 and PST3	Port Stringer 3	
		Sided (in.)	Molded (in.)	Molded Top Timber (in.)		Sided (in.)	Molded (in.)			Sided (in.)	Molded (in.)
13'0.5"								19		5	1.5
20'2.5"								29.5			
28'11"								38.5			
37'9"								52			
38'9"	16	12	10.5								
45'11"	21	14							37		
54'7"	21	13.5									
63'6"	25										
63'8"		15									
80'0"				Starts	2.5	Starts					
80'10"	25	16.5									
87'3.5"	25										
93'5"	28		Break			16					
98'0"				2nd top timber starts							
99'5"	27	13			5	13					
104'5"	27	12			3	12					
107'5"					End 3.5	13					

109'0.5"	28.5	12									
113'10"	28	10									
118'10"	27	12									
121'9.5"					Resume 122 ft.	14					
122'8"					3.5	12	15				
123'10"	21	12			3.5	15					
127'9.5"	17.5	14			5	15					
132'10"	13	15			6.5	14.5					
139'6"											
139'9"	11.5	16.5			4	14					
148'8"	8	14				12					
148'10"	8				4						
149'0"	Ends	13.5									
157'3"					15.5 (from KS)	15					
166'0"					6 (from KS)	12					
173'0"					Ends	8.5					
Averages		13.4				13.3					

Table D-3. Wreck 3 port side engine bed timber measurements taken at points along the baseline.

Steamboats on Lake Champlain from 1809 to 1916												
Names	Year Finished	Where Built	Length (ft.)	Breadth (ft.)	Depth (ft.)	Tonnage	Cost	H.P.	Speed (mph)	For Who	Master Carpenter	Service
Vermont I	1809	Burlington	120	20	8	167	20,000	20	4	John & James Winans	John Winans	5 yrs – Sunk near Isle Aux Noix, Oct. 15, 1815
Phoenix I	1815	Vergennes	146	27	9 ½	336	45,000	45	8	LCSC	Roberts	4 yrs – Burnt 1 AM near Burlington, Sept. 5, 1819
Champlain	1816	Vergennes	90	20	8	128	18,000	20	5	LCSC	John Winans	1 yr. - Burnt at Whitehall, Sept. 1817
Congress	1818	Vergennes	108	27	8	209	30,000	34	8	LCSC	Gorham	16 yrs – Condemned, 1835
Phoenix II	1820	Vergennes	150	26	9 ½	343	45,000	45	8	LCSC	Young & Gorham	16 yrs. – Condemned, 1837
General Greene	1825	Shelburne	75	22	8	115	12,000	28	8	CFC	Phillips & White	7 yrs – Converted into Sloop, 1833
Franklin	1827	St. Albans	162	22	9	350	50,000	75	10	CTC	Collins	16 yrs – Condemned, 1838
Washington	1827	Essex, NY	92	20 ½	7 ¾	134	14,000	30	8	Ross & McNeil	Charles Sampson	16 yrs – Condemned, 1843
MacDonough	1828	St. Albans	89	20 ½	8 ½	138	12,000	30	8	St. Albans Steamboat Company	Charles Sampson	13 yrs – Wrecked, 1841
Winooski	1832	Shelburne	136	20 ½	8 ½	226	15,000	60	10	CFC	L.S. White	18 yrs – Condemned, 1850
Water Witch	1832	Fort Casson	90	17	8	107	14,000	40	8	J. Sherman	Samuel Wood	3 yrs – Converted into Schooner, 1836
Burlington	1837	Shelburne	190	25	9	405	75,000	200	15	CTC	L.S. White	17 yrs – Condemned, 1854
Whitehall	1838	Whitehall	215	23	9	460	70,000	200	15	CTC	Samuel Wood	15 yrs – Condemned, 1853
Saranac	1842	Shelburne	166	22	9	375	25,000	100	14	CTC	L.S. White	13 yrs – Condemned, 1855
Francis Saltus	1844	Whitehall	185	26	8 ¾	473	50,000	160	14 ½	P. Comstock	Thomas Collyer	15 yrs – Condemned, 1859
J.H. Hooker	1846	Whitehall	136	23	7	258	18,000	50	9	J. H. Hooker	George Collyer	33 yrs – Converted into Barge, 1879
United States	1847	Shelburne	240	28 ½	9	648	75,000	250	18 ½	CTC	Capes & White	26 yrs – Condemned, 1873
Ethan Allen	1847	Shelburne	136	27	8 ½	328	36,000	75	10	Steam Tow	Wm. Caper & Son	23 yrs – Condemned, 1870
Boquet	1848	Essex, NY	80	17	1	111	7,000	30	7 ½	Ross & McNeil	Orson Spear	6 yrs – Sold to go into Canada, 1854
Boston	1851	Shelburne	127	25	8 ½	284	25,000	70	12	CTC	L.S. White	20 yrs – Condemned, 1871
America (*R.W. Sherman*)	1851	Whitehall	250	31 ½	9 ½	745	80,000	270	19	Collyer &	Thomas Collyer	15 yrs – Condemned, 1866
Canada	1853	Whitehall	260	33 ½	10	881	100,000	340	18	CTC	John Englis	17 yrs – Condemned, 1870
Montreal	1855	Whitehall	224	23	9	417	40,000	140	16	CTC	L.S. White	25 yrs – Burned in Maquam Bay, 1880
Oliver Bascom	1856	Whitehall	136	27	9 ½	360	30,000	150	13	Northern Transportation	John Riley	27 yrs – Outlived usefulness
Adirondack	1867	Shelburne	251	34	9	1087	90,000	250	18	CTC	L.S. White	8 yrs – Taken off 1875
Oakes Ames	1868	Marks Bay	258	35	9	1145	100,000	270	19	Burlington (Railroad?)	O.S. Spear	7 yrs – Made, Champlain 1873; wrecked, Westport, 1875
A. Williams	1870	Marks Bay	132	22	8	240	50,000	160	12	Orin Corbin and Andrew Williams	A.B. Curtis	23 yrs – Outlived usefulness
Vermont II	1871	Shelburne	262	36 ½	10	1124	175,000	1500	19	CTC	L.S. White	31 yrs – Outlived usefulness
Maquam	1881	Swanton	142	25	8	370	50,000	700	13	St. Johnsbury	Cookson	24 yrs – Outlived usefulness
Reindeer	1882	Alburgh	168	27	9	498	56,000	800	14	Grand Isle	Jeremiah Faulks	20 yrs – Sunk at C.V. Wharf while out of commission
Chateauguay	1888	Shelburne	205	54	9 ½	742	101,000	1000	20	CTC	A.B. Curtis	
Vermont III	1903	Shelburne	262	62	10 ½	1195	201,000	1800	23	CTC	L.F. Barrett	
Ticonderoga	1903	Shelburne	220	57 ½	11 ½	892	170,000	1500	23	CTC	L.F. Barrett	

From Wilkins, 1916: 14-15.