

A Ship for Every Season:

A Reconstruction and Analysis of the Double-Ended Steamer *Waccamaw* (1861-present)

(Eagles Island, North Carolina)

By

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May 2025

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ABSTRACT

Built on the foot of 10th St. in Manhattan in 1861 by shipbuilder John Englis, the double-ended steamer *Waccamaw* (ex. *Nuestra Señora de Regla*, ex. *Commodore Hull*) existed in a turbulent time in United States history. Amidst technological advances, bloody warfare, and a difficult reconstruction period, the face of the United States would change greatly from the middle to the end of the 19th century. *Waccamaw* was a product of these times, being used and reused to suit the needs and aspirations of individuals whose actions reflected the uncertainty of the day. This thesis endeavors to explain the processes which formed the *Waccamaw* site as it exists today on the bank of Eagles Island, North Carolina and by doing so provide insight into the behaviors of those who interacted with the vessel and its archaeological remains. This study is made up of four key elements to accomplish this task: the application of behavioral archaeological concepts of site formation theory, the consideration of environmental circumstances and broader historical trends, the digital reconstruction of the vessel in each stage of its life via the modeling software Rhinoceros® 3D, and the investigation of the site to collect the data necessary to complete a scaled photogrammetric model via Agisoft Metashape®.

A Ship for Every Season:
A Reconstruction and Analysis of the Double-Ender Steamer *Waccamaw* (1861-present)
(Eagles Island, North Carolina)

A Thesis
Presented to the Faculty of the Department of History
East Carolina University

In Partial Fulfillment of the Requirements for the Degree
Master of Arts in Maritime Studies

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May 2025

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Dedication

This thesis is dedicated to my parents, Geoffrey and Sherri Fosdick whose support, patience, and advice have made any accomplishment I could claim possible.

Acknowledgements

First and foremost, this thesis would not have been possible without the support of my advisor Dr. Nathan Richards. He gave many hours of his time to work with me on every aspect of this thesis and always pushed me to go the extra mile. For this, and his continued support and mentorship, I will forever be grateful. I'd also like to give thanks to committee member Dr. Jason Raupp who originally sparked my interest in ship construction, was always available for consultation or advice, and has generally taught me many things about what it means to be an archaeologist. Thank you to committee member Dr. Christopher Oakley, whose instruction and time has been instrumental in my completing this degree.

I would like to thank my partner in crime, Lydia Showalter, whose love and support gave me the strength I needed to keep pushing forward with my research. I would also like to thank Alex Morrow, Konstantinos Raptis, and Christopher Triplett for their support, advice, and camaraderie over these past few years. I could not ask for finer friends and future colleagues. Additionally, thank you to Ian Shoemaker, Konstantinos Raptis, and Christopher Triplett for their help in the field whose effort was key in ensuring data was collected accurately and professionally.

Finally, I would like to give thanks to The Mariners Museum and Park, the Cornell University Library, and the North Carolina Underwater Archaeology Branch. All three institutions went to great lengths to ensure I received any documents or information I requested in a timely manner. The fields of history and archaeology would be much worse off without their continued effort and commitment to preserving the past.

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CHAPTER 1: Introduction

The 19th century brought a fundamental change to navies across the world. Steam power and industrialized production quickly superseded the thousands of years of trial and error which had produced excellent sailing vessels and the highly trained sailors who operated them. Steam technology was becoming more and more common place in the United States by the 1850s, and when the Civil War erupted a decade later, those who doubted steam power's efficacy were forced to become quick converts. Given that much of the United States Navy's ship design, tactics, and production was underdeveloped and stuck in the 18th century, it had to rely substantially on conscripted steamers for the blockade squadrons, transportation for supplies and troops, and for rooting out coastal and riverine confederate encampments. While the purpose-built ironclads often received most of the public's attention after the Battle of Hampton Roads (8-9 March 1862) and due to their continued success in riverine environments, conscripted civilian steamers had a vital role in defeating the Confederacy and its navy. The vessel that is subject of this study is an example of one such civilian steamer.

Built in New York by well-respected shipbuilder John Englis in 1861, *Waccamaw* was a double-ender side wheel ferry designed for "over-and-back" service, traveling only a few miles at most between destinations across shallow waterways, bays, or riverine environments. It was originally christened *Nuestra Señora de Regla (Regla)*, being built for the Spanish railroad company "Compañía del Ferro-Carril de la Bahía de la Habana a Matanzas" based in Havana, Cuba (United States Supreme Court 1882:92; Triebe and Wilde-Ramsing 1992:14). Standing 11 ft. tall from keel to deck, with a 141 ft. overall length, and a 43 ft. extreme breadth (Merchant Vessels of the United States 1885:378; United States Department of the Navy 1921:63), the

vessel was not big for its class. This made *Regla*'s 28 October 1861, voyage from New York's upper bay to the Bay of Havana, over 1,300 miles of open ocean, ever more perilous. Indeed, the vessel never reached its destination, as it was unable to escape the exigencies of the Civil War which had begun only a few months prior. *Regla* was taken as a prize by the United States Army in November of 1861 where it operated in Port Royal, South Carolina as an unmodified troop and supply transport (Triebe and Wilde-Ramsing 1992:15). When it became clear the war would not be short and more vessels were needed for the blockade, the United States Navy requested the ferry be sent to the Brooklyn Naval Yard to undergo conversion into an iron plated, riverine gunboat.

“A craft which only the emergency of the times excused sending to the sea” is how *Waccamaw*'s (then called *Commodore Hull*) first commander, William G. Saltonstall, described the newly modified ferry after its conversion in early spring of 1862 (Saltonstall 1913:41). Indeed, a New York ferryboat seemed to be a dubious choice at best for a gunboat expected to see hard combat in the coming years. Nevertheless, *Commodore Hull* was sent to operate in the sounds and rivers of North Carolina engaging in both naval combat and coastal sieging where it performed with relative success. After the war, the vessel was deemed to be unneeded and therefore sold at auction on 27 September 1865, making its way back into the waters of North Carolina, the Cape Fear River specifically (United States Department of the Navy 1921:63). It was operated first by the Wilmington & Manchester Railroad Company, where it was renamed *Waccamaw*, to ferry people and cargo to and from Eagles Island. The vessel would move to at least three other enterprises and undergo several modifications to accommodate service in the excursion, towing, and salvage industries before it was finally laid up on the shore of Eagles Island in 1884 (Jackson III 2008:260). As *Waccamaw* transitioned into an unusable derelict

watercraft, it would undergo several iterations of vandalism and salvage before the first archaeological recording of it remains in 1975 (North Carolina Underwater Archaeology Branch 2024).

This study aims to determine the behaviors involved in the construction, adaptation, discard, and salvage of the 1861 built double-ender ferryboat *Waccamaw* (ex. *Nuestra Señora De Regla*, ex. *Commodore Hull*), and how broader processes influenced them. This site, located in the Cape Fear River on the bank of Eagles Island adjacent to Wilmington, North Carolina (Figure 2), represents a promising opportunity to understand the intricacies of mid-19th century American riverine transportation technology and how this technology was used and reused. Furthermore, this vessel has a historical context that speaks directly to the processes of technological modification and the behavioral insights that can be derived from them.

The goals are therefore to first, analyze historical documentation to understand the social, economic, technological, and environmental processes which influenced New York ferryboat construction and conversion into Union gunboats during the American Civil War. Second, to use the *Waccamaw* site, its life history, and construction information to test the material effect of these processes visualized by a three-dimensional (3D) reconstruction of the vessel at each stage of its use cycle. Third, to produce a scaled photogrammetric model of the vessel's archaeological remains to integrate with the 3D reconstruction. The utility of this is to better understand the post-discard salvage and project what portions of *Waccamaw*'s (state ID: CFR0001) remains still exist below the surface. Finally, relevant statistical information will be juxtaposed with vessel's construction trends and contextual history to test the applicability of behavioral models of site formation, discard, and salvage in explaining the processes and behaviors which changed *Waccamaw* materially.

Previous Research

Several theses have touched on the theoretical framework which informs this study of technological change and this research builds upon that previous work (Seeb 2007; Diveley 2008; Sassorossi 2015; Pawelski 2023; Phipps 2024). Indeed, by producing a precise understanding of *Waccamaw* throughout its stages of adaptation to and from a Union gunboat and its post depositional archaeological site formation, a theoretically focused and holistic perspective may be produced. Furthermore, most theses which have considered technological adaptation thus far have focused only on the initial transition from civil craft to naval vessel (Spirek 1993; Diveley 2008; Sassorossi 2015). This thesis, however, considers the entire use cycle of converted New York built ferries using *Waccamaw* to ground the study in material reality.

Previous archaeological investigations of the CFR0001 site and the greater Eagles Island Ship Graveyard (Figure 1) have been important in laying the groundwork for the investigations carried out for this study. Archaeological recording of the *Waccamaw* site was first conducted by the North Carolina Department of Archives and History (NCDAH) and the University of North Carolina Wilmington (UNCW) as part of collaborative field school in 1975 which collected basic dimensional information, photographs, sketches, and preliminary interpretations of the vessel's remains. The site was revisited in 1987, 1990, and 1996 by North Carolina's Underwater Archaeology Branch (UAB). They produced small reports regarding the dimensions of framing and planking, interpretation of the main mechanical components which remained, and the type and size of fasteners (North Carolina Underwater Archaeology Branch 2024).

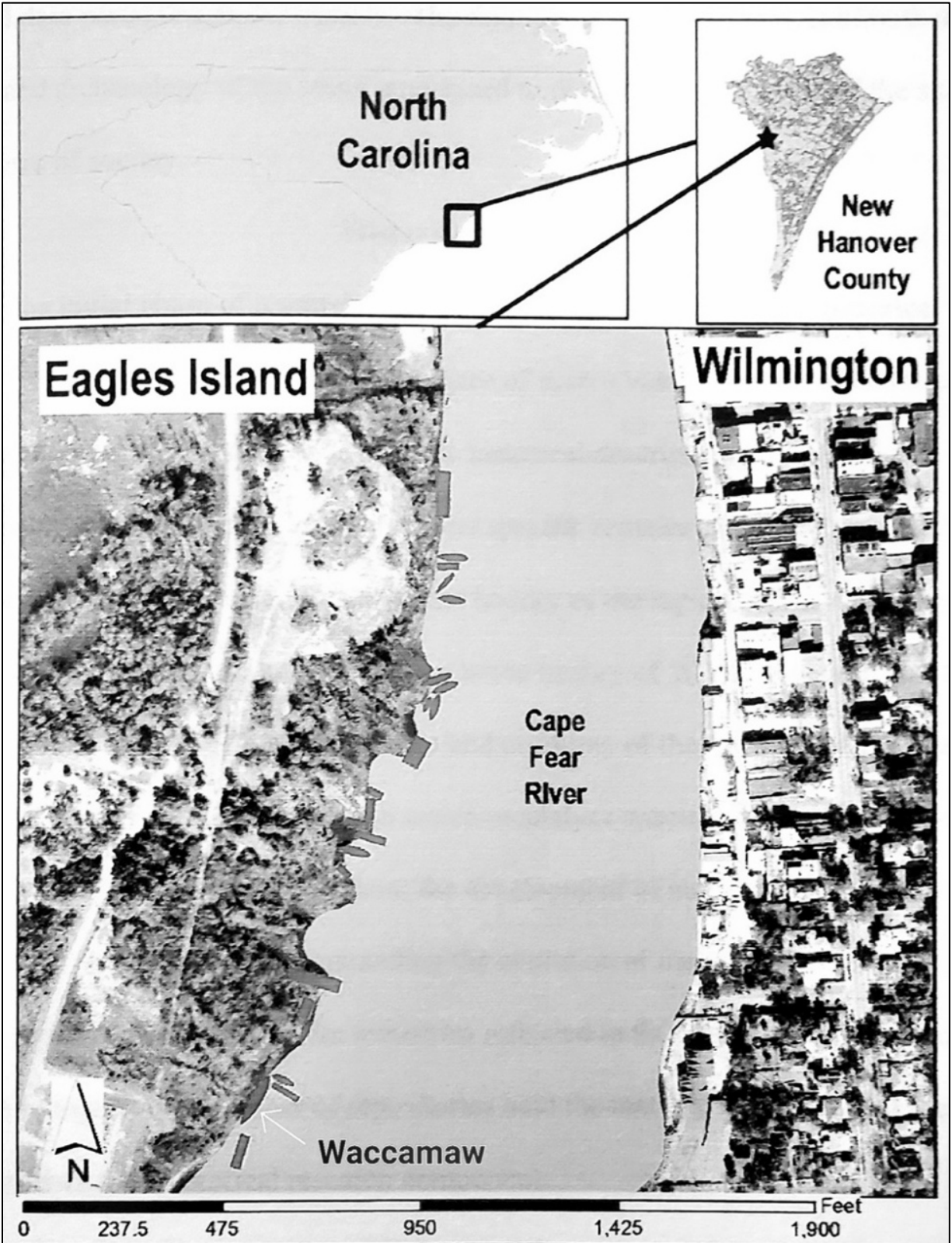


FIGURE 1. Location of *Waccamaw* in original depositional site (image courtesy of Sami K. Seeb 2007, “Waccamaw” label placed by author).

In 1992, an article produced by archaeologist Mark Wilde-Ramsing and historian Richard Triebe recounted their efforts to identify the remains of the CFR0001 site which had previously been known simply as the Eagles Island Side-Wheel Steamer. Based on archaeological and historical evidence outlined in the article and the vessel's site file, they identified the remains as the steamer *Waccamaw*, an interpretation which was subsequently accepted by the UAB (Triebe and Wilde-Ramsing 1992:10-11; Overton and Lawrence 1996:141). Finally, Sami Seeb's 2007 thesis regarding the Eagles Island Ship Graveyard provided the best interpretations of the salvage which occurred to *Waccamaw*'s remains to date. Given her application of behavioral archaeological theory, it also provided key theoretically based explanations of the site's post-discard salvage (Seeb 2007).

Research Questions

The questions which guide the research of this study revolve around the tenets of behavioral archaeology, specifically, that artifacts and human behavior are inextricably linked (Schiffer 2010:19). Given that human behavior is influenced by environmental, social, technological, and economic processes, the primary research question comprises secondary questions dealing with each process and then asking how the archaeological data changes the quantitative and documentary results. It should be noted that questions regarding the site's post-deposition cultural processes are part of the overarching research question, as it is an important part of behavioral archaeological theory and the reality of *Waccamaw*'s use cycle.

Primary

Using *Waccamaw* as an example, what behaviors are associated with the transformation of civilian watercraft for military use, their reversion to their previous civilian purpose, and final deposition during the 19th-century?

Secondary

- What are the techno-economic processes?
- What are the techno-social processes?
- What are the environmental processes?

The association of technology with economic and social processes (e.g., techno-economic and techno-social) is an admission that technological processes are directly connected to and affected by them, however, not always in a unidirectional manner. Indeed, as has been noted by theorist of technological change, Thomas Hughes, “social development shapes and is shaped by technology,” with the influence of a technology on a society depending on its scale and integration with said society (Hughes 1994:102). Economy can be accurately viewed as a product of social mechanisms, but for the purposes of this study, they will be broken into two sections so those motivations for material design or modification that result from, at base, monetary concerns can be more closely examined.

Structure of Thesis

This thesis is broken into eight chapters in total, including this one, which provided a brief overview of *Waccamaw*’s history, the goals of this study, and the research questions which guide it. Chapter 2 discusses the theoretical basis which helps explain the technological processes that *Waccamaw* underwent including reuse, discard, and salvage. Theories regarding cultural processes are derived chiefly from Schiffer (1987, 2010, 2011) and Richards (2008), while theories regarding environmental processes are taken mainly from Ward et al. (1999) and Gibbs (2006). Chapter 3 relays the broader historical context in which *Waccamaw* existed, focusing on early to mid-19th century New York and the United States Civil War from the perspective of the North Atlantic Blockading Squadron stationed in the waters of North Carolina. Chapter 4

reviews the methodology used for historical research which obtained the documents necessary to complete the 3D reconstruction, that used for the field work and production of the photogrammetric models, and that of the analysis.

Chapter 5 and 6 discuss how the 3D reconstructions of *Waccamaw* were made in Rhinoceros 3D® and results thereof, including a reconstruction of the ferryboat *Regla*, the gunboat *Commodore Hull*, the working boat *Waccamaw*, and archaeological site CFR0001. Chapter 7 presents the analysis of the use, reuse, discard, and salvage of the vessel which applies behavioral archaeological concepts to the specific material changes in *Waccamaw* throughout its active use and derelict existence, and related broader statistical data. The goal of this is again to understand the behaviors related to the material change of the vessel and how broader techno-economic, techno-social, and environmental processes affected it. Finally, Chapter 8 concludes the thesis by reviewing its contents and restating the conclusions, stating the limitations of the study, and suggesting avenues for further research.

CHAPTER 2: Behavioral Archaeology and Site Formation Processes

This study uses a theoretical framework derived from Michael B. Schiffer's behavioral archaeology to guide the process of answering why *Waccamaw* was constructed, adapted, salvaged, and disposed. This theory focuses specifically on concepts regarding the decision-making processes involved in the development, adaptation, discard, and salvage of technology (Schiffer 1987, 2010, 2011; Schiffer et al. 2001). Additionally, Nathan Richards (2008) is referenced extensively given his preoccupation with applying behavioral archaeological concepts to the maritime world, specifically discard and salvage. Furthermore, processualists such as I. K. Ward and Martin Gibbs (Ward et al. 1999; Gibbs 2006) provide relevant perspectives on the environmental processes which affect artifacts both while they are being used and after becoming an archaeological site. Therefore, core concepts developed by Schiffer and furthered by his peers, namely site formation theory, will be utilized to understand the behaviors associated with the life-history and archaeological remains of *Waccamaw*. It is therefore important to first define behavioral archaeology and its goals before continuing with the concepts involved in Schiffer's understanding of site formation theory and how it can be applied in a maritime context.

Behavioral Archaeology

To begin, behavioral archaeology can be defined as, "the study of relationships between human behavior and material culture in all times and all places" (Schiffer 2010:6). This means that through connecting material culture to the human processes which produced them, such as invention, adoption, adaptation, and abandonment, we can deepen our understanding about human behavior cross-culturally. Behavioral archaeology, therefore, attempts to create theories

that are sufficiently general to encompass all technologies (Schiffer et al. 2001:731). These theories provide archaeological explanations that happen on two levels: first, the documentation of a specific behavioral or organizational property of a past cultural system explains observations of a site and/or artifact, and second, the documented properties become the object of further explanation. Both explanations make use of generalizations such as laws and models while seeking to create their own (Schiffer 2010:11). Behavioral models for technological change and archaeological interpretation will therefore be tested in this study with *Waccamaw*'s historical and archaeological record. Site formation theory will work on both levels of archaeological explanation. A lack of support for these concepts may indicate a needed revision to behavioral archaeology's site formation theory and how it has been applied in a maritime context. On the other hand, the utility of these proximate and broader generalizations may prove indispensable in explaining the influences that produced the three stages of *Waccamaw*'s life as well as its final stage of deposition.

A behavioral archaeological approach also emphasizes the necessity of utilizing historical documentation when the history surrounding a site is available. As Schiffer states, "Behavioralists emphatically see no conflict between history and science" (Schiffer 1996:644). Indeed, researchers using the behavioral approach see historical archaeology as a means of creating technological and archaeological change models of increased accuracy. This is important to note because to prove any cross-cultural tendencies in technological adaptation and conversion that may be derived from the data taken from this study of *Waccamaw*, the historically and temporally dependent factors must be understood. Furthermore, the behavioral approach to archaeology, "to infer human behavior from variability in the archaeological record" applies to the historical record as well (Schiffer 2010:19). Indeed, understanding quantitative

dimensions and trends in population, immigration, importation, raw material production is necessary to understand how to interpret the archaeology. The utility of applying these dimensions can be seen in several studies related to maritime activity (e.g., Kenderdine 1994; McCarthy 1996; Seeb 2007; Richards 2008; Cook 2021).

Archaeological Site Formation

As stated above, archaeological site formation may help in ascertaining why *Waccamaw*'s archaeological and historic record currently exists as it does. Furthermore, this analytical framework can provide a more fine-tuned interpretation of the vessel's construction history and use cycle, as seen in numerous other studies (Muckelroy 1976; Gibbs 2006; Seeb 2007; Richards 2008). It is important, therefore, to first understand how this theory differs from the original processual understanding of the archaeological site as it helps show why it is key in explaining the changes seen in *Waccamaw*. Then, the theory's general principles are discussed alongside studies which give insight into abandonment processes in the maritime context. As will be seen, site formation provides a framework that is useful in peeling back the layers of change seen in *Waccamaw*'s use, reuse, abandonment, and salvage.

To begin then, while many processualists shared the same notions as to what basic methodologies should be included in archaeological interpretation, the behavioral conception of site formation offered a more nuanced understanding of the archaeological site than the traditional processualist cared to admit. For example, processual archaeologist Lewis Binford stated, "The loss, breakage, and abandonment of implements and facilities at different locations, where groups of variable structure performed different tasks, leaves a 'fossil' record of the actual operation of an extinct society" (Binford 1964:425). This quote was initially widely accepted in processualist circles, producing inferential procedures founded on the assumption that past

behaviors of interest were the sole determinants of the present-day properties of the archaeological record (Schiffer 1987:5). While encouraging archaeologists to universally apply statistical analysis when interpreting a site, this methodology indicated no framework to consider the effects of intervening forces on the statistical or distributive nature of said site (Schiffer 2010:5).

Indeed, it is clearly not the case that an artifact's provenience in a site always corresponds directly with its use location, type frequency, or relational co-occurrence within said site. To the point, Mark Varien and Barabara Mills (1997:144) state in, "Accumulations Research: Problems and Prospects for Estimating Site Occupation Span," that many studies, including Mark Aldenderfer (1981), Michael J. Shott (1989), and Kent Lightfoot (1993), have shown that variation in artifact reuse cycles can produce variation in assemblage composition that might be mistakenly attributed to different activities. It is this fact that led Schiffer to seek a framework to answer the question, "how is the archaeological record formed by behavior in a cultural system?" (Schiffer 1972:156). This question also led him to define when an artifact is in use in a behavioral system and when it is not, which was to be a preliminary step in identifying further intervening forces on the archaeological record.

Schiffer (1987:7) laid out some basic concepts to explain the formation of any given site, stating plainly, "The factors that create the historic and archaeological records are the formation processes." Before discussing these factors and how they are broken down, it is important to define the historical and archaeological records. The historical record consists of artifacts retained within a living society because a change in their form, function, or use gives them continued value. The historical record of an artifact, when paired with the available treaties, documents, or records which also make up this record, can provide detailed evidence of earlier

behaviors. In contrast, the archaeological record contains the culturally deposited objects that are no longer part of the society from where they came (Schiffer 1987:3). This is what the archaeologist encounters on a survey or excavation and can consist of everything from pottery fragments or, in the case of this study, discarded steam-powered boats.

The archaeological record (alongside any available treaties, documents, or records) is what provides evidence for an artifact's historical record while indicating what processes affected its use, reuse, and discard. These processes can be cultural, as in the product of humans operating in behavioral systems, or environmental, that is adhering to the laws of chemistry, physics, geology, and other natural sciences (Schiffer 1972:156). Cultural processes are dubbed c-transforms while environmental, or non-cultural processes, are dubbed n-transforms. As will be discussed in the following section, both effect a site's historical and archaeological record in what is termed their systemic and archaeological contexts.

The Systemic and Archaeological Contexts

As defined by Schiffer, the systemic context, "refers to artifacts when they are participating in a behavioral system" (Schiffer 1987:3). This means when archaeologists identify c-transforms imbued into the artifact, it is relaying information about its systemic context since cultural transforms occur, by definition, in a systemic context. The archaeological context, on the other hand refers to an artifact that is only being affected by the natural environment (n-transforms). An artifact cannot be in systemic and archaeological contexts simultaneously; however, it can move in and out of them due to processes such as abandonment, reclamation, or even archaeological excavation and/or survey. The general division between the systemic and archaeological contexts and the generalized patterns that produce c-transformations within the systemic context can be seen in a chronological format in Figure 2 (Schiffer 1972:158). It is

ultimately the goal of the archaeologist to reconstruct the systemic context from the archaeological record by making inferences based on evidence found in the historical and archaeological (Schiffer 1987:4).

When an artifact is in a systemic context, it is being used in a behavioral, or cultural, system which is itself made up of subsystems that relate to the use of the artifact. Within an industrial capitalist society these subsystems can be many things, but in relation to this study, they include military entities of a governmental system and manufacturing or service providers of an economic system. These subsystems are in turn made up of activities which are equated to patterned energy transformations, or put more simply, humans acting on proximate material elements. Depending on performance requirements placed on the subsystem, these activities could include anything from mining for iron ore at a specific site to adapting a civilian vessel for military use. These sites and artifacts can be seen as elements of the activity of a subsystem with the subsystem relating, naturally, to the larger behavioral context. Therefore, because these activities leave traces of c-transforms and n-transforms on an element (i.e., artifact, the terms can be used interchangeably), their identification can lead to a better understanding of their primary use while accounting for additional changes that also relay information about the subsystem (Schiffer 1972:157).

Elements are divided into two broad categories: durables and consumables. Durables are tools, machines, and facilities, or the transformers and preservers of energy, while consumables are foods, fuels, and other similar elements that release their energy when used (Schiffer 1972:158). Durable elements, such as steam-powered ferryboats, often use consumables such as coal and water, and as such one cannot be used without the other. As can be seen in Figure 2, durable elements follow a basic chronological path. Consumable elements follow a similar path

except manufacturing is replaced with preparation, use is replaced by consumption, and the maintenance cycle is taken out entirely. Given this study is concerned with a site that is a durable element, the below model is the most relevant. Furthermore, a later publication from Schiffer implies this model's general applicability titling it, "The Basic Flow Model of Artifact Life History" (Schiffer 2010:22).

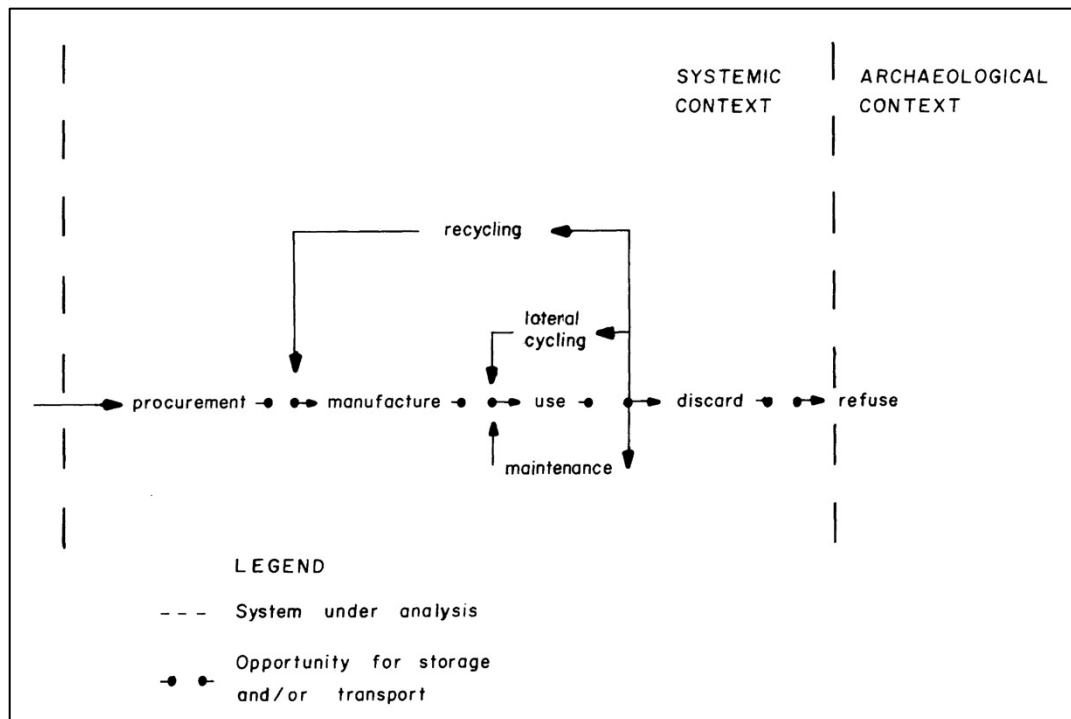


FIGURE 2. A flow model for the life cycle of durable elements (courtesy of Michael B. Schiffer 1972:158).

As is seen in the model, elements within the systemic context follow a chronological path starting with procurement and ending as a type of refuse where they then pass into the archaeological context to potentially re-enter the systemic context as mentioned above. The nature of each of these processes as they relate to the broader contexts that influenced *Waccamaw*'s construction as a ferryboat, conversion into a gunboat, transfer back into civilian use, and final deposition are important to understanding any of its in situ archaeological remains. Manufacture, use, discard, and refuse cycles are of particular interest in this study. Indeed,

Waccamaw was a well-used and reused vessel having occupied five distinct roles in its lifetime (i.e., ferry, gunboat, excursion, tow, and wrecking) each with its own equipment requirements. The following section deals with the concepts that aid in making grounded inferences of an artifact's use and reuse as seen in the historical and archaeological record.

Use and Reuse

Use and reuse are core components of the site formation process and, as has been noted, "Site formation studies rest on the fundamental principle that after use, humans either reuse or deposit artifacts in some manner" (Richards 2008:54). As seen in Figure 2, the use of an object may lead to its reuse in a cyclical and generalizable manner but before these reuse cycles are initiated, it operates in the systemic context for its intended use. Understanding a technology's initial use is important as it relays the original intended function it was designed to perform and economy it was constructed to operate in. Richards refers to this as a vessel's *primary mercantile* phase or *primary support* phase based on what function it occupies (Richards 2008:119-120). A vessel with primary mercantile function could be a fishing trawler or ferry while one with primary support function could be a barge or lighter.

An artifact's function(s) can be further broken down into three basic categories: techno-function, socio-function, and ideo-function. *Techno-function* includes preferences in utilitarian performance including manipulating, storing, or transforming matter, energy, or both. *Socio-functions* are symbolic and convey social information of someone or something's affiliation with a social group, institution, or organizations. *Ideo-functions* are also symbolic, yet they communicate ideology or ideas (Schiffer 2011:23). An example of an object with primarily ideo-functional design preferences would be a crucifix, while an object designed with mainly socio-functional preferences might be a doctor's scrubs. These categories are by no means zero sum as

most artifacts perform more than one function, for example, the doctor's scrubs have the utilitarian function of being easily changeable and washable (Schiffer 1987:14).

The function an object was originally designed to accomplish will likely correspond in some formal way (i.e., the artifacts shape, size, weight, color, hardness, and chemical composition) to the function of its reuse activity. In a maritime context, for a vessel to be reused for a newly envisioned purpose, it must have design/constructional features commensurate to its new function. For example, Richards notes that the choice of a wooden vessel as a gunpowder hulk would not have made much sense by the late 19th century given ferrous-hulled vessels were available. In this case, the formal qualities of wood allow it to absorb nitroglycerin from "sweating" TNT, making it explosive and thereby incompatible in its hypothetical reuse as a gunpowder hulk (Richards 2008:128). These concepts will be important in understanding why *Waccamaw* was reused as it was and may indicate what other subsystems would reuse an artifact given the artifact's applicability in functional and formal dimensions. To continue then, let's consider the general ways in which artifacts are reused in a subsystem: lateral cycling, recycling, secondary use, and conservation processes.

Lateral cycling is defined as simply being a change in an artifact's user (Schiffer 1987:29). This type of reuse occurs frequently in the maritime world; vessels change hands many times over often to fulfill the same function. For example, at least four ferries that ran routes in the Hudson and East Rivers for the New York Central R.R. and predecessor companies between 1850 and 1925 were sold to railroad or ferry interests to be used in that capacity elsewhere (Cudahy 1990:373-375). Lateral cycling causes issues for archaeological inference because, as noted by Schiffer, "it does not change an artifact's formal properties" (Schiffer 2010:32).

However, the documentary evidence including registries, newspapers, and inspection records can provide ample evidence of these occurrences in the maritime world.

Recycling is the reintroduction of an artifact into an industrial process that transforms the object's formal properties into some other form or function (Richards 2008:55). This process is usually initiated when an object has fulfilled its primary purpose or when its waste is put into new use, often changing its techno-function so it can be used for a completely different task (Schiffer 1987:29; Seeb 2007:18). An example of recycling could be the removal and reshaping of planks from a vessel for use in the construction of a house, or it can take more drastic form where an object's entire function changes as it is now used in a new behavioral context (Schiffer 1987:30). An example of this would be sculptures that use metallic framing members from various industrial structures or technologies. Furthermore, as suggested elsewhere, recycling often occurs in the maritime industry as the salvage of various parts from a vessel or even its complete dismantling (Richards 2008:55).

Secondary use, put simply, is the change in the object's use but not its form (Schiffer 2010:33). Following the above concepts of primary mercantile and support phases, in the context of a watercraft, this would be the object's (i.e., vessel's) *secondary mercantile* (commercial function to commercial function) or *secondary support* (commercial function to support function). A secondary mercantile function would be when the owner modifies their vessel to fulfill a new commercial role such as a passenger ship's hull or propulsion being modified to accommodate its new role as a cargo transporter. Secondary support function, conversely, would be the vessel being converted from a cargo ship to a storage hulk (Richards 2008:120). While modifications might be made to an object for its new use, nothing extensive is done that would change its function entirely, this would be recycling.

Secondary use is usually a one-way trip towards the discard of an item, meaning the object is older, worn, or technologically obsolete by the time it is being used for a secondary purpose. As noted by Richards, secondary use was common with many vessels prior to their abandonment in ship graveyards across Australia, indicating this relationship between wear/obsolescence and secondary use (Richards 2008:55,130). The ability to infer secondary use from the archaeological record generally depends on the presence of use wear that is different than what is expected or what has already been noted based on its primary or initial use (Schiffer 1987:31). Furthermore, as will be seen in the historical account of New York built ferries converted into gunboats, the applicability of design features relating to their initial use was undoubtably a factor in the decision to reuse them as gunboats for the Union Navy.

Finally, a conservatory process is a type of secondary use that involves a change in the artifact's use, and likely function, with the intention to preserve it permanently (Schiffer 1987:32). In other words, the artifact is likely making a transition from a techno-function to a socio or ideo-function (Richards 2008:55). This is not just a matter of archaeological excavation removing an artifact from the archaeological context and placing it back into the systemic as a display in a museum, this can also be the scavenging of artifacts deemed to be of historic value to an individual. Indeed, as noted by Schiffer and of relevance of this study, is the fact that conservatory processes are especially well developed in complex societies where, "individuals and institutions collect and conserve an enormous range of things" (Schiffer 1987:32). Artifacts secondarily used in this way by individuals can function as a symbol to indicate social standing transitioning it to be socio-technical in nature (Schiffer 1987:32). This has a long history in maritime wreck diving and treasure hunting, as is conveyed in publications on the subject. A quote describing early wreck divers of the Atlantic illustrates this point: "It is an odd sight to see

grown men covet teacups and saucers, and build noble display cases to these dainty relics. But to divers ... these trinkets represent exploration, going off the charts” (Kurson 2004:7).

Cultural Deposition

The above description of use and reuse processes provides a conceptual framework to guide this research in considering the material changes of *Waccamaw* while firmly within the systemic context. The following concepts, on the other hand, will guide this study in framing the processes that transitioned the vessel from the systemic context to the archaeological context. As has been noted in past research regarding Eagles Island Ship Graveyard, much is still unknown about the abandonment behavior of its earliest deposits, including *Waccamaw* (Seeb 2007:163). Therefore, the vessel’s archaeological remains are likely to be the best source of information to clarify this stage of its life history while providing possible revision to past interpretations of the behaviors associated with its disposal. As Figure 2 illustrates, discard processes and the subsequent state as refuse represent the transition of an artifact from the systemic context to the archaeological context. This transformation from systemic to archaeological context is termed cultural deposition (Schiffer 2010:34).

Cultural deposition encompasses several processes including discard, abandonment, and reclamation (Schiffer 2010:34). To begin with, discard occurs if an artifact can no longer fulfill its function and it is not placed into a cycle of reuse (Schiffer 1987:47). Abandonment falls under the general patterns of discard behavior while displaying its own behavioral patterns as indicated in the historical and archaeological record. In vessel abandonment, however, documentation and records are often vague, sparse, or non-existent (Richards 2008:11). This may hold true for *Waccamaw*, making the site and comparative analyses the only avenue in which to understand how cultural and non-cultural processes affected its depositional state. Finally, as will be

discussed in more detail, discarded materials may be brought back into the systemic context through reclamation processes. To continue then, the circumstances that produce discard activities will be briefly described to be followed by the spatial features of discard, abandonment processes, and its relation to salvage.

Discard processes begin when an artifact breaks, wears out, or deteriorates (Schiffer 2010:34). Breakage is a sudden mechanical failure of an artifact or one of its parts, wear is the gradual reduction of an artifact's function, and deterioration is the change of an artifact caused by its interaction with the environment. The combination of wear (c-transforms) and deterioration (n-transforms) leads to breakage and determines the length of an artifact's use-life, that is, how long the artifact spends in its use-processes (Schiffer 1987:48). Different artifacts or components of artifacts/sites have a greater or lesser use-life depending on the intensity of wear and deterioration. For example, throughout the 19th century, steam vessels of all types regularly had to replace their boilers. This is because boilers underwent intense wear and deterioration including scaling caused by using water with high salinity, poor manufacturing, or a weakening of the iron or steel by rust (Roper 1907:207-208). While certain components are discarded at a higher rate in the case of technology such as a steam powered vessel, this does not necessarily mean that they will be represented proportionally in the archaeological record. As will be discussed, abandonment processes and the associated preliminary or subsequent salvage operations may lead more regularly discarded components to be recycled. First, however, it is important to define the spatial variations of discard behaviors in the maritime context.

Discard is delineated spatially by the terms *primary* and *secondary refuse*. Primary refuse is defined as objects discarded at their locations of use while secondary refuse are objects discarded elsewhere. In the maritime context, an example of primary refuse could be a vessel

discarded at the site of their use or salvage with secondary refuse being vessels brought to a more out of the way location as to not inhibit further activity. Secondary refuse has other behaviors associated with it such as clustering, that is, the tendency for people to dump trash where others have done so previously (Schiffer 1987:62). This patterned nature of primary and secondary refuse has led to the hypothesis that, “the larger the population of an activity [e.g., a settlement], and the greater the intensity of occupation, the larger the ratio of secondary to primary refuse produced” (Schiffer 1987:59). Seeb’s analysis of the Eagles Island Ship Graveyard, however, concludes that the ship graveyard *Waccamaw* is associated with is a rare instance primary refuse within the active industrial zone that was Eagles Island. This instance of primary refuse includes the behavior of discard clustering that is generally associated with secondary refuse as described above (Schiffer 1987:62). While evidence for the later phases of use on Eagles Island indicates Seeb’s assessment may be accurate, further examination of *Waccamaw* in its systemic and archaeological contexts may prove that its deposition is the cause of behaviors unassociated with the larger context of the graveyard.

As stated above, abandonment can be seen as a process of discard and as a description of how an artifact comes into the archaeological context. Indeed, abandonment processes occur when a place – an activity area, structure, or entire settlement – transitions to an archaeological context whether this transition is planned, unplanned, gradual, or abrupt (Schiffer 2010:36). Abandonment is generally linked with salvage, the occurrence of which leaves recognizable traces in the archaeological record. Deliberate abandonment in particular relays a large range of human decision-making processes, many of which may apply to *Waccamaw*. As defined by Richards, deliberate abandonment occurs when the act, “involves premeditation in every sense” (Richards 2008:10). The way this premeditation is expressed in the archaeological remains of

deliberately abandoned vessels provides information the underlying technological and economic changes in human communities (Richards 2008:10,14). When deliberately abandoned vessels display evidence of salvage, further insight into the technological and economic circumstances of a group of people can be extracted.

Salvage can be broken down into three types of activity occurring to deliberately abandoned vessels: primary, secondary, and tertiary salvage. Primary salvage describes the salvage of materials of ship remains after their wrecking by owners, insurers, or their agents. Secondary salvage describes the work activities by professional salvors or sport divers. Tertiary salvage refers to attempts at salvage that occur throughout the time following abandonment. With primary salvage, reducing the contents of the hull in such a manner that the most valuable or accessible components are removed before the vessel is moved to its final resting place is vital. Failure to do so can lead to the deposition of the vessel in its location of use thereby hindering the location's primary activities. Furthermore, interpreting primary salvage from the archaeological record presents difficulties because vessels moved to their secondary locations are often done with the intent of further salvage. Therefore, what may have been interpreted as post-depositional salvage on a vessel's remains may be pre-depositional.

Evidence for secondary salvage may exist only on the portions of a vessel's hull necessary to keep it floating. This relates to another strategy employed in the salvage of wooden hulled vessels: setting a ship on fire to allow easy access to the potentially valuable remains of the interior. Yet, detecting this strategy in the archaeological record also presents issues as the destruction of the hull due to fire could be the evidence of vandalism. Photographic evidence, if available, may therefore provide one of the few sound bases in which to infer secondary salvage from archaeological remains (Richards 2008:155-162).

N-Transforms in Maritime Archaeology

The above processes are mostly descriptions of c-transforms that occur within the systemic and archaeological contexts. Given that understanding how behavioral systems and subsystems affected *Waccamaw* in the historical and archaeological record is the primary focus of this study, they have received more detailed attention. Yet, environmental processes affect all archaeological sites and CFR0001 is certainly no exception. Indeed, *Waccamaw*'s remains may be at even greater risk given the intertidal nature of the Cape Fear River and its orientation on the riverbank. Unfortunately, Schiffer's theory deals with terrestrial settings, therefore, the theory employed to understand the non-cultural transformations of the site are derived chiefly from Ward et al. (1999), Gibbs (2006), and Richards (2008), given their focus on underwater or coastal environments.

Environmental processes can affect a vessel both in the systemic and archaeological contexts depending on what material it is made from, what role it fills for a society, and where geographically it fulfills said role. For example, a wooden hulled transatlantic passenger vessel will be more at risk from teredo worms than a wooden hulled Great Lakes freighter. Furthermore, both vessels are designed differently to mitigate that biological risk and other risks posed by the operational environment. Martin Gibbs supports the notion when he states:

Response to known or potential conditions and threats (or lack of understanding or response) might have been expressed in numerous ways. Most visibly, there was not only the design, and construction of a new vessel or the selection and modification of an existing vessel, but also any equipage and stowage, the selection of a route, the sailing strategy and potentially the season of travel (Gibbs 2006:8).

Indeed, as this quote indicates, the cultural decisions that dictate the design, use, and outfit of a vessel are strongly influenced by its operational environment. Similarly, it is cultural decisions that influence where a vessel is laid up (Richards 2008:172) and thereby what environmental processes affect it when it makes the transition from the systemic to the archaeological context via cultural deposition (Schiffer 2010:34). In this way there is an inseparable connection between cultural and non-cultural forces as applied to the site formation of vessels.

Several features of a seascape/riverscape need to be considered to understand the environment's effect on a vessel, but those most relevant to this study include sediment, hydrodynamic environment, and the three forms of deterioration: physical, biological, and chemical. In considering the effects of sediment on a site within the archaeological context, Ward et al. (1999) provides the concept of sediment budget. This is defined as, "the rate of net supply or removal of different types and sizes of sediment grains to the wreck area" (Ward et al. 1999:564). The sediment budget is in turn tied to the hydrodynamic environment which can be either high or low energy. Waves, currents, and tides can cause a high-energy environment where deterioration to the site will be significant. A low energy environment generally lacks those elements, so the site's deterioration usually occurs over a longer period. Considering both the sediment budget and hydrodynamic environment of a site's location, a hard rocky substrate with a high-energy environment generally results in much lower preservation for a site than a soft, muddy substrate with a low-energy environment (Ward et al. 1999:563-565). However, a soft, muddy substrate with a high-energy environment could also produce high preservation if sediment accumulation occurs rapidly.

Substrate and hydrodynamic environment are also important non-cultural factors in cultural decisions around vessel storage and abandonment. Regarding substrate, historical

sources have indicated that an area should consist of sand or gravel and free of rocks when looking to deliberately beach a vessel (Cockcroft and Nicholls 1983:200; Richards 2008:172). The desire for a soft substrate could be due to a desire to reduce damage to a ship's hull if wanted for future refloating. In terms of the hydrodynamic environment, the tide has also been an important consideration in decisions made around beaching a vessel. Indeed, if the tidal variation is large enough various methods are used to ensure the vessel stays where it is put, particularly if material within the hull had previously been salvaged or everything above the waterline had been removed (Richards 2008:175).

Finally, the three forms of deterioration (e.g., physical, biological, and chemical) affect a vessel both in the systemic and archaeological context. Physical deterioration is considered the hydraulic forces applied to the vessel via waves and currents. Biological deterioration includes the direct action of organisms on a vessel and can also include the indirect effects of micro-organisms which add to deterioration over time. A classic example of this is teredo worm boring through the planking of wooden ships. Chemical deterioration is the rate of corrosion of vessels and can include the direct reaction of, say, iron fasteners and seawater or the indirect biochemical reaction of where a vessel's remains lay, e.g., anoxia or acidification (Ward et al. 1999:565-567).

Conclusion

The core tenants of behavioral archaeology are commensurate with the goals of this study, that is, to understand the behaviors associated use, reuse, discard, and salvage of *Waccamaw*. Indeed, while the material change noted in historical and archaeological records of this vessel may have proximate influences, the patterns of behavior may have cross-cultural implications.

Furthermore, site formation processes, as understood by behavioral archaeology, are at the heart

of how applied theory may help explain the broader processes which influenced an artifact or site's use cycles. However, it is vitally important that the archaeologist understands what can and cannot be said about any given site or artifact. This is the other point of understanding how formation processes affect the archaeological record. The systemic and archaeological contexts present their own distinguishable and systematic filters to extract and therefore it will be seen how they may or may not apply to *Waccamaw* and its documentary record. Indeed, the removal of each filter will allow this study to inspect the life-history of New York built ferries and *Waccamaw* in relation to human decisions that follow known patterns.

CHAPTER 3: In East Coast Waters, New York Ferries and Their Conversions

Waccamaw came from a tradition of ferry construction that formed during a turbulent time in American history. The first 65 years of the 19th century were wrought with technological, economic, and social changes which are represented in the designs of New York ferries built like *Waccamaw*. Those vessels, and their conversions into Union gunboats, were a product of the technological, economic, and social changes and the constraining factor of their operational environments. It is therefore important to provide the historical context in which the humans who designed, used, and reused *Waccamaw* and like vessels operated. This knowledge provides insight into the circumstances in which a vessel of this type was created and adapted for a completely secondary use.

This chapter is therefore broken into two sections, the first spanning from the early 1800s to 1860 and the second spanning from 1860 to 1865. Each section is further divided into five subsections, the first four being the environmental, economic, technological, and social contexts as relevant to the creation and adaptation of New York ferryboats. The final subsection will consider how those ferryboats were a response to the challenges and opportunities presented by those four processes according to the historiography. Given this is a large span of time encompassing a large amount of historical documentation, this chapter will endeavor to impart the most relevant environmental, economic, technological, and social trends relating to the development of New York built ferries and their conversion into gunboats. This scope is further narrowed by applying these factors to *Waccamaw*'s particular ferry design and naval area of operation. Therefore, New York's Upper Harbor and the naval theater of the North Atlantic Blockade Squadron will command much of the attention in the two respective sections.

New York City and its Ferries

This section covers the key aspects of New York City's environmental circumstances and economic development. Environmental circumstances begin this section to establish the setting with the economic development following to illustrate how the environment was used to the advantage of trade and commerce. Then, the technological developments in transportation will be discussed, to be followed by the social influences that affected the use of said technology. In setting the scene, then, three of the four key areas in New York's port and their advantages over its other east coast rivals will be described. These areas are the Lower Bay, the Upper Bay, the Hudson River, and the Long Island Sound. The Sound, while important to the development of the state's technology and trade, will not be covered here given it is not directly connected to the development of the double-ended ferry.

Environment: The Natural Advantages of New York Harbor

To begin, the Lower Bay of New York City lies at an apex formed by Long Island and the New Jersey coast. Upon entering the harbor, a mariner in the Lower Bay would see what looked to be six miles of clear water laterally from Sandy Hook to Coney Island (Albion 1939:17-19).

However, a broad sandbar, barely visible at the surface at some points, joined the two shores with Staten Island's West Bank also protruding outward as seen in Figure 3. This required specific routes in and out of the bay (Figure 4) for most of the century as few efforts to dredge the bays were made between 1800 and the 1880s (Albion 1939:28). Yet, the Lower Bay acted as a crucial buffer zone between the ocean and the Upper Bay, offering protection from heavy nor'easters while a bottle neck leading into the Upper Bay, known as "The Narrows," lessened gales from the southeast (Albion 1939:29).

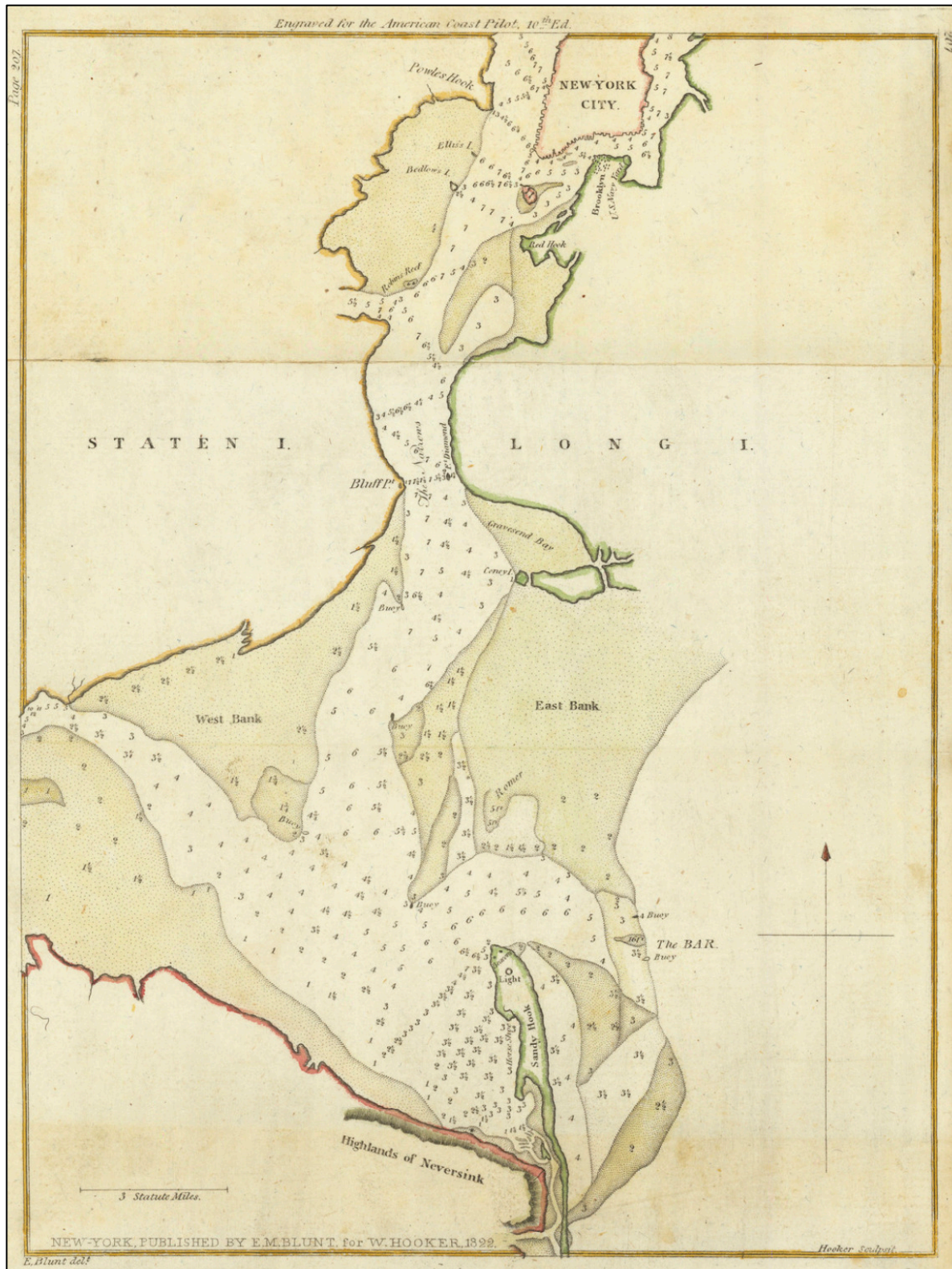


FIGURE 3: Navigation chart of New York's Bays engraved for the *American Coast Pilot* 1822, soundings in fathoms (courtesy of Edmund M. Blunt).



FIGURE 4: "Sea Approaches to The Port Of New York" (courtesy of Robert G. Albion 1939:18).

Upon approaching the Upper Bay, the advantages to New York City's waterfront became apparent. As mentioned above, the Upper Bay is isolated from the Atlantic due to a bottle neck two miles wide known as the Narrows (Figure 4). This land formation provides New York City with what few ports can, a virtually landlocked harbor almost completely protected from ocean gales (Albion 1939:19). Like the Lower Bay, depths for the Upper Bay changed little from 1800 to the 1880s as is indicated by late 19th century navigational charts and averaged around 17 ft. with its main channel being no less than 30 ft. (Bache 1866; Ascher 2006). Furthermore, the Hudson River side of Manhattan Island offered safe passage for virtually all vessels as its depth was anywhere between 18 and 72 ft. with no significant obstructions. The East River, on the other hand, was a tidal strait and was therefore shallower than its western counterpart, not getting much deeper than 52 ft. (Bache 1866; Albion 1939:19). The Upper Bay also had little chance of freezing over due to its tidal nature. Generally, only ice drifting down from the Hudson could cause problems for vessels plying or anchored in its waters (Albion 1939:30).

The Hudson itself is a distinguishing feature of New York City's harbor. Indeed, no other East coast port city was connected to the country's interior in such a direct and naturally navigable manner via waterborne routes (Albion 1939:36). The Hudson, about a mile wide beginning at Lower Manhattan, spans 315 miles sourced by Lake Tear of the Clouds (Freeman 1991) but is tidal for only 151 miles. For this stretch depth varies from about 40 to 200 ft. (Aimone 2009:1). The Hudson River was, however, subject to an annual freeze which made it impossible to navigate. This also caused some trouble for the Upper Bay, as floating ice from the Hudson caused vessels to be driven ashore, inflicting damage to their hulls, and occasionally keeping them locked to their piers. When navigable, the river offered a good depth of water,

apart from a dangerous sandbar a few miles below Albany, and plenty of width for maneuvering (Albion 1939:20,30-31).

Economics: The Hub and its Spokes

The above-described environmental features of New York's bays, rivers, and tidal straits allowed it to develop as one of the early American examples of a hub-and-spoke distribution network (Glaeser 2005:12). The hub-and-spoke paradigm is essentially where any number of key facilities act as anchors or hubs to a regional economy, with suppliers and related activities spread around them like spokes of a wheel (Markusen 1996:302). In the case of New York City, Lower Manhattan and its Upper Bay can be seen as the central hub with its four main trading routes being the spokes. These routes, delineated in Figure 4, include the European, Hudson, Southern, and New England routes. For the sake of space, the European, Southern, and New England routes will not be discussed to any great length. Instead, the hub that was the Upper Bay and the all-important "spoke" of the Hudson route will be addressed given this was the environmental and economic contexts New York ferries operated within.

Through the course of the early to mid-19th century, the Upper Bay grew dramatically both in terms of economics and population. Comparing statistics between the 1820s and 1860s highlights this. As seen in Figure 5, New York City's population grew dramatically between 1820 and 1860. Accompanying this trend was a massive growth in imports and exports, both being close to 100,000 tons annually in 1824 and 1.5 million and 2 million tons respectively by 1860 (Cudahy 1990:42). As seen in Figure 6, however, New York quickly began to gross more as an importer than an exporter during this period (Glaeser 2005:13). This was because manufacturers were able to sell state produced goods locally, given the demand of a growing urban population, while distributing European and southern exports more effectively to

America's western hinterland and New England (Glaeser 2005:16-18). Furthermore, European packets benefited early in the 19th century as they could be piloted directly to Lower Manhattan's wharfs and unload almost right next to the auction houses without needing any knowledge of the market or their own storage facilities to effectively sell their goods (Cohen 1971:499).

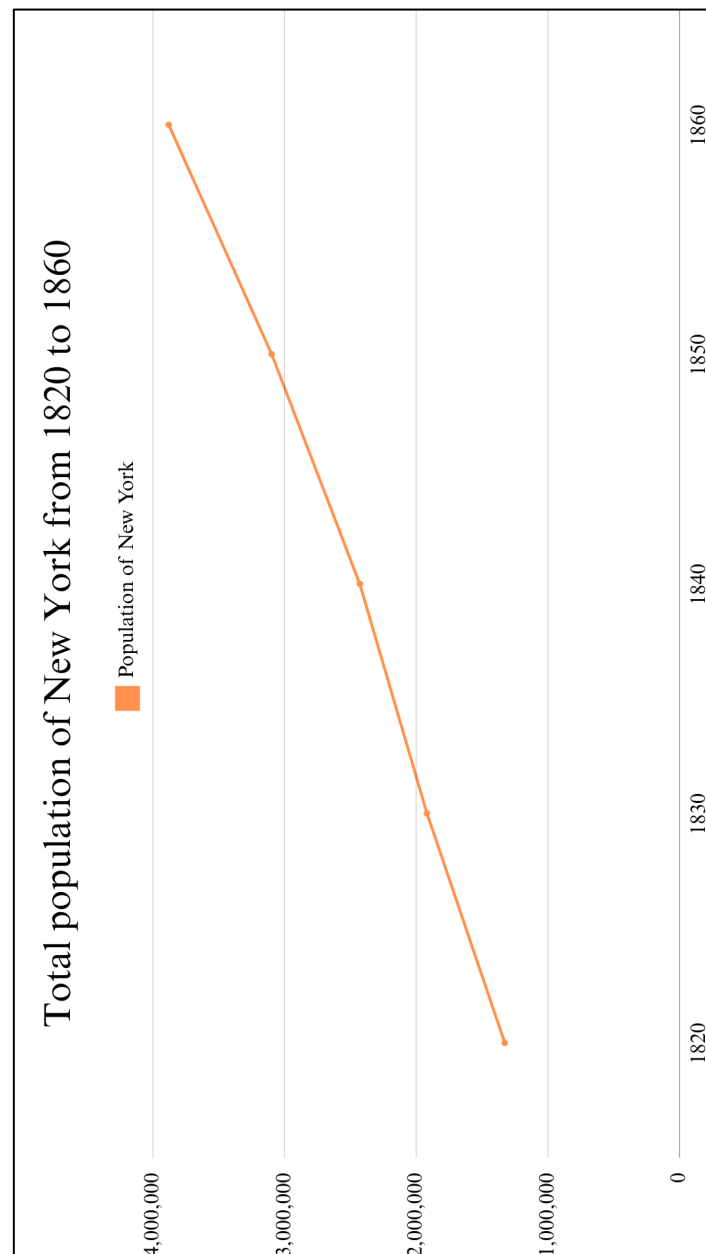


FIGURE 5: Total population of New York, 1820 to 1860 (figure by author; data courtesy of the United States Census Bureau 1901a:1).

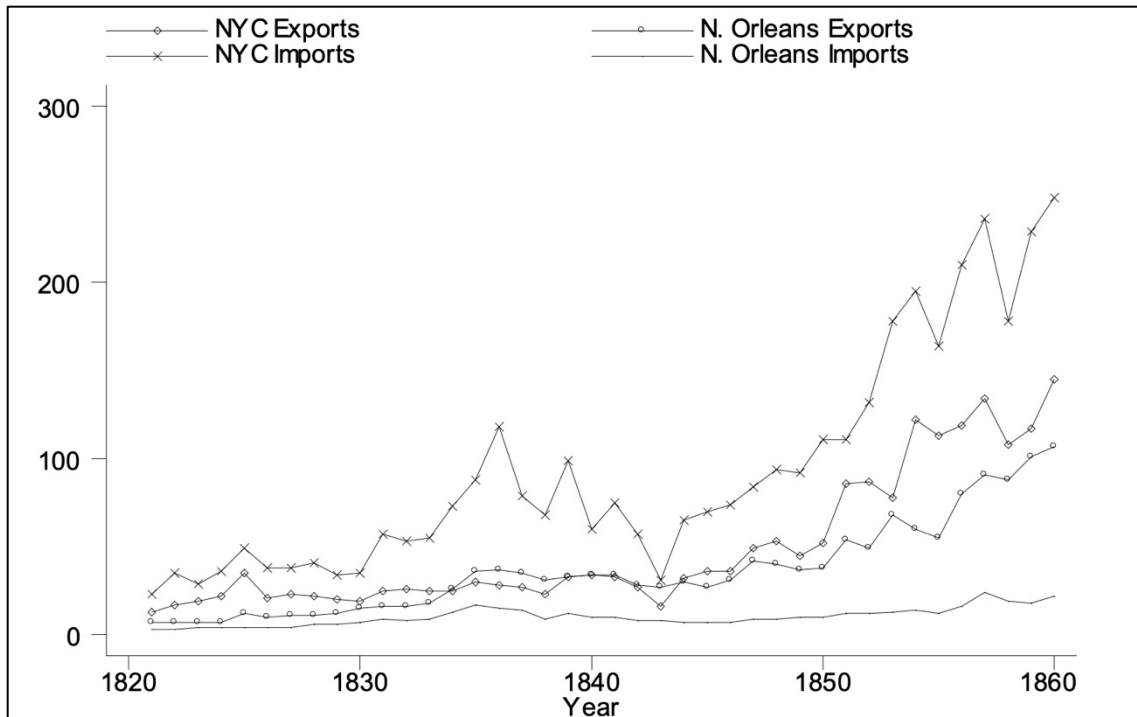


FIGURE 6: Exports and imports balance totals New York and New Orleans in millions of dollars (courtesy of Edward L. Glaeser 2005:13).

Manufacturers and merchants also benefitted from the Upper Bay's combination of a sheltered and deep waterfront. Some estimates have put the area of potentially workable waterfront at 771 miles (Albion 1939:34). This was ample room for the wharfs, shipyards, iron works, stores, and distribution centers that developed along Lower Manhattan and the adjacent Long Island and New Jersey coasts throughout the course of the 19th century. Indeed, by 1850, a collar of piers wharves, docks, and slips encircled Manhattan. The deeper waters at the mouth of the Hudson allowed larger coastal and transatlantic steamships to port while sleeker Liverpool packets could dock in the shallower waters of the East River (Burrows and Wallace 1998:653). The fact that New York's upper harbor could accommodate both shallow and deep drafted vessels gave it a major leg up to other port cities along the coast (Glaeser 2005:15).

Another important reason for New York City's economic growth from the early to mid-19th century was the forementioned access it had to the country's western expanse via the

Hudson River. This was arguably New York's most advantageous natural proclivity when compared to contemporary North American ports (Albion 1939:36). This deep and navigable river not only brought products from the Hudson Valley, but it also allowed for the travel of merchants and migrants from Albany and Troy. Furthermore, several towns upriver, such as Newburgh, had important maritime communities built on the ability for commercial shipping to navigate upriver (Aimone 2009:1,17).

Technological Developments: Industrializing Travel

As has been discussed, New York harbor's natural advantages made it a prime location for the distribution of both international and domestic products and the place to go for entrepreneurs, speculators, and foreign immigrants. Yet it was not nature alone that afforded New York City its remarkable economic growth from the early to mid-19th century. It was the introduction of the steam engine to land and waterborne transportation and developments in manufacturing that made New York the example of industrialization in the United States. Indeed, the state's growth from its economic conditions in concert with its environmental proclivities spurred the innovation and adoption of steam transportation technologies in and around the city.

Ferry construction would be affected by the general manufacturing trends that swept through the United States from 1800 to 1860. New manufacturing technologies propelled by the steam engine changed many aspects of America's practical shipbuilding tendencies, namely industrializing the construction process. As demand for more imports and exports in the growing New York City increased, shipbuilders sought to cut the cost for skilled labor by using mechanized manufacturing to streamline both the construction and repair of vessels. Two good examples are the steam-powered sawmill and the trunnel lathe. By the 1850s, both had replaced much of the handiwork of sawyers and adzmen allowing the subdivision of labor, reduction of

production costs, and greater output of vessels (Thiesen 2006:67-68). The introduction of marine engines to shipbuilding similarly divided the construction process. Much of New York's shipbuilding occurred on the banks of the East River, with the Manhattan side lined with shipyards for hull construction and the Brooklyn side, then being America's largest industrial site, containing iron works for engine and boiler construction (Thiesen 2006:59). These yards built many types of marine engines over the course of the 19th century but two were utilized most frequently in shallow drafted inland paddle steamers: the single cylinder walking beam and inclined engines (Kemp 1976:932; Cudahy 1990:367).

The walking beam engine quickly became a favorite in American inland waters. By the 1830s it was the standard engine in New York's sound, river, and bay ferries and continued to have prominence even after becoming an obsolete design (Buell 1906:93; Kemp 1976:932). The reasons for this revolve around reliability and cost. Walking beam engines had a simple design which meant they were easily operated and cheaper to construct, and if there was a mechanical issue the solution was likely simple (Greenhill and Giffard 1972:35). Yet, the engine type had its own difficulties, one of the most detrimental being the engine's affinity to stall if valves were not manipulated properly in concert with the piston (Cudahy 1990:47-48). By the 1850s, the single cylinder inclined engine became another engine type tried for shallow drafted ferries as it mitigated some of the walking beam's technological deficiencies (Cudahy 1990:367). "Inclined" simply refers to the orientation of the cylinder(s) and therefore encompasses many engine configurations. However, configurations for shallow drafted vessels were compactly arranged on the centerline (Bisbee 2018:13) with the cylinder inclined below the piston, the rod of which then connected to the crankshaft if configured for direct action or connected to a half beam which then transferred motion to the crank if not (Sennett and Oram 1899:7). Direct acting engines,

introduced in the late 1830s, were even more compact and light weight being that the piston rod connected to the crank shaft directly thereby applied power without a beam acting as an intermediary (The Mechanics' Magazine 1838:185). In either the half beam or direct acting configuration the issue of stalling was more easily remedied.

Society: The Influences on Transportation

There are many societal developments in the United States from 1800 to 1860 that could be discussed, but the most relevant to ferry construction was the consolidation of regulatory power within the Federal government. Perhaps the most significant and detrimental policy to the progression of ferryboat design was the monopoly granted to Robert Livingston by the state of New York in 1798 which gave him exclusive rights to operate steam vessels in New York waters for 30 years (Turnbull 1927:231; Cudahy 1990:37). It was not enforced until Robert Fulton, who was partnered with Livingston, launched the steam ferry *Clermont* to run between New York City and Albany in 1807. The next 17 years saw slow progress in design improvements as litigation and heated reprisals dominated the industry. For instance, in 1808 the Fulton-Livingston combine was empowered to seize any vessel violating their exclusive rights to operate in New York waters, to which New Jersey's state government reciprocated by giving their ferry operators the same right. This increasingly heated situation ultimately ended with the United States Supreme Court decision *Gibbon v. Ogden* 22 U.S. 1, 9 Wheat. 1, 6 L. Ed. 23 (1824) ruling that the Livingston-Fulton monopoly was unconstitutional. The Court decided that under the Supremacy Clause the federal government had the sole right to regulate commerce between states opening the industry to competition and experimentation (Cudahy 1990:37,39). The end of this monopoly meant the beginning of a golden era for steam ferries as competition and experimentation could continue without hinderance.

This competition and experimentation at times led to disaster, which within the ferry service usually came in the form of boiler explosions. The longer routes up the Hudson and through the Sound benefited from offering quicker travel times therefore racing and experimentation with high-pressure boilers ensued. The exploding boiler became notorious for causing catastrophic damage as seen in an early example of the Hudson ferry *Aetna* killing between 12 to 15 and injuring even more when its high-pressure boiler exploded (*Maryland Gazette* 1824:3). Furthermore, between 1830 and 1840 the United States government reported nine boating accidents in New York waters, seven of which were due to boiler explosions, nearly all in the Hudson River (Tyne 1840:1-5). The public sentiment became so worried over these explosions that at one point in the mid-1820s “safety barges” were towed behind some Hudson ferries. These tragedies ultimately lead to a series of Federal regulations culminating in 1852 after the *Henry Clay* disaster. After this tragic event, Congress passed their most stringent inspection standards to date, which included the licensing of pilots and engineers (Albion 1939:161) and pushed builders to use low-pressure systems.

Ferries: The Life Blood of a Global Port

By the time the Civil War began in the spring of 1861, the synergy of the environmental, economic, technological, and social processes created ideal conditions for the further development of the well-established tradition of ferryboat construction. The environment’s “natural combination of sheltered waterways” (Albion 1939:144), provided the space to develop and design ferries, the growing population provided the market, developments in manufacturing processes provided the means, and society applied boundaries. As specialization continued, ferries increasingly sat between two sides of the waterborne travel market: cheap and safe passage from point A to point B or an experience of comfort, luxury, and social activities while

traveling longer distances (Wergeland 2012:162). Indeed, to facilitate travel more efficiently throughout bays, rivers, and sound, New York ferries developed specialized features based on these market priorities and the routes they were slated to run. These can broadly be broken down into two categories based on length and nature of travel: “distance” ferries, and “proximity” ferries.

The distance ferries of New York were those running routes up the Hudson River and through the Long Island Sound. The rise in New York’s population in combination with that populations increasing domestic reach via the Erie Canal meant the need for more waterborne travel to and from the city at increasing distances. Given the time one might spend aboard, travelling in style became a big selling point to passengers, with even early designs including a long, high, and narrow central saloon which occupied most of the length of the vessel (Greenhill and Giffard 1972:35). This was surrounded by galleries onto which individual staterooms opened with ornate carpentry and rich upholstery to give an aura of luxury. Mechanically, Hudson steamers commonly placed their boilers directly aft of midships on either side of the deck to allow room for more berths and cargo below. The hull was designed for speed with Hudson ferries’ length to beam ratios reaching upwards of 11:1 (Albion 1939:157). The vessel *New World* is a good example as its 371 ft. in length and 37 ft. in breadth was a marvel at the time of its construction in 1847 (Murdock 1930). To reduce the risk of sagging caused by this extreme ratio and the machinery located midships, distance ferries employed exterior frames mounted on the deck known as hogging frames (see Figure 7) (Albion 1939:157). The combination of speed and luxury was an important economic force as inland and New England travelers were offered what was essentially a cruise with a comfortable berth on their way into the city.

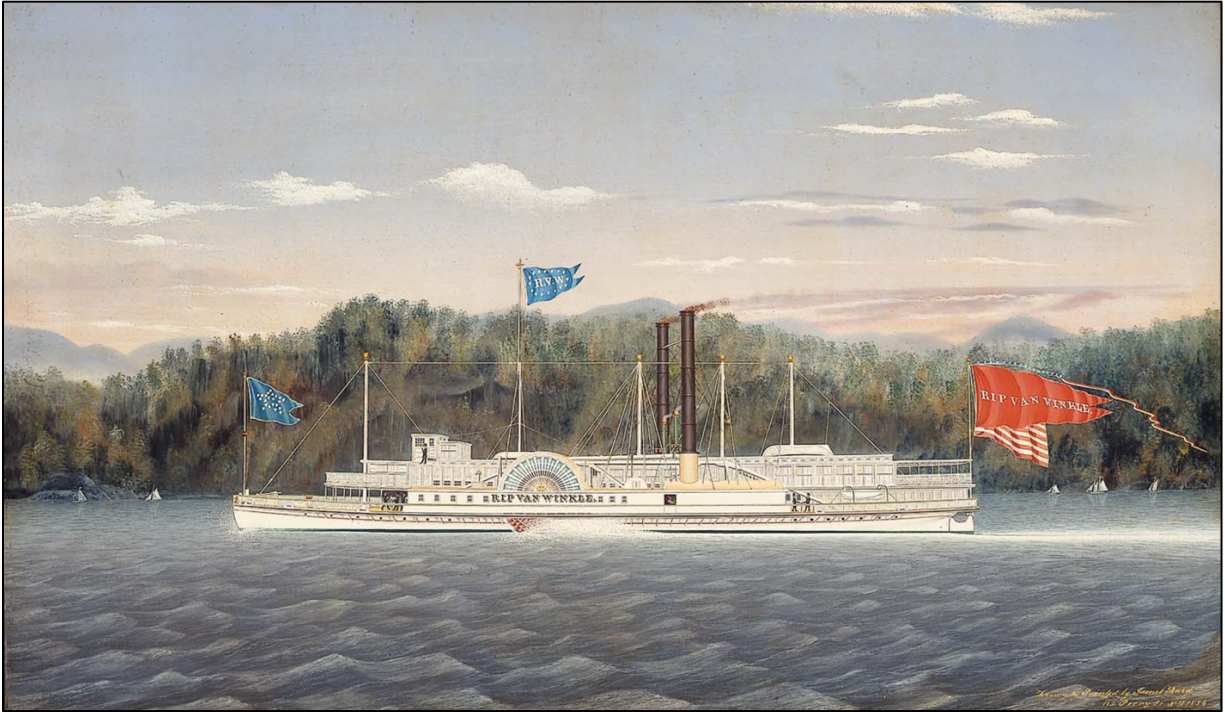


FIGURE 7: The Hudson River steamboat *Rip Van Winkle* by James Bard, 1854 (courtesy of the M. and M. Karolik Collection of American Paintings, 1815–1865, Boston Museum of Fine Arts, reference # 47.1212).

Proximity ferries, as the name suggests, were meant only for day trips within a much more confined area (Albion 1939:156). The insular position of Manhattan made this type of ferry service vital in crossing the mile-wide Hudson River to New Jersey and the narrower East River to Brooklyn. These ferries had services associated with three main routes: the trans-Hudson route, the East River routes, and the Staten Island routes all linking the surrounding land to Manhattan Island. By the 1840s, these ferries were invariably double enders, their origins tracing back Robert Stevens' ferry *Hoboken* built in 1822 that ran between Barclay St. and Hoboken (Cudahy 1990:33,43). The double-ender design seen in Figure 8 was very efficient, allowing the unloading of the maximum amount of passengers/cargo in the minimum amount of time. These ferries could then reload that same number for a return trip without any preparations necessary other than reversing the engine and steering from the other end (Hardy 1927:114).

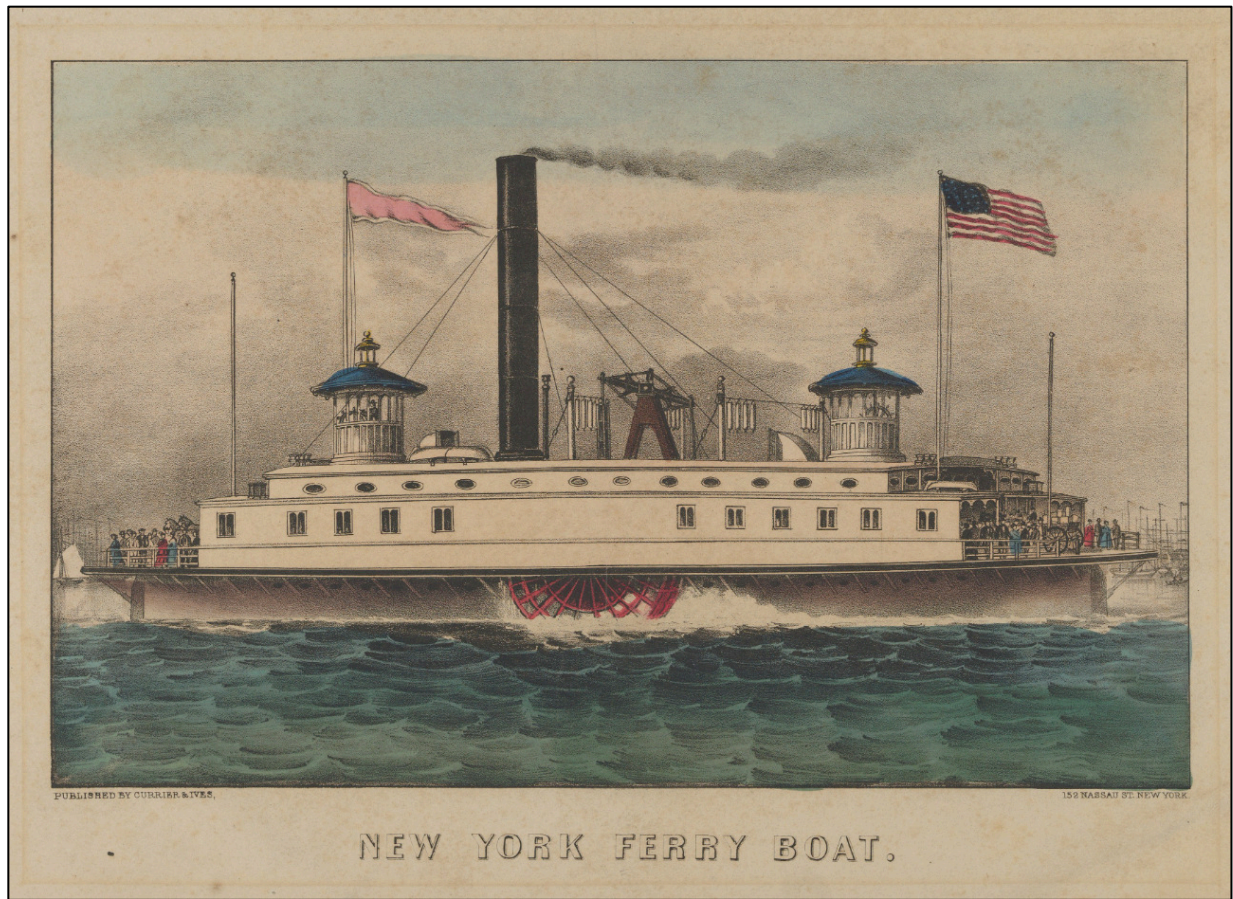


FIGURE 8. Lithograph of New York “proximity” ferry circa 1860 published by Currier & Ives (courtesy of the Edward W. C. Arnold Collection, New York Metropolitan Museum of Art, reference # 54.90.785).

Yet, to gain the most from these design benefits, the double enders needed to be paired with a corresponding terminal system. Also developed by Robert Stevens in the 1820s, New York’s terminal system consisted of pilings driven into the river bottom with flexible vertical planks attached between them to define the slip and absorb vessel momentum. For boarding and alighting, a gallows-like gangway was raised and lowered from a fixed frame by cable and pulleys. The gangway was separated into three sections that corresponded with the ferries’ main deck arrangement, a middle path for vehicles and two outer ones for foot passengers. The entire system, including the greater organization of ferry houses had nearly been standardized by 1860 and is essentially what is still used today (Cudahy 1990:54-56,63). Double enders were the most

practical when terminal facilities accommodated them, yet those facilities were expensive and therefore only feasible in large economic centers that had the money and population to justify them. This at least partly accounts for why most Mississippi ferries were side loaders, while New York and, later, some San Francisco ferries were double enders (Hardy 1927:114).

Returning to the ferries themselves, the main deck's arrangement included twin vehicle gangways running the length of the vessel at the centerline with two passenger cabins on either side surrounding the paddlewheels, one designated male and the other female. The passenger cabins were arranged to not just efficiently increase capacity, but also to protect the paddlewheels from damage they might incur from ice or shallow bars. These ferries almost exclusively used low-pressure engine systems often including a walking beam or, in some cases, an inclined engine averaging around 10 knots. To the point, these Upper Bay ferries did not need to worry about reaching high speeds and therefore had a much less extreme length to beam ratio, typically being between 4:1 and 6:1 (Cudahy 1990:45-46,49). Finally, from very early on these ferries were used for multiple purposes. Towing became a part-time job for many ferries employed around the Upper Bay, with one of the first instances being as early as 1818 (Albion 1939:147). In certain cases, the superstructure could be burned down to where the deck meets the hull to salvage engine components. This practice was also used to rebuild a new vessel from the hull in a short amount of time and place the vessel in service for some separate purpose (Cudahy 1990:50). Proximity ferries were essentially doubled-ended hulls with a large oval platform fixed to its surface and when viewed in this way, the manner of its use could change dramatically.

The Union Blockade and the Quick Need for Shallow Drafted Vessels

When the American Civil War broke out on 12 April 1861, the United States Navy was underprepared for the task it was soon to receive. Just seven days later, President Abraham

Lincoln would order the blockade of all seceded Southern states which meant to halt rebel trade and travel over a whopping 3,550 miles of coast starting at the Potomac and ending at the Rio Grande. To accomplish this task, the Navy only contained 1,300 officers, 7,600 sailors, and 42 steam-propelled warships (Taaffe 2009:xii,26). Of those 42 steamers only 5 frigates were available for blockade duty, none of which were fit to effectively blockade the South's shallow waters. The Union Navy therefore had to act quickly and soon created an informal board of advisors, mostly including shipping merchants from New York, for matters of acquisition. With the advice from the board, the Navy would go on to purchase 79 steamers by the end of 1861 and by the end of the war, it had purchased over 300 (Browning 1993:1,143,146). Of the total purchased, 20 were New York ferryboats converted for use as gunboats and over half of them served in the North Atlantic Blockading Squadron (NABS) (Minick 1963:186). Of these, the majority spent most of their time in North Carolina waters, including *Waccamaw*, or as it was then known, *Commodore Hull* (Minick 1962:433-435; Naval Heritage and History Command 2023).

Environment: The Waters of North Carolina

Blockading eastern North Carolina proved to be no easy task and a glance at a map soon indicates why (Figure 9). Union Naval forces blockading Virginia and North Carolina had more shoreline to cover than any other squadron during the Civil War. Moving from the outside in, the coast consisted of low and sandy islands that separated the Atlantic from large and comparatively calm inner sounds (Taaffe 2009:27). These 330 miles of outer shoreline was broken up by 24 tidal inlets which connected the interior waters with the ocean but were by no means stable, for example, the Oregon Inlet moved some 7000 ft. between 1850 and 1916 (Heddefine 1954:I-6).



FIGURE 9. Map of the “Eastern portion of the Military Department of North Carolina”, produced by the United States Army Corps of Engineers (courtesy of the Geography and Map Division, Library of Congress, reference # G3900 1862.U5).

Once past the dangerous inlets of the Outer Banks, a ship would find itself in either the Albemarle or Pamlico Sound with access to most of the major ports of the state, including Elizabeth City, and Edenton in the Albemarle and New Bern, Washington, and Plymouth upriver from the Pamlico. The Albemarle Sound spanned over 500 square miles with mostly uniform depths of 17 to 20 ft. The Pamlico, on the other hand, spanned over 1700 square miles and also had a mostly uniform depth of about 20 ft. outside of its extensive coastal shoals (Heddefine 1954:I-8). These large sounds allowed shallow drafted vessels to travel great distances without being in open ocean but precluded many larger vessels from making safe passage. While not conducive to the development of international or even intracoastal trade, these sounds would quickly become a wartime haven for blockade runners and Confederate privateers. The depth allowed them to sortie out and return before blockaders could react as the large warships of the coastal blockade were unable to chase them into the sounds due to their deep drafts (Browning 1993:7, 20).

The many rivers that make up the inland waterways of North Carolina are too numerous to discuss extensively here, however, a summation of their key features can be described. The Pasquotank, Chowan, Pamlico/Tar, Neuse, Roanoke Rivers were heavily plied by Union gunboats and provide good examples of the typical riverine conditions. The initial stretch of the first four are quite wide being no less than a mile across from their mouth until only several miles of their port cities (Heddefine 1954:App. A-5). Depths were similar between the first two rivers with the Pasquotank between 10 and 12 ft. until Elizabeth City and the Chowan averaging around the same until Winton (Bache 1850; Heddefine 1954:Plate No. 6). The Pasquotank was also connected to Virginia via the Dismal Swamp Canal; built in 1805, it was an important supply route for the South, if held (Browning 1993:27). In the Pamlico, the depth was just over

11 ft. at Washington and slowly decreased to 3-1/2 ft. at Greenville (Hinde 1954:App. A-20). The Neuse River had a depth of just under 11 ft. at New Bern but also became quite shallow soon after (Hinde 1954:App. A-26). While all were wide at their mouth, each river became quite shallow upriver, for instance, about 10 miles up from New Bern, the Neuse narrows to just over 250 ft. while Chowan narrows to about 300 ft. in portions a few miles upriver from Winton. Roanoke River, on the other hand, was narrow from the start. While the mouth of its delta was roughly 2 miles wide, it quickly narrows to three separate entrances all less than a quarter mile wide with depths averaging around 10 ft. at Plymouth and inclining slowly to around 7 ft. at Hamilton (Hinde 1954:App. A-10).

Economy: Acquisitions and Blockading North Carolina

The above-described environmental conditions were what the North Atlantic Blockading Squadron had to build its fleet around. Unfortunately, the Navy simply did not have the means nor the time to construct the number of vessels required to effectively blockade trade and travel of North Carolina's inland waters. To make up for this fact, the Navy department, under the direction of Gideon Welles, decided to charter vessels en masse and once it was clear the war would not be short, it began purchasing vessels outright for conversion (Browning 1993:143). Initially, a board of officers headed by Admiral Hiram Paulding would advertise for bids, inspect the vessels, and bargain for purchase or charter. The Navy purchasers were not seasoned businessmen however, and they regularly paid too much for their initial charters and purchases. Indeed, there are instances in which the Navy chartered vessels worth \$35,000 for \$7,000 a month with the owners potentially making up the total cost of their vessel in only 5 months (Browning 1993:144-145). It should be remembered the war was not universally viewed as a patriotic mission in the North and some owners likely felt no need to make sacrifices (Cudahy

1990:96). Like the construction contracts however, the Navy's demand for vessels was high, so over the course of the war it purchased 418 vessels making up about 2/3rds of their entire Navy (Browning 1993:146).

Contracted construction was generally as inefficient as the purchases and charters. Issues commenced in 1861, as soon as Congress mandated all purchases and contracts to be advertised and awarded to the lowest bidder, regardless of their industrial capabilities (Canney 1998:30). The Navy department soon contracted many builds to private yards that did not have the experience or expertise to accomplish what the Navy requested. The typical situation which would arise was an ill-equipped and inexperienced shop would enter the lowest bid, receive the contract, and then, sometime within the specified term, conclude that they did not have the ability to meet the Navy's requirements (Canney 1998:30-31). Regardless, private contractors built 124 out of the total 179 constructed by the end of the war (Browning 1993:147), indicating the impotency of the existing naval shore facilities.

A portion of these chartered, purchased, or constructed vessels made their way into the muddy North Carolinian waters to participate in the NABS's capture and control of the coastline. The blockade was, essentially, an economic stranglehold on the South attempting to halt not just Confederate foreign trade, but the flow of resources between the states (Canney 1998:19). Although North Carolina had many products to offer the Confederate war effort, prior to the war the eastern portion of the state was struggling economically. The cities of the inner banks had little modern infrastructure connecting them with the rest of the state, let alone the nation, up until the completion of the Wilmington and Raleigh (later Weldon) Railroad in 1840. The Wilmington and Raleigh Railroad did help stimulate growth in the southeast however (Figure 10), aiding Wilmington in New Hanover County and New Bern in Craven County to become the

state's most populated cities by 1860 having 9,552 and 5,432 inhabitants respectively (Reid 1866:29; Watson 1992:46). The southeast also averaged 300 thousand bushels of corn annually with the eastern portions also producing vast stores of fish, oysters, and other goods. Going northeast in the state, several counties produced large amounts of agriculture and livestock and were vitally important to the South's war effort. During the war, these counties annually produced 10 million pounds of pork and bacon, and 40 thousand bushels of corn (Browning 1993:124). Distribution routes for these products were quite insular as suggested by Figure 11. Indeed, the state did not have an adequate draft to develop direct foreign trade since the entrances to most ports were hazardous to many vessels over 300 tons (Albion 1939:24). Accordingly, these riverine routes were well known and established by North Carolinians by 1861, and their disruption would be an important objective for Union gunboats.

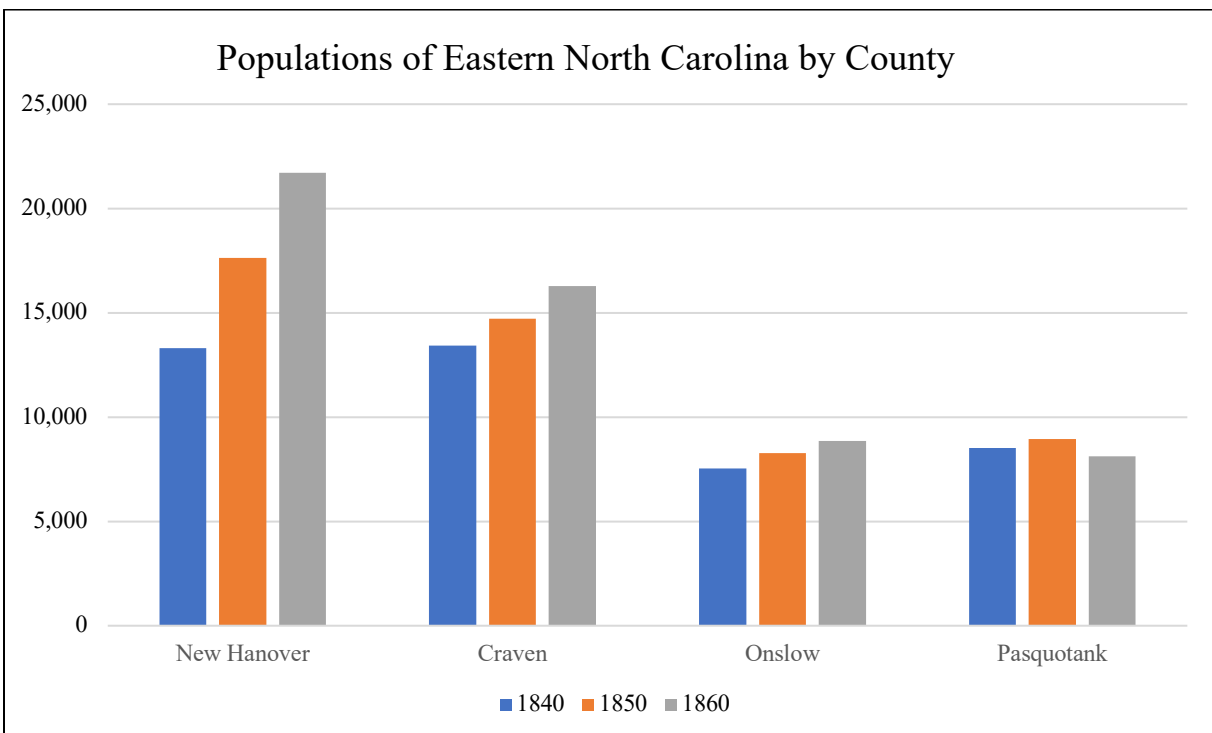


FIGURE 10. Populations of prominent coastal North Carolina counties (data courtesy of the United States Census Bureau 1901b:2-3; figure by author).

	Domestic		Foreign	
	Entrances	Clearances	Entrances	Clearances
Wilmington	11,555	19,718	9,115	11,380
New Bern	2,664	3,643		
Washington	2,118	1,372		
Edenton		131		
Camden	2,170	2,945		
Plymouth	1,205	2,175		113
Beaufort	473	755		
<i>The New American State Papers, 32:693, 697.</i>				

FIGURE 11. Tonnage entering and clearing North Carolina ports, July 1, 1849 - June 30, 1850 (courtesy of Alan Watson 1992:67).

Technology: New Tools for an Old Navy

The technologies available to the United States government at the start of the Civil War dictated how the Navy decided to build a massive fleet in a short amount of time. It is therefore important to discuss the Navy's yards, general armament employed, and the use of iron in ship construction. It should be noted that the Navy department never totally committed to iron hulled or steam propulsion prior to 1861 and its facilities were far more capable of constructing of wooden ships (Browning 1993:150). Indeed, these yards represented the state-of-the-art for wooden shipbuilding facilities incorporating large shipbuilding workhouses to facilitate year-round construction, dry docks and rail systems, timber sheds, spar shops, block shops, joineries, blacksmiths, and plumbing shops (Thiesen 2006:73). The Brooklyn Navy Yard, the largest on the east coast, had a stone dry dock that measured 320 ft. in length and 70 ft. in width. Completed in 1851, the dry dock took 10 years and \$2 million to complete and had a 217 ton wrought iron floating gate which was the first of its kind in the country (Canney 1998:43). However, these resources did not translate well for the mass production of steam powered or iron hulled vessels. Beyond the fact that two yards were lost to the Confederates at the war's onset, the remaining had few facilities to produce engines on a large scale. This again forced the Navy

department to contract with third parties to produce vessels (Canney 1998:35-36). Moreover, given the nature of blockade duty the yards would soon be overwhelmed with vessels in need of repair. Indeed, it was not unusual for months to go by before repairs were made to steamers that had received significant damage or needed extensive refitting (Browning 1993:151).

Regardless of these weaknesses, the Navy yards had an irreplaceable importance for the Navy's war effort including the fitting out of vessels, converted or otherwise, for combat. Armament varied from vessel to vessel and often changed multiple times through the course of the war (United States Department of the Navy 1921:59-243). There was, however, standard weaponry that could be expected, invariably including some kind of muzzle loaded smoothbore or rifled gun. The Union Navy typically used 32 pounder (pdr.) smoothbores, Parrots, and Dahlgren rifled guns of varying sizes (Silverstone 2006:xix). Rifled weapons were a relatively new addition in marine and field artillery. While experiments with the technology were being conducted by the early 19th century, it was not until the early 1850s that the practical rifled cannon became available in mass. Rifling was a technological innovation in ordinance design that greatly improved both range and accuracy of a cannon through the manufacturing of spiraling grooves within its barrel. These grooves essentially induce rotation to the projectile making it more resistant to the blocking power of air (Thomas 1863:14). Guns were usually mounted on either traditional carriages with wheeled trucks or on pivot mounts. On pivot mounts, guns with carriage rotated around a central point, usually recoiling on skids with this system generally being placed close to the bow and stern of gunboats.

Finally, the development of iron production in the northern states in the first half of the 19th century aided in the Navy's production responsibilities and was a key element in the Union's industrial advantage over the South. The use of iron in American ship construction occurred

more slowly than it did in countries such as Britain, but by the beginning of the war there were several practices that had become common. By the 1850s, shipbuilders began to reinforce wooden ships of all kinds with iron keels, frames, and strapping to reduce the stress steam machinery placed vessel's midship which caused hogging (Thiesen 2006:82), such as the forementioned hogging frames seen in New York distance ferries. Iron hulled vessels, however, had not been excepted to any great extent by the Navy and there were technical reasons for this reluctance beyond general apprehensions caused by the introduction of new technologies. Common technical arguments against were that barnacles and sea growth fouled iron hulls more quickly than coppered wooden hulls and projectiles penetrating an iron hull proved deadlier than splinters from wooden hulls (Thiesen 2006:83). Yet doubts regarding the efficacy of iron hulled vessels or even simple iron plating soon disappeared by March of 1862 after the famous clash between the USS *Monitor* and the CSS *Virginia* (Bisbee 2018:2).

Society: In Pursuit of a Modern Navy

The Civil War was a defining event in United States history, not just in terms of answering the question of slavery, at least on paper, but also in consolidating power in the nation's central government and modernizing its military. While the United States Navy was no exception to this modernization, it would have a difficult time overcoming "old Navy" conceptions of what it should be. After the War of 1812, the nation was concerned with suppressing piracy and holding hegemony over all North and South America (i.e., the Monroe Doctrine). Yet this was not done through investing in steam technology, but instead by building "frigates and seventy fours" (Toll 2006:456-457). The emphasis on wooden hulled sailing ships is reflected in the disposition of United States Navy at the beginning of the Civil War. They had a total of 90 vessels, the majority of which were sailing vessels fit mainly for receiving and training duties steamers (Browning

1993:1-2). The remaining vessels were steamers, however, only five were available for blockade duty as the majority were tasked with protecting American trade interests abroad (Silverstone 2001:ix). As can be seen, it was a social interest in external power projection via sea-faring warships that guided the United States' initial naval construction efforts. Therefore, a dramatic shift in the structure of the fleet and command was needed if the Navy was to effectively blockade the southern states.

Overcoming old prejudices to build a steam-oriented navy was one thing, but implementing this new technology effectively in combat was another. Army commanders routinely failed to recognize the strategic possibilities presented to them by occupying stretches of rebel coastline. Indeed, the inability of the Navy to persuade the Army of a concerted collaborative effort has been cited as one of the Union's greatest strategic mistakes (Taaffe 2009:28). The latter often viewed the former as occupying a subordinate role and, as was much to the consternation of the naval commanders, this was often the reality. It was widely accepted within the Union government that whatever the Navy's contributions to the war effort, it would be the Army that destroyed and occupied Rebel territory (Taaffe 2009:xiii). In North Carolina, this led the Army to have a policy of holding as many east coast positions as was feasibly possible. This kept the Navy's gunboats constantly under orders to support or extract various Army units all the while still being expected to fulfill picket and patrol duty. The constant needs of the Army hindered the Navy's ability to keep these vessels in good working order, provide more concentrated support, and spread blocking efforts thin (Browning 1993:96-97). Army commanders simply prioritized their needs over the Navy's without truly grasping how to effectively utilize the shallow drafted, often double-ended, riverine gunboats.

Gunboats: The White Blood Cells of the Union Navy

The above-described processes shaped the need for gunboats, how they were acquired, how they built/converted, and how they were used in the war. The environmental and technological factors dictated that the type of vessel for the interior waters of North Carolina be a shallow drafted, preferably doubled ended, boat that could either be constructed or converted quickly (Cudahy 1990:96; Browning 1993:x-xi). The economic and social processes were important in shaping the specific operations these gunboats undertook, and which objectives were pursued in earnest.

The blockaders of North Carolina had to capture, patrol, and control the state's extensive and shallow inland waters (Minick 1963:186). This meant gunboats would be working in concert with the Army to capture positions by facilitating fire support, resupply, and extraction.

Gunboats were also tasked with stopping the enormous network of contraband trade and act as advance parties sweeping for torpedo mines and combating Confederate guerrilla units (Browning 1993:119). By the end of the war, the Navy built 47 purpose-built wooden side-wheeled double-ended gunboats to accomplish these tasks. Of those, 24 were stationed in the NABS for at least a portion of their service. They were designed in accommodation of the narrow and shallow waters they were intended to work in, and as can be seen, those dimensions did not differ greatly from their converted counterparts (Figures 12 and 13). Their double-ended hulls eliminated the need to turn around and their flat bottoms, drawing no more than 12 ft., lessened the potential for grounding (Silverstone 2006:34-41). Yet maneuvering was still an issue for all gunboats as Union pilots unfamiliar with the shifting shoals of the inlets and nuances of North Carolina's hazardous rivers routinely experienced difficulties. For instance, gunboats operating in the rivers frequently sustained damage to their hulls and rudders due to contact with the bottom. Natural obstructions did not only affect what was below the waterline, however, as

lifeboats, foremasts, smokestacks, and spars were all liable to be snagged on overhanging trees and branches (Browning 1993:120).

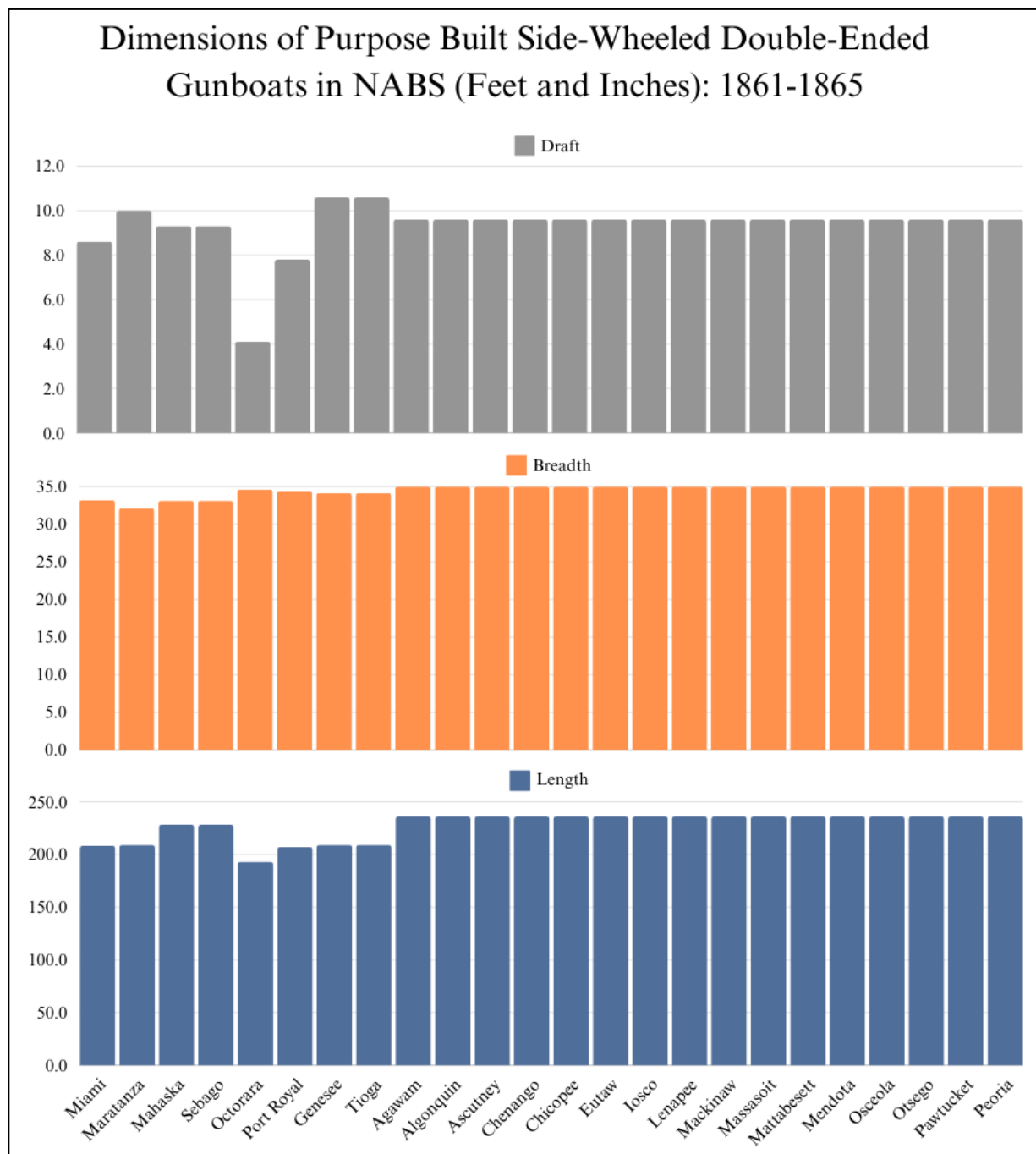


FIGURE 12. Dimensions of purpose-built side-wheeled double-ended gunboats in the North Atlantic Blockading Squadron from 1860 to 1865 (figure created by author; data courtesy of Paul Silverstone 2006:35-40).

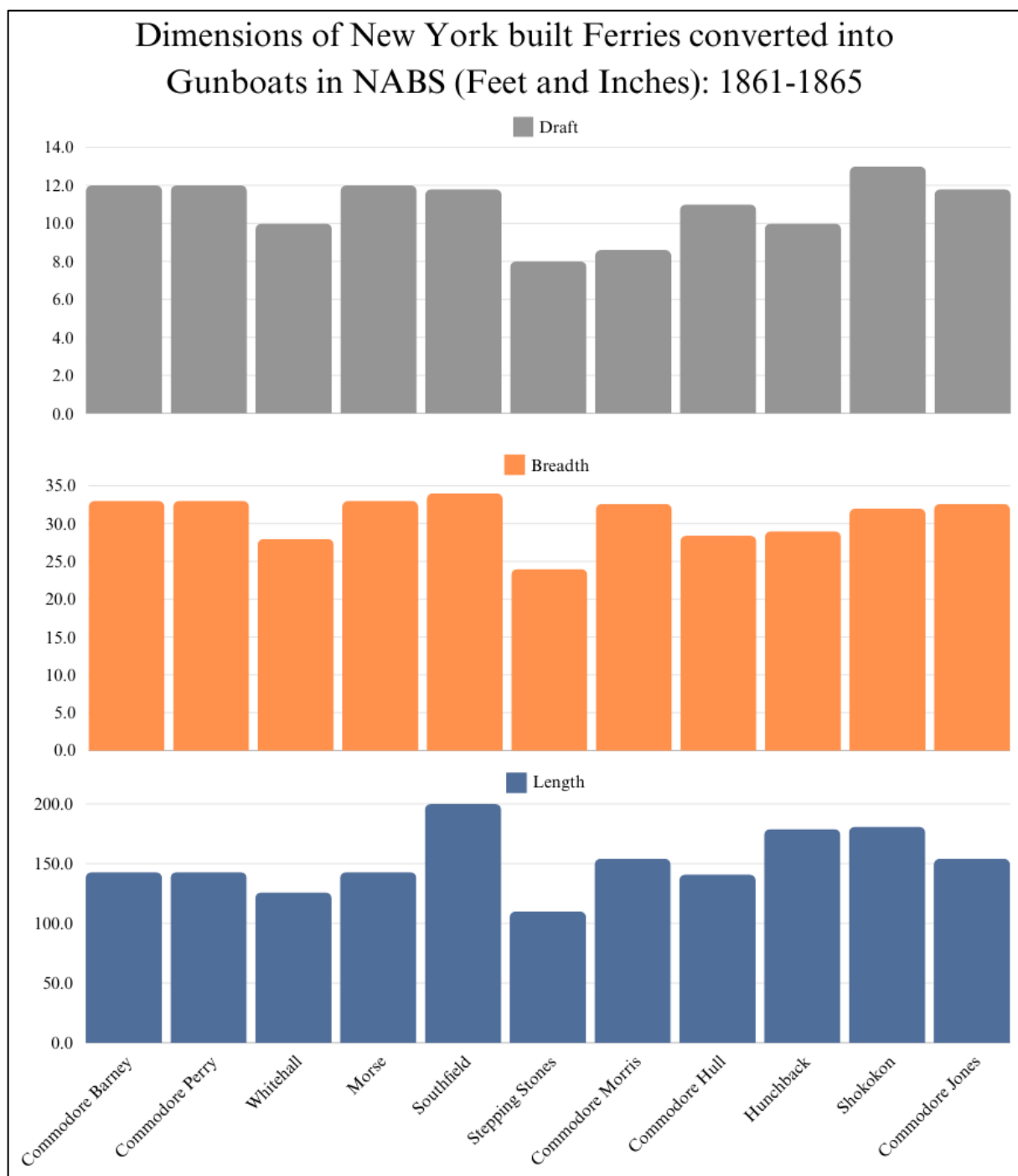


FIGURE 13. Dimensions of New York built ferries converted into Union gunboats in the North Atlantic Blockading Squadron (figure created by author; data courtesy of the Official Records of the Union and Confederate Navies 1921:59-243 and Paul Silverstone 2006:66-69).

The economics of acquisition affected the physical reality of both purpose-built and converted double-ended gunboats. As mentioned above, the Navy purchased many vessels quickly with the initial purchases being overpriced for their value and use wear. Purpose-built

boats from both private and naval yards were subject to flaws. As pointed out by Diveley (2008:139), only three out of the ten *Sassacus*-class double-enders built by the United States Navy served without some type of mechanical or constructional issue. Browning (1993:148), furthering the point, states that the NABS was a major victim of fraud and careless workmanship as many of the privately constructed gunboats not only failed to meet the specified draft, speed, and capacity requirements set forth by the government, but consistently failed to meet the agreed upon completion date. Yet, as seen in Figure 13, purpose-built gunboats and converted New York ferries shared similar dimensions reflecting an ability to enact design preferences. One benefit of purchased vessels was the guarantee that the length, breadth, and draft would be what was requested. However, the Navy did require some significant modifications to these vessels which caused added work for the already overwhelmed private and Navy yards. The modifications usually included the strengthening of hulls, addition of another bilge pump, and replacement of boilers before the converts were commissioned (Browning 1993:146).

Once commissioned, the difficult to control North Carolina inter/intra-state trade necessitated a significant presence of gunboats, given the sounds and rivers allowed for many routes and hiding spots for the illegal flow of the state's agricultural products as described above. Controlling this was accomplished by destroying commerce and by patrolling the inland waterways and sounds. Boats, bridges, carts, storage facilities, and production centers became important targets while conducting patrol duty. From the Navy's perspective, trade in the interior must be tightly controlled. Only civilian boats carrying sutlers' goods, wood, fish, oysters, and supplies for the Army would be allowed entry into Union controlled southern ports. Operations upriver became important, causing riverine gunboats to have a very active role when compared to the exterior coastal blockade. For instance, excursions in the Roanoke River were taken to

prevent supplies and reinforcements from reaching Wilmington via the forementioned Wilmington and Weldon Railroad (Browning 1993:115,125,130). A mixture of purpose-built and converted gunboats, including New York built ferries, were utilized for this and many other similar types of missions.

Technologically, conversions were given a mix of modern and antiquated technology. As mentioned above, naval vessels typically carried some combination of smoothbore and rifled guns, almost invariably including Dahlgrens and Parrotts. Double-ended gunboats, both purpose-built and converted, had similar arrangements. A good example is the *Sassacus*-class gunboat *Ostego*, which in 1863 had two pivot guns, one fore and one aft, and six broadside guns all either port or starboard (Diveley 2008:151). By 1864, two more guns were added for a total of ten consisting of two 100 pdr. Parrott rifles, two 20 pdr. Parrott rifles, four IX-inch Dahlgren smoothbores and two 24 pdrs. (United States Department of the Navy 1921:168). Converted ferries had the added advantage of being able to place guns directly fore and aft, as seen in *Commodore Perry* (Figure 14). The common tactics used by Union gunboats with this weaponry can be seen in the capture of New Bern in March of 1862. Union gunboats began their attack by shelling woods on the west bank of the Neuse River to drive Confederate forces from it so the Army could land there. Once landed, Union troops advanced while gunboats shelled the woods before them driving back the enemy. This was one of the first uses of a creeping barrage (Browning 1993:32) and was made possible by range and accuracy permitted by rifled weaponry. Adding weapons to converted gunboats was also the primary reason for strengthening their hulls. Indeed, some ex-merchantmen sprang severe leaks as timbers pulled from their frames from firing and the strain of additional weight (Browning 1993:155).

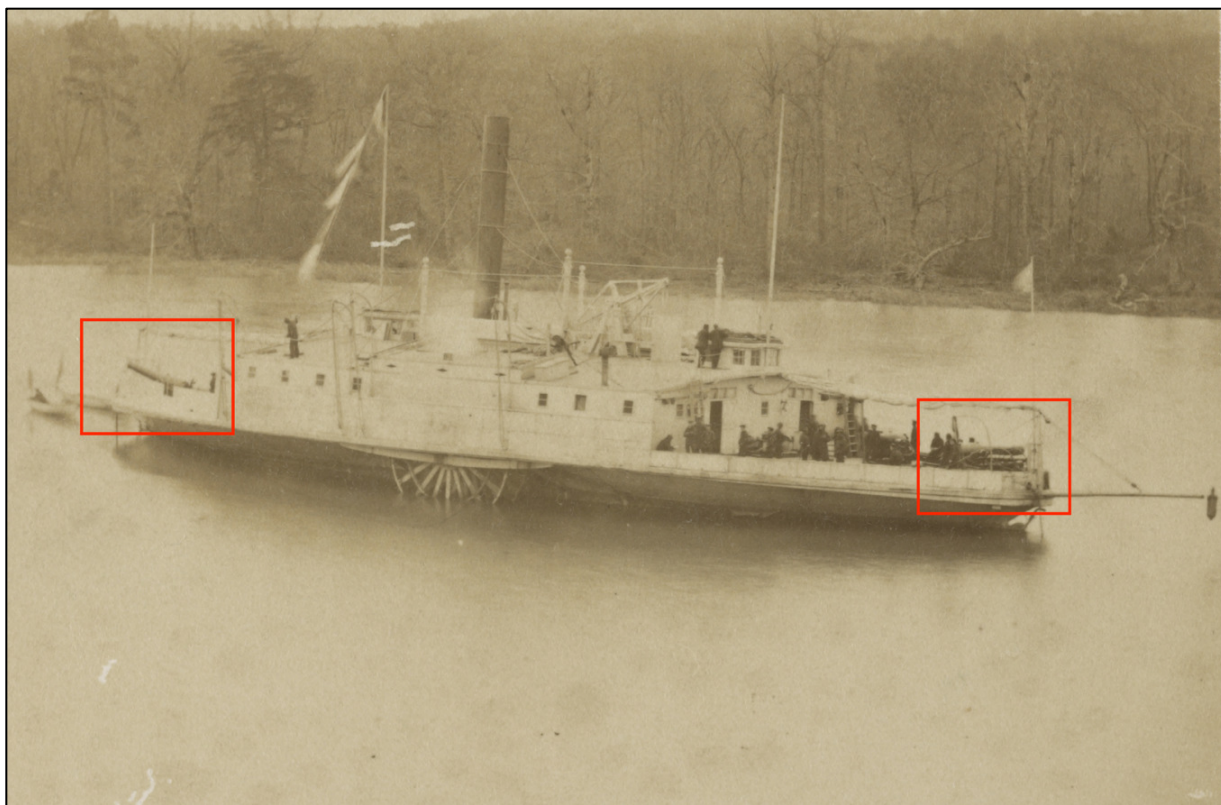


FIGURE 14. Gunboat "*Commodore Perry*" in the James River, Virginia between 1861 and 1865. Note cannon at either end (courtesy of the Division of Prints and Photographs, Library of Congress, reference # LOT 4182, no. 7; annotations added by author).

As experience accumulated, it was clear gunboats plying in the muddy rivers would need some type of protection against small arms. A typical Confederate strategy that soon developed was to make Union vessels “run the gauntlet” by lining artillery and small arms behind earthworks and bottlenecks to harass them as they came upriver. Instances of this can be seen in the Union’s capture of Elizabeth City in February 1862 (Browning 1993:29) and the Confederate siege of Washington in spring of 1863 (Saltonstall 1913:61). Early protection for most gunboats consisted of sandbags and cotton bales, but this was only a stop gap until iron could be fitted. As early as August 1861, plans to use boiler iron in lining the bulwarks and steam drums of boilers were proposed (Minick 1962:428). By the winter of 1862, plating for converted gunboats was becoming more standardized with Squadron Commanders such as Phillips Lee requiring vessels in the North Carolina sounds to plate their pilothouses, steam drums, machinery, and batteries

with boiler iron. Adding plating was a lengthy process and while some vessels went north to be fitted, others received their protection in the sounds if able to ensure their continued service (Browning 1993:89).

As mentioned, the Army's overcommitment to controlling eastern North Carolina meant gunboats would be held back from repairs as long as possible. This practice caused issues born, in part, from a lack of cohesion between the Army and Navy. This was exacerbated by the fact that yards were overcrowded and underprepared. The breakdown of boilers was a common issue as enemy projectiles, the use of grease, tar, and pork to stoke the fire, and salt accumulation from the environment could all cause irreparable damage. By 1863, gunboats needing new boilers were simply kept at their station to act as floating batteries (Browning 1993:155) causing some animosity between the Navy and Army. Gunboat patrol duty was another area that caused friction between the Army and Navy as Secretary Welles generally took a hardline stance on trade restrictions. He believed that once special permissions were given to northern speculators, they would be difficult to stop (Welles 1911:227). North Carolina would suffer particularly from a lack of consistent trade policy as the Navy, Army, and federally appointed state military governors all attempted to deal with trade in their own ways. For instance, Edward Stanly, who was appointed military governor of North Carolina on 26 May 1862, opened civilian trade to New Bern and Washington and gave permits allowing vessels to trade in nearly all navigable state waters with other permitted "loyal citizens" (Brown 1968:267). Fed up with the reality that many of these citizens sold their goods to Confederate troops, Squadron Commander Lee only honored permits signed by the War, Treasury, or Navy Department (Browning 1993:133-134).

Ultimately, the reason why ferryboats were natural choices for use as gunboats is indicated above but is also stated directly in the historiography. Browning (1993:130) points out

that ferries were built strong to carry the heaviest horse-drawn vehicles, had enough power to push away ice in the rivers, drew little water, and had the important advantage indicative of all double-enders: the ability to proceed in the opposite direction without turning around. Historian Rachael Minick agrees with this reasoning but adds that these vessels also had ample room to carry a large number of people, armament, munitions, and supplies comfortably (Minick 1962:425-426). But perhaps Brian J. Cudahy states the most influential reason, “It would take months and years for northern shipyards to turn out sufficient numbers of new vessels for the Navy. Why not purchase existing bottoms right away and make do until proper vessels came on-line?” (Cudahy 1990:96). Indeed, while ferryboats had many design features which made them ideal for riverine gunboat warfare, they were only needed because the Union Navy was underprepared, understaffed, and technologically antiquated at the start of the war.

Conclusion

The above description explains the technological, economic, and social influences on the creation of New York built ferryboats and their subsequent conversions into Union gunboats from the perspective of the historiography. The interplay between New York’s environment and economic growth provided an ideal breeding ground for the development of transportation technologies. Society spent the early part of the 19th century figuring out how to best regulate the use of marine steam propulsion until technological innovations and economic impetuses opened the way for expanded routes and the creation of timely, efficient, comfortable, and eventually standardized steam ferries.

When the Civil War erupted, an underprepared United States Navy recognized that the “proximity” ferry’s design features aligned with their new mission of placing an economic strangle hold on the Confederacy. Indeed, an effective blockade of the southern North American

coastal and interior waters called for a multitude of shallow drafted vessels. Given relative similarities between New York's Upper Bay and the sounds and rivers of North Carolina, New York proximity ferries could be converted for secondary use as gunboats for a Navy that had neither the time nor resources to construct enough of their own. The physical nature of the ferryboat's conversion would then be dictated by first, the need to amass a great number of combat vessels in a short time frame; second, the Navy's inadequate technological infrastructure; and third, combat experience gained on the battlefield. Once at their stations, the gunboat's duties could vary depending on the politics of command but were standardized to an extent that rendered them operationally effective. The above discussion represents the broader context that may provide further insight into how certain reuse cycles and discard processes show themselves in the archaeological record.

Chapter 4: Investigating *Waccamaw*'s Systemic and Archaeological Contexts

To answer the primary research question, and the subsequent secondary questions, a methodology was designed to be broken into three distinct but interconnected areas: historical research, archaeological investigation, and analytical methodology. This chapter provides a detailed account of the methods used to acquire the data needed to analyze the systemic and archaeological contexts that shaped *Waccamaw* during its use and subsequent abandonment.

Historical research required the acquisition of primary and secondary sources to first understand the operational contexts which influenced the material reality of *Waccamaw*, and second, to understand its construction, conversion, later modifications, and eventual abandonment. Secondary sources included histories of early to mid-19th century New York City, the United States Navy prior to and during the Civil War, and the general development of shipbuilding practices in the United States throughout the 19th century. Primary sources were key in providing firsthand detail to histories and the retelling of construction practices. Through the course of historical research, no plans of *Regla* were discovered requiring the author to rely on close correlates to complete the 3D reconstruction. The key and supplementary sources are described within the historical research section of this chapter.

The archaeological investigation was the material foundation that both informed and was informed by the historical research by providing material evidence of the construction trends, filling gaps in the contextual data, and relating the site formation data. The primary methodology used to record and analyze the *Waccamaw* site was photogrammetry, but targeted measurements, and scaled photographs of diagnostic features were also gathered. Two trips were taken to Eagles Island to collect this data, the first on 27 October 2023 and the second on 30 June 2024. How the

field work was planned and how the data was collected are discussed in this section.

Furthermore, the challenges in data collection and how they were dealt with are also discussed in detail within the archaeological investigation section.

The last portion deals with the analytical methodology which is composed of the integration of the photogrammetric model with the 3D reconstruction of *Waccamaw* and the juxtaposition of broader statistical data with the use and discard cycles of the vessel. Any relationship between the statistical data and the use cycles of the vessel can be understood within the theoretical framework of Behavioral Archaeology as described in Chapter 2. The analytical methodology was, therefore, a synthesis of the theory, historical research, digital models, and broader contextual and statistical data.

Historical Research

A variety of sources, primary and secondary, were used to understand the operational contexts in which *Regla*, *Commodore Hull*, and *Waccamaw* existed and the construction and modifications resulting from them. With the broader historical contexts having been discussed in the history chapter, those sources which aided in understanding *Waccamaw* specifically are reviewed in this section. With many unknowns regarding the original build, conversion, and modifications specific to *Waccamaw*, it was necessary to have a strong understanding of the operations and tasks that ferries, gunboats, and towing/salvage vessels were expected to perform respectively. With that knowledge in hand, educated decisions were made on how to proceed with the field work, 3D reconstruction, and analysis. The first two segments of this section of the chapter are therefore divided between contextual and construction sources, with the contextual sources speaking to operational information. Both segments begin with a description of secondary sources which consisted of various books, chapters, and articles. Primary sources are then

discussed including contemporary newspaper articles, construction treatises, and government documents. There were also a select number of archaeological site reports used to inform construction characteristics of the same or similar types of vessels and are discussed with the secondary sources. Two small segments conclude this section, the first discussing the only discovered depictions of *Commodore Hull*, and the second covering the photographs and plans used in reconstructing the vessel.

Contextual Sources

Several key secondary sources were used to inform the operational contexts within which *Waccamaw* existed, with smaller publications and articles used to fill in gaps or deepen the understanding on a certain topic. The following segment discusses these sources with brief descriptions being provided for those most influential in the research methodology.

Secondary Sources

Three key secondary sources spoke to the first stage of the vessel's life, the first one being an article by archaeologist Mark Wilde-Ramsing and historian Richard Triebe titled "The Mystery of the *Nuestra Señora de Regla*: Underwater Archaeology in North Carolina" (1992) and published in the National Archives quarterly magazine *Prologue*. This shares basic details regarding the original construction of the vessel, an overview of its capture by the Union Navy and the major battles the vessel took place in, all based on primary documents and construction plans. Both authors and North Carolina Underwater Archaeology Branch were contacted to ascertain the location of the primary documents consulted but to no avail. Therefore, this and the next article discussed, remained the most detailed accounts of the vessel's early past and construction available to the author.

This next source was an article by Carolyn Busse entitled “A Ship with a Colorful past: *Nuestra Señora de Regla*” (1992) and published in the University of North Carolina, Wilmington’s quarterly magazine *UNCW: A Magazine for Alumni, Parents and Friends* gave an excellent summary of letters found onboard the vessel when originally taken by the Union. While the current location of these letters and their transcriptions were not found, the article gives good incite to the events leading up to vessel’s conscription. The third key secondary source consisted of articles and notes found in The Mariners Museum’s Eldridge Collection. Documents included a typed notebook containing all the information the researchers Edwin Eldridge and John H. Morrison found on *Regla*. This included newspaper articles contemporary to 1861 discussing basic construction elements and a magazine article and newspaper clipping which regarded *Regla*’s builder John Englis (The Mariners Museum and Park 1939).

In the discussion of the Civil War era of this vessel, the first source, Robert Browning’s *From Cape Charles to Cape Fear: The North Atlantic Blockading Squadron During the Civil War* (1993), proved invaluable. This book provides a thorough account of the how the United States Navy acquired the vessels needed for their operations in the mid-Atlantic with a particular emphasis on gunboat operations, converted and purpose built alike, including specific information on the major battles in which *Commodore Hull* participated. Another invaluable publication, “New York Ferryboats in the Union Navy” by Rachael Minick (1962-1965) discusses basic conversion features seen in New York built converted ferry gunboats based on original correspondence between Navy Secretary Gideon Welles and naval contractors with specific reference to *Commodore Hull* and its first commander William Saltonstall.

Finally, the key secondary source used to understand post-war Wilmington, North Carolina and the Cape Fear River maritime community was Claude V. Jackson III’s book *The*

Big Book of the Cape Fear River (2008). This book includes a wide range of primary and secondary documents compiled to produce an overview of the most important business owners, companies, ships, shipwrecks, and navigational aids that accumulated along the Cape Fear River from the colonial to the modern era. Information relating to *Waccamaw*'s use as a Cape Fear River ferry, towing, and salvage vessel were also acquired within this book.

Primary Sources

The key primary sources used to inform the various operational contexts of *Waccamaw* consisted of an anthology of letters and correspondence of the Navy department during the Civil War, an autobiography from the first commander of *Commodore Hull*, and a variety of contemporary newspaper articles from Wilmington, North Carolina. First, the *Official Records of the Union and Confederate Navies in the War of the Rebellion* (ORN) was an anthology of letters and correspondence released by the Department of the Navy from 1894 to 1922 consisting of two series, the first of which contained 27 volumes and the second containing three. All 30 volumes were reviewed to find any references to *Commodore Hull* resulting in the collection of 314 pages between eight volumes in the first series and the first volume of the second. These pages contained letters, vessel station lists, after-action reports, and statistical data that referenced *Commodore Hull* in some capacity and were important in establishing common operations and posts occupied by the vessel. In 1913, William G. Saltonstall privately published an autobiography entitled *Reminiscences of the Civil War and Autobiography of William Gurdon Saltonstall Acting Volunteer Lieutenant Commander, U.S.N* (1913). In that work, Saltonstall recounts his time as the first commander of *Commodore Hull*, providing important insight to some of intense action the vessel saw and information layout of space after its conversion.

Continuing, many contemporary Wilmington newspapers spanning from the 1860s to the 1880s were collected to learn of the jobs occupied by *Waccamaw* post-war. Furthermore, these sources were the primary references that stated anything regarding modifications or repairs made to the vessel as it finished out the last stage of in the systemic context. Table 1 displays the number of articles accessed by decade and the papers from which they originate.

A final source that should be noted was produced in 1882 by the United States Supreme Court. Due to the interest in enhancing diplomatic relations between the United States and Spain in the late 19th century, the United States government attempted to reopen a stagnant case regarding the wrongful seizure of *Regla* as a war prize. The case's statement of facts document provided some additional context to the motivations and causes of the vessel's conscription into the Union Navy.

TABLE 1. The number of Wilmington based newspaper articles collected in researching *Waccamaw*'s career in Wilmington, North Carolina by decade.

Decade	Number of Articles	Sources
1860s	12	<i>The Daily Journal; The Wilmington Journal; The Wilmington Morning Star; The Wilmington Post</i>
1870s	74	<i>The Daily Journal; The Evening Post; The Wilmington Journal; The Wilmington Morning Star; The Wilmington Post; The Wilmington Sun</i>
1880s	3	<i>The Weekly Star; The Wilmington Morning Star</i>

Construction Sources

No contemporary photographs or plans were ever uncovered for *Waccamaw*. Yet, the vessel was a known type from a known period meaning how it was constructed and modified over the course of its use could be surmised based on the requisite construction information. Therefore, secondary and primary sources used to inform the vessel's original form and conversions dealt

with contemporary Northeastern double ended ferries, converted ferry gunboats, and towing and salvage vessels.

Secondary Sources

Beginning with the key secondary sources, William L. Crothers 2013 book *American-Built Packets and Freighters of the 1850s: An Illustrated Study of their Characteristics and Construction* was a foundational aid to understanding the likely features of *Regla*'s original reconstruction. Crothers provides excellent illustrations, dimensions, and explanations of general mid-19th century wooden ship construction. James D. Spirek's 1993 "USS *Southfield*: An Historical and Archaeological Investigation of a Converted Gunboat" also provides a thorough overview of one of the only archaeologically documented converted ferryboats and certainly the most intact. This master's thesis provided scaled plans, artifact drawings, and insights into both original and military conversion features not easily obtained elsewhere.

In a similar vein, Justin Parkoff's PhD dissertation "'A Formidable Looking Pile of Iron Boilers and Machinery': Reconstructing the Civil War Gunboat USS *Westfield*" (2016) discussed the findings of the excavation of the heavily disarticulated remains of the converted ferry gunboat USS *Westfield* and connecting them with a 2D reconstruction of the original vessel and converted vessel. Parkoff's work uncovered some important primary sources, including two letters from New York shipbuilder Charles Copeland to then Assistant Secretary of the Navy Gustavus V. Fox regarding proposals for ferry conversion (Copeland 1861a, 1861b). Yet, none of the sources found in Parkoff's work were more vital than (likely) the only surviving deck plan of the converted New York-built ferry *Clifton* (Daniel D. T. Nestell Papers 1900). He also provided transcriptions of several letters from 1861 containing conversion proposals for the ferry boats. Amy Borgens and Robert Gearhart's 2010 article, "USS *Westfield*: The Loss and

Rediscovery of a Civil War Ferry-Gunboat in Galveston Bay” also provided references to primary sources that proved vital to reconstruct an accurate conversion of *Regla* to *Commodore Hull*, one being a letter from shipbuilders Copeland and Howe (1861) to Rear Admiral Hiram Paulding regarding *Westfield*’s conversion. Finally, Jack Coggins’ book *Arms and Equipment of the Civil War* (2004) provided detailed illustrations and descriptions of naval cannon and their carriages during the Civil War.

Additional secondary histories that aided in the understanding of broader construction trends include A.C. Hardy (1927); Ken Watson (1985); Bob Whittier (1987) and Paul H. Silverstone (2006). Several other archaeological reports, thesis, and publications that were referenced to understand and derive measurements for specific portions of the vessel include Frank J. Cantelas (1994), Saxon T. Bisbee (2012; 2018), Adam I. Kane (2004), and Matthew A. Russell (2004). Finally, *Paasch’s Illustrated Marine Dictionary* (1885) by Heinrich Paasch and René de Kerchove’s *International Maritime Dictionary* (1948) aided in defining and identifying construction features.

Primary Sources

Several of the primary sources utilized in this study that proved most useful came from institutional archival collections. The first, from The Mariners Museum and Park archives, was a set of waterline offset measurements for the double-ended ferryboat *Southfield*. This came from the John Englis Family Papers Collection (The Mariners Museum and Park 1948) and was an original 1857 document from the same builder of *Regla*, John Englis (Figure 15). The measurements stated within the document provide points that, once plotted out, delineate the shape of the vessel’s hull. This was the basis for the 3D reconstruction of *Regla*’s hull.

The *American Lloyds' Registry of American and Foreign Shipping*, the *Merchant Vessels of the United States* (MVUS) registration records spanning from 1860 to 1890, and the *List of American-Flag Merchant Vessels that Received Certificates of Enrollment of Registry at the Port of New York: 1789-1867* (Holdcamper 1969) were also accessed through the Mariners' Museum and were essential in understanding when the vessel was in the registers, when it was redocumented, and its basic statistical information. *American Lloyds'* (1861) specifically was also a key source in deriving recommended dimensions for framing, timbering room, keel and keelson assemblies, and anchor sizes.

One treatise and an article on mid-19th century ship construction were particularly important sources for the original build; these are Lauchlan McKay's *The Practical Ship-Builder* (1839) and Norman Russell's 1861 article "On American River Steamers" from *Transactions of the Institution of Naval Architects Vol. II*. These sources provided helpful information regarding rudder and superstructure construction for mid-19th century east coast ferries. Several other treatises, Robert Murray (1852), Henry Evers (1878), Richard Sennett and Henry J. Oram (1899), and articles William Cowles (1886), Edwin A. Stevens (1893) filled in many gaps encountered during the 3D reconstruction. Primary information regarding the post-war addition of a Worthington salvage pump was obtained from a catalogue produced by the Worthington Hydraulic Works company in 1883, which provided output and size information for their "wrecking" pumps (Worthington 1883).

Perhaps the only known deck plan of a converted ferry gunboat was obtained from the Daniel D. T. Nestell Papers in the United States Naval Academy Special Collections and Archives (Figure 16). Originally found referenced in Parkoff (2016:55), this drawn deck plank of the New York ferry gunboat *Clifton* was the most informative reference found for how deck

space may have been arranged on *Commodore Hull*. As mentioned in the above segment, several works (Gearhart and Borgens 2010; Parkoff 2016) provided citations to letters proposing naval modifications for the New York-built ferry *Westfield* from the Copeland and Howe shipbuilders to Admiral Hiram Paulding and Assistant Secretary of the Navy Gustavus V. Fox in 1861. These letters were obtained from the National Archives and the New York Historical Society via digital scan and became the basis for the military conversion of *Regla* to *Commodore Hull*. The transcription of one such letter can be found in Appendix A.

Finally, plans for 13 vessels built by John Englis, his son John Englis Jr., and his grandson C.M. Englis, were obtained from the Cornell University Library, Division of Rare and Manuscript Collections. The most useful plans were for that of an unnamed and undated doubled ended paddle steamer gunboat designed by John Englis for the United States Navy likely at the beginning of the Civil War (Cornell University Archives [1950]). The profile plan was most helpful in determining magazine storage and hold spacing for the vessel's conversion to a gunboat. Additionally, Henry A. Wise's 1866 *Ordnance Instructions for the United States Navy* helped in understanding the cannon arrangements stated for *Commodore Hull* in the ORN.

Artistic Depictions of Commodore Hull

As stated above, no original plans or photographs of *Waccamaw* in any stage of its use-cycle were ever discovered. Only seven depictions of the vessel are known and are all from the period of its naval service. They include four paintings spanning from the late 19th to the mid-20th century, one engraving from 1864, and two sketches circa 1863. Unfortunately, the contemporary depictions (Figures 17, 18; Appendix A) are the most lacking in detail and artistically interpreted relaying no information of conversion features that were not already

known from more reliable sources (Copeland and Howe 1861; Saltonstall 1913; Minick 1962; Browning 1993; Parkoff 2016).

Line of Ferry Boat	Southfield	Remarks
4	12-2-0	Length of Boat from O to Head
8	14-2-0	90 feet
12	4-1-7	2 ft 6 in under
16	4-1-3	2 ft 6 in under
20	4-5-4	13 ft 6 in
24	3-7-1	9 ft 3/4
28	3-4-4	Keel side 12 in
32	3-1-4	Stem ahead 11 ft 9 in
36	2-10-1	Waterline 15 in
40	2-6-3	

FIGURE 15: "Lines of Ferry Boat Southfield" written by John Englis, 1857 (courtesy of the John Englis Family Papers, Library and Archives, The Mariners Museum and Park, Newport News, Virginia; reference # MS0131).

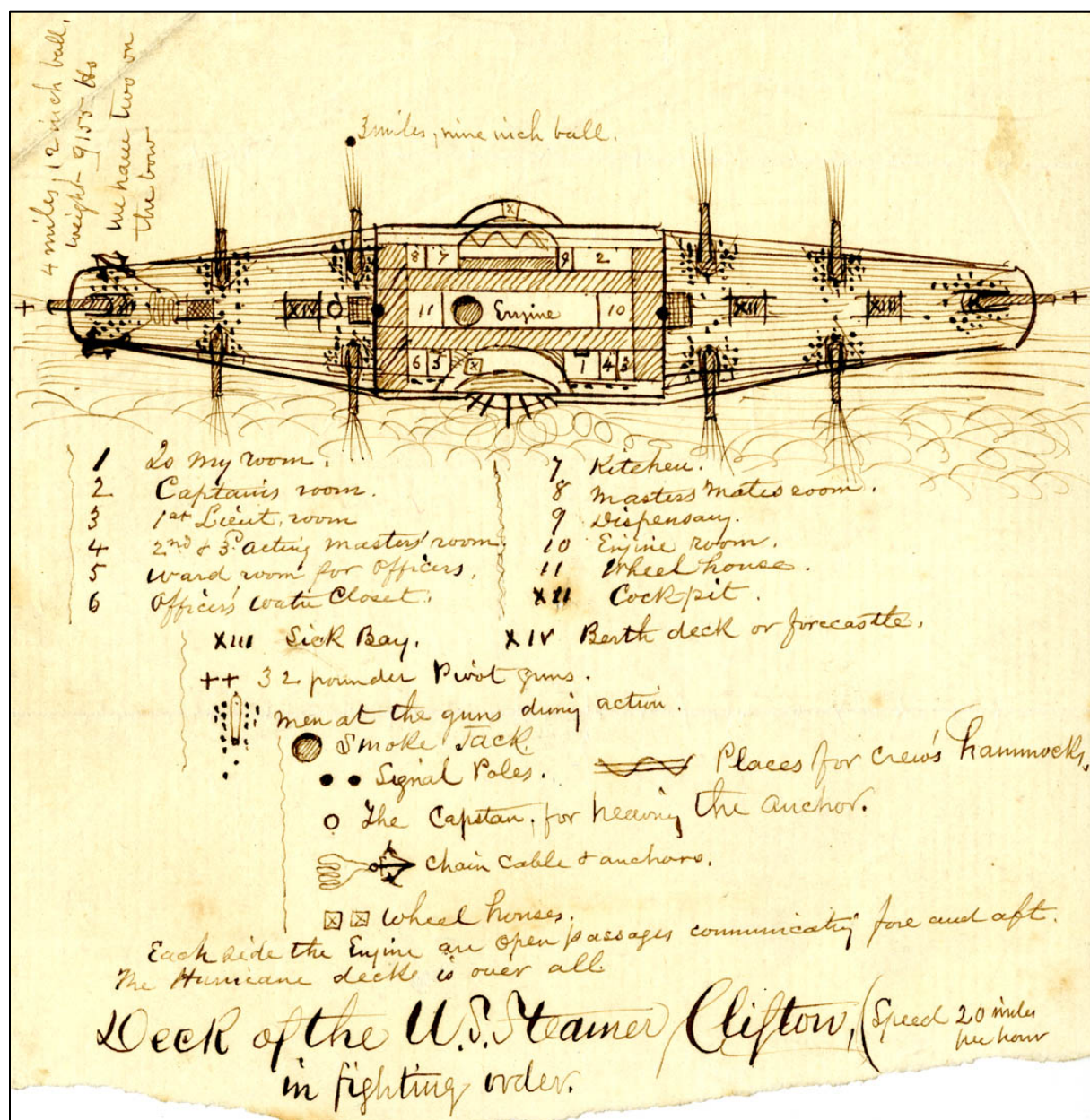


FIGURE 16. A Sketch of the deck plan for the converted New York built ferry gunboat *Clifton* by Dr. Daniel Nestell dating between 1862 – 1865 (courtesy of Nestell Collection, Nimitz Library, U.S. Naval Academy, Annapolis, Maryland; reference # Nestell 2-075, MS. 310).

The paintings, on the other hand, did provide limited information that confirmed the likely addition of modifications more clearly shown in the images cited below. Indeed, several common traits that existed across all depictions indicated the existence of features specific to *Commodore Hull* when compared to relatable features from photographs of other converted ferry gunboats. The comparison between the paintings and contemporary photographs will be

discussed in more detail in the results chapter. The four paintings and the 1864 engraving (Figure 17) were obtained from the NHHHC's digital archive and the circa 1863 sketch was obtained from the George H. and Laura C. Brown Library archives in Washington, North Carolina (Figure 18).

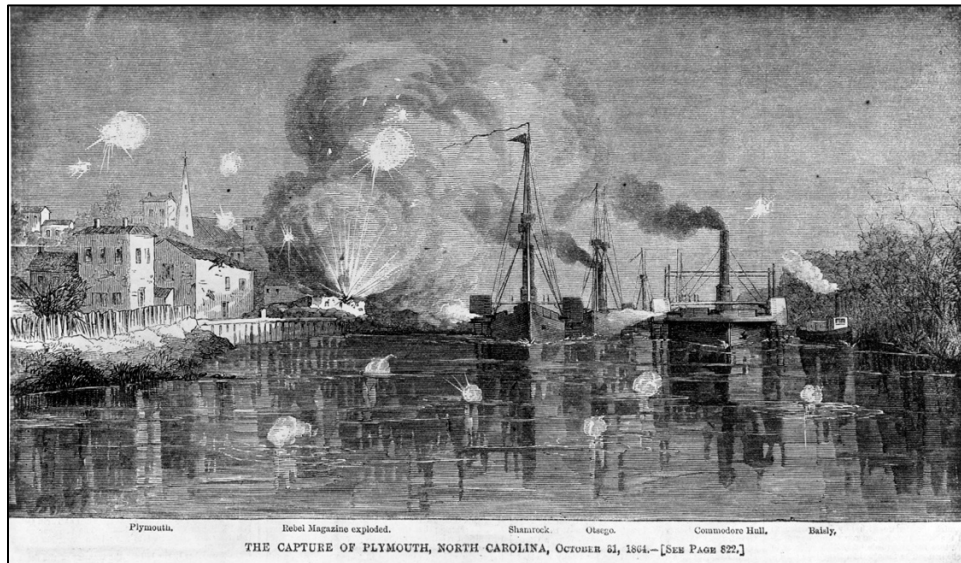


FIGURE 17. Line engraving published in Harper's Weekly, December 1864 depicting the waterborne bombardment of Plymouth, North Carolina *Commodore Hull* second to last on the right-hand side (courtesy of the Naval Heritage Series, Naval History and Heritage Command, Washington D.C.; reference # NC 59163).



FIGURE 18. Photocopy of a sketch by Lt. Col. Edward C. Cabot circa 1863. Double ended gunboats depicted, not stated which is *Commodore Hull* (courtesy of the George H. and Laura C. Brown Library, reference # not established).

Photographs and Construction Plans

49 photographs, 12 vessel construction plans, and five engine construction plans became the backbone for the 3D reconstruction for many portions of the vessel, including its superstructure, steering arrangement, pilot houses, and engine. The following segments provide tables of these sources, their number, and where they were sourced from. Each section includes a brief description of their character and how they were obtained.

Photographs

When descriptions failed to adequately explain original or converted features that may have been installed on *Waccamaw*, photographs were used (Table 2). Without these photographs, the reality of how conversion features were installed would not have been known. The use of photographs

TABLE 2: Photographs referenced for the 3D reconstruction of *Waccamaw* through its three use-cycles divided by the number of photographs per vessel type.

Vessel Type	Number of Photographs	Sources
Double Ended Ferry boats	19	Historic American Engineering Record, National Park Service; Library of Congress Digital Collections; The Mariners Museum and Park; Mystic Seaport Museum; Over and Back: <i>The History of Ferryboats in New York Harbor</i> , Cudahy (1990)
Single Ended Ferry Boats	4	Historic American Engineering Record, National Park Service; The Mariners Museum and Park;
Converted Gunboats	10	Library of Congress Digital Collections
Purpose Built Gunboats and Naval Craft	4	Library of Congress Digital Collections; The Mariners Museum and Park
Weaponry	5	Library of Congress Digital Collections; Naval History and Heritage Command; “A Formidable Looking Pile of Iron Boilers and Machinery”: Reconstructing the Civil War Gunboat USS <i>Westfield</i> , Parkoff (2016)
Towing and Salvage Vessels	7	Historic American Engineering Record, National Park Service; <i>Historic Photos of North Carolina</i> , Dudley (2008); The Mariners Museum and Park

of comparable vessels contemporary to the period of the vessel use ensured decisions made in the reconstruction were based on the strongest evidence available.

Construction Plans

Construction plans were obtained almost entirely through various digital archives and online sources (Tables 3 and 4). These plans, once scaled in Rhino®, provided accurate dimensions for construction features that were not stated in any of the above-described sources. Indeed, it is hard to overstate how important the plans were in constructing a proportionally accurate and detailed 3D model of the *Waccamaw* in all three stages of its use-cycle.

TABLE 3: Plans referenced and scaled to aid the reconstruction of *Waccamaw* order by date built, oldest to newest.

Vessel Name (Date Built)	Vessel Type	Number (Type) of Plans	Source
Unnamed (undated)	Double Ended Paddle Steam Gunboat	1 (Profile, Plan waterlines)	C.M. Englis, Inc. papers, #280. Division of Rare and Manuscript Collections, Cornell University Library
USS <i>Trenton</i> (1877)	Screw Frigate	1 (Armament Arrangement Drawing: Profile and Plan)	USS <i>Trenton</i> , NH 43587, Naval History and Heritage Command
<i>Flushing</i> (1877)	Double Ended Paddle Steam Ferry	1 (Architectural Drawing: Profile, Plan, and Cross Section)	East River Ferry Boat “Flushing”, MS0573/01-#47, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park
<i>Wenonah – Beverly</i> (1881)	Double Ended Paddle Steam Ferry	1 (Architectural Drawing: Profile and Plan)	Ferry Boats <i>Wenonah</i> . – <i>Beverly</i> . MS0573/02-#54, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park
<i>Southfield II</i> (1882)	Double Ended Paddle Steam Ferry	2 (Profile and Plan)	William Cowles 1886 pg. 190 in <i>Transactions of the American Society of Mechanical Engineers</i> , Figures 76 and 77
<i>City of Reading</i> (1888)	Double Ended Paddle Steam Ferry	1 (Architectural Drawing: Profile and Plan)	MS0573/01-#21, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park

<i>Eureka</i> (1890)	Double Ended Paddle Steam Ferry	3 (Profile, Plan, and Cross Section)	Historic American Engineering Record, National Park Service, Richard K. Anderson, Jr. (1996), Dana Lockett (1998)
<i>New York</i> (1892)	Double Ended Paddle Steam Ferry	1 (Architectural Drawing: Profile and Plan)	New York Ferry Boat #7 <i>New York</i> , MS0573/02-#14, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park
<i>Edgewater</i> (1902)	Double Ended Paddle Steam Ferry	1 (Cross section)	Brian J. Cudahy 1990 pg. 45 in <i>Over & Back: The History of Ferryboats in New York Harbor</i>
<i>Ticonderoga</i> (1906)	Single Ended Paddle Steam Ferry	1 (Profile)	Historic American Engineering Record, National Park Service, Ellen Stoner (1988)
<i>Hercules</i> (1907)	Screw Steam Tug	2 (Profile and Plan)	Historic American Engineering Record, National Park Service, Dana Lockett (1997)
<i>Epplenton Hall</i> (1914)	Paddle Steam Tug	1 (Plan)	Historic American Engineering Record, National Park Service, Tri-Coastal/De Pavloff Co. (1996)

TABLE 4: Scaled inclined steam engine architectural drawings which informed the construction of *Waccamaw*'s engine.

Engine Type (Year)	Name (Type) of Associated Vessel	Source
Inclined direct-acting steam engine (1858)	<i>Richard Magger</i> (Side Wheel Steamer)	<i>R. Magger's</i> engines, MS0573/03-#33, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park
Inclined direct-acting steam engine (1860)	<i>Mountain Buck</i> (Side Wheel Steamer)	Engine for Steamer <i>Mountain Buck</i> , MS0573/03-#24, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park
Inclined direct-acting engine (1869)	<i>Southampton</i> (Double Ended Steam Ferry)	Engine for Steamer <i>Southampton</i> , MS0573/03-#36, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park
Inclined direct-acting steam engine (1872)	<i>Peerless</i> (Doubled Ended Steam Ferry)	Engine of Gloucester Ferry Boat <i>Peerless</i> , MS0573/03-#31, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park
Inclined direct-acting steam engine (1876)	<i>Flushing</i> (Double Ended Steam Ferry)	Engine of the Iron Ferry-Boat <i>Flushing</i> , MS0573/01-#48, Harlan & Hollingsworth Company Plans, The Mariners Museum and Park

Archaeological Investigation: Field Work and Photogrammetric Modeling

The archaeological investigation of the *Waccamaw* site (State ID: CFR0001) took place over the course of two days with the overarching goal of collecting photogrammetric data to produce a scaled plan of the site and the secondary goals of recording and confirming measurements and information gathered from previous field investigations (Overton and Lawrence 1996; Seeb 2007; North Carolina Underwater Archaeology Branch 2024). This included capturing photographs of diagnostic features. The following section discusses the planning and preparation to accomplish the above stated goals, how the data was collected, and the methods used to produce a scaled photogrammetric model of the site.

Planning

The first step in deciding on how to approach the archaeological investigation of *Waccamaw*'s remains was reviewing previous investigations. This exposed what was already known about the site, what may be remaining, and what portions of the wreck needed attention. Sami Seeb's 2007 master's thesis was one of the first sources consulted as it was the latest archaeological field investigation that dealt with the *Waccamaw* site. Her work, now over a decade old, also provided the most current indication of the state of the site. From photographs, it was clear that not much of the overall vessel remained above the mud line. However, important details were still exposed, specifically the presence of cut marks on the southern end of the vessel and to its boilers. This was interpreted as evidence of salvage which occurred to the vessel after its abandonment in 1884 (Seeb 2007:186,203).

The next sources reviewed were in the North Carolina Underwater Archaeology Branch's (UAB) site file of *Waccamaw* which contained portions of the 1975 North Carolina Department of Archives and History (NCDAH) and University of North Carolina Wilmington (UNCW) field

school that dealt with the *Waccamaw* remains, notes taken from the 1990 investigation of the site, and two UAB reports, one created by Richard Lawrence, and the other by Lawrence and Glenn Overton. The 1975 NCDAH/UNCW field school report included an overall site description, student drawings, and several photos that indicated the degradation of the site, specific construction features, photographs, and measurements. Comparison of the between the 1975 photographs (Figure 19), one from the 1990 investigation (Figure 20), and several from Seeb's 2007 research (Figure 21) indicated a significant deterioration and possible savaging of the wood and iron exposed to the elements within that 32-year period.



FIGURE 19: Southern end of the CFR0001 site remains from the 1975 field school (courtesy of the North Carolina Underwater Archaeology Branch).



FIGURE 20: Southern end of the CFR0001 site remains from the 1990 field investigation (courtesy of Carolyn Busse 1992:11).



FIGURE 21: Eastern side of the CFR0001 site remains from the 2007 field work (courtesy of East Carolina University's Eagles Island Ships' Graveyard Heritage Trail Flyer).

Richard W. Lawrence's 1987 report included basic sketches and measurements of the engine bed, paddle wheel shaft and flanges, and boiler. Lawrence also states the presence of a plug stock rudder at the southern end alongside the first instance where a tentative identification of the machinery is made with the boiler being identified as a horizontal fire-tube boiler and the engine bed being the remains of an inclined steam engine. The 1990 investigation's fieldwork notes provided a mud map of site which included basic site dimensions and that the depth of the hull below the mud was 6 ft. (Figure 22). Finally, the 1996 report produced by Lawrence and Overton in collaboration of the Army Corps of Engineers reiterated the identification of the boiler and engine while also stating that the boiler had been cut off and removed sometime after 1924 based on photographic evidence (NCUAB 2024:3,21,28).

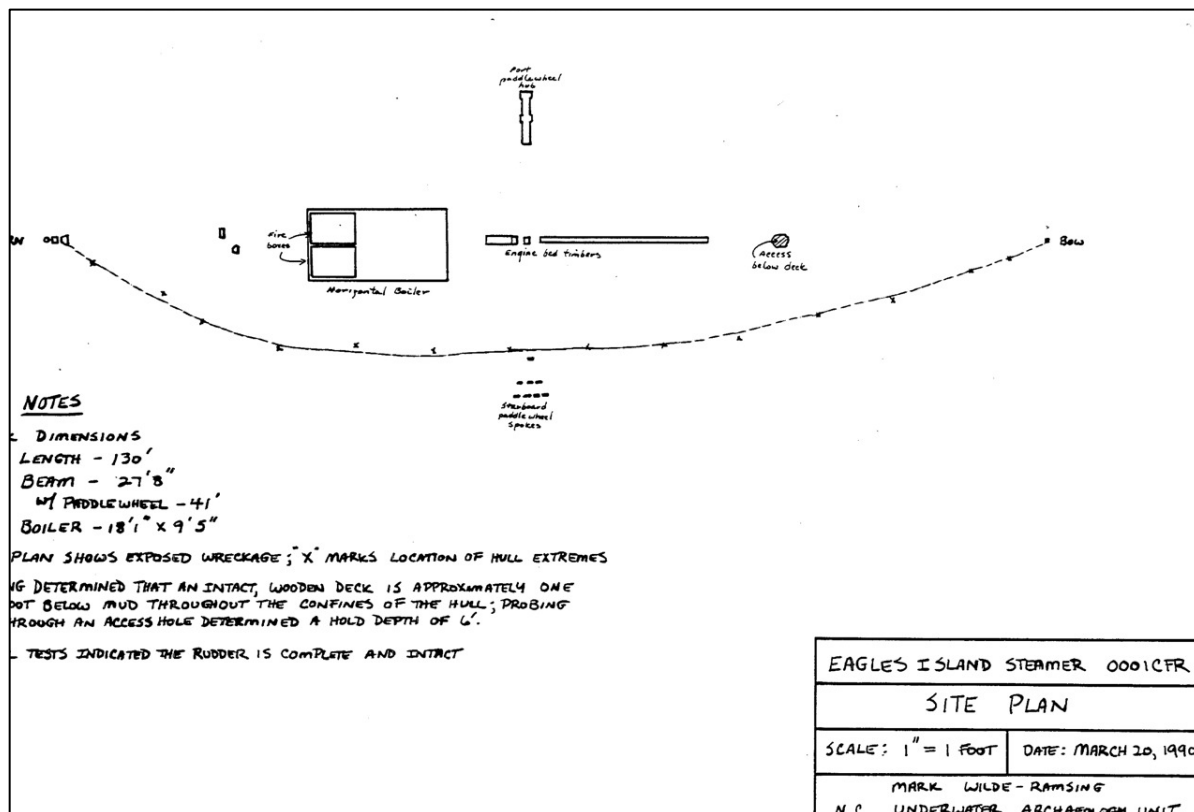


FIGURE 22. Mud Map of CFR0001 from the 1990 archaeological investigation. Map created by Mark Wilde-Ramsing. Note that the fireboxes are on the wrong end of the boiler (courtesy of the North Carolina Underwater Archaeology Branch 2024:28).

Given this information, a plan was created to first collect the data necessary to produce a scaled photogrammetric model of the entire site while examining the boiler, engine bed, paddle wheel shaft and arms, and southern end for evidence of salvage. Photographs were also taken of these features including the center to center spacing between frames. This was key in not only confirming previously recorded information, but also in identifying any additional evidence of salvage. Furthermore, measurements taken helped with the 3D reconstruction of the vessel.

East Carolina University's Dr. Nathan Richards advised on the equipment needed for the field work, which can be viewed in Appendix B. The basic plan to collect the photogrammetric data was to lay coded targets around the perimeter of the site for scaling and then take three circular passes around the vessel, one pass down its centerline, and finally take several focused passes around the boiler and engine bed all the while taking photographs. The coded targets were used to easily establish a scale in the photogrammetric model. In a method that has been tried for years in the field (Yamafune and Castro 2016:12), the coded targets provide a symbol easily recognized by the Agisoft Metashape® software. The distance between targets is taken and recorded after they are placed. Those measurements were later input into Metashape® which thereby defined the scale of the model. Taking photographs and measurements of diagnostic features and material evidence of potential conversion processes occurred after the photogrammetric data. This ensured as little disturbance to the site as possible prior to the capture of the photogrammetric data. Dr. Richards also aided in communication with John Mintz of the Office of State Archaeology and Chris Southerly of the NCUAB to ascertain the nature of permitting for the site. Given the minimal disturbance of the proposed field work, no permitting was necessary to collect the data, which was communicated via electronic correspondence.

In planning the specific days to conduct the field work, it was vital to choose a date when the tide would be low, there would be no rain, and the atmospheric conditions were consistent. Indeed, past research shows that consistent lighting, alongside the selection of the proper equipment is essential to capturing high quality images to produce photogrammetric models (Yamafune and Castro 2016:6). Furthermore, the intertidal nature of the site's environment presented difficulties. The creation of a photogrammetric model relies on the ability of processing software to recognize commonalities between photographs. Moving water, therefore, presents an impossible task for the software: to recognize common points on a constantly moving object. Fortunately, the National Oceanic and Atmospheric Administration (NOAA) has a tides and currents monitoring station (station ID: 8658120) approximately 700 ft. south of *Waccamaw's* remains. The station provides graphs that predict the tidal and current conditions up to a month in the future of the current date one is accessing the data. While this meant that only so much planning for a specific day could happen prior to field operations, it also meant that the prediction data accurately reflected the conditions of the site. Figures 23 and 24 show the charts with both the predicted (blue) and verified (green) tide levels for the months of October 2023 and June 2024. Based on those charts and predicted weather, the dates of 27 October 2023, and 30 June 2024 were chosen.

Field Work

Basic photogrammetric methodology began by setting up the coded targets around the site 3 to 4 ft. from its outermost edge with the number of targets depending on the water level of the specific day. This was done several minutes before the tide hit its lowest point to ensure enough dry riverbank was available to allow the site to be surrounded by as many targets as possible.

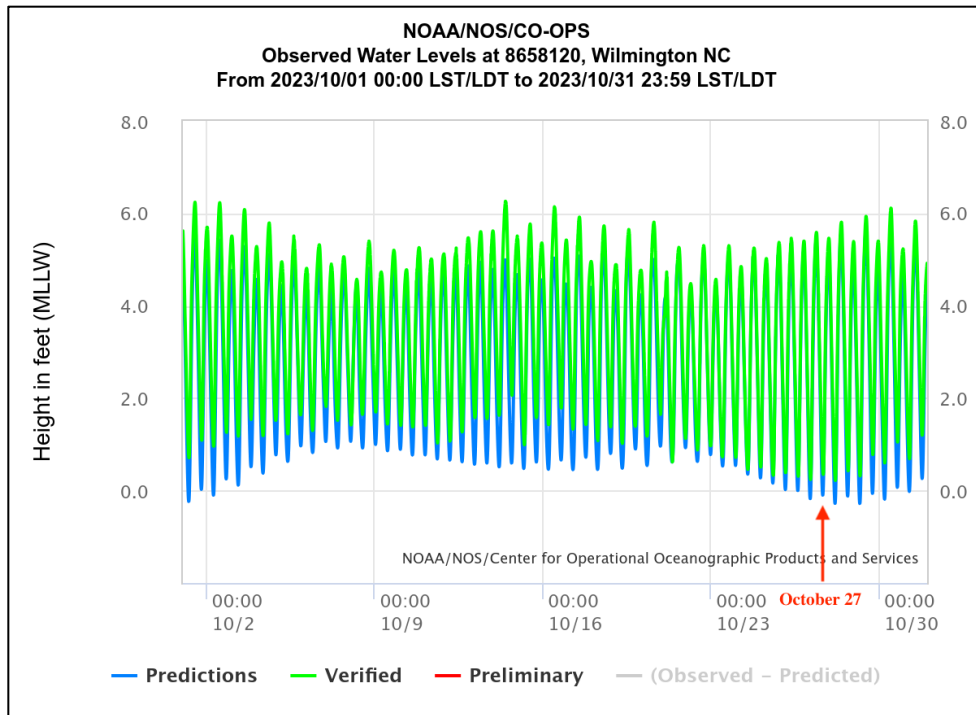


FIGURE 23. Predicted (blue) tidal range and verified (green) water levels for the month of October 2023. The morning of the 27th is indicated by the red arrow (courtesy of the National Oceanic and Atmospheric Administration).

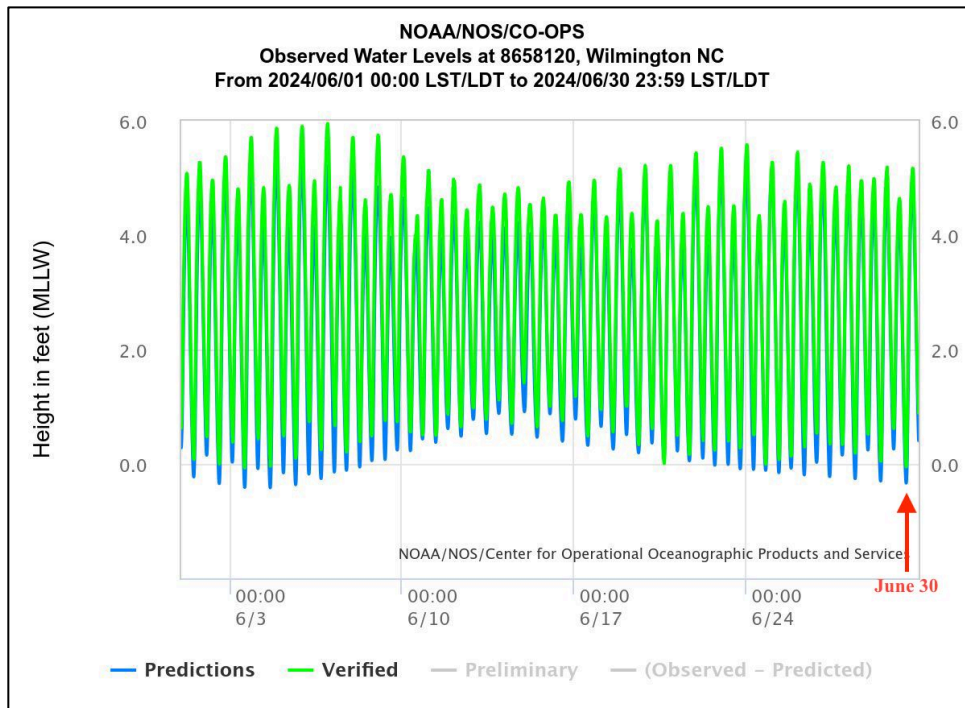


FIGURE 24. Predicted (blue) tidal range and verified (green) water levels for the month of June 2024. The afternoon of the 30th is indicated by the red arrow (courtesy of the National Oceanic and Atmospheric Administration).

Once this was done, three sets of photographs would be taken from the circumference of the vessel each at different levels of elevation, starting low and ending high. After these passes were completed, another pass would intersect the vessel longitudinally to get more detail of the engine bed and boiler with an additional path to capture more detail of frames, fasteners, and the remains of the paddle wheel. Photographs were to be captured in a manner which ensured the recommended minimum of 80% overlap was achieved (Kōtarō Yamafune 2024, pers. comm.), which meant walking a slow and steady pace while taking a photograph nearly every step.

27 October 2023

For the first day of field work, the tide was predicted to be one of the lowest of the month, coming in at -0.098 ft. at 3:38 pm (National Oceanic Atmospheric Administration 2024), and the weather was predicted to be sunny with partial cloud coverage. Leaving Greenville, North Carolina at 11:11 am with all equipment loaded, Dr. Nathan Richards, the author, and students Christopher Triplett and Konstantinos Raptis left for the Duke electrical substation, as shown in Figure 25, to park the vehicle. The site lays only 500 ft. from the substation and proved to be easily accessible with minimal foliage disturbance required to navigate through the wooded section that leads up to the Cape Fear riverbank. Investigators arrived at the site at 1:40 pm which allowed for ample time to set up the camera considering the ambient lighting conditions and to prepare the coded targets, scales, and measuring tapes. A Nikon D3400 DSLR was used with the focus mode being set to an aperture setting of F22, an ISO of 800 and a shutter speed of 160.

At 3:21 pm the targets were set and the distances between them taken. As can be seen in Figure 23, the tide did not come as low as was predicted, only going down to 0.46 ft. (NOAA 2024). This meant that only three of the nine targets brought could be used on the upriver, or

western side, of the vessel's remains (Figure 26). This also meant that only two circumference passes, and one centerline pass were able to be made (Figure 27) since the photo quality and recognizable overlap diminished drastically as the water rose. The window of time from the lowest point of the tide to the water height of inoperability proved to be a short 20 minutes but a total of 583 photographs were captured. The remaining minutes were used to collect scaled photographs of the boiler, futtocks on the southeastern end of the wreck, and the remains of the paddle wheel shaft on the eastern side of the vessel. By 4:20 pm the water was too high to capture quality photographs or place the scale. Indeed, finding a relatively level place that was not inundated by water was difficult from the start. Operations were therefore ended, and the investigators left the site.



FIGURE 25. Duke power plant (yellow polygon) in relation to the *Waccamaw* site, approximate location (image created by author).

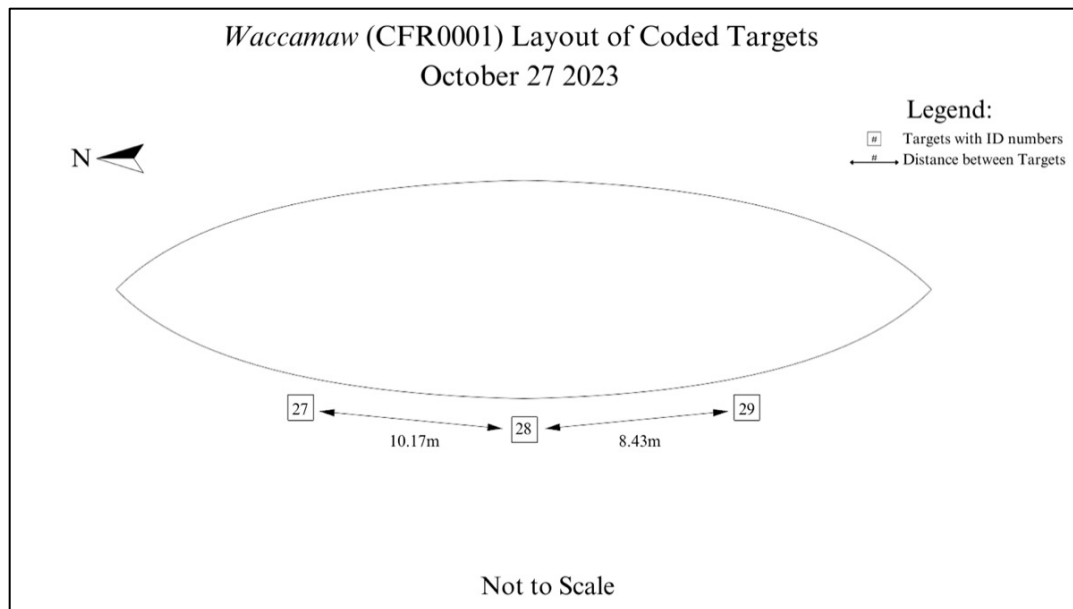


FIGURE 26. Layout of coded targets on 27 October 2023 field day (image created by author).

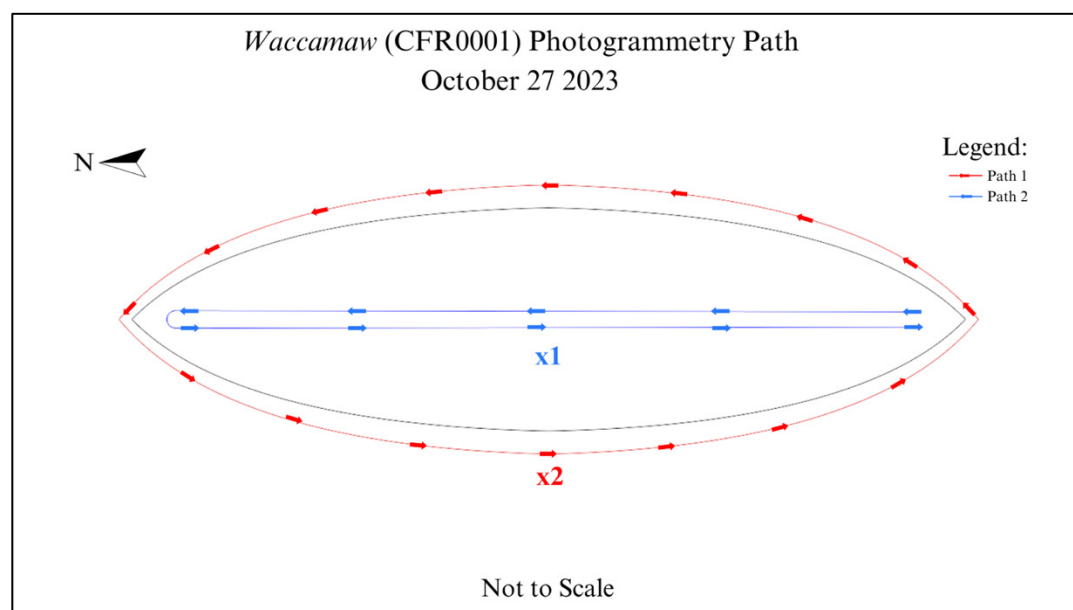


FIGURE 27. Path taken to collect photogrammetric data on the 27 October 2023 field day (image created by author).

30 June 2024

Due to issues with processing the photogrammetric data—discussed in further detail in the photogrammetric processing segment of this section—and lack of photographic coverage, the decision was made to make a second trip to site with the same goals, methods, and equipment. It was determined that a tidal level at least a foot lower than the previous field day would be

necessary to capture quality photogrammetric data. June 30 ended up being the best day to follow up with the predicted tide level being -0.333 ft. at 11:48 am. Furthermore, the day was predicted to be overcast with no rain, a potentially preferable weather condition due to the consistency in ambient lighting. Dr. Richards and the author were aided by student Ian Shoemaker and the group left for the site at 8:00 am from Greenville, North Carolina. Investigators arrived at the site at 10:20 am and left over an hour before the low tide. While targets, scales, and tapes were once again prepared, the Nikon D3400's settings were changed to an ISO of 400, an aperture setting F14, and a shutter speed of 1/160 given the darker ambient lighting that started the day.

The tide proved to be lower than 27 October with a verified at -0.04 ft.: a half foot difference. As such, all nine targets were set in the orientation seen in Figure 28. As discussed in the next section of this chapter, this aided in obtaining better accuracy in scaling the photomodel. The weather was only partly cloudy however, which proved to be only a slight inconvenience with the ISO being switched between 400 and 800 depending on cloud coverage. As the previous field day, photogrammetric data was collected beginning at the peak low tide allowing for the greatest exposure of the vessel, however, an adjustment was made in the path as can be seen in Figure 29. Instead of following a tight loop around the centerline of the vessel, the second path started along the southern inboard side of the eastern futtocks and wrapped around to a straight path further inboard back towards the southern end. This change was made because the approaching tide was over the vessel's centerline, the images of which would degrade the dataset. In total 497 photographs were captured within the 20-minute window and while 86 less images were captured, more features of the vessel were visible in each frame. Once the photogrammetric data was collected measurements and photographs were taken of the engine

bed, paddlewheel shaft and arms, and eastern-oriented futtocks. With the data gathered, the equipment was packed up and investigators left the site at 1:00 pm.

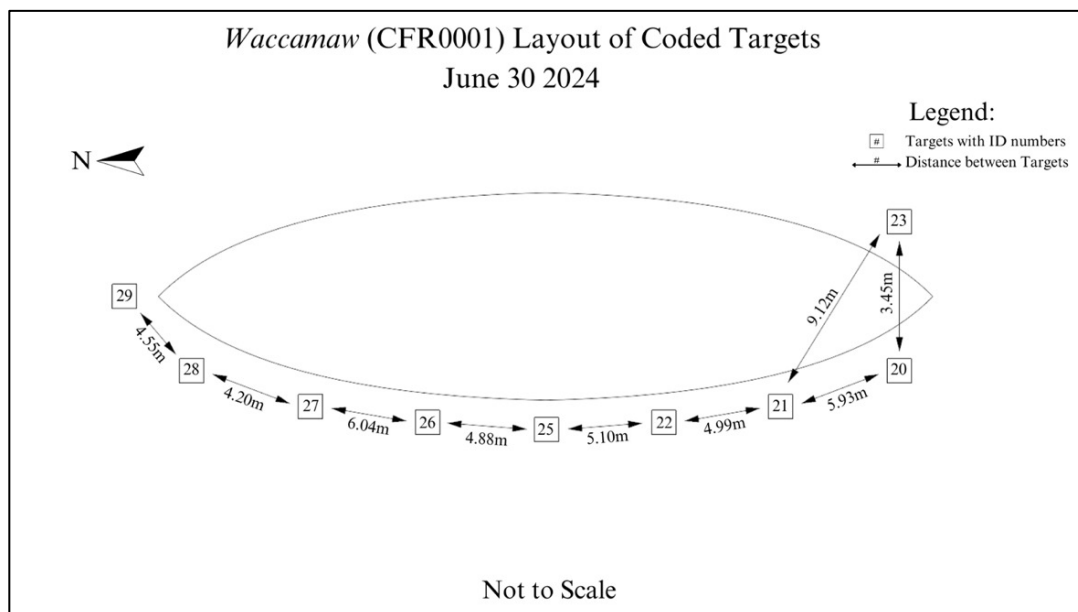


FIGURE 28. Layout of coded targets on 30 June 2024 field day (image created by author).

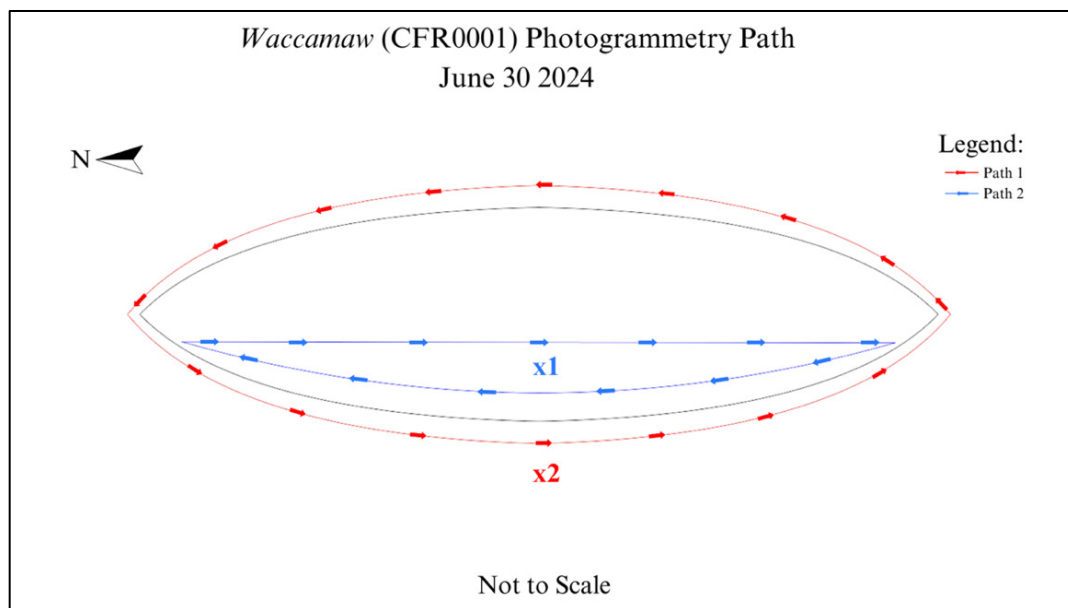


FIGURE 29. Path taken to collect photogrammetric data on the 30 June 2024 field day (image created by author).

Photogrammetric Modeling

With the photogrammetric data collected, processing the data in Agisoft's photomodeling software Metashape® was undertaken. The steps taken to create models from both field days are

broken into separate sections based on the day the data was collected. As will be explained, a different processing method was applied to the second field day's data set which was the higher quality of the two. This methodology used for the second model was then applied to the first in an ultimately unsuccessful attempt to improve it. The following two subsections describe how the models were produced and what efforts were made to improve the first model.

Photomodel 1: October Field Day Data

Post processing began several days after the data was collected with the first step being to upload the photographs into Metashape®. Next the photos were aligned with the accuracy set to low, generic preselection on, key point limit set at 40,000 and tie point limit set to 4,000. Setting the accuracy to low drastically reduced the processing time, however it only aligned 193 out of the 583 photos, equating to only a 33.1% alignment. Such a low level of alignment was not enough to produce a quality model; therefore, a re-alignment was attempted this time with the accuracy set to high and the generic preselection turned off. Turning the generic preselection off gives the software a better chance at aligning more photographs, however, greatly increases the processing time. Indeed, the re-alignment took nearly 24 hours to process.

The resulting alignment was worth the wait, however, as 542 out of the 583 (92.9%) of the photographs aligned. The next step involved correcting camera distortion and position by running a point (dense) cloud. From this a mesh was built (Figure 30) with the source data being set to depth maps, the quality and face count set to high, and the calculate vertex colors set on. At this point the background was cropped out to improve the texture and was done by opening the “selection tool” tab and cropping with the “free form” tool. From there the texture was built with the texture type set to “Diffuse map,” the source data set to “Images,” texture size set to 8192 x 1, and “Enable hole filling” selected. Markers were then detected by going to the “Tools” tab,

going to “Markers,” and then selecting “Detect Markers” from the drop-down menu. The textured model, the targets, and target accuracy can be seen below (Figures 31 and 32).

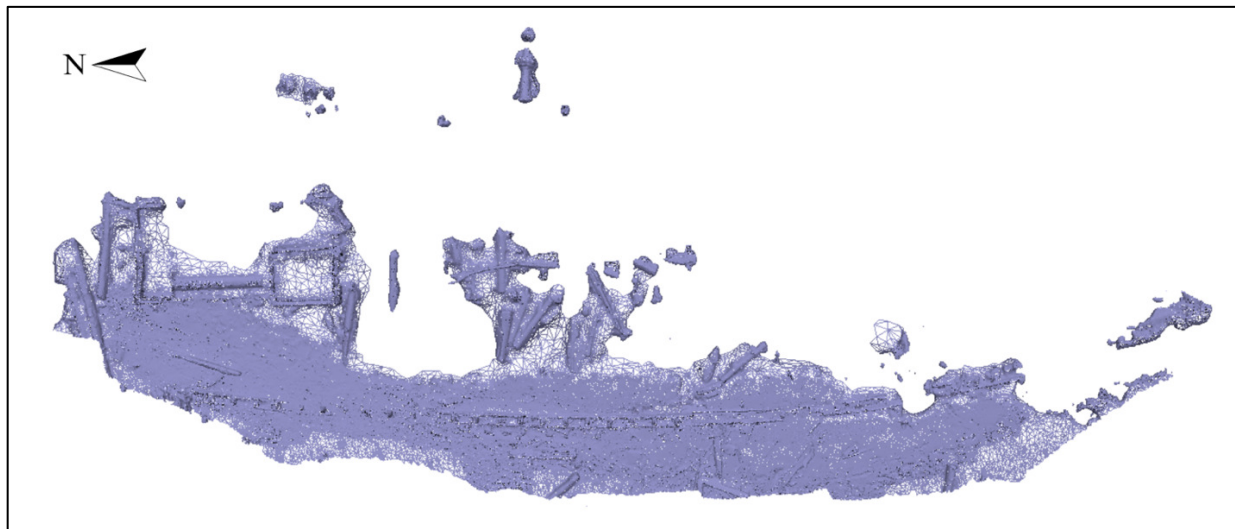


FIGURE 30. Mesh of original run of 27 October 2023 data (image and model created by author).

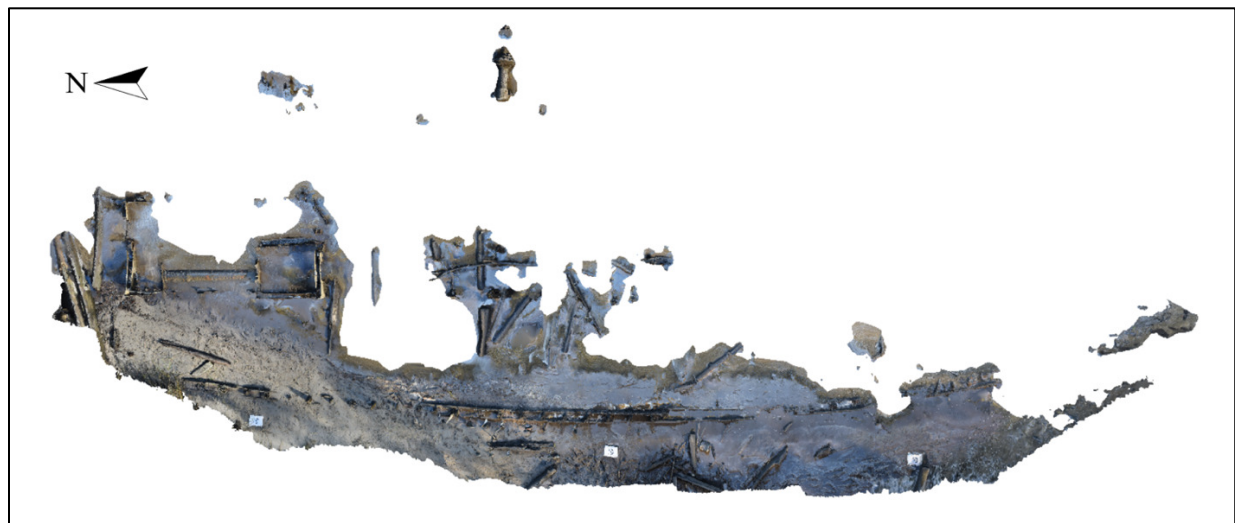


FIGURE 31. Textured photomodel of original run of 27 October 2023 data (image and model by author).

After the processing finished, an alternative methodology was discovered from attending a photogrammetric workshop taught by Kotaro Yamafuné in the summer of 2024. This methodology was first used in processing the data collected on the second field day but is described here to conclude the discussion of the first data set. One key difference between what

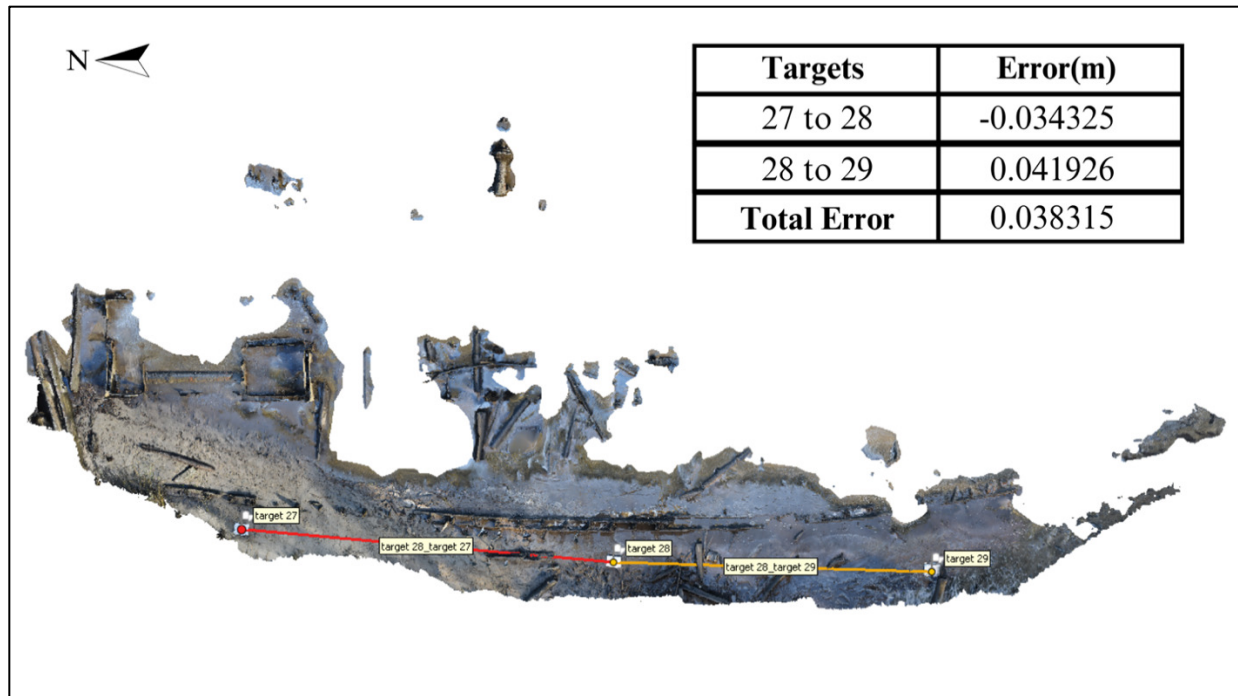


FIGURE 32. Textured photomodel of original run of 27 October 2023 data with targets and their error in metric (image and model created by author).

Yamafune taught, and the above-described methodology was the systematic removal of tie points using a tool called “Gradual Selection”. After the photographs were aligned and the background and blurred tie points removed, the “Gradual Selection” tool was selected within the “Model” tab. Within the “Gradual Selection” tab, tie points were removed under three parameters, “projection accuracy,” “reconstruction uncertainty,” and “reprojection error.” Tie points are selected by moving a slider until 10% of the total points were selected and deleted under each parameter. Before moving to the next parameter however, the camera alignment was optimized. This was done by going to the “Tools” tab and selecting “Optimize Camera Alignment.” This process was repeated twice before moving forward with mesh and texture creation.

The first attempt to re-process the original data set started by creating a new Metashape® file and importing the images. The images were aligned using the same process as described above and again only 193 out of 583 photographs aligned. Instead of running the alignment again with “Generic Preselection” switched off, a method also derived from Yamafune’s workshop

was used. The first step was to select any tie points that were clearly depicting background or Cameras that were in incorrect positions. Cameras (represented by the blue squares with black lines) in incorrect positions were selected by left clicking the black lines, then by right clicking selecting “Reset Camera Alignment.” Incorrect tie points were selected by using the “free form” tool then right clicking to select “Filter Photos by Tie Points.” This command displays the cameras associated with the selected tie points so their alignment can also be reset. Then the “Reset Filter” command is used so when the images are realigned and do not simply go back to their original position in the model. Once done, in the workspace panel, images that are not aligned are selected with those that are and then aligned together. This is done several times until as many unaligned images become aligned.

This method only realigned another 76 images leaving a total of 269 out of 583 (46.1%) aligned photographs. The decision was made to continue forward with Yamafuné’s methodology described above to produce a textured model (Figure 33). Given the lack of aligned photographs the model had much larger gaps and none of the coded targets were detected. Therefore, a second attempt was made, only with the original alignment kept and the Yamafuné methodology once again utilized. This produced a more complete model (Figure 34) than the first re-run and two of the targets were detected. In fact, the margin of error between targets 28 and 29 was only .000265m, 0.041661m less than the initial run. Yet, the second re-run still had more gaps than the initial processing of the model. The reason for this stems from the quality of the data. Re-running the first data set allowed for a closer inspection of the images and it was discovered that at either end of the vessel the sequence of photographs had little overlap between images obtained. This in turn lead to larger sequences of photos becoming unaligned as they had little to tie them to the aligned images within the dataset. Therefore, for a low-quality dataset such as

this, resetting alignment, filters, and eliminating low confidence tie points hurts the software's ability to interpolate between gaps. The first method was most successful because taking generic preselection off forced Metashape® to consider each image more closely to produce tie points that otherwise were not recognized.

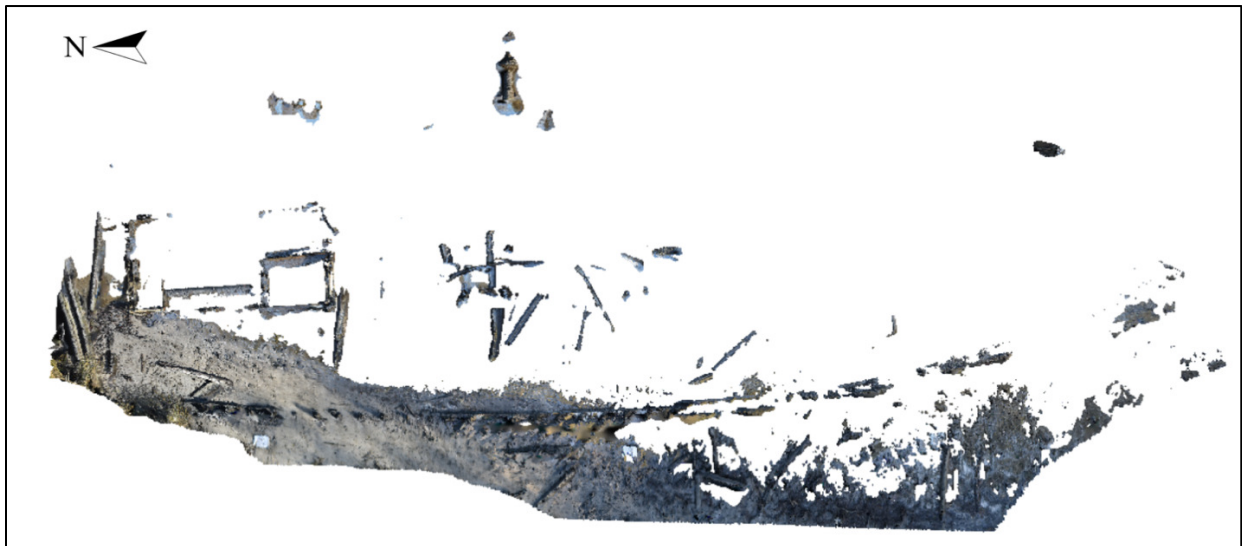


FIGURE 33. Textured photomodel of 27 October 2023 dataset, first re-run (image and model created by author).



FIGURE 34. Textured photomodel of October 2023 dataset, second re-run (image and model created by author).

Figures 35 and 36 illustrate the different outcomes of the methods: the first re-run from scratch (middle image in both figures) could not associate photos taken on the eastern side of the vessel with the rest of the aligned photos. They were therefore not considered in processing the rest of the model and, coupled with the deletion of low confidence points, a very sparse finished product was created. The second re-run (bottom image in both figures) was more complete given it started with the same alignment as the initial run, however, still had more gaps than the initial run given the use of “Gradual Selection” to delete low confidence points. When the dataset is of a low quality, therefore, the best option is to run an alignment on high with the generic preselection off to get a much higher level of alignment. If possible, however, the best solution is to return to the site and collect a new dataset insuring, in this case, a lower tide, and 80% overlap between images.

Photomodel 2: June Field Day Data

Fortunately, the proximity of *Waccamaw*’s remains allowed investigators to return to the site on 30 June 2024. The photogrammetric data collected consisted of 497 images and the Yamafune methodology described above was used. While less photos were taken, the lighting was more consistent, the tide was half a foot lower, and a high level of overlap was obtained in the image sequence. That said, 411 out of 497 (82.7%) images were able to be aligned. The remaining 86 photographs that were unable to be aligned all came from the southwest quarter of the vessel’s remains. This area had no frames protruding from the water’s surface giving the software nothing to tie points to. Regardless, the camera alignment was considerably more accurate than all editions of the first photo model. This becomes even more clear when comparing 27 October camera locations (Figure 35) to the 30 June location diagram (Figure 37).

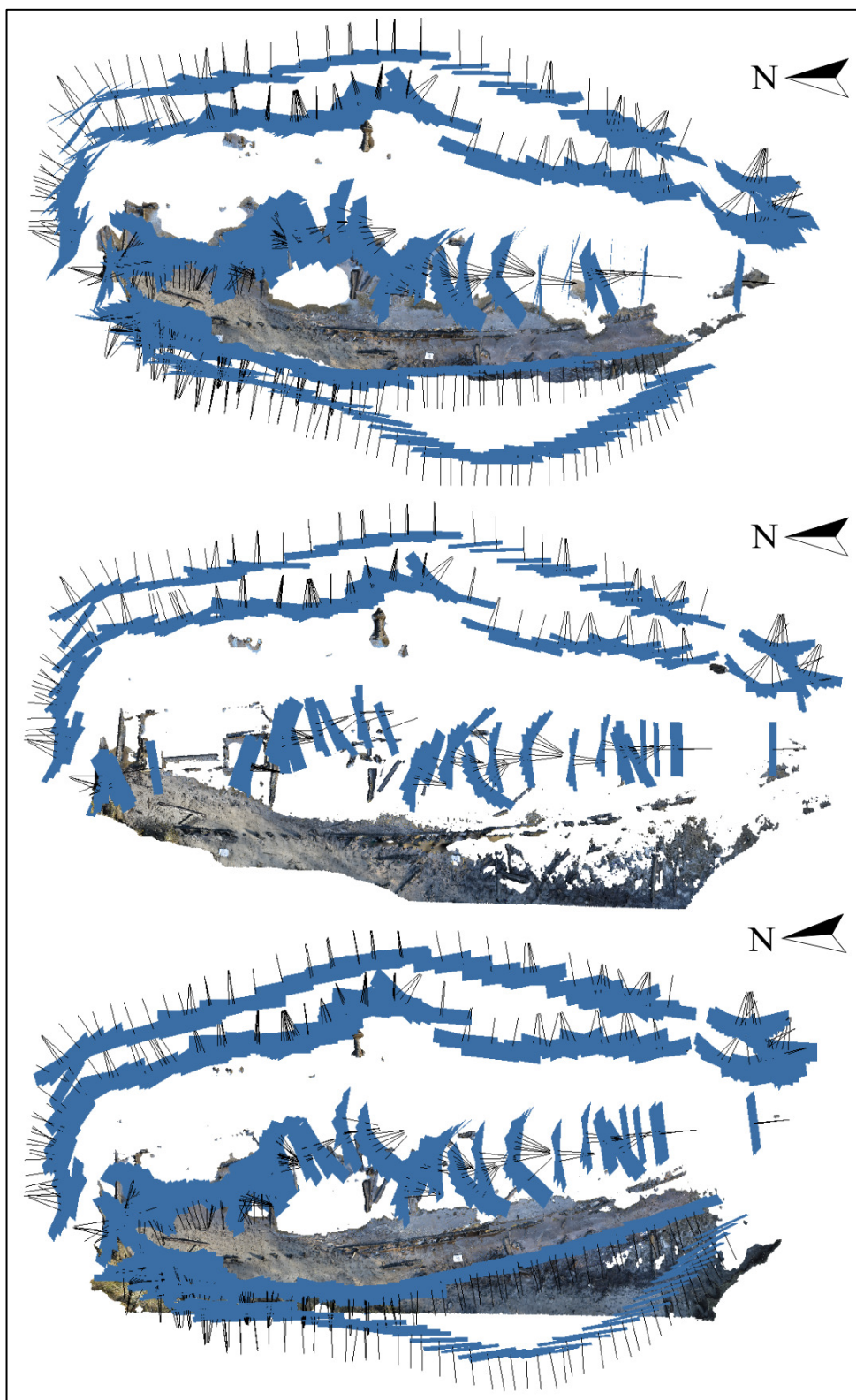


FIGURE 35. Location (blue squares) and direction (black lines) of photographs taken to produce the photomodel. Original processing of the 27 October 2023 dataset (top), first re-run (middle), second re-run (bottom) (image and models created by author).

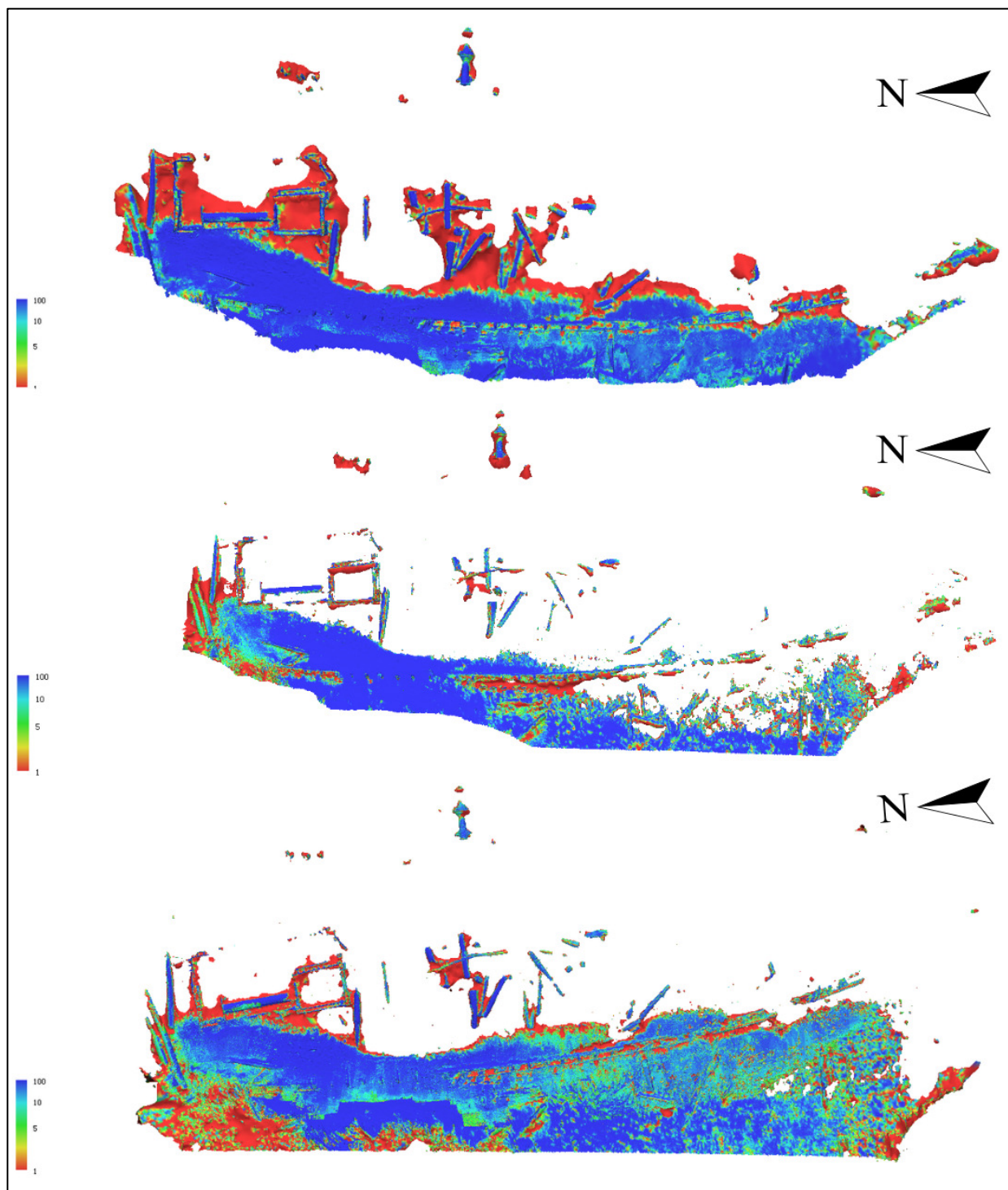


FIGURE 36. Confidence of photoalignment, with blue being high confidence and red being low. Original processing of 27 October 2023 dataset (top), first re-run (middle), second re-run (bottom) (image and models created by author).

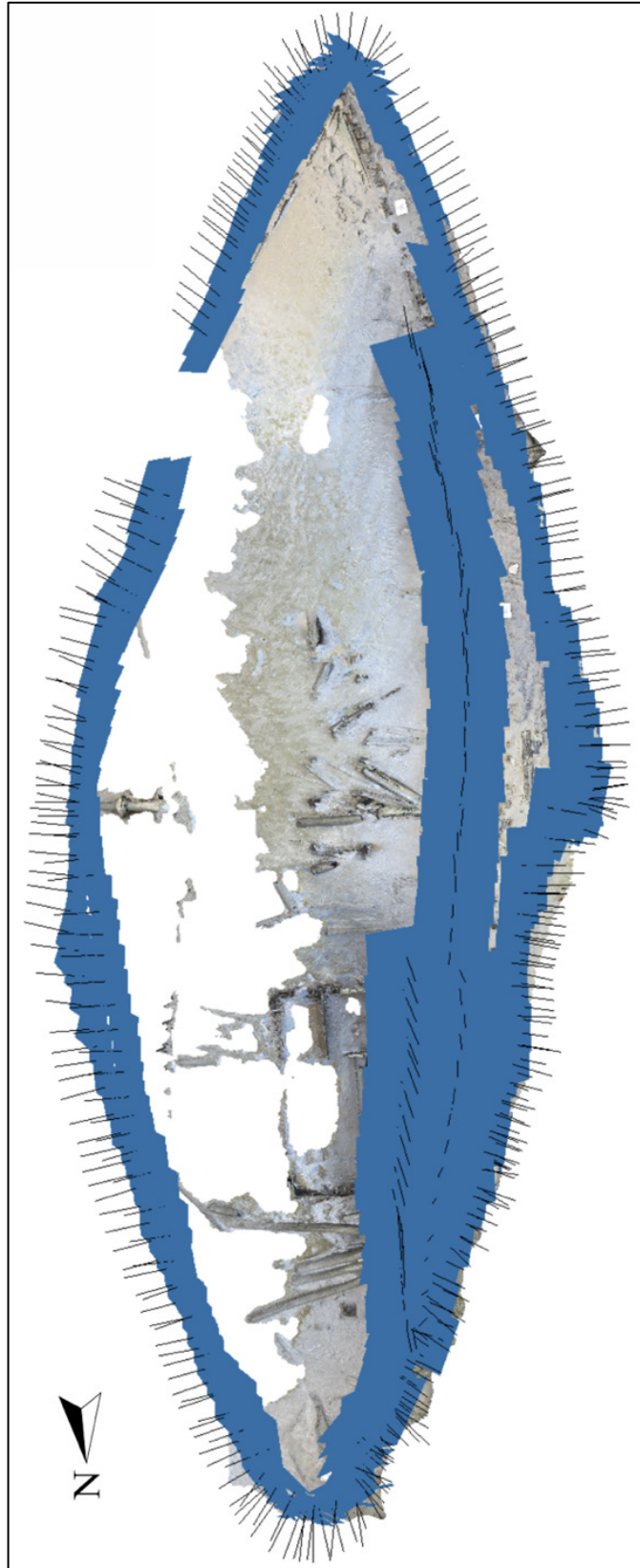


FIGURE 37. Location and direction of photographs taken to produce the photomodel based on 30 June 2024 data (image and model created by author).

The finalized confidence of tie points and the textured model can be seen in Figures 38 and 39. Given the higher quality data, the Yamafune methodology worked well, with the elimination of low confidence points producing a model that was both more complete and more accurate than the first photomodels. The model was scaled with much less error as well due to the ability to place nine coded targets (Figure 40). Indeed, the total error for the model was 0.002716m, that is 0.380434m less error than the original run of the previous model. Measurements could then be accurately derived from the models, which was important in informing the reconstruction of *Waccamaw*. Furthermore, the point confidence (Figure 38) was much higher with high confidence tie points being created well towards the centerline of the vessel. The second model was therefore used in the overlay with the 3D reconstruction and an overall key analytical product.

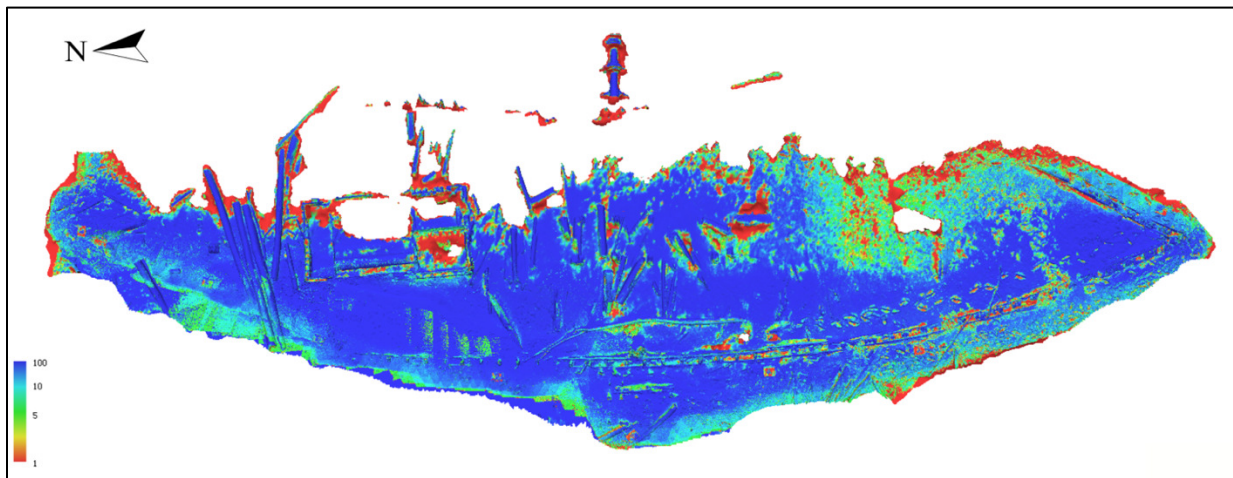


FIGURE 38. Confidence model of 30 June 2024 data; blue indicates and red indicates low confidence (image and model created by author).

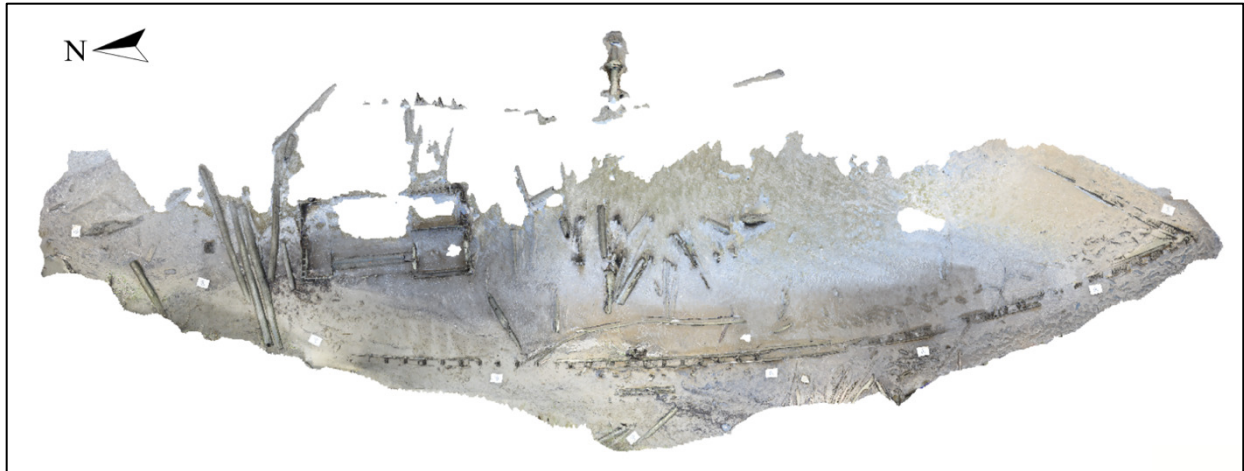


FIGURE 39. Textured photomodel of 30 June 2024 data (image and model created by author).

Analytical Methodology

The following two chapters describe the results of reconstructing the four stages of the vessel, that is: *Regla*, *Commodore Hull*, *Waccamaw*, and CFR0001. These reconstructions, combined with the results from the above described historical and photogrammetric methods constitute three of the five key components in analyzing the life and discard of the vessel. The other two components are the theoretical framework and the broader statistical and historical data. As stated in the introduction of this chapter, methods for analysis revolve around the synthesis of these components, the purpose of which is to understand how and why civilian craft was converted for military use during the Civil War, their subsequent post war uses, and depositional circumstances. Therefore, the 3D reconstructions and relevant modifications were placed in comparison with appropriate statistical information regarding economic processes and historical and environmental processes dealing with contemporary social influences that affected the people, institutions, and businesses that interacted with and changed the vessel materially.

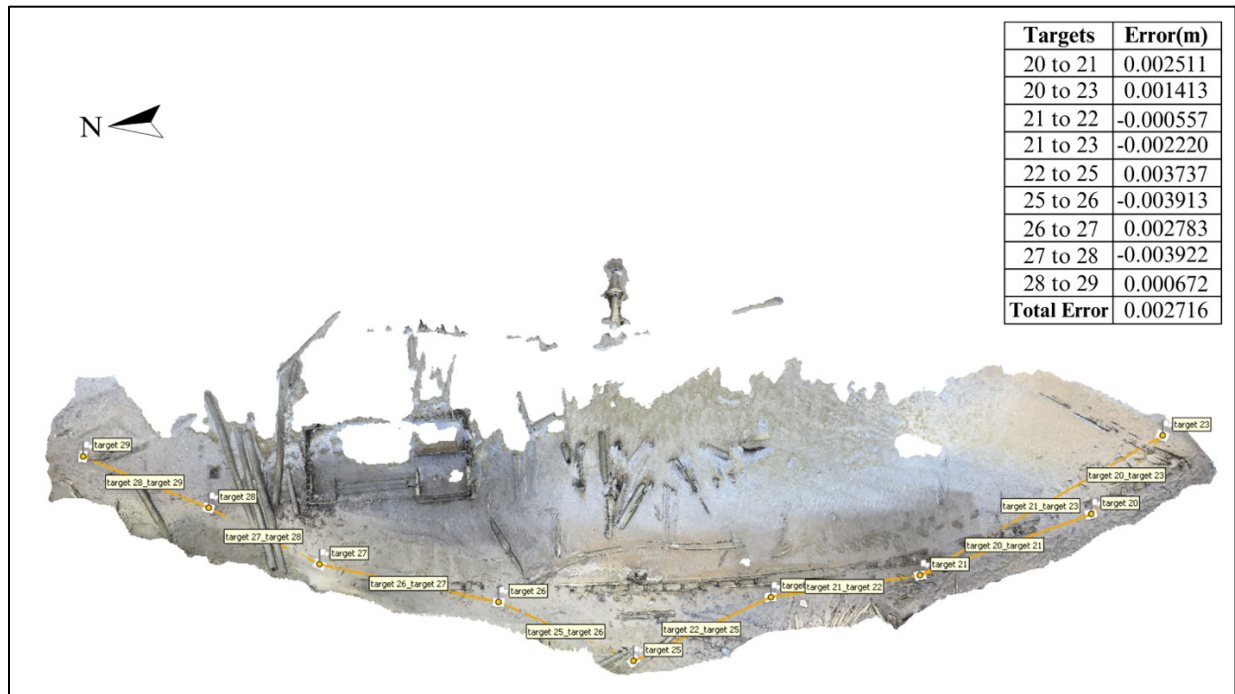


FIGURE 40. Textured photomodel of 30 June 2024 data with targets and their error displayed in metric measurements (image and model created by author).

Correspondingly, the analysis was broken into three categories: Techno-economic, techno-social, and environmental processes. The modifier “techno” before economic and social indicates the inextricable link between technology and social and economic processes. Indeed, through this juxtaposition of the use cycles, discard, and salvage of the vessel with broader statistical and contextual information, it was shown how the material changes correspond with changes in the three categories stated. Reference to the significant material changes at each stage of the vessel’s use, as displayed by the 3D reconstructions, was vital in this analytical method. Finally, the photogrammetric model was overlain on the reconstruction of *Waccamaw* to aid in informing what conversions features may remain in-situ and in the projection of what may remain below the mudline.

CHAPTER 5: Reconstructing *Nuestra Señora de Regla*

This chapter discusses the processes used to create the 3D model of *Nuestra Señora de Regla*, that is, the original build of the vessel as a ferry boat. It will be shown how the results of the historical research, field work, and photogrammetric methodologies discussed in the previous chapter were synthesized within the Rhinoceros® (Rhino) 3D modeling software to digitally reconstruct the vessel's original build. Given the quantity of information discussed for the original build of the vessel, the subsequent conversions and the vessel's post-abandonment formation processes are discussed in the following chapter.

This chapter begins by describing the vessel's foundational structural components created in Rhino® including the hull shape, frames, outer hull planking, internal hull strengthening members, and machinery. This is followed by a second section which describes the construction of the deck, superstructure, pilot house, and steering arrangement. To reiterate, no specific plans for *Regla* were found through the course of the historical research, so the process of 3D reconstruction relied heavily on a broad range of sources to provide the best interpretation possible of the construction of the vessel. Throughout the discussion, references to the documentary sources and photographs which informed the resulting model are included.

The Foundation: Hull, Internal Hull Structure, Beams

The first action taken was to create the shape of the double-ended hull based on the 1857 *Southfield* waterline offset measurements (The Mariners Museum and Park 1948). Before plotting the waterlines, the X, Y, and Z grid was established. The first step was to lay out a line representing the length of the keel, referred to here as the keel line. This was done by creating a line using the “single line” tool then stretching it across the X axis to the vessel's length between

the perpendiculars (LBP). The offset stations, representing the X axis and where the points would be placed, were then created on the keel line starting at midships and moving towards the end being spaced every 9 ft. The final step was the placement of the waterline intervals on the Z axis by creating a vertical line at the intersection at one end of the keel line, placing points along it to delineate the starting height of each waterline.

With the grid established, the offset measurements were then plotted into the appropriate waterline interval (Z axis) and offset station (X axis). Starting with the first waterline at the midships line and moving down the X axis, points were placed at the keel line with their measurements then input into the “gumball” (the core tool used to move objects and manipulate one’s view in Rhino®) to move them to their lateral position. Once all were placed, a curve was created between the points using the “interpolate curve” tool (Figure 41). The measurements for the sheer line, also provided in the Englis plans, delineating the curvature of the rails and thereby the deck, were placed in next (The Mariners Museum and Park 1948). Inputting the sheer height was no different than the waterlines, only this time points were placed on the keel line at the appropriate offset station and moved vertically with a curve again being created between the points.

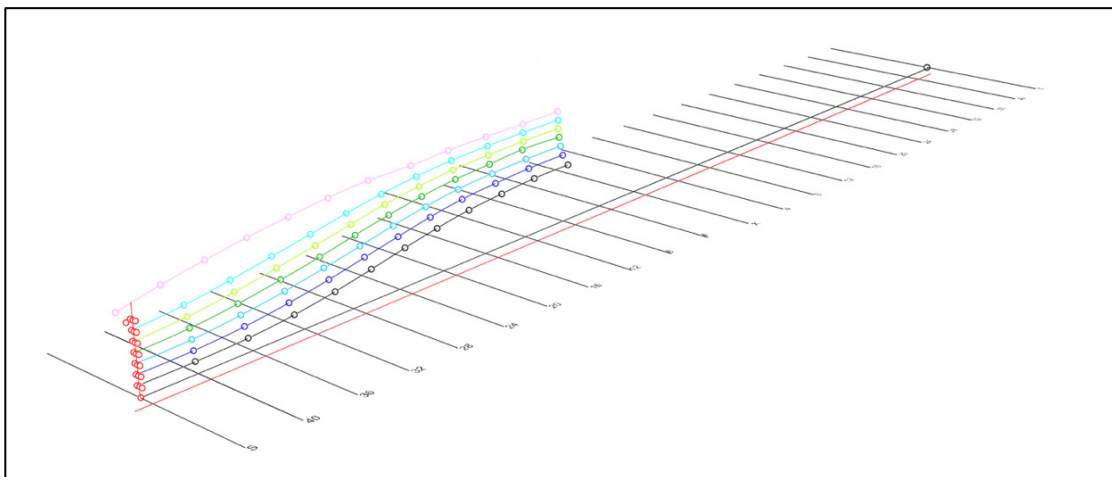


FIGURE 41. Waterlines created from offset measurements; in “Arctic” view (image and model created by author).

With the waterlines created, the hull loft was then made. This was done using the “loft” tool then selecting each waterline at midships starting at the keel line and then pressing enter. The loft was mirrored along the X and Y axes to create the shape of the entire hull. The hull lofts then had to be scaled down as *Southfield* was 67 ft. longer, 5 ft. wider, and 1 ft. deeper than *Regla*. Using the “scale” tool in Rhino®, either end of the loft was selected and scaled to *Regla*’s LBP of 131 ft. The depth and breadth of the loft had to be resized as utilizing the “scale” tool affects an object proportionally, meaning those dimensions were then smaller than appropriate. The “stretch” tool was therefore used to affect only one axis of the model at time, first stretching the loft laterally to the proper breadth of 28 ft. and 4 in., then the depth was brought to the proper 11 ft. Comparing the previous hull loft with the new adjusted loft showed no significant distortion caused by stretching (Figure 42). Furthermore, the overarching research goal, depicting modifications born from reuse cycles, did not necessitate correction for the slight distortion which did occur. Thickness for the hull was created by extruding it to the appropriate thickness, 3 in., using the gumball’s “distance to extrude” function. The hull’s copper sheathing was then created by copying the loft, cutting it to the appropriate height and then extruding it to the appropriate thickness in the same manner as the hull loft.

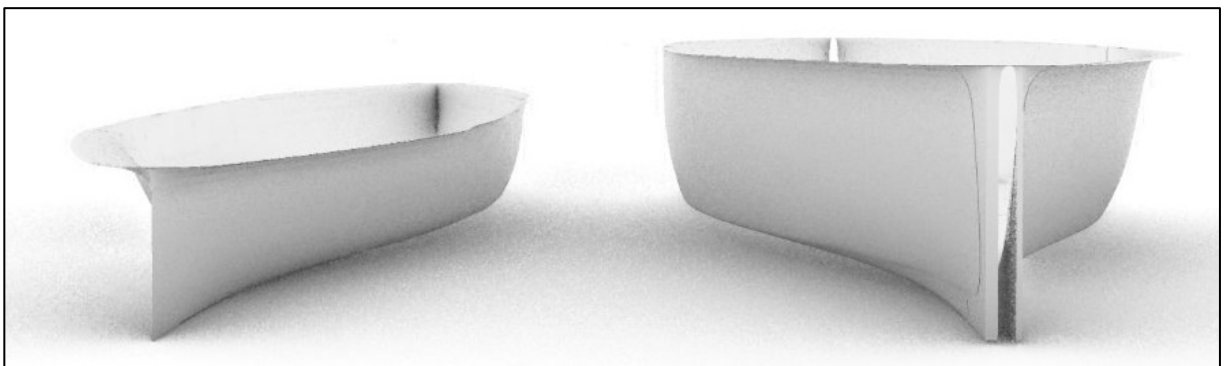


FIGURE 42. Comparison between the original scaled down loft (left) and the resized loft (right); in “Arctic” view (image and model created by author).

Internal Hull Structure

With the hull and coppering lofts created, the internal hull structure was built. Starting with delineating the frame spacing, the first step involved placing perpendicular lines across the keel line delineating the position of paired frame centers, referred to as frame center lines. Given the vessel's 22 in. center-to-center spacing (American Lloyds 1861:xiii), the frame center lines were placed 22 in. away from each frame station by copying the frame station and inputting the measurement into the "gumball." Doing this at each frame station resulted in two lines between each station. Another set of thwartship lines, referred to here as width lines, were then placed on either side of the frame center lines. These delineated the sided (width) dimensions of the frames at 11 in. at each floor timber (American Lloyds 1861:xiv). It was noticed that the space between the frame lines was quite close, only 2 in., since the distance between frame stations was reduced from 9 ft. to 5 ft. and 11-3/4 in. after the initial scaling. This would result in frame pairs fitting too close to the floor's heel than what was likely. Furthermore, the center-to-center spacing of *Waccamaw*'s remains was measured via the scaled photogrammetric model to get a consistent 24 in., providing further proof that initial spacing was inaccurate.

To fix the issue, the last station at either end of the keel was removed and the lines respaced, resulting in a total of 10 offset stations rather than the original 12. The spacing between the offset stations was then 6 ft. and 6-1/2 in. with the half-length of *Regla* being divided by 10. Each 6 ft. and 6-1/2 in. distance between the stations was divided by three, on account of the three spaces between the four paired frames. This measurement came out to be 2 ft. and 3/16 in., or in other words, just over 24 in., thereby closely matching the measurements taken from the archaeological site.

The next step was to extrude the frame center lines and the width lines to the top of the hull loft using the “surface from 3 or 4 corner points” tool to create what looks like a series of tightly packed lateral bulkheads. Once done, the hull loft was used as a cutting surface by using the “trim” tool to shape the surfaces as they extended past the exterior of the hull. The hull loft was copied and moved to trim the rest of the surfaces within the hull's interior giving the frames their molded shape at 11 in. at the floor and 5-1/2 in. at the top futtocks (American Lloyds 1861:xiv). The surfaces were then lofted together and trimmed again using the “surface from 3 or 4 corner points” tool to give the frames their proper sided taper (Figure 43).

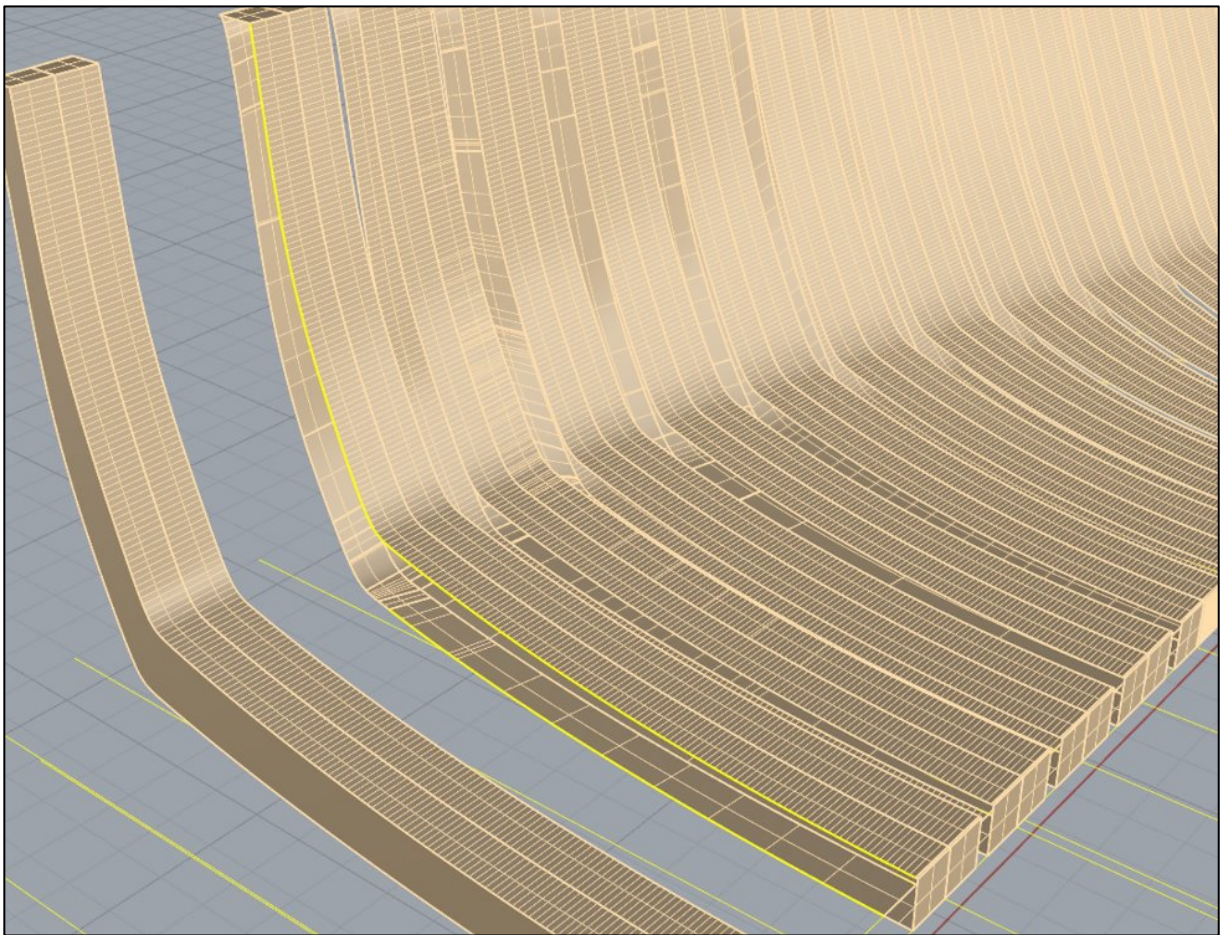


FIGURE 43. Lofting the molded side of the frame after cutting the sided taper; in “Shaded” view (image and model created by author).

The keel, keelson, and rider keelson were modeled next. The keel was created by using the “Box: corner to corner, height” with the resulting shape being oriented to the centerline of the vessel, beneath the frames. The keelson was created by simply copying and pasting the keel and placing it directly over the frames. The rider keelson was created the same way and was placed directly over the keelson. The end post assembly was the next portion of the hull structure that was built. Given the vessel was a double ender with each end having the ability to act as the bow or stern, there was some question as to how these end post assemblies would have been built given the difference in bow and stern construction.

After further consideration, it was determined to create posts and deadwood assemblies typical of a stern construction and the filling pieces typical of a bow assembly. The stern deadwood assembly was chosen given double ender’s end posts were generally angled sharply on the keel to accommodate the rudders on each end (Figure 44). Yet, the heads of either end of these ferries were considerably more “bow shaped” than “stern shaped” with the hull coming to a point rather than splaying out. To fill the space left between the stem post and half frames in single ended ocean-going vessels, small frames with little space were fastened from the molded side of the half-timber to the deadwood assembly. This was to give the bow a solid surface with which to take the force of the water as it plied, while also providing support for the hawse pipe, anchor, and chain (Crothers 2013:151). While the anchor assembly was not a consideration for the New York double-ended ferry, reinforcement of the ends to break through ice and other potentially damaging forces in the water certainly was (Stevens 1893:192; Spirek 1993:36).

The first portion of the end post assembly to be built was the stern post. The sided dimensions for the “stem” were stated the Englis plans alongside the rake of the keel being 2 ft. and 6 in., that is 1 ft. and 3 in. at either end (The Mariners Museum and Park 1948). The molded

dimensions matched that of the keel with its width tapered to accept the hull planking. The stern post was built by first placing points using the “points” command and spacing them with the correct dimensions and respective tapering. These points were then connected by creating curves using the “line” tool which were then lofted to create the stern post. The deadwood assembly was the next portion of the assembly created. For this, Crothers’ (2013:115) scaled drawing of the deadwood assembly of the William Webb built packet ship *Ocean Monarch* was digitally scanned, imported into Rhino®, and then scaled to take molded dimensions (Figure 45). The sided dimensions conformed to that of the keel. *Regla*’s deadwood assembly can be seen in Figure 46. The way the deadwood terminated at the stern post was derived from the scaled plan of Englis double ended paddle steam gunboat proposal plans, terminating at the deck beam. The assembly was created by making curves using the “line” tool, spacing them appropriately and then lofting them together. The hawse pieces (filling pieces for a vessel’s bow), like the deadwood knee, were traced in Rhino® by scaling a drawing created by Crothers (2013:153) of a standard hawse piece assembly for mid-19th century packet ships (Figure 47). *Regla*’s filling pieces are shown in Figure 48.

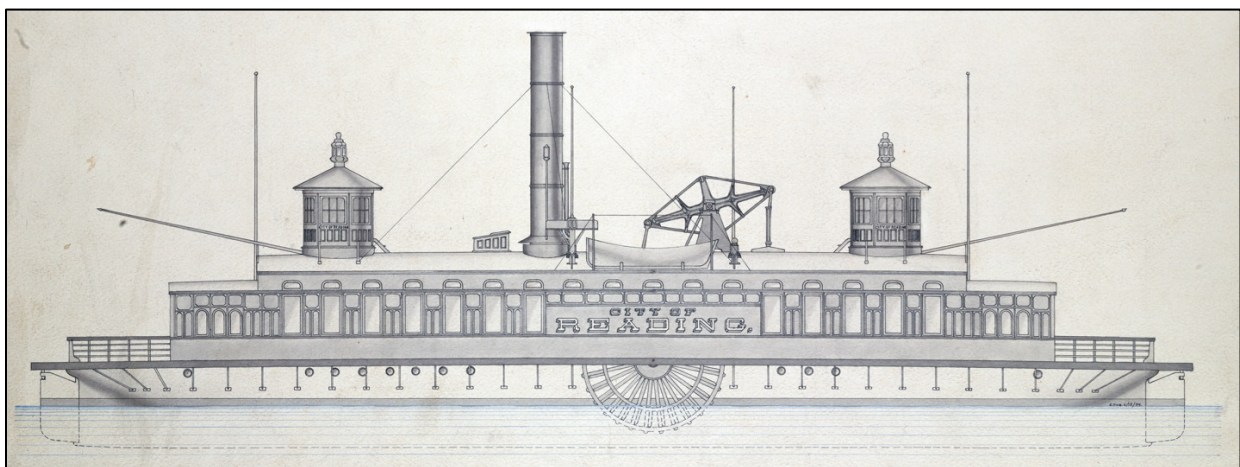


FIGURE 44. Profile of the Kaighns Point ferry boat No. 2 City of Reading from Harlan & Hollingsworth architectural drawing (1888) (courtesy of the Harlan & Hollingsworth Company Plans, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0573/01-#21).

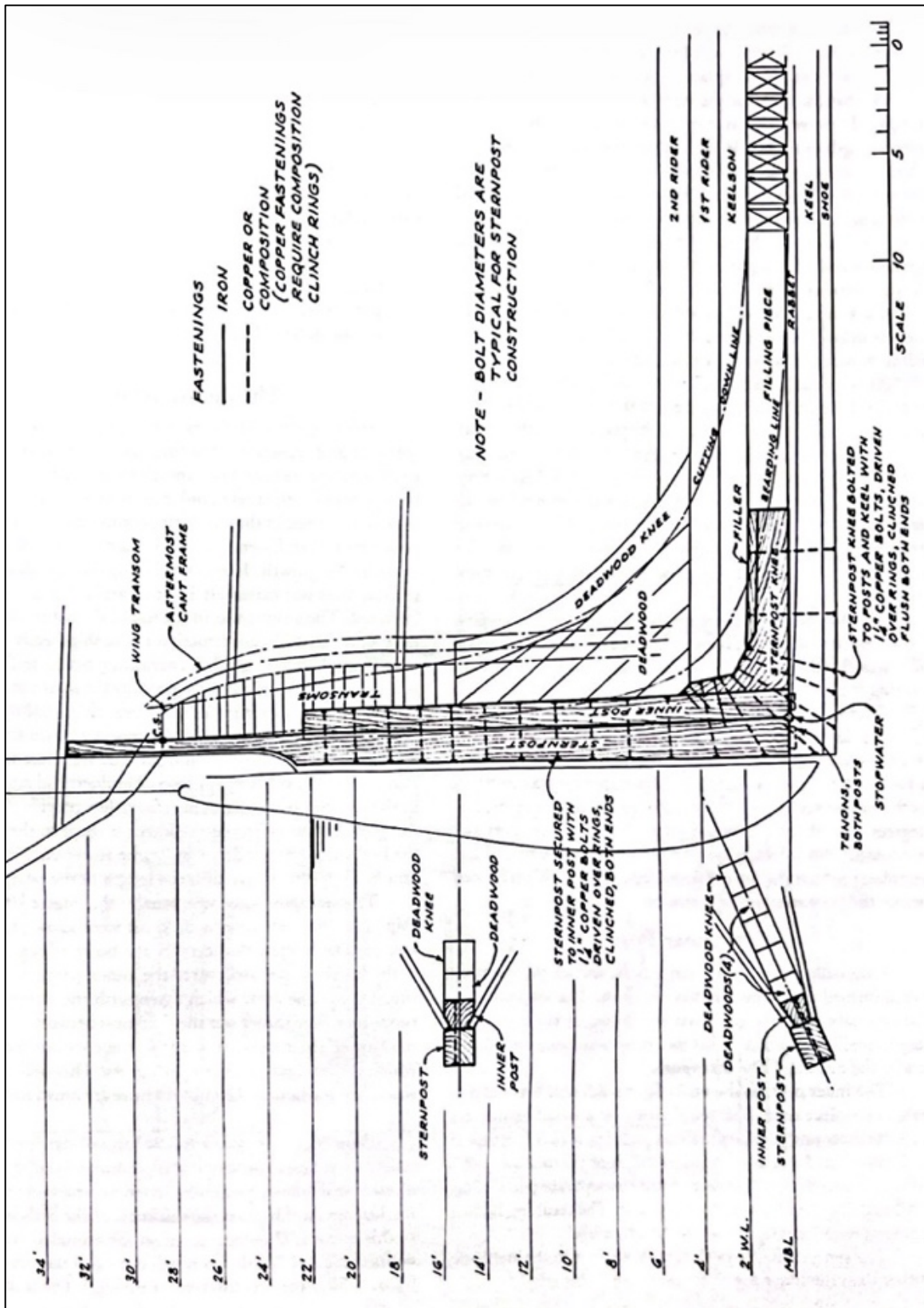


FIGURE 45. Sternpost assembly, details and fastenings for packet *Ocean Monarch* (courtesy of William L. Crothers 2013:115).

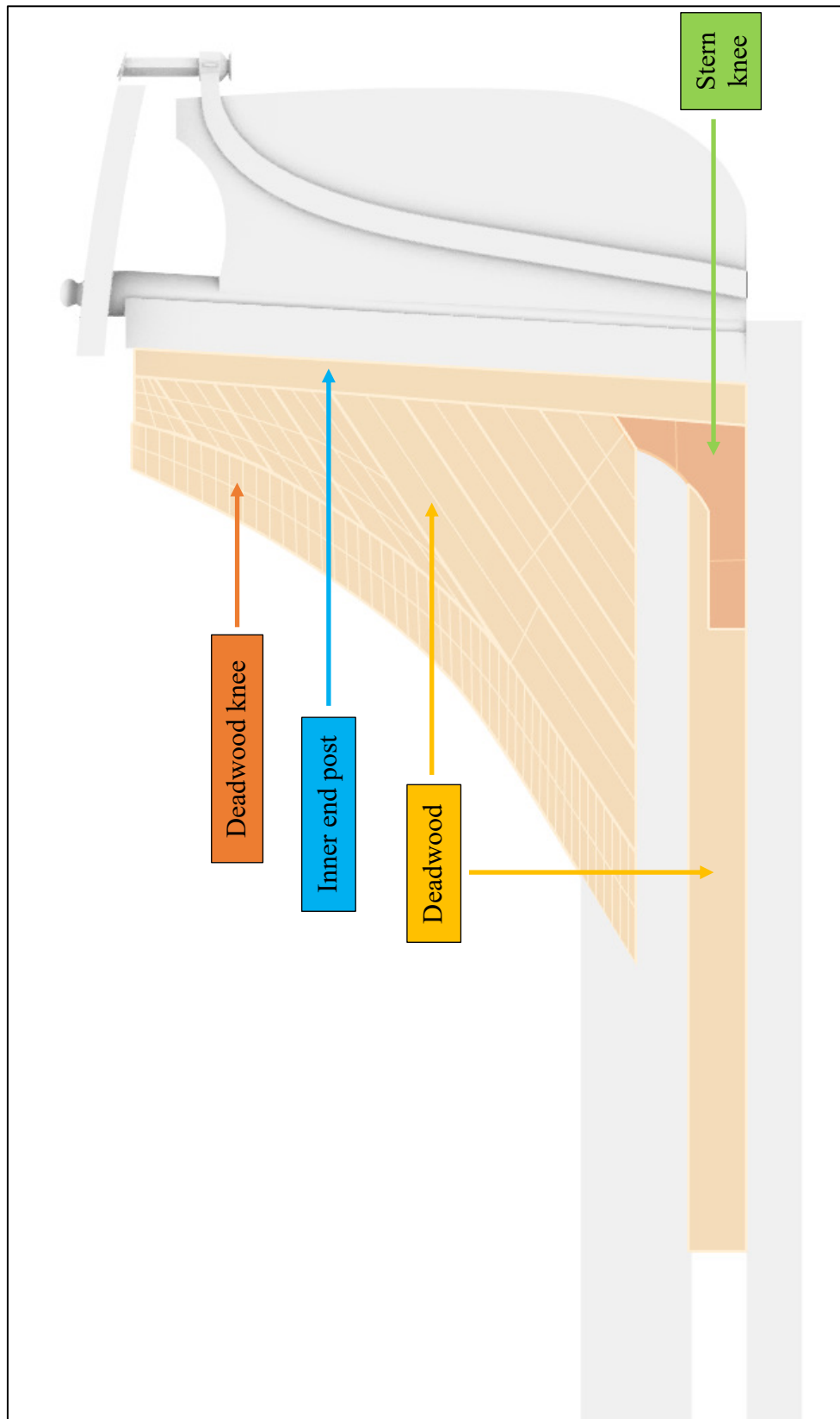


FIGURE 46. Deadwood assembly, inner end post (tan), and stern knee (orange) of *Regla*; in “Arctic” view (image and model created by author).

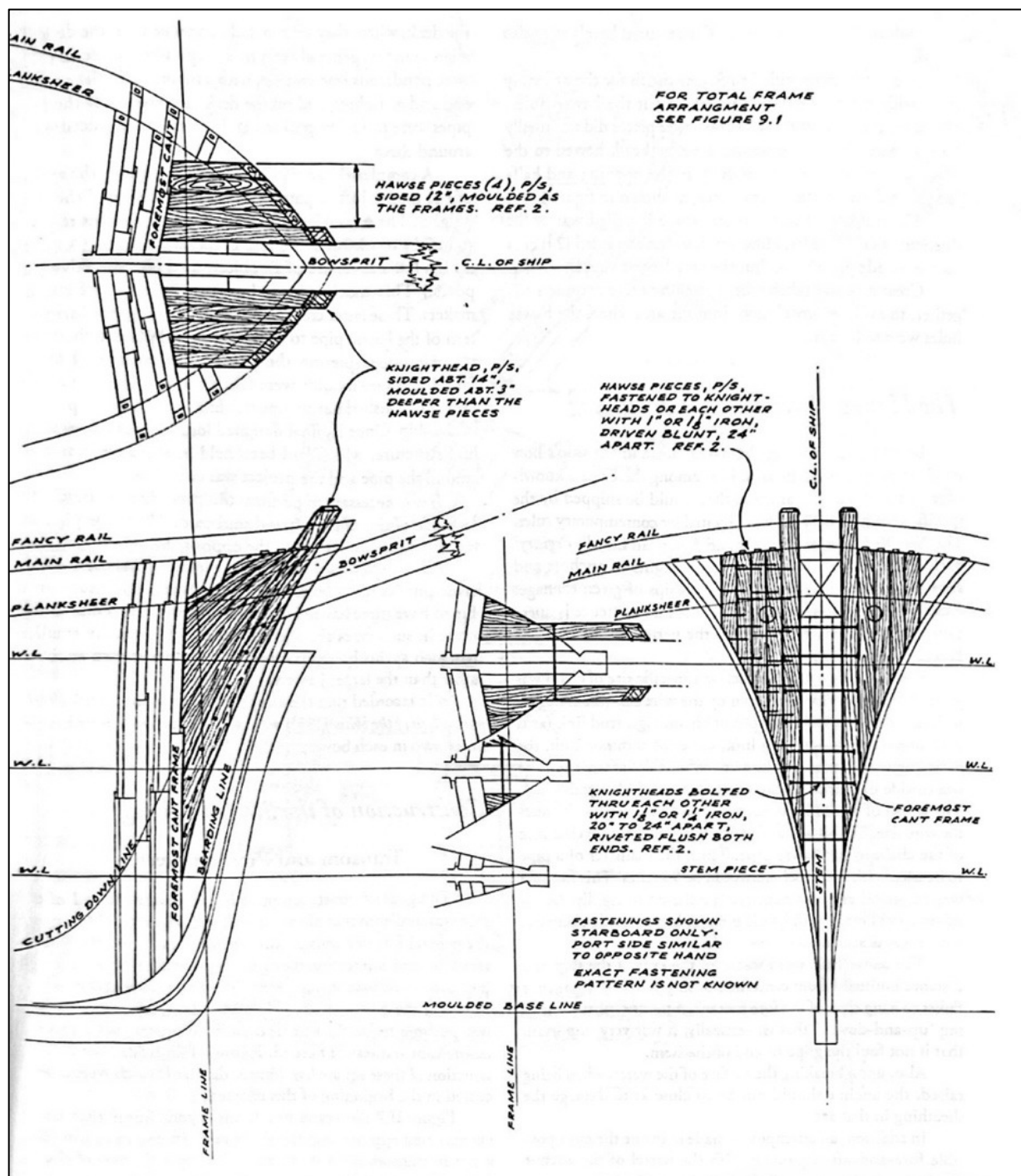


FIGURE 47. Knightheads and hawse pieces (courtesy of William L. Crothers 2013:153).

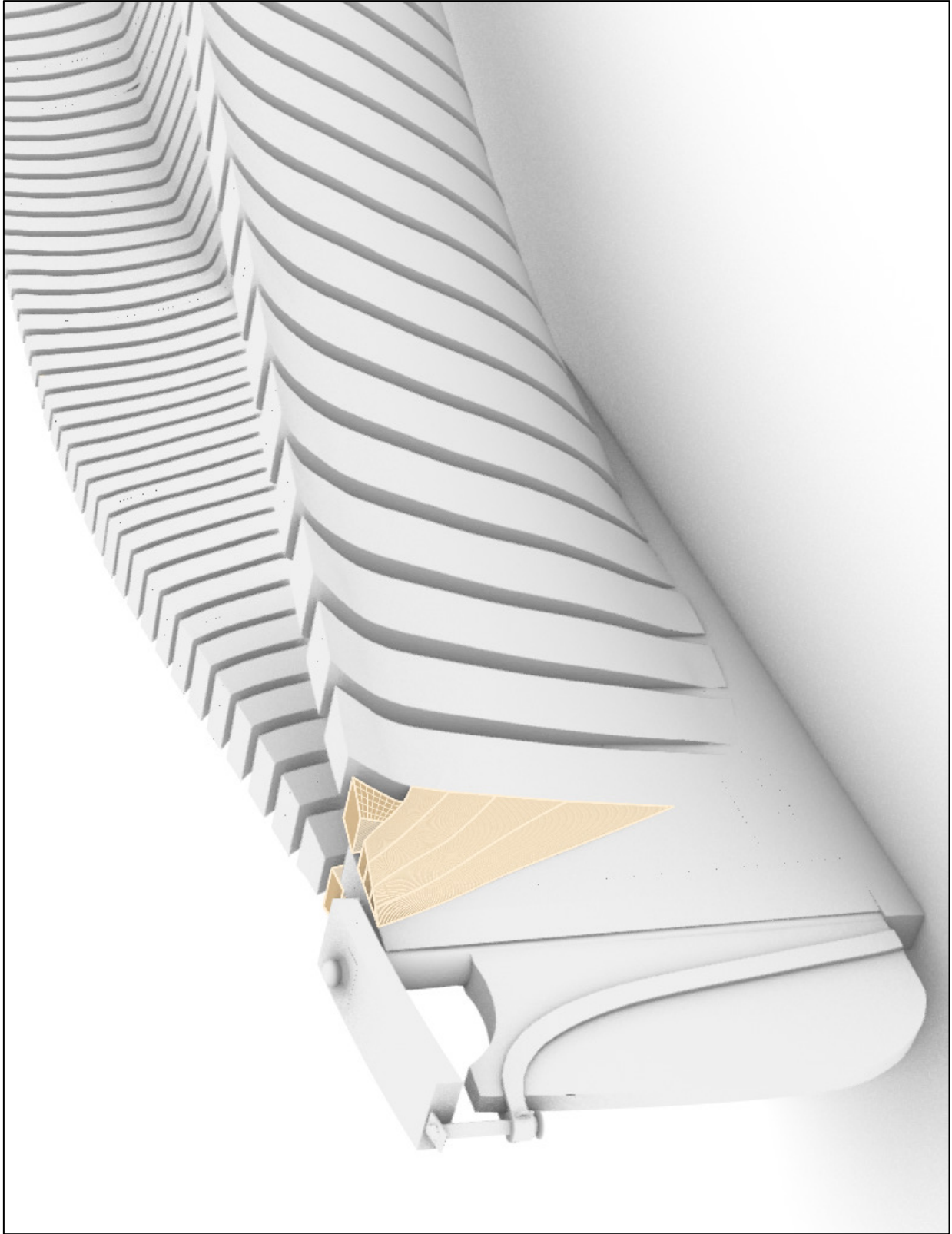


FIGURE 48. Filling pieces (tan) of *Regla* as traced from *Ocean Monarch*; in “Arctic” view (image and model created by author).

The next step involved creating the 3 in. thick ceiling planking. The ceiling planking having the same width as the hull's was reflected in remains of the Canadian sidewheeler *Maple Leaf* (Cantelas 1994:17) and the remains of *Waccamaw* itself. The ceiling was created by lofting the space between the frames, then lofting between these newly created lofts. This was done for the length of one side of the hull where they were then joined using the "join" command extruded out 3 in. using the gumball. Finally, the ceiling was mirrored to complete its construction. The next step was to install the longitudinal strengthening timbers, that is the bilge planks and clamps.

The bilge planks were 4 in. sided and molded (American Lloyds 1861:xvi). The shape was derived from Crothers' (2013:176-178,183) depictions of bilge strakes running along the futtocks just inboard of the turn of the bilge and terminating at the deck beams on either side. The three bilge planks were treated as one unit in the model, where a curve was created using the "interpolate points" command allowing the shape of the curve to follow that of the hull. Once four curves were created, they were lofted together and then mirrored to the opposite side. The clamps were built next and consisted of two timbers butted along the upper inboard edge of the frames and measured 12 in. and 15 in. in width respectively with both being 5 in. molded (Cantelas 1994:17). To create them, a line was made at the top of the frames and extruded out to create a splitting surface. The surface was then moved first 12 in. then 15 in. down and the "split" command was used to separate these top portions of the ceiling from the rest. The clamps were then extruded out to 5 in. using the gumball. Figure 49 shows the ceiling, bilge planks, and clamps during the modeling process.

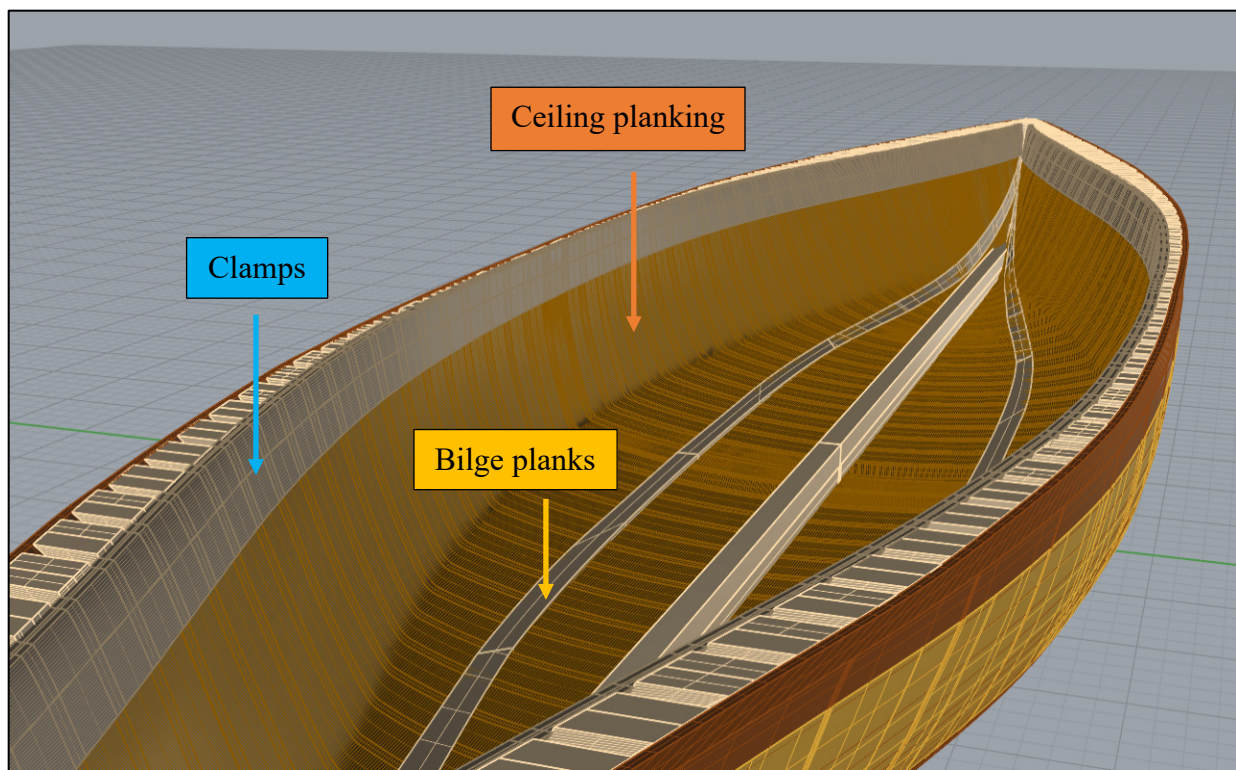


FIGURE 49. Perspective view of the ceiling planking, clamps on the upper edge of frames (dark tan), and bilge planks on either side of keelson; in “Shaded” view (image and model created by the author).

Deck Beams

Creating the deck beams was one of the lengthier processes as, according to the sheer height offsets, the deck had a significant reverse sheer. This curve would not just have occurred longitudinally, but athwartship as well given the beams had to be fastened to the top of the frames (Stevens 1893:196). The purpose of the longitudinal crowning was to accommodate the paddle shaft which, to allow the unimpeded traffic of passengers and carriages across the main deck, lay inline or below the height of the deck beams (Hardy 1927:115). This longitudinal crowning can be seen in the architectural drawing of *City of Reading* (Figure 44), while the transverse crowning can be seen in the photograph of the late 19th century New York ferry *Atlantic* (Figure 50).



FIGURE 50. Main deck of New York ferryboat *Atlantic* (built 1884) at East Kingston, New York to be dismantled, 1939. Note the slight drooping of the deck as it continues outboard (courtesy of the Elwin Eldridge Collection, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0091-03.01-04-061B).

In terms of modeling, this meant each frame would have to be shaped differently to meet the hull as it came to a point at its end. The first step was to create the extreme breadth shape of the beams by copying the top waterline and extending it outboard of the hull until *Regla's* extreme breadth of 28 ft. and 4 in. was reached. These lines were then extended to the length over all (LOA) on either end of the vessel and traced over, using the “interpolate points” tool to create a new extreme breadth line. The sheer height line was then copied, extended to reach the LOA, and then brought down to meet the extreme breadth line. Then, to ensure the frame had an appropriate thwartship curve to meet the frames at their intersection, the extreme breadth line was extruded down 8 in. and a curve created on the outboard edge of the frame heads was

extruded up 8 in. Curves could then be connected to the surfaces as they passed through one end, to the sheer height line, and then to the other.

The beams were to be placed on the center of every frame pair (Cantelas 1994:19-20), so points were created on the extreme breadth line surface, the frame head surface, and the sheer height line spaced with the requisite molded and sided dimensions (American Lloyds 1861:xiv). After that the “interpolate points” command was used to make curves outlining the shape of the frames. The deck beam had to be canted in at either end to complete the sponson deck structure. A photograph of the 1883 ferry *Albany* obtained from The Mariners Museum digital archive (Figure 51) and Crothers’ (2013:163) depiction of stern frame assemblies of packet ships with transom-less counter sterns informed the construction of the canted beams (Figure 52). The first canted beam timbers created were those running longitudinally and they were spaced to accommodate the width of the rudder hatch (Spirek 1993:128). The canted beams were then spaced at the heads at the same distance as the space between the previously created deck beams.

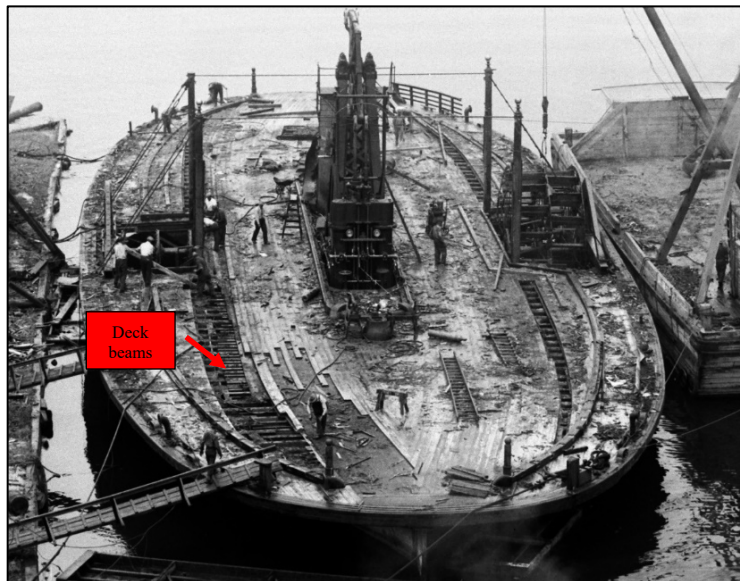


FIGURE 51. Ferry boat *Albany* being dismantled at Island Dock, Rondout Creek, New York. Note the tight spacing between the deck beams (courtesy of the Elwin Eldridge Collection, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0091/03.01-02-036a).

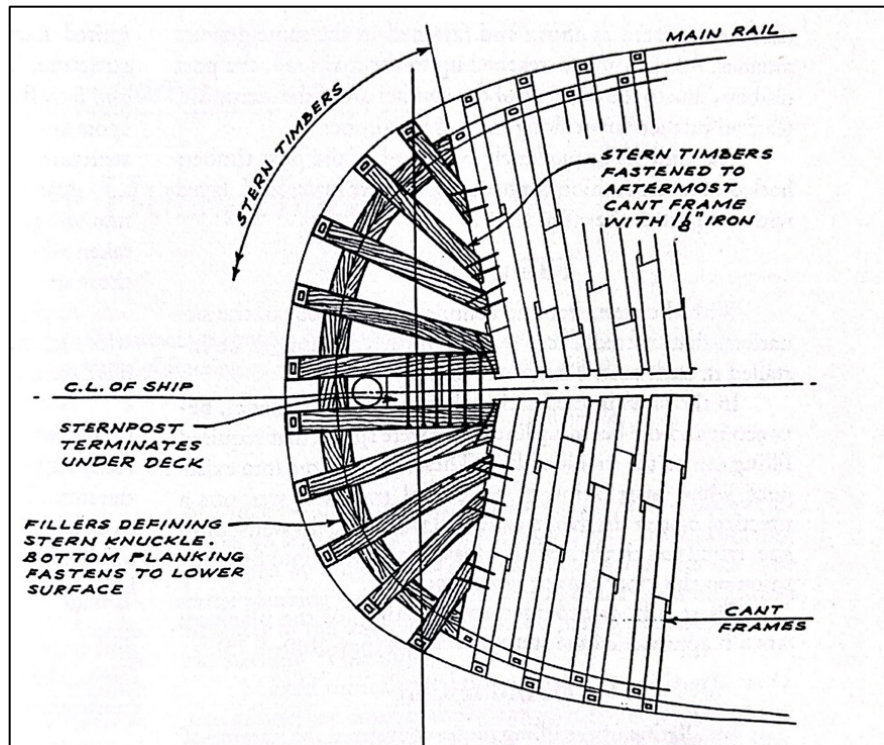


FIGURE 52. Counter stern timbers without transoms (courtesy of William L. Crothers 2013:163).

Final Structural Features

The last portions of the deck's structural members modeled were the stanchions, carlings, headers, and sponson struts. The position and dimensions of hold stanchions were based on a photograph of the exposed hull structure of the double ended ferry *Plainfield* (Figure 53), Crothers' illustrations (2013:194-197), and the photograph of the *Waccamaw* site from the 1990 field investigation (Figure 20). When winged, stanchions were generally stepped into the bilge keelsons (Crothers 2013:194), therefore, stanchions for the model were placed on the bilge planks and extended to the bottom of the deck beams using the "corner to corner height" tool. The longitudinally running carlings were based again on information found in Crothers (2013:213), being spaced to divide the hull into thirds. They were created in a similar manner to the beams by using points to define the dimensions, lines to connect the points, and then lofting between the lines.

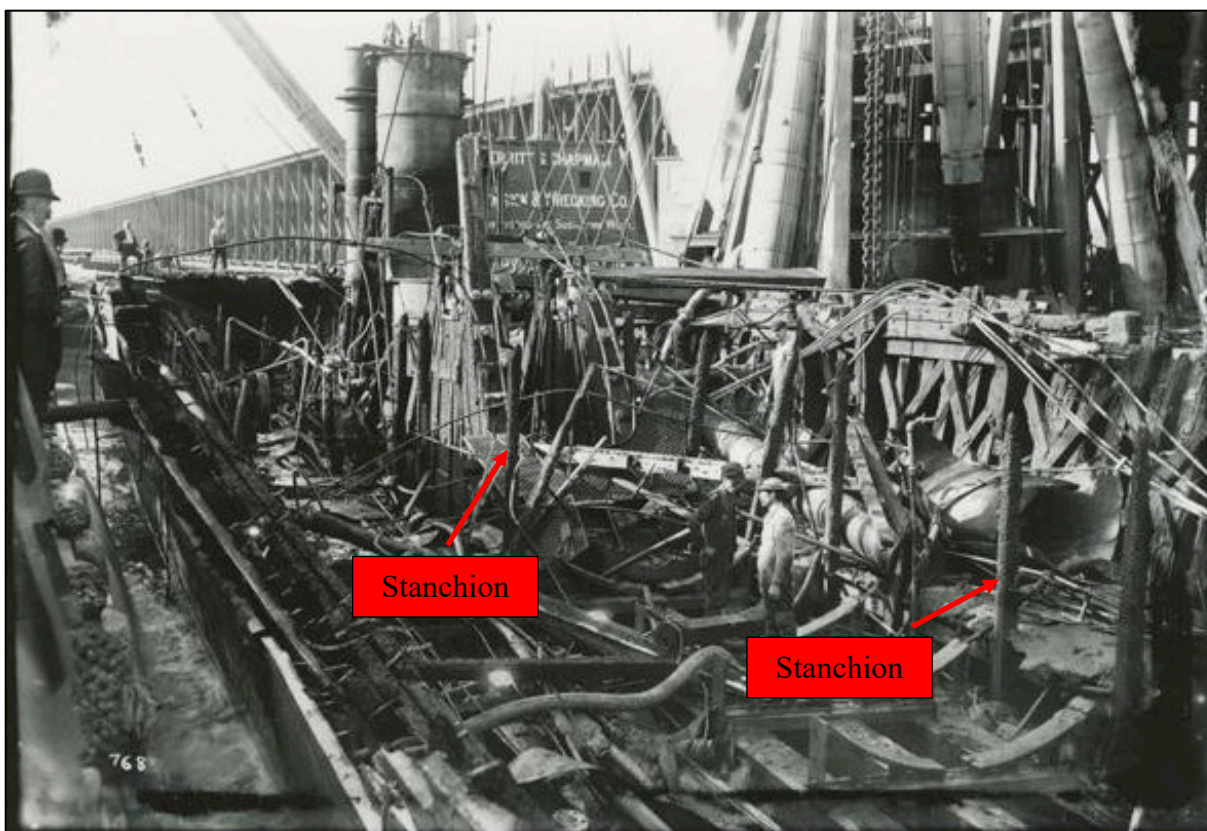


FIGURE 53. Raising the ferryboat *Plainfield* after burning. Note the winged stanchions on either side of the machinery (courtesy of the Mystic Seaport Museum; reference # 1964.660.128).

Before cutting the openings to the hold in the deck beams for the ventilation and machinery, the space taken up by the boiler and engine and their location within the hull needed to be established. This was done by taking dimensions of the boiler and engine bed remains from the *Waccamaw* site via the scaled photogrammetric model and using them to create basic polylines over the rider keelson. This also helped determine the location of the paddle shaft by drawing a line in Metashape® from the paddle shaft remains on the western side, across the remaining vertical timber of the engine bed, and to the arms of the paddle wheel on the eastern side. Then the distance between the line and the southern end (given it was the most intact) was taken. Doing so allowed the position of the engine bed and the boiler remains to be determined in relation to the paddle shaft.

With the position and dimensions of the boiler and engine now outlined into the hull, the headers could be created for the ventilation hatches forward of the boiler and the method for creating these timbers was the same as the carlings. The opening for the machinery was created next with its width being taken from *Southfield*'s remains (Spirek 1993:123) and the length being taken from *Flushing*'s architectural drawing (The Mariners Museum and Park 1933a). A line was created with the appropriate length, copied and then moved laterally at the appropriate width. *Southfield*'s site plan (Spirek 1993:133) was then brought into Rhino® and scaled in reference to the scale bar provided within the plan. This was used to trace the curvature of the timbers on either end of the machinery opening. The resulting curve was joined to the lines previously created and was then extruded out to use as a cutting surface to trim the deck beams. Headers of the same dimensions of those placed for the ventilation hatches were then placed at either end of the cut deck beams. With the deck appropriately arranged (Figures 54 and 55), the machinery could be constructed.

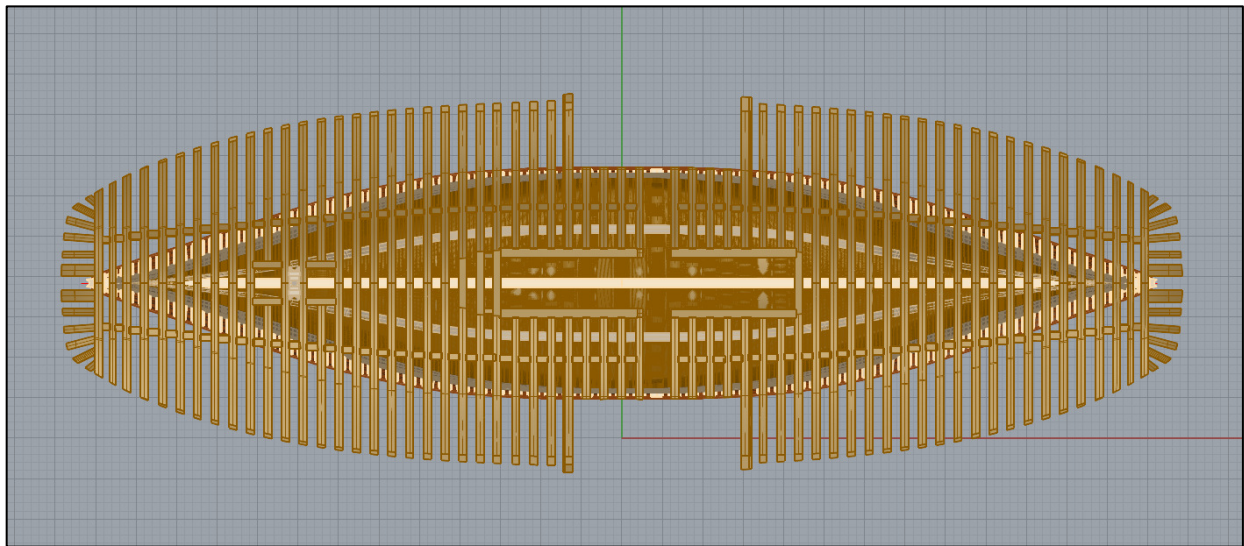


FIGURE 54. Plan view of deck beams, carlings, and headers; in “Shaded” view (image and model created by author).

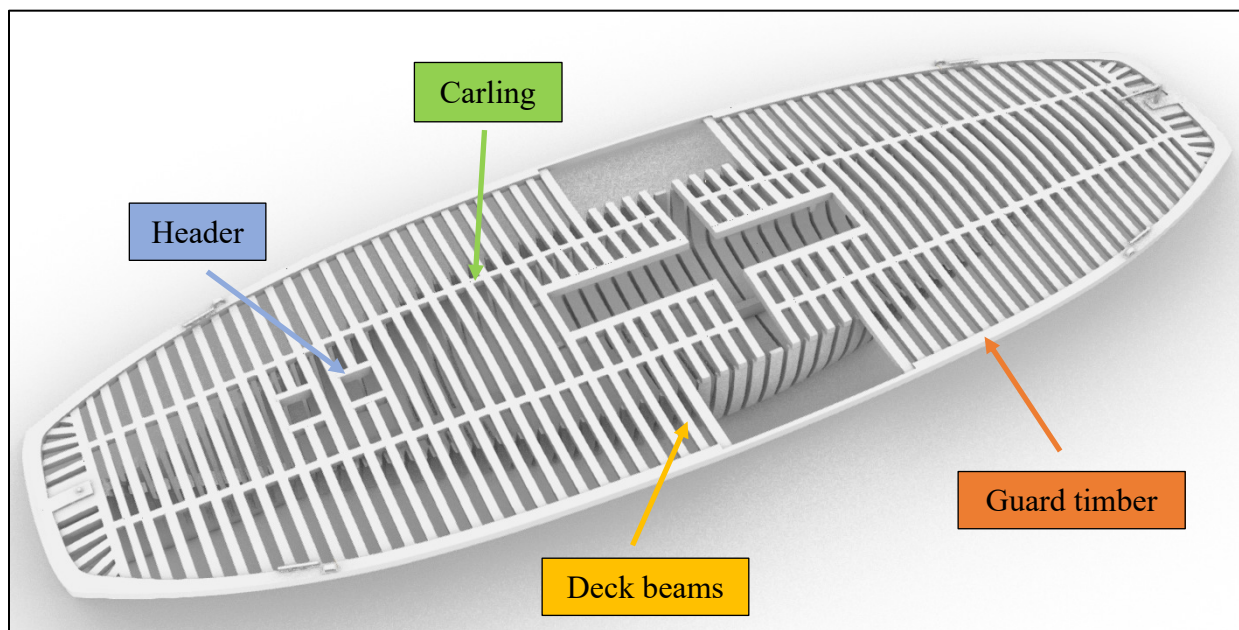


FIGURE 55. Perspective view of the deck beams, carlings, headers, and guard timber; in “Arctic” view (image and model created by author).

Machinery: Engine, Boilers, and Paddle Wheel

The powerhouse of the vessel, the direct-acting inclined steam engine, was the first piece of machinery modelled. *Regla*’s engine type, cylinder diameter, and the stroke of the piston had been noted in original and secondary naval records (United States Department of the Navy 1921:63; Silverstone 2006:67) and was confirmed upon inspection of the UAB site file (NCUAB 2024:21) and the site itself. Of the several scaled Harlan and Hollingsworth architectural drawings found in the Mainers Museum digital archives, the one depicting *Flushing*’s engine (The Mariners Museum and Park 1933b; Figure 56) was primarily used for modeling given its deck plan was also available to arrange the machinery opening. The plan was brought into Rhino®, scaled out, then brought into position on the centerline of the hull where it was copied so the plan view could be used as well. The piston and crank shaft were traced from the drawing alongside the steam pipe using the “interpolate curve” command and was routed to the boiler’s steam chimney by extruding then bending the traced circle using the extrude function on the

“gumball” and the “bend” command respectively. With the engine complete (Figure 57), the boiler was next to be installed.

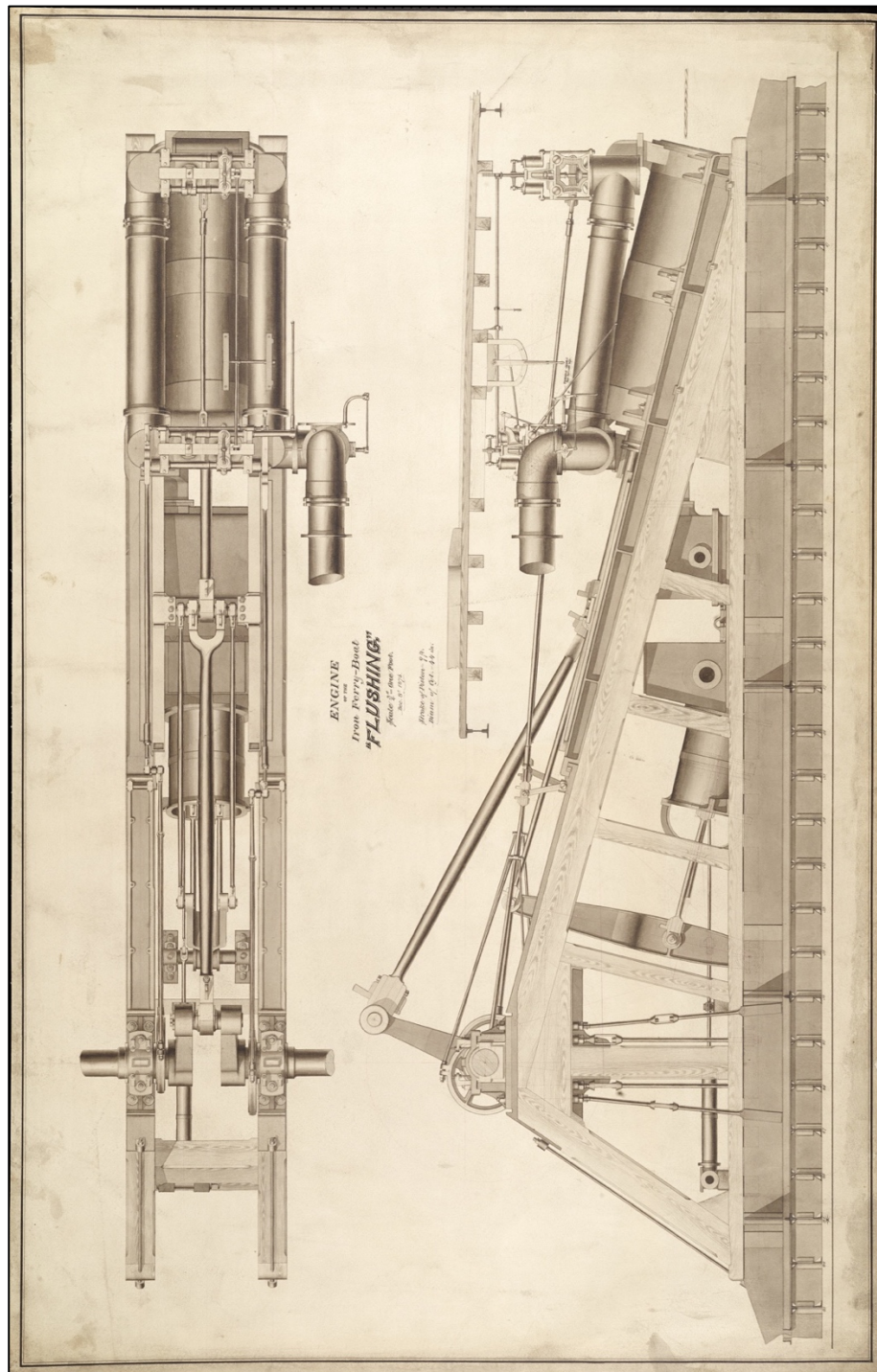


FIGURE 56. Direct acting incline engine of the ferryboat *Flushing* (built 1877) (courtesy of the Harlan & Hollingsworth Company Plans, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0573/01-48).

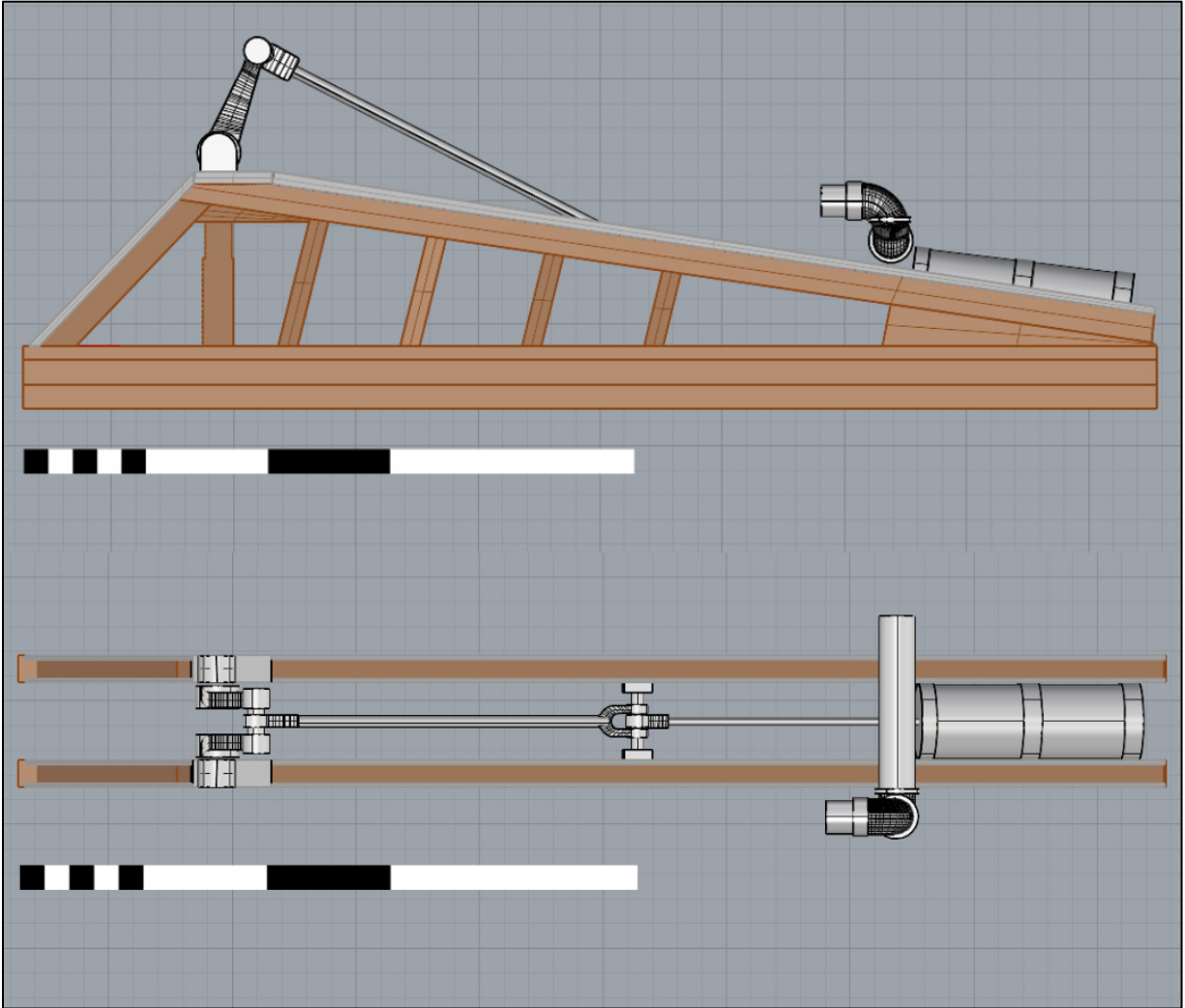


FIGURE 57. Profile and plan view of engine with 30 ft. scale (one square is 1 ft.); in “Shaded” view (image and model created by author).

The boiler was modeled after a horizontal firetube boiler based on the archaeological remains, past archaeological determinations (Overton and Lawrence 1996:141) and the use of said boiler in comparable craft of the period (Whittier 1987:18; Bisbee 2012:86, 2018:17). The core components for this boiler included furnaces at the forward-facing base, several large pipes to direct smoke from the furnace to the smoke box at the rear of the boiler, which in turn connected to the fire tubes situated above the large pipes which directed the smoke to the stack. A steam chimney at the top of the boiler wraps around the stack and is a variation of a steam chest, acting as reservoir to collect steam, thereby maintaining a steady supply of steam to the

engine. It had the added advantage of providing a “backup” supply in the event steam was being used faster than the boiler could produce it (Evers 1878:139).

As mentioned above, the dimensions of the base of the boiler, 18 ft. and 2 in. long and 9 ft. and 2 in. wide, were taken from the photogrammetric model. The dimensions for the stack, steam chimney, and boiler diameter were taken on the contemporary sketch of the boiler installed on the CSS *Lady Davis* (ex. *James Gray*), an 1858 built tugboat (Figure 58) (Bisbee 2012:193;201). Creating the boiler was a simple process that only required extruding the previously placed outline using the gumball and filleting the edges to the proper diameter using the “fillet surface” tool. The steam chimney was made using the “cone” tool and the stack was created by extruding a circle created with the “radius” tool. The engine and boiler final models positioned within *Regla*’s hull can be seen in Figure 59.

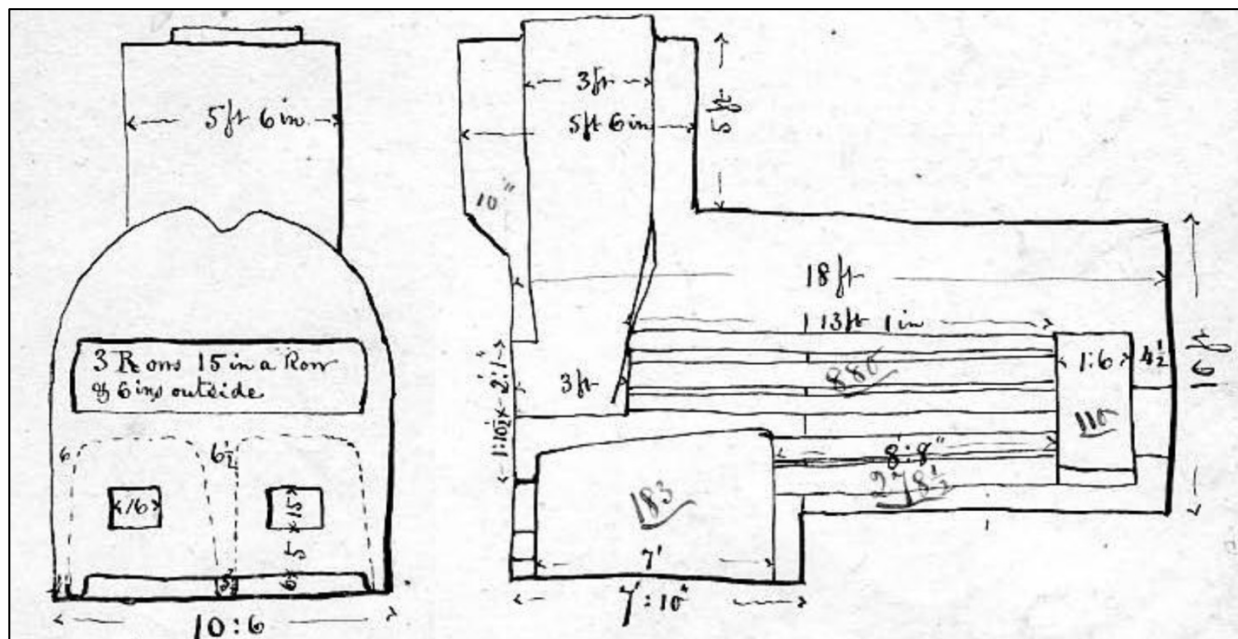


FIGURE 58. Low-pressure horizontal firetube boiler sketch, basis of *Regla*’s boiler shape. (courtesy of Saxton T. Bisbee 2012:201, from The Mariners Museum and Park Archive, Newport News, Virginia; reference # MS102/05-211).

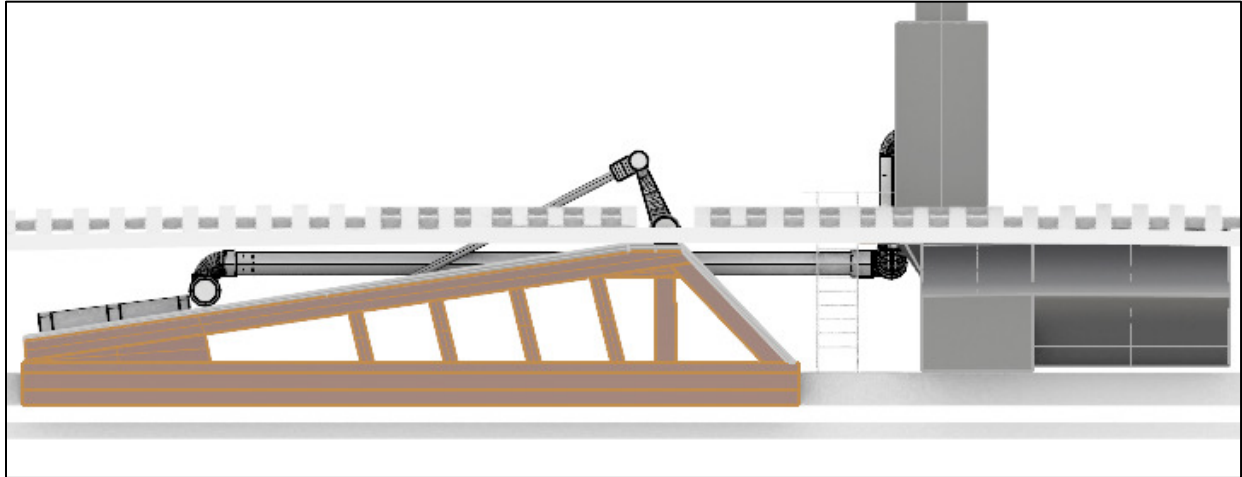


FIGURE 59. Engine and boiler orientation within the vessel's hold; in "Arctic" view (image and model created by author).

Finally, with the engine and boiler installed, the paddle wheels and shafts were created. First were the paddle wheel shafts, which were connected to either end of the crank. The diameter of the shaft, 14-1/2 in., was taken from the photogrammetric model of the *Waccamaw* site and made by creating a circle and extruding it out to the end of the beams. The diameter of the wheel, 18 ft. and 6 in., was based on *Wenonah's* (1881) architectural drawing (The Mariners Museum and Park 1933c). The wheel's width was determined by how much space was available from the end of the beams, where the spring beam and rub rails would be installed, and the outer hull planking. Based on measurements taken from the Harlan & Hollingsworth architectural drawings, anywhere from 3 in. to 7 in. of space was kept between the most inboard portion of the wheel and outer hull planking. The distance between the extreme breadth and the breadth between guards of *Regla* was 14 ft. and 2/3 in. (Merchant Vessels of the United States 1885:378; United States Department of the Navy 1921:63), leaving 7 ft. and 1/3 in. available on either side. Yet, 1 ft. was still needed for the installation of the spring beam which supported the paddle shaft and the bushing it rotated in. Therefore, a width of 5 ft. and 7 in. was chosen to give the wheel enough clearance to rotate.

With the basic dimensions of the wheel determined, a radial wheel was built with the details informed by Watson's depiction (Watson 1985:71; Figure 60). Radial wheels, rather than feathering wheels, were still the primary type used by these American river steamers during the mid-19th century (Cudahy 1990:127). While feathering wheels more efficiently propelled a vessel through the water, the numerous parts and bearings needed to allow the bucket planks to pivot required constant maintenance to keep it operational. This fact pushed many American owners to order the less efficient but more robust radial wheel to be installed on their vessels (Whittier 1987:36).

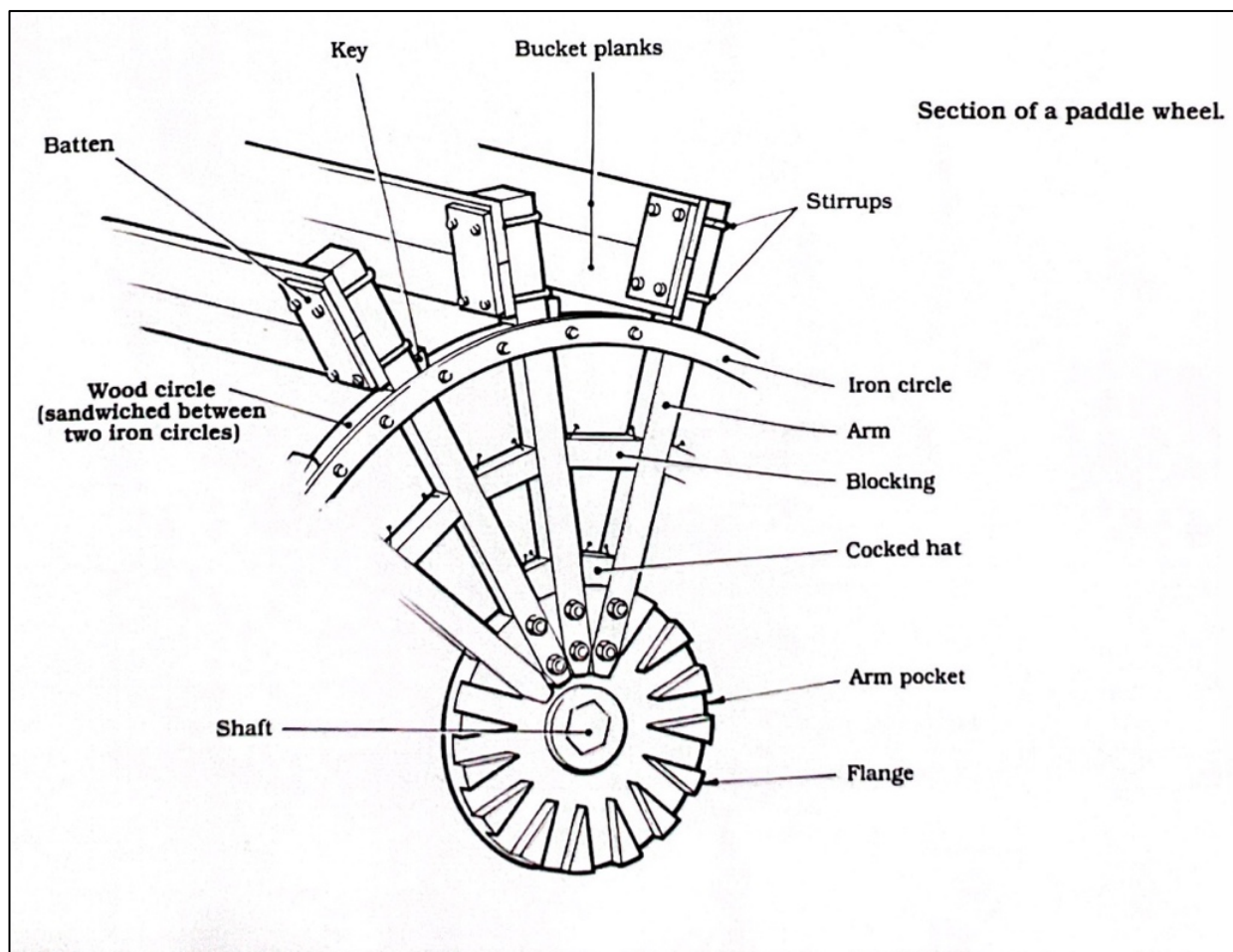


FIGURE 60. Labeled section of a radial paddle wheel, used as reference for reconstruction of *Regla's* wheels (courtesy of Ken Watson 1985:71).

The diameter for the flanges, the thickness of the bucket planks, and the width of the upper and lower iron circles were taken from *Wenonah*'s architectural drawing (The Mariners Museum and Park 1933c). The photogrammetric model informed the center-to-center distance between the flanges and their thickness. The “radius” and “extrude” commands were used to create the flanges and iron circles with the “line,” “loft,” and “extrude” commands were used to make the arms and bucket planks. Once finished, the wheel was mirrored to the other side of the vessel (Figure 61).

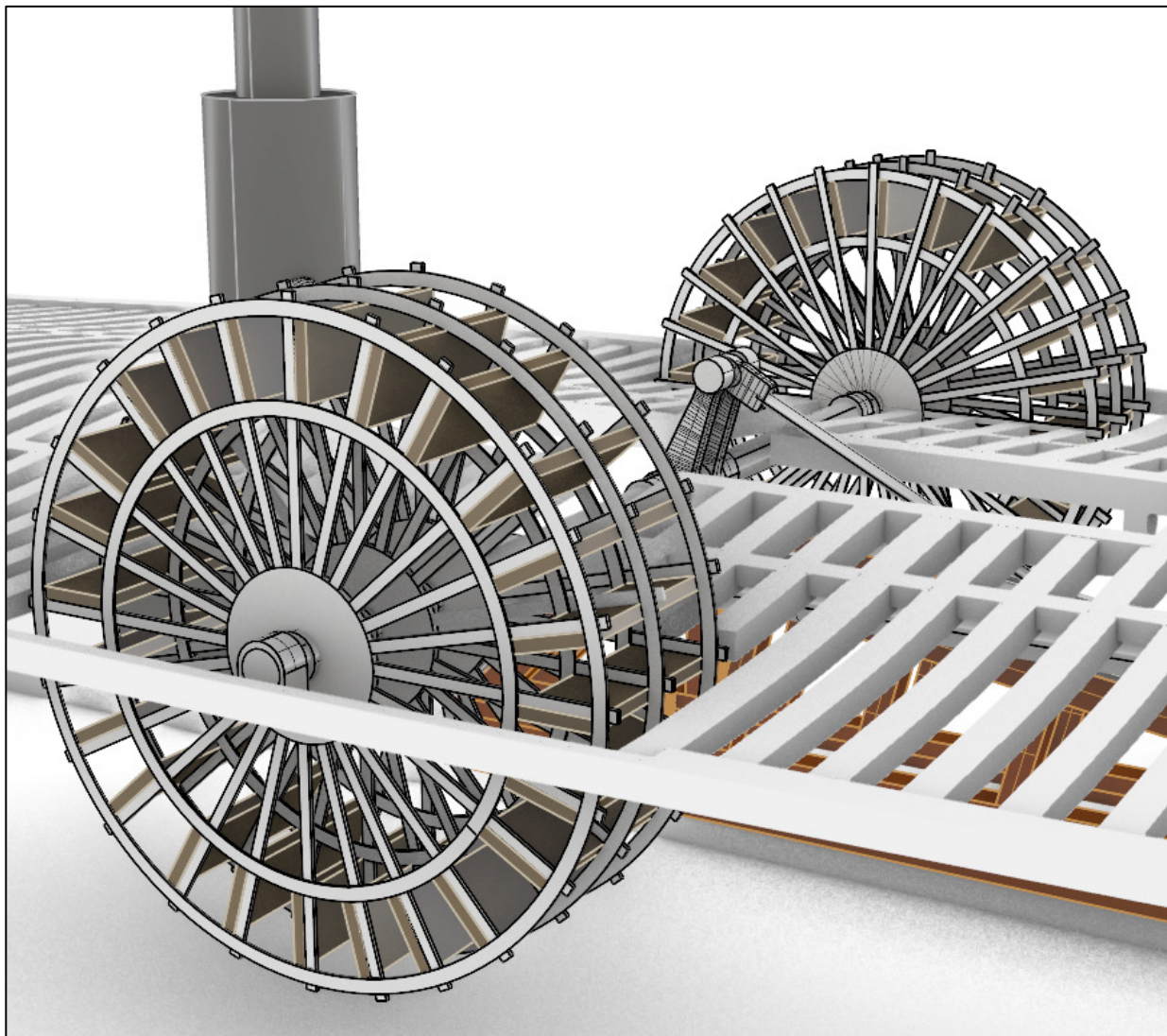


FIGURE 61. Paddle wheel of *Regla* complete with bearings, flanges, arms, bucket planks, and iron support circles; in “Arctic” view (image and model created by author).

Fitting out the Ferry: Deck, Superstructure, and Piloting System

With the hull structure and machinery complete, its original build as a New York style proximity ferry could begin (Figure 62). For this discussion, the reconstruction of its configuration will be broken into three parts: the deck, the superstructure, and the piloting system.

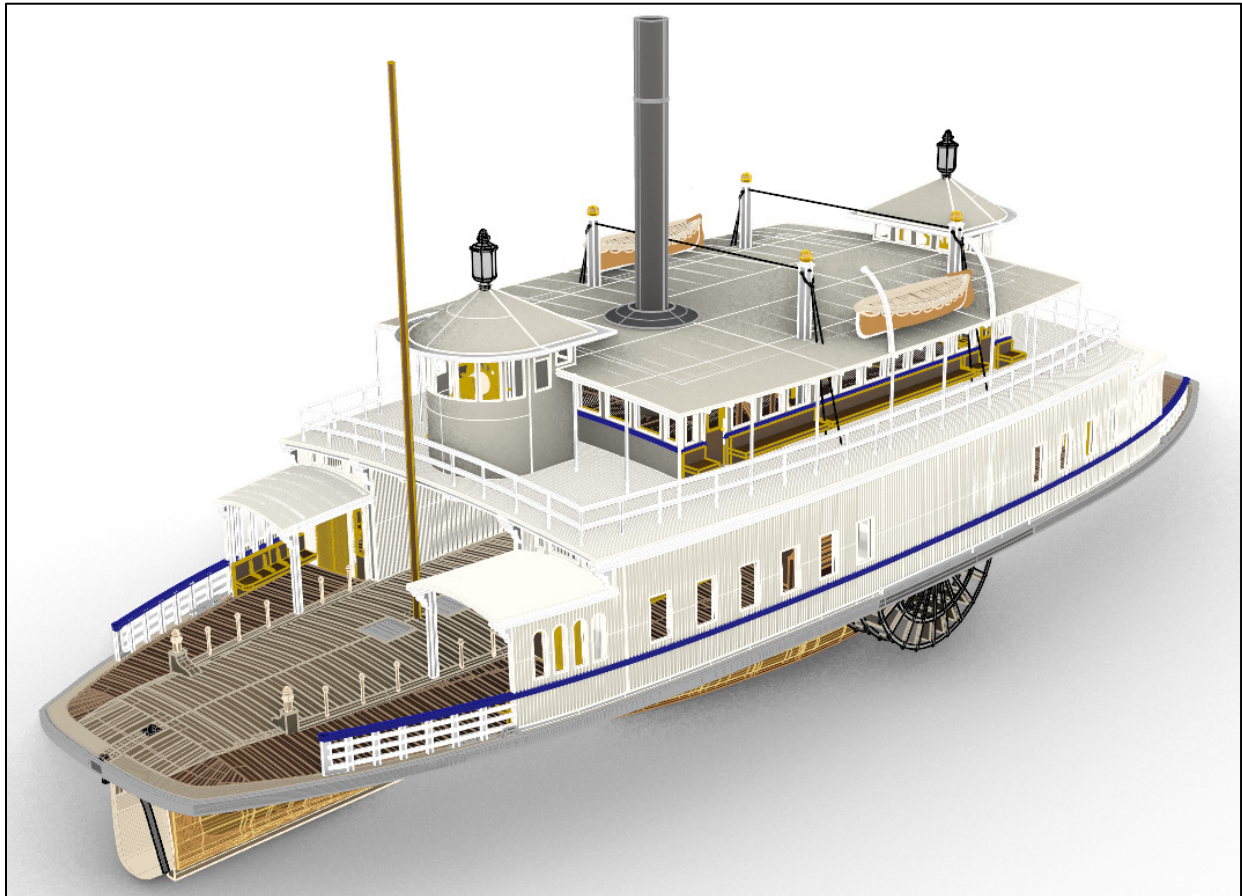


FIGURE 62. Interpreted 3D reconstruction of the ferryboat *Nuestra Señora de Regla* built by John Englis at the foot of 10th St. Manhattan, New York in 1861 (Blume 2012:254) (image and model created by author).

Deck

The first items modelled to fit out the deck were the iron struts which supported the sponson. The position, dimensions, and spacing for these sponsons supports were derived from several photographs of mid to late 19th century ferries, descriptions from Parkoff (2016:23), and scaled architectural drawings and plans of the ferry boats *Flushing*, *Southfield II*, *City of Reading*, and

Eureka (Cowles 1886:190, The Mariners Museum and Park 1933d; National Park Service 1998; Figure 63). Finding the angle was the first step taken in making the sponson supports by using the “angle” command. The average of the measured angles, 67° , was used and the sided and molded dimensions were taken from *Flushing* (The Mariners Museum and Park 1933a). The final product in comparison with a contemporary photograph can be seen in Figures 64 and 65.

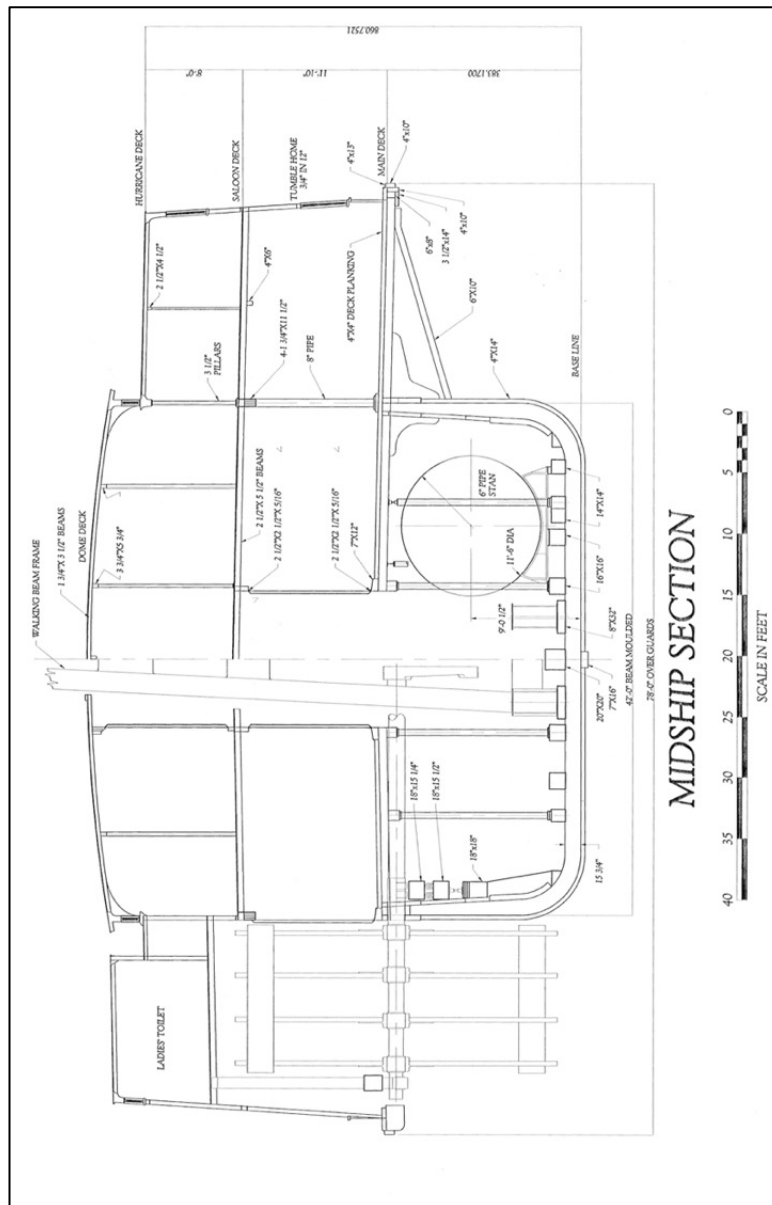


FIGURE 63. Midship section of the San Francisco ferry *Eureka* built 1890. Note the oblique structure extending from the hull to the end of the deck beam on the right side of the section (courtesy of Historic American Engineering Record, National Park Service, drawn by Dana Lockett (1998).

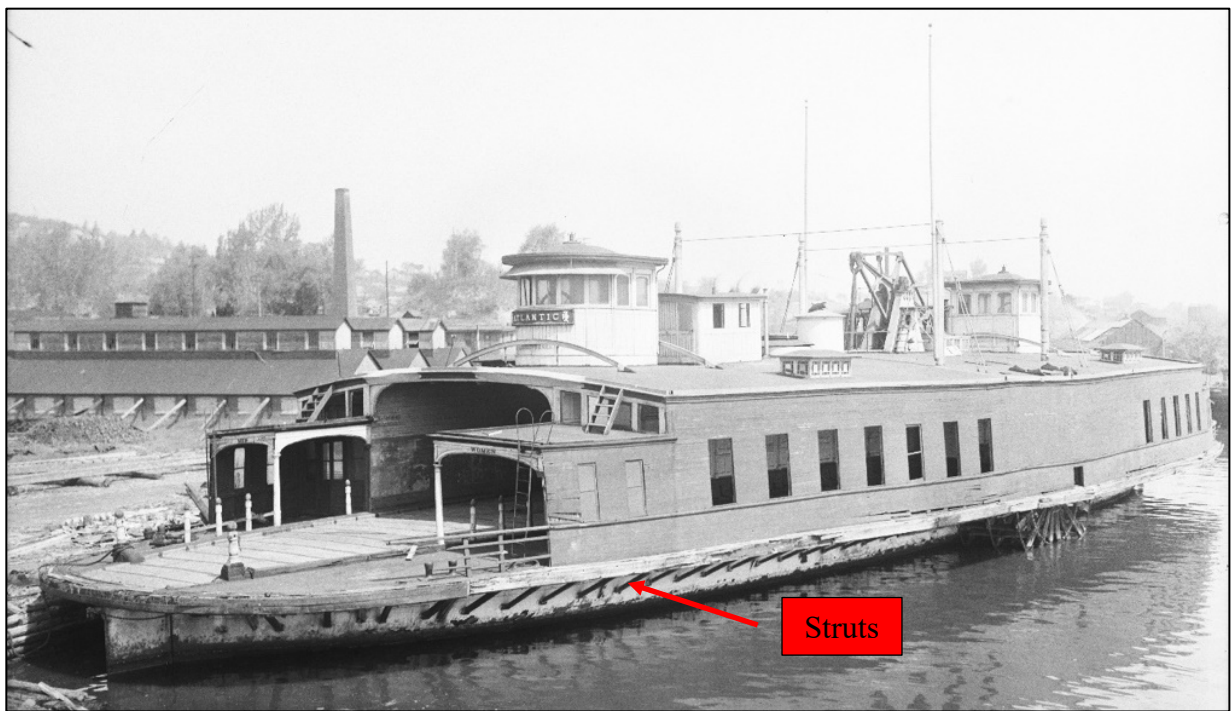


FIGURE 64. Ferryboat *Atlantic* (built 1885). Note the diagonal struts extending from the hull to the end of the sponson (courtesy of the Elwin Eldridge Collection, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0091/03.01-04-061d).

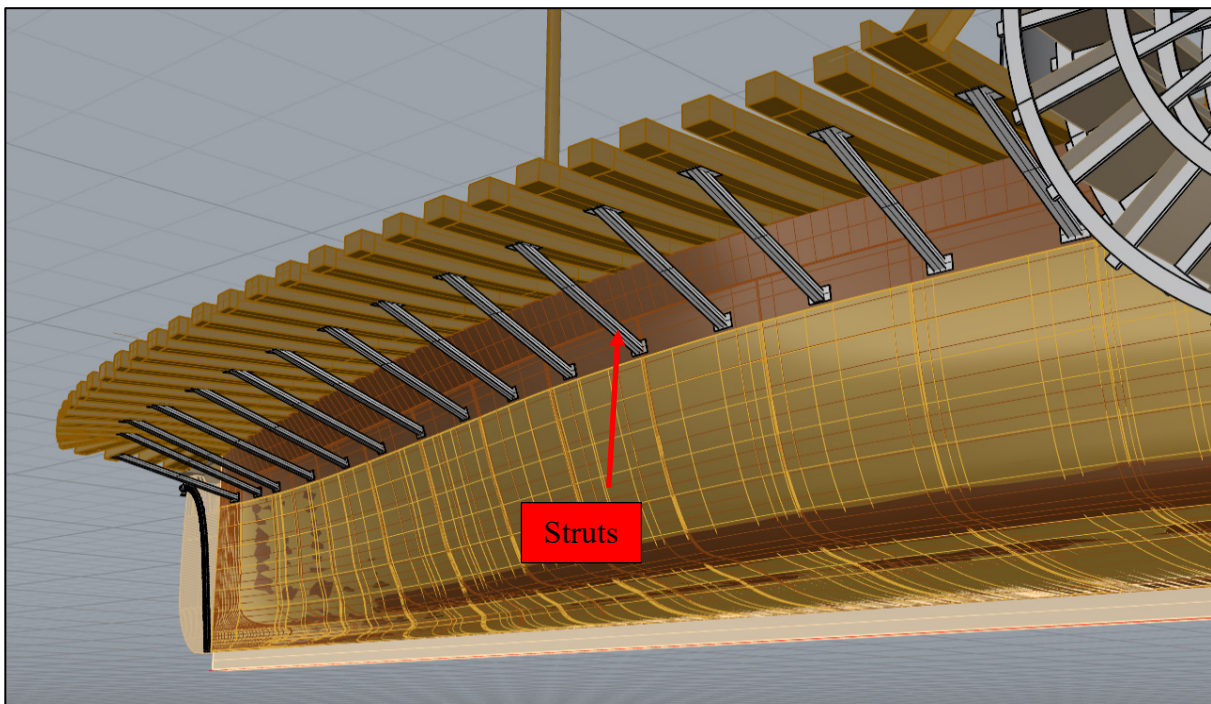


FIGURE 65. Sponson support struts; in "Shaded" view (image and model created by author).

With the sponson supports installed, fitting out the deck began. This started with the creation of the rudder access hatch, informed chiefly from the *Southfield* remains. The recorded hatch was 5 ft. in length and 1 ft. and 9 in. in width. It consisted of two levels of planking (Spirek 1993:128-130) and each is interpreted as being 3 in. in width (Crothers 2013:245). The “interpolate curve” tool was used to first provide an outline that conformed to the shape of the deck beams. The outline was lofted with the first level laying flush with the deck beams and the second level laying directly over it, itself becoming flush with the deck once the deck planking was installed.

The deck planking was modeled next in the same manner as the ceiling planking. Lofts were created between the beams and then lofts were made between the lofts, they were all joined and then extruded up 3 in. (American Lloyds 1861:xiv; Crothers 2013:247). The guard and iron rub rails which fastened to and wrapped around the beams (Russell 1861:113; Spirek 1993:128) were built next. The molded dimension of the guard and the two rub rails were taken from *Wenonah*’s architectural drawing with the sided dimension conforming to the molded dimension of the beams. All three pieces were created in the Rhino® program the same way, by making a curve that wrapped around half of the deck beams using the “interpolate curve” command then extruding the curve down and out to the appropriate dimensions.

The waterways were installed next, which consisted of an outboard and inboard portion for the main cabin bulwarks and stanchions to rest on (Russell 1861:122). The basic dimensions for the waterways were derived from Crothers (2013:224) as being 8 in. sided by 12 in. molded. Where the waterways terminated on either end of the deck was based on *Wenonah* due to its similarity in size to *Regla* (The Mariners Museum and Park 1933c). Sacrificial gangway planking was then created between the passenger cabins extending longitudinally to the forward-

facing guard timbers at either end of the vessel. This planking was created by copying the floor planking, then creating curves to extrude as surfaces which were then used to trim the copied deck which was moved 3 in. up. The last piece installed before modeling the superstructure were the ventilation grates. The structure and dimensions were based on *Flushing* (Figure 66), with a square iron frame being placed within the headers and deck beams horizontal iron slates fitted in between. With the foundational elements of the deck complete (Figure 67), the superstructure was built.

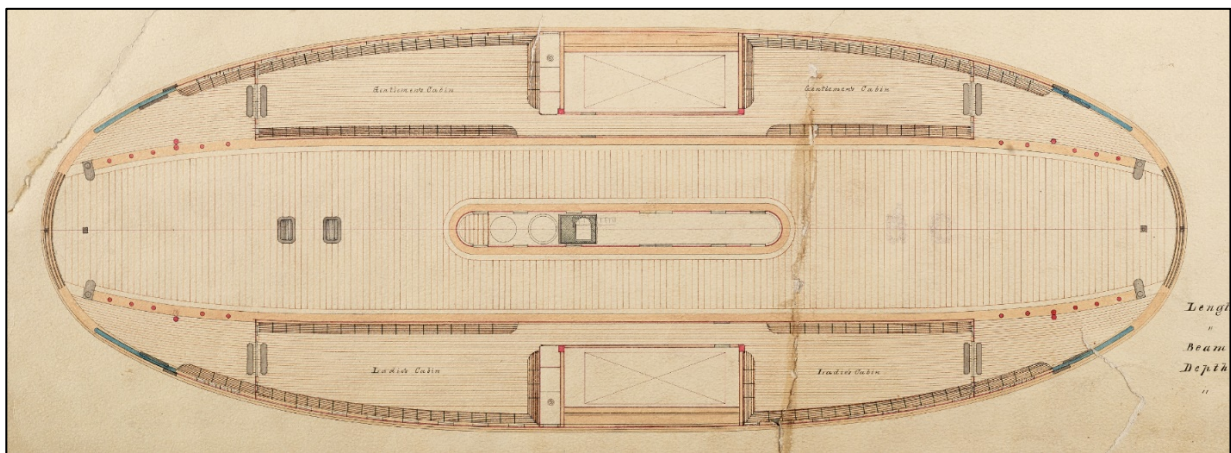


FIGURE 66. Deck plan of *Flushing*, note sacrificial gangway planking and orientation of ventilation (courtesy of the Harlan & Hollingsworth Company Plans, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0573/01-47).

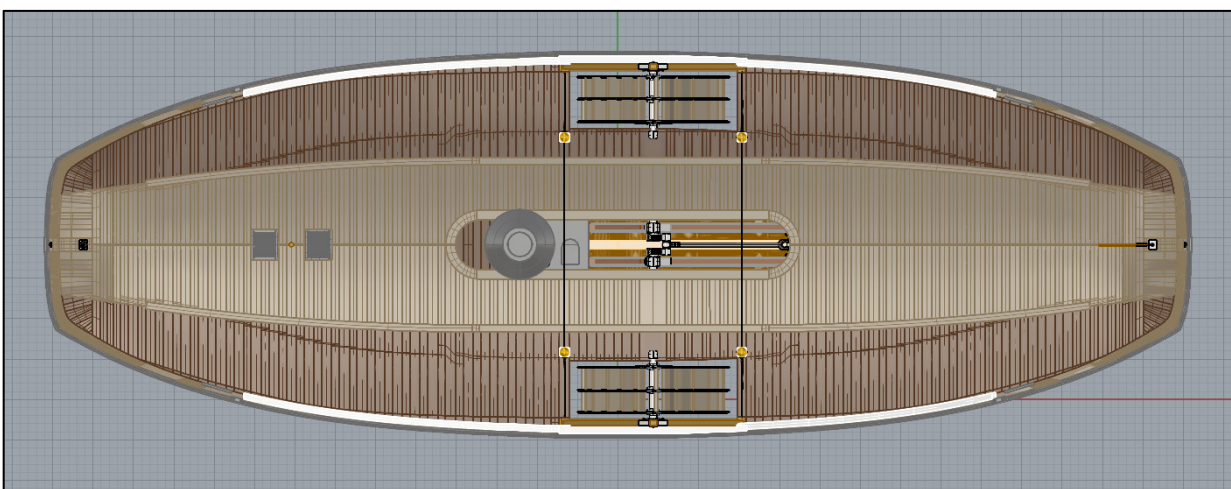


FIGURE 67. *Regla* model with deck planking (brown), sacrificial planking (dark tan), waterways (white), guards, and iron straps; in “Shaded” view (image and model created by author).

Superstructure

The hogging supports for the paddle wheels were the first features of the superstructure modelled, which began with the cross-chain braces (Kane 2004:113). Their size, orientation on the deck, and height were all taken from *Flushing's* architectural drawing with details for the cross-brace coming from a photograph of the ferryboat *Atlantic* (The Mariners Museum and Park 1933a; Figure 68). They were 10-1/2 x 9-1/2 in., rose to a height of 27 ft. and 5 in., and built with the “corner to corner height” tool. The diameter for the wire ropes reaching towards either side of the wheel and those reaching athwartship from brace to brace were based off *Wenonah's* drawing given it was the most detailed in this regard. Two shackles were modeled in at the top of the cross braces using the “radius,” “extrude,” and “bend” tools. The wire rope, which ran through the shackles, was created next by making a circle of the appropriate diameter then extruding it. The “bend” tool was then used to shape the wire rope that reached down to the deck.

The next portions of the paddle wheel support constructed were the paddle beams and the spring beam. The paddle beams were simply the deck beams on either side of the paddle wheel, only their sided dimensions were larger than a typical deck beam. These beams were therefore extruded out 3 in. to create a sided dimension of 2 ft. and 2 in. The spring beam was created in the same manner as the cross-chain braces and was placed directly underneath the paddle beams. The main A-frame rafters were then placed on the spring beam with the general design being taken from a photograph of the ferry *Atlantic* (Figure 69) and dimensions obtained from Cantelas's description of the paddle shaft support on *Maple Leaf* (Cantelas 1994:27). The collar tie and kingpost were then placed using the same dimensions. Finally, the paddle stays that went from the top of the frame to the spring beam were built using the same dimensions as those for the cross-chain brace (Figure 70).



FIGURE 68. Hurricane deck of ferryboat *Atlantic* at East Kingston, New York, to be dismantled. Note shackles and wire rope connected to cross braces (courtesy of the Elwin Eldridge Collection, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0091/03.01-04-061a).

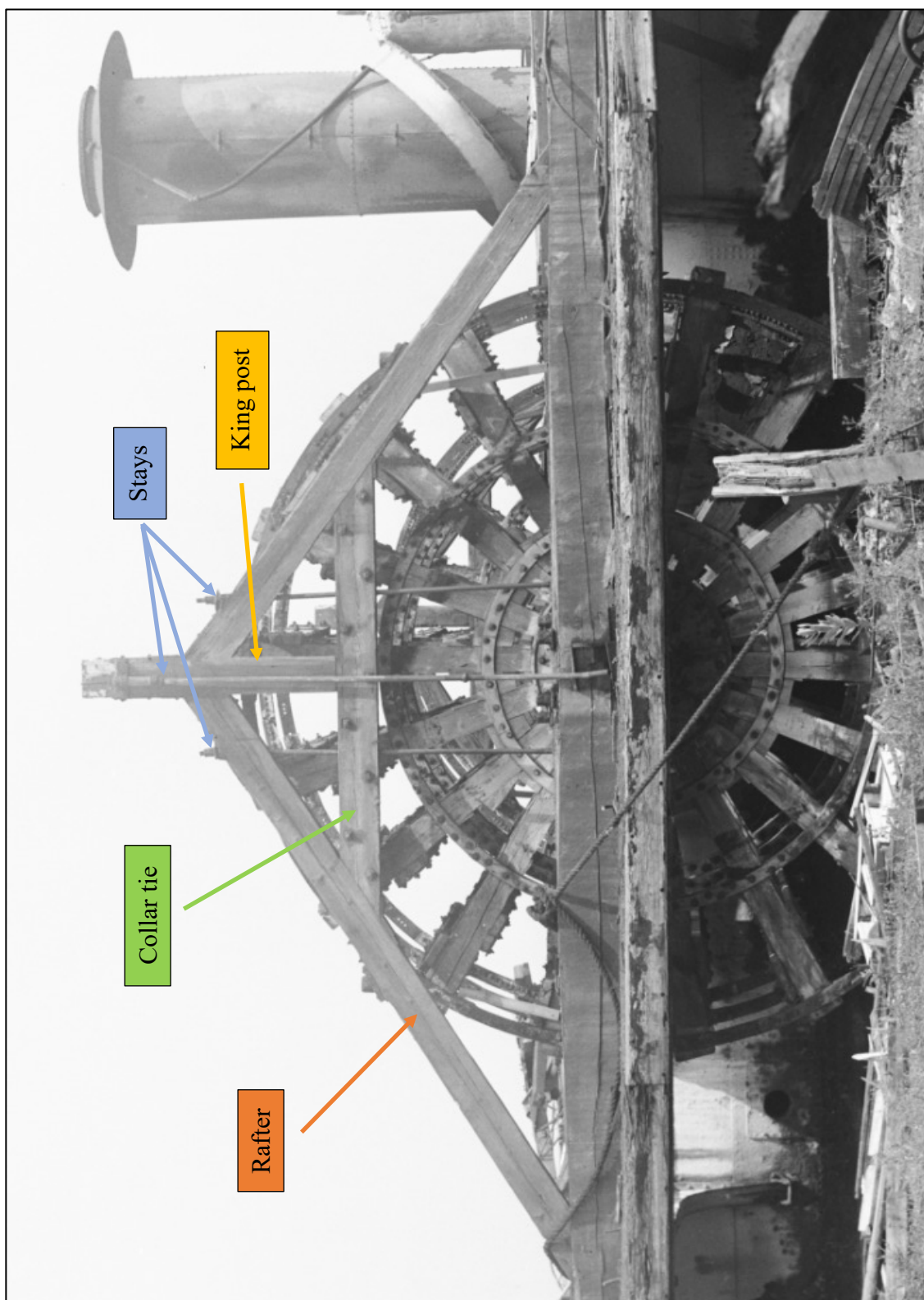


FIGURE 69. Ferryboat *Atlantic* with stripped superstructure at Kingston, New York. (Courtesy of the Elwin Eldridge Collection, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0091/03.01-04-060a).

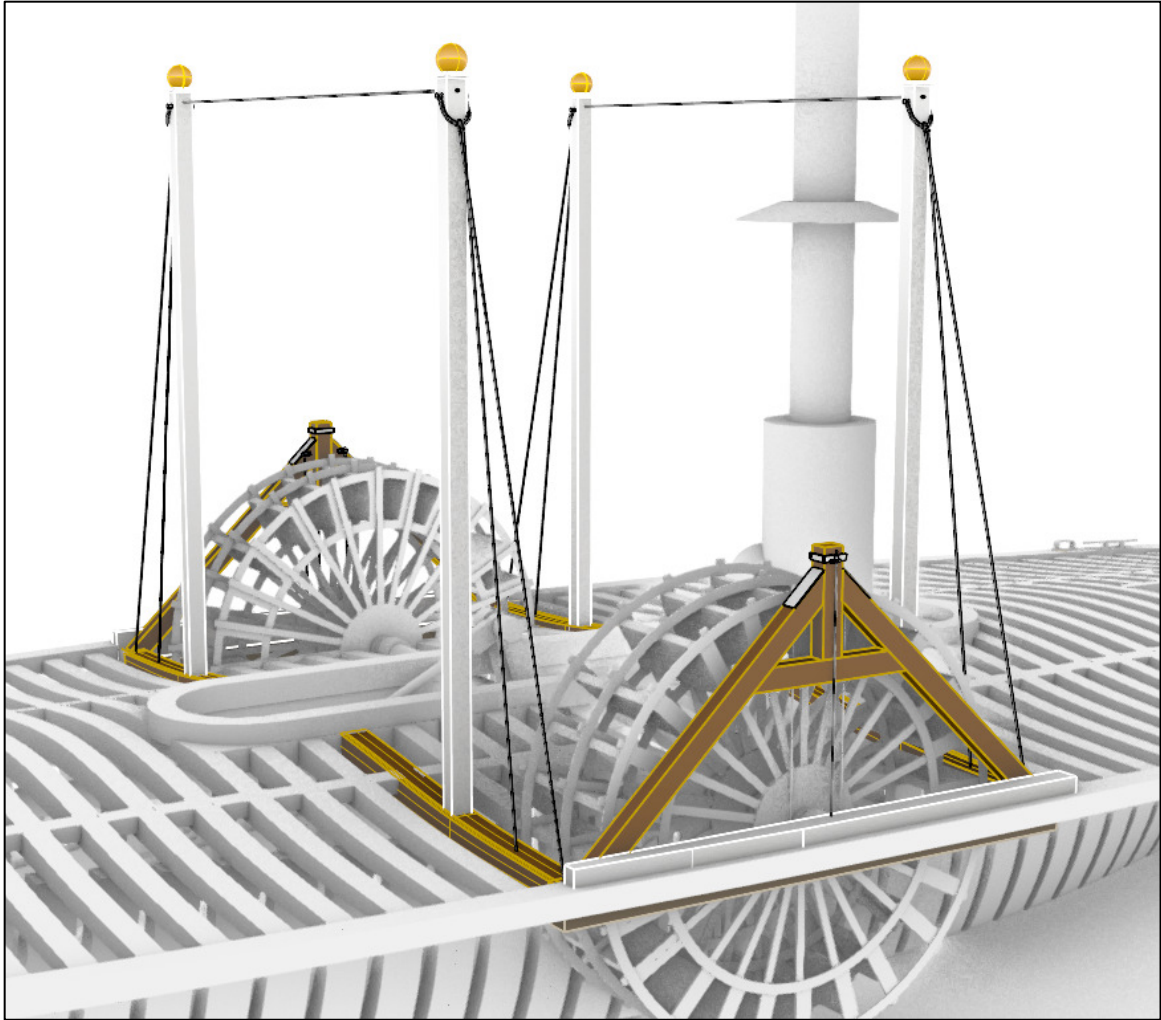


FIGURE 70. A-frame, cross-braces, spring beams, and paddle beams that support the paddle wheels; in “Arctic” view (image and model created by author).

The bulkheads and machinery enclosure were the next portions of the superstructure created. The bulkhead shape was taken from *Wenonah*’s architectural drawing (Figure 71) with its thickness, 2-1/2 in., taken from the scaled *Flushing* drawing. *Wenonah*’s drawing was placed in line with the length being scaled down to *Regla*’s. Guidelines were then drawn from either end of *Wenonah*’s main cabin to *Regla*’s hull and extruded up. A curve was then created using the “interpolate curve on surface” tool on the waterways from one end of the extrusion to the other. The curve was then extruded up and angled inboard for the tumblehome. Another curve traced from *Wenonah*’s cabin was then brought to the appropriate height, extruded out, and used to trim

the extruded lines that would become the outer and inner bulkheads. The newly created bulkhead surface was then extruded to the appropriate thickness. The window spaces, traced from *City of Reading*, were then cut out of the bulkhead with stanchions being placed on either side. Once finished, the bulkheads and stanchions were mirrored to the adjacent side. Bulkheads were then placed to create the paddle box and close off the passenger cabins. The passenger cabin doors were traced from the *Flushing* drawing, with their outlines being used to cut the shape in the thwart facing bulkheads closing in the main passenger cabins (The Mariners Museum and Park 1933a,c,d).

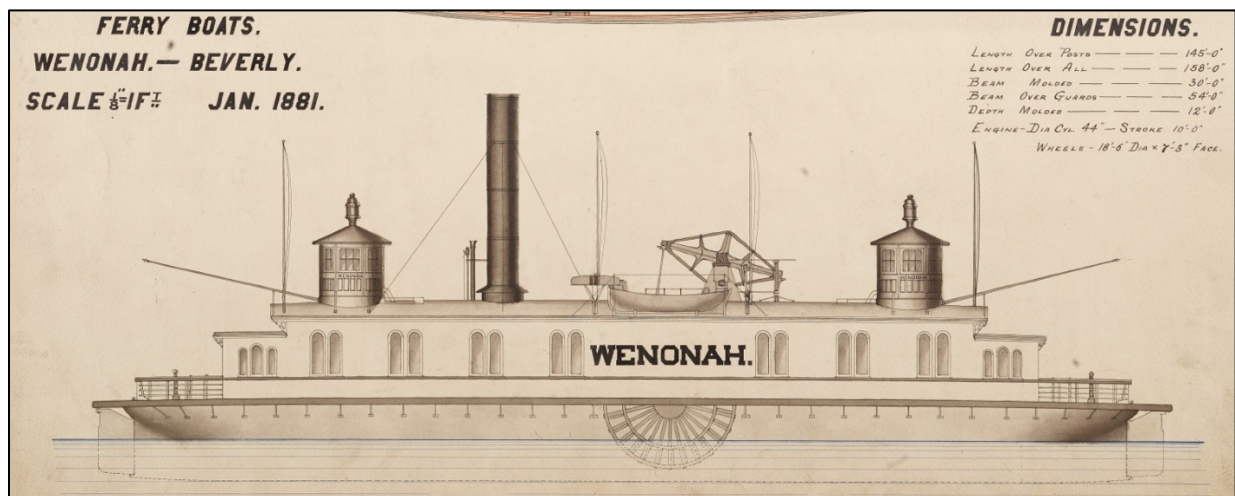


FIGURE 71. Profile of the ferryboat *Wenonah*, basis for *Regla*'s main cabin structure (courtesy of the Harlan & Hollingsworth Company Plans, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0573/02-54).

Longitudinal beams and knees that spanned across the main cabin and foyer's bulkheads were then installed based on dimensions derived from *Flushing*'s scaled drawing. The roof was created by copying the sheer height line, turning the copies 90°, spreading the curves above the bulkheads and then lofting between them. This resulting surface was then extruded to the proper thickness. The thwartship beams which supported the roof were then cut from a copy of the roof surface just created and extruded to the proper dimensions before being placed into their proper positions (Russell 1861:122; Figure 72).

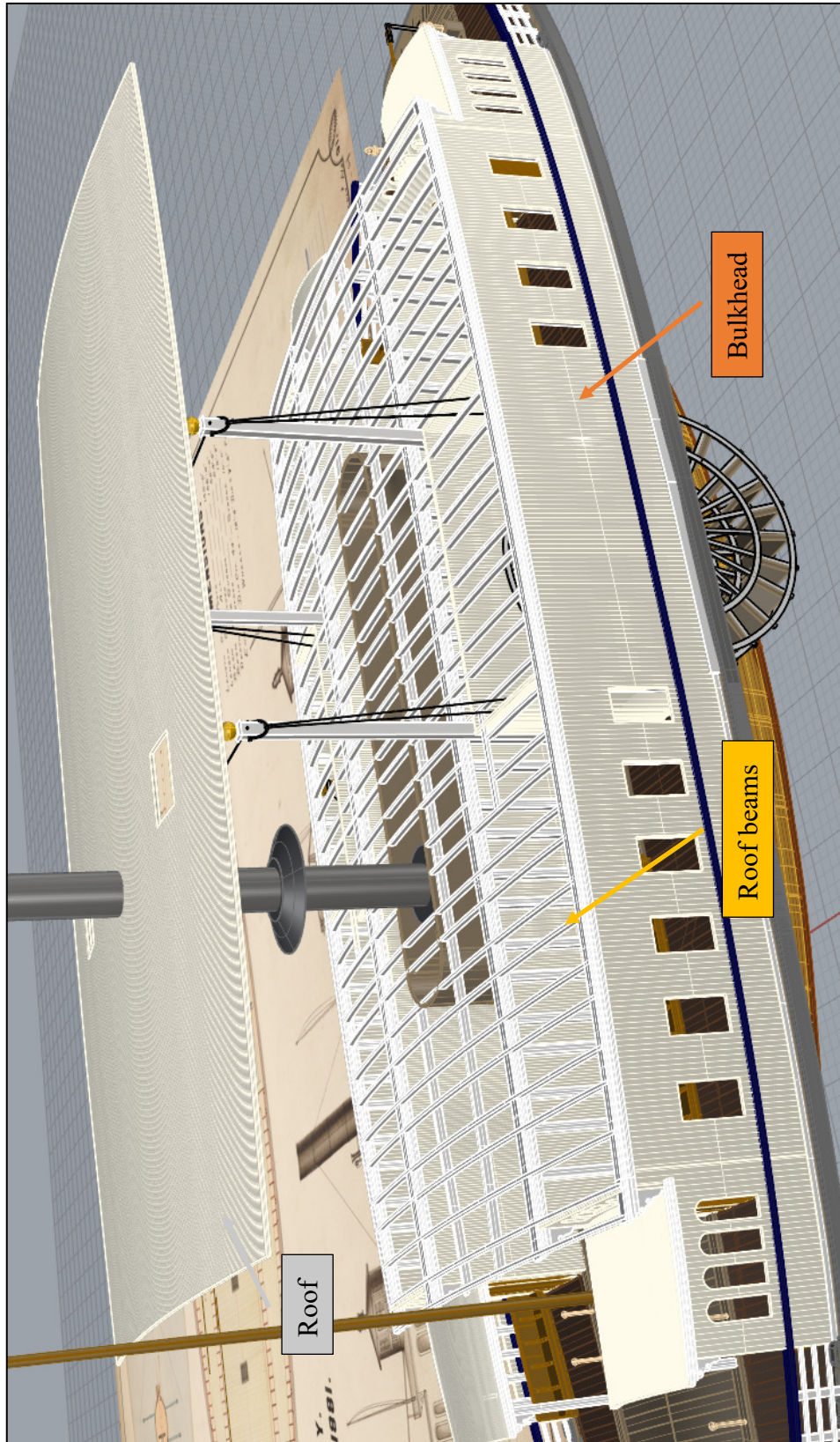


FIGURE 72. *Regla* model with bulkheads, roof beams, and roof; in “Shaded” view (image and model created by author).

The enclosure was built next and was placed on top of the inboard edge of the machinery opening timbers (installed earlier). Their thickness, 2 ft. and 1-1/2 in., was based on the *Eureka* cross section (National Park Service 1998; Figure 63). It was made by first creating a curve around the inboard circumference of the enclosure timbers using the “interpolate curve on surface” tool which was then extruded past the roof of the main cabin. The main cabin’s roof was then used to trim the enclosure down to size. The access to the machinery room was based on *Flushing*’s drawing, this being composed of a grate with a manhole opening to a ladder. The grate was traced directly from *Flushing*’s drawing then extruded down and the ladder was created from extruded circles the dimensions of which were based on *Ticonderoga*’s scaled construction plan (The Mariners Museum and Park 1933a; National Park Service 1988).

The main cabin’s seats were traced from the plan view of *Wenonah*’s scaled drawing, with their height being taken from the New York ferry *Edgewater*’s scaled cross section (Cudahy 1990:45). Given the length of the passenger cabins differed on the model, the traced outline of the seats had to be adjusted to fit, however, the general layout was kept the same. The seats were created by lofting the outline and extruding the resulting surface to proper thickness. Knee shaped seat dividers were then spaced at regular intervals on these seats (Figures 73 and 74).

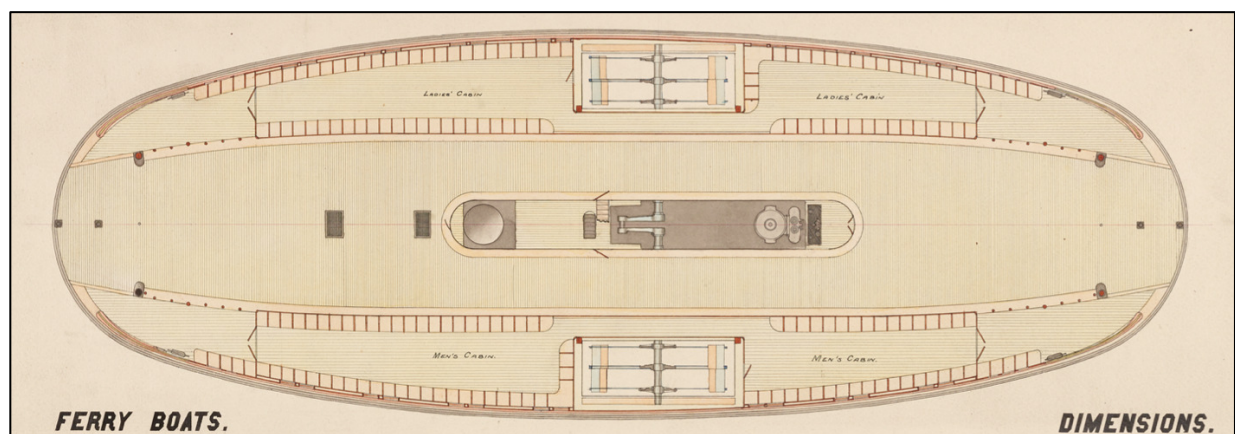


FIGURE 73. Deck plan of the ferryboat *Wenonah* (courtesy of the Harlan & Hollingsworth Company Plans, The Mariners Museum and Park Archives, Newport News, Virginia; reference # MS0573/02-54).

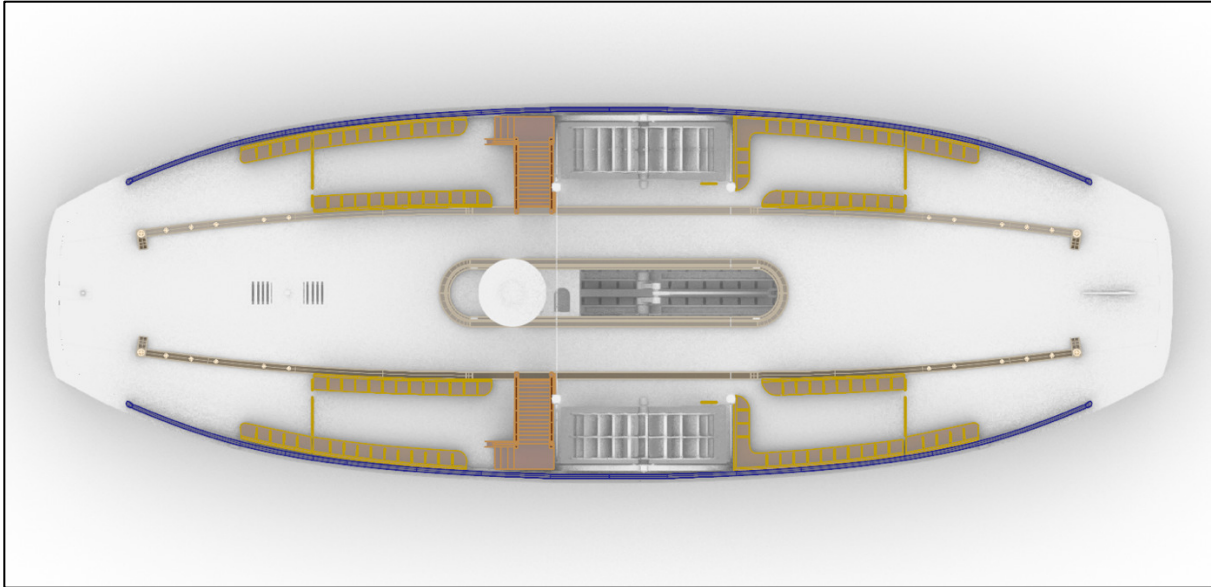


FIGURE 74. Main deck arrangement of *Regla*. Note the seating arrangement (light brown), and staircase to promenade deck next to paddle box (brown) (image and model created by author).

Finally, the outer rails and inner stanchions were created. The outer railing extended from the passenger foyer bulkheads and the inner stanchions extended from the gangway bulkheads. Both were placed on the waterways (created earlier) with their dimensions and spacing being taken from *Flushing*. The railing was created with a horizontal curve based on the bulkhead and then extruding said curve to the proper dimensions. Stanchions were created by extruding circles to the proper height. Fairleads and cleats were then placed on the port and starboard sides of the vessel just forward of the foyer bulkheads; these were traced directly from the *Flushing* drawing using the “interpolate curve” tool (The Mariners Museum and Park 1933a). The curves were then copied, spaced accordingly, and lofted together with the resulting surfaces being joined together (Figure 75).

With the main passenger cabins and vehicle gangways completed, the promenade deck cabin was constructed. There was scant reference in the historical record regarding the nature of *Regla*’s superstructure, with the most specific statement coming from Triebe and Wilde-Ramsing’s 1992 article in *Prologue*. Apparently referencing the original plans, they stated, “She

was to be built with seasoned white oak, have two pilot houses on the promenade deck and a square rigged fore mast and top-mast” (Triebe and Wilde-Ramsing 1992:12). The term “promenade deck” is vague but at the very least implies the existence of some type of upper superstructure (de Kerchove 1948:557). Furthermore, *Regla* was built to ply several miles between the city of Havana and the province of Regla (The Mariners Museum and Park 1939). This, coupled with the fact that the first New York ferries built with two decks plied between Manhattan and Staten Island, another several mile run (Cudahy 1990:68), led to the installation of a fully enclosed promenade cabin on the vessel.

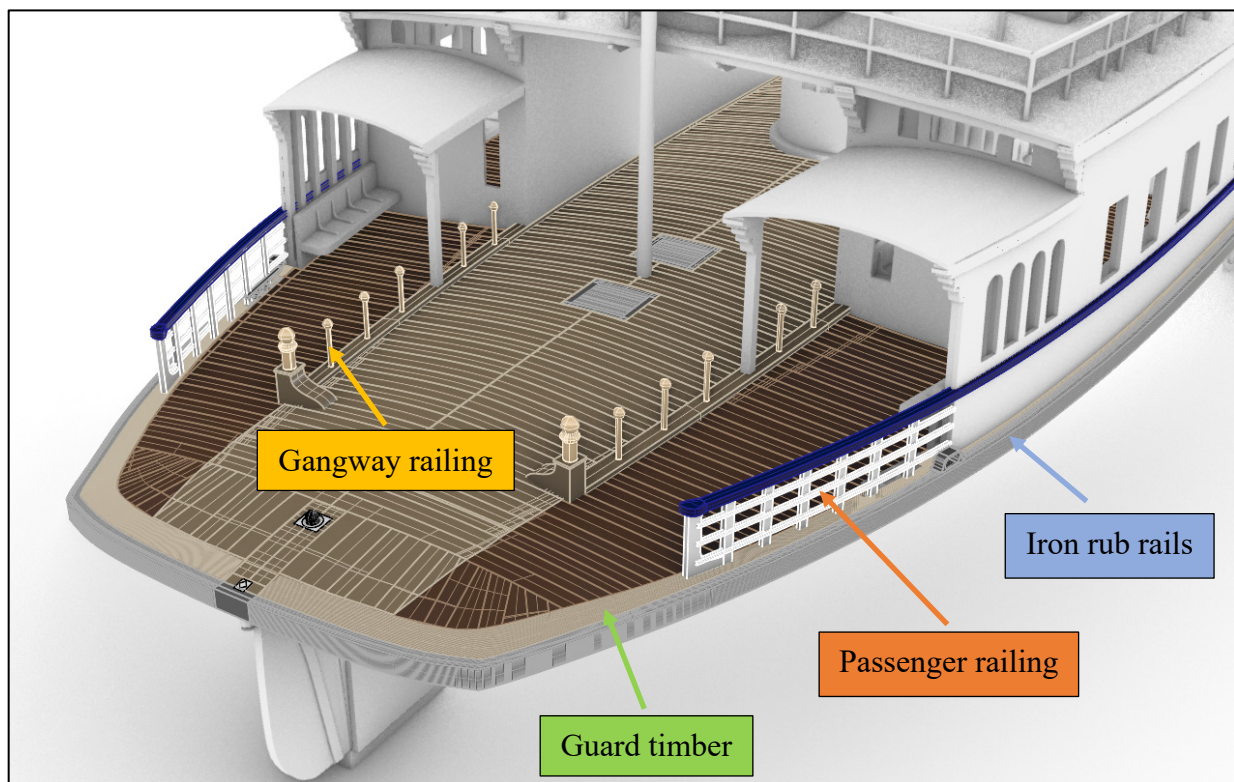


FIGURE 75. Main deck of *Regla* model complete with outer passenger railing (white and blue), inner gangway railing (dark and light tan), guard timber, and iron rub rails (gray) (image and model created by author).

The style and general exterior layout were based on a photograph of *annex No. 2* (built 1878) given its similarity in size and main cabin design (Cudahy 1990:114,397; Figure 76). The width and height of this promenade cabin was based on *Edgewater*’s scaled cross section found

in Cudahy (1990:45). The length was based on the space needed for the pilot houses, the construction of which will be explained in the following paragraph. The “line” tool was used to create a basic outline of the bulkheads. The outlines were then extruded out with the bottom being trimmed by the roof of the main cabin. A roof surface was then created using the “interpolate curve on surface” tool on the edges of the main cabin roof, and scaling the resulting curve to a length based on *Edgewater*’s cross section. This curve was extruded out and used to cut the top bulkhead surface with both surfaces then being extruded to 2 ft. and 1-1/2 in. of thickness. The orientation of the supporting stanchions on either side of the window opening was kept the same as the main deck cabins. The windows, based on *Edgewater*’s, were then trimmed out and stanchions placed on either side.

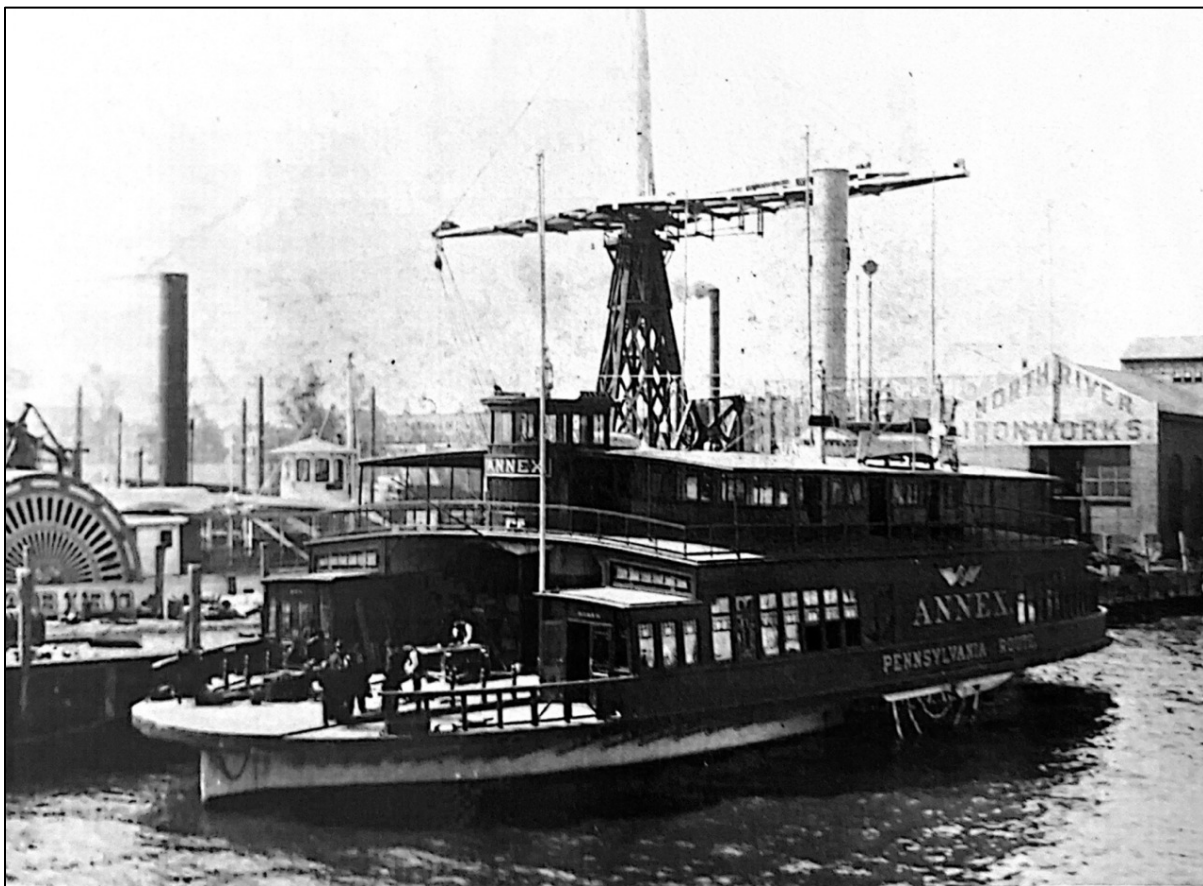


FIGURE 76. The Pennsylvania Annex Fleet’s *Annex No. 2* ferryboat, built in 1878, ran between Jersey City and Brooklyn (courtesy of Brian J. Cudahy 1990:114).

Thwartship beams supporting the roof were added next and were created in the same manner as the those for main cabin roof, only with smaller dimension (Russell 1861:122). Floor planking was then created for the cabin based on the same thickness as the main deck floor planking. Outdoor seating was placed on the port and starboard side of the bulkheads using the same methods and dimensions as those for main passenger cabins with space added for the wire rope extending down from the cross-chain braces to the spring beam. Indoor seating was then placed in rows within the cabin based on the *Eureka*'s arrangement with the protruding stack given a cover of the same thickness as the machinery enclosure (National Park Service 1998; Figure 77). The cover was created by extruding a circle up past the roof of the cabin and using the roof to trim the cover.

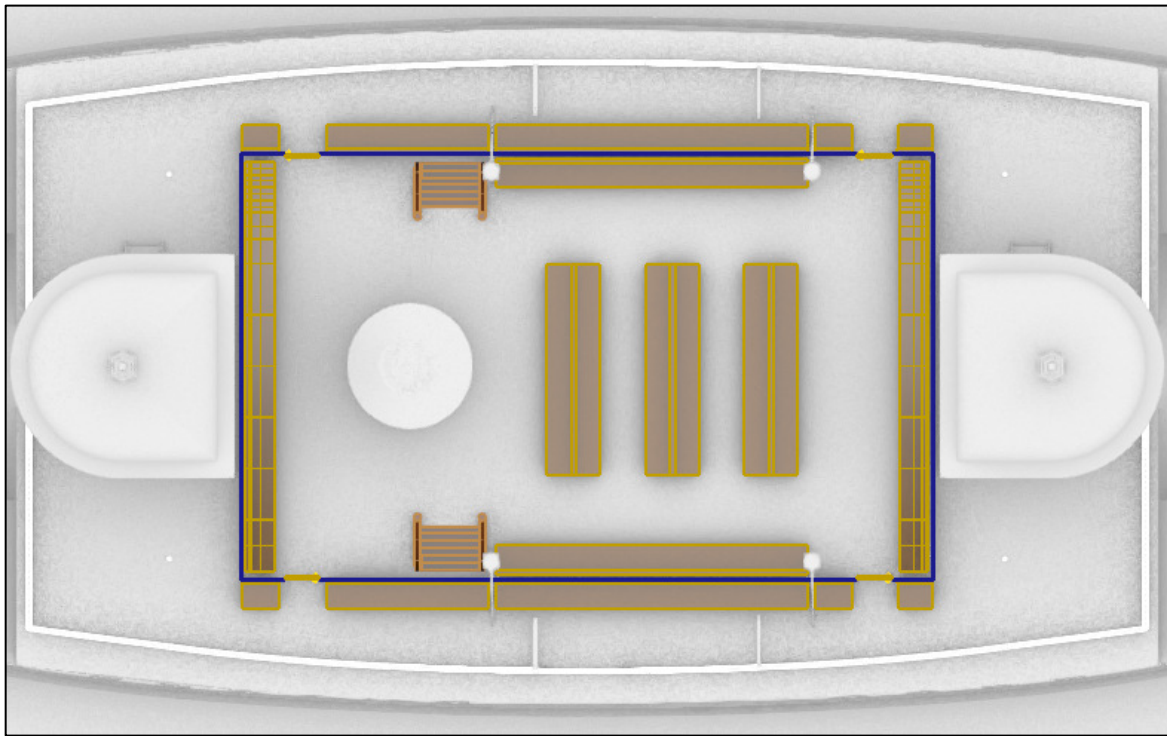


FIGURE 77. Plan view of the Promenade Cabin interior of the *Regla* model; in “Shaded” view (image and model created by author).

The outer railing was then installed around the circumference of the main cabin roof with the dimensions and orientation based off the *Edgewater* cross section and *Annex #3*'s photograph

in Cudahy (1990:114). They were created in the same manner as the railing and stanchions for the main deck only some rails were extruded up to the overhanging roof. Next, the vessel had two lifeboats that were placed on the promenade cabin's roof between the cross-chain braces. These boats were modeled by "axstream" and obtained on SketchFab.com (axstream 2022). The davits and identification markers were removed from the model and new davits which were traced and lofted from the *Flushing* were installed on the outboard edge of the roof at either end of the vessel (Figure 78).

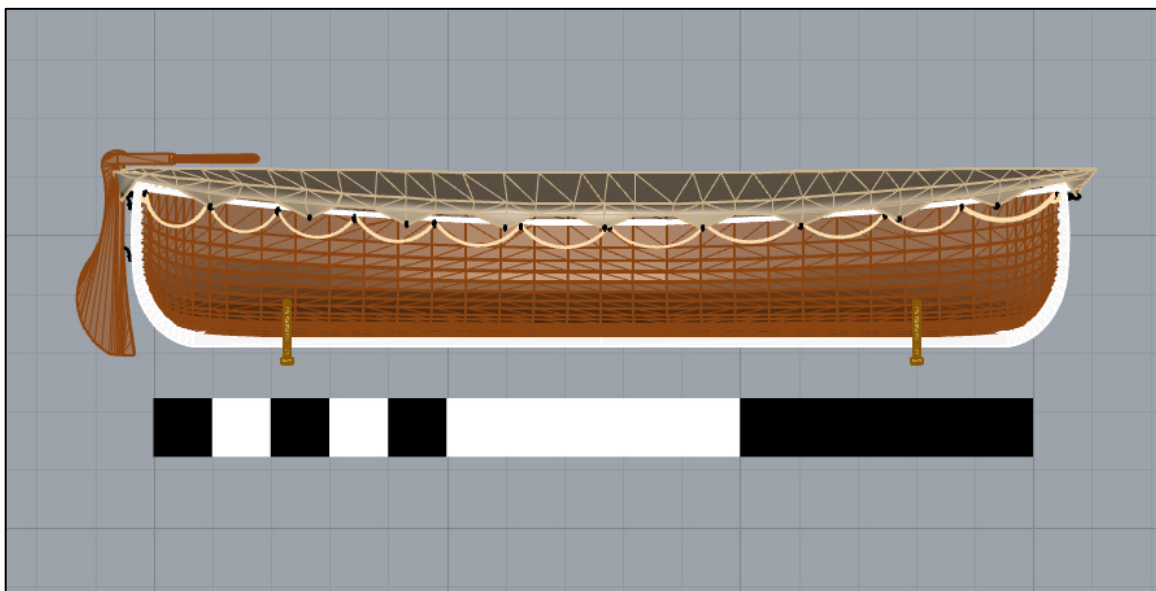


FIGURE 78. "Titanic lifeboat" obtained on sketchfab with davits removed and colors changed with scale (one square is 1 ft.); in "Shaded" view (courtesy of axstream, 2022).

Stairs were then installed to connect the main cabin to the promenade deck based on photographs of ferryboats *Middletown* and *Southfield II* found in Parkoff (2016:26). These were placed in both passenger decks on the boiler end, given more space was available there. A small flight of stairs was placed leading up to a platform that abutted the paddle box with another flight running up the side of the paddle box up into the promenade cabin. Solid rectangles were created and placed horizontally for the steps with the gaps being filled by vertical rectangles and trimmed accordingly. Siding was placed on the inboard side of the stairs with stanchions

extending vertically from it being connected at the top with railing. Finally, the roof of the main cabin was trimmed and capped to create the opening leading to the promenade deck.

Pilot House and Steering Arrangement

The final portions of the original construction to be modelled were the pilot houses and steering arrangements. The two pilot houses were placed several feet aft of end of the main cabin roof with their style and dimensions again being derived from the *Annex No. 2* photograph and the scaled cross-section of *Edgewater*. First, the bulkheads were created in the same manner as those added to the promenade deck, only the front facing bulkhead was made as a semi-circle by filleting the edges. The supporting frames were placed on either side of the windows which were wrapped around the entire structure. Like the windows for the main cabin and the promenade cabin, the window spaces were made by creating an outline of the windows then extruding the outline through the bulkheads, the surfaces of which were used to trim the bulkheads. The space for the door was created in the same manner, with the door itself being created from an extruded surface. The roof was then created using the “pyramid” and “cone” tools to accommodate the squared shape of the back of the pilot house and rounded shape of the front. The floor was then added with a steering wheel (Figure 79) placed on the fore end. The wheel was created by user “aryan_yadav” and obtained on Sketchfab.com (aryan_yadav 2020) and modified in Rhino® to represent the gun-tackle purchase steering mechanism typical in mid-19th century American river steamers (Russell 1861:119; Paasch 1885:53; Crothers 2013:313). Next, fog lamps were modeled on the top of the roof by tracing their circumference from *Wenonah*’s scaled drawing and rotating them 30° to produce 12 segments that were then lofted together. Finally, stairs

leading to the door of the pilot house were created using the same methods as the stairs leading to the promenade deck (Figure 80).

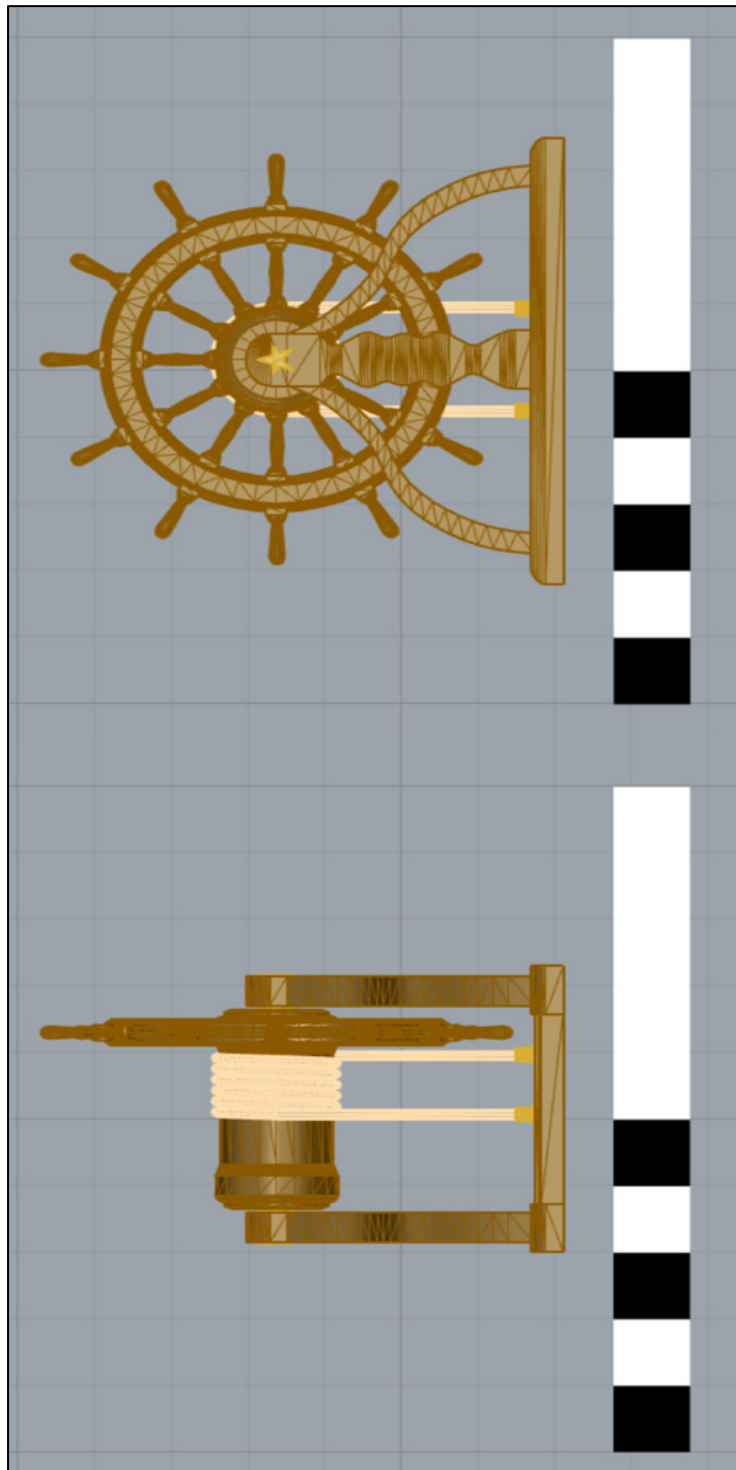


FIGURE 79: Profile and front facing view of “Ship steering wheel. Helm” with one wheel removed and colors changed (one square is 1 ft.); in “Shaded” view (courtesy of aryan_yadav, 2020).



FIGURE 80. *Regla* model with completed pilot house; in “Arctic” view (image and model created by author).

With the pilot house completed and the wheel installed, the steering arrangement was created. This began with the two rudders, one at either end of the vessel. These rudders had posts that rotated in a rule-joint fashion within the stern post, which was recessed to accept it, making the rudder more hydrodynamic (McKay 1839:75). The rudder post was then stepped into the keel at its heel and continued through the deck, terminating below the rudder hatch at its head. The top forward section of the rudder came up to create a U shape at its head, which was traced from *Southfield II*'s construction plan (Cowles 1886:190). The trace was then extruded out and tapered to be thinner at the top and thicker at the bottom. The iron bar which splayed on either side of the rudder and joined at the fore end of the rudder head was then modeled in. Slightly outboard of

the joined iron bars, the lock pin's receiver was created. This was oriented directly below a plated opening that was installed on the guard, the dimensions of which were taken from Spirek (1993:130). Whichever end of the vessel was to be the bow, the lock pin would be dropped into the receiver of that rudder holding it in place (Figure 81), with the other end's rudder being free to swing (Cudahy 1990:54). This function is also reflected in the profile view of *Wenonah*'s architectural drawing with the left side's rudder being in the bow position as indicated by downed lock pin (Figure 71). Attach points were installed for the steering chain shackles on either side of the lock pin receiver (Figure 82).

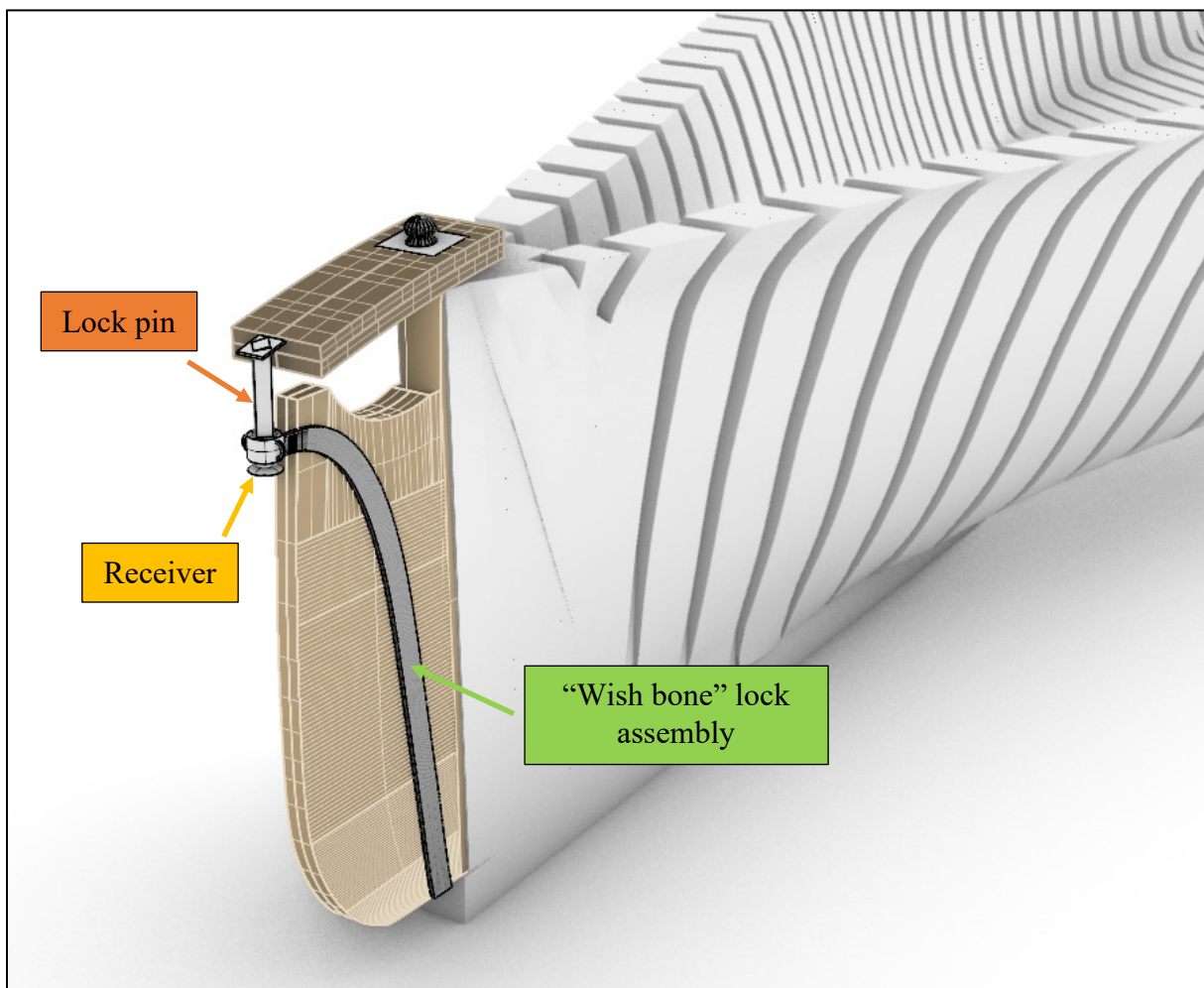


FIGURE 81. *Regla* model rudder and lock pin assembly below rudder hatch. In this image the lock pin (gray) is placed into the receiver locking the rudder in place, making this end the temporary bow (image and model created by author).

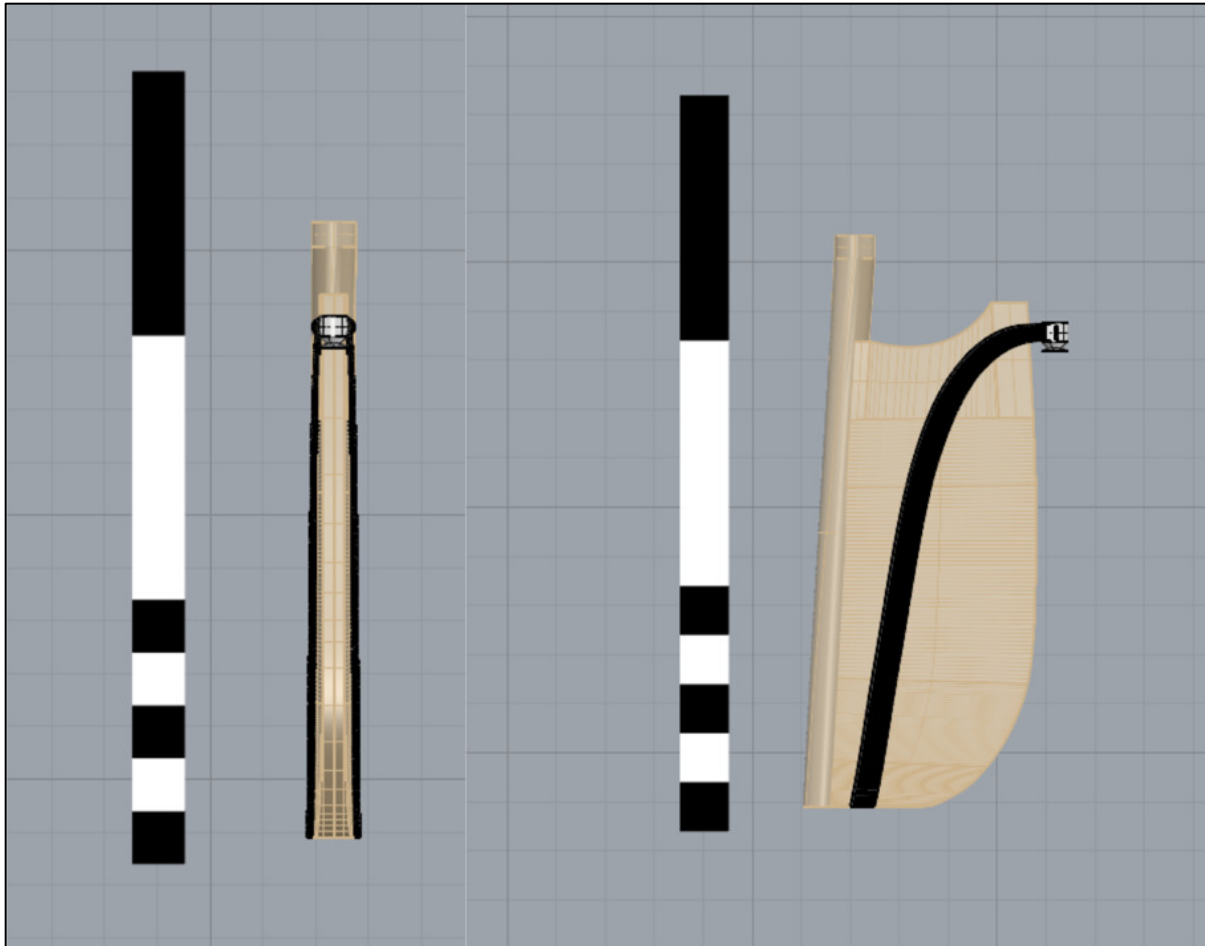


FIGURE 82. Front facing (left) and profile (right) view of *Regla* model rudder and associated lock-pin assembly (one square is 1 ft.); in “Shaded” view (image and model created by author).

With the rudder in place, the steering chain was installed, the dimensions of which were derived from the steering chain found on the *Westfield* site (Borgens et al. 2015:191). The chain was created first by taking an outline of the shape, extruding the outline, and then lofting it together. The chain was then copied as many times as was needed for the length of the link. The steering chain was placed to either side of the shackle and then angled upward to pass through chain rollers attached to the underside of the deck beams as seen with *Ticonderoga* (Figure 83). The chains were then brought inboard past the engine and boiler (Whittier 1987:40), up through the top of machinery enclosure and to then be funneled into the pilot house. To direct the steering chain leaving the machinery enclosure and into the pilot house, a triangular shaped solid was

placed with its apex being directly under the house and its base trimmed to key against the machinery enclosure.



FIGURE 83. Port side view of rudder and steering chain system of steamer *Ticonderoga* (courtesy of the Historic American Engineering Record, Library of Congress Prints and Photographs Division, reference # HAER VT,4-SHEL,1-9).

The final portions of the steering arrangement installed were the auxiliary tiller and the fore mast. No source stating how the auxiliary tiller worked was found, however, it was noted that the insert on *Southfield*'s rudder head (Spirek 1993:129) had the same diamond shape as the tiller as depicted in the artifact drawings (Figure 84). It was therefore interpreted that a diamond shaped iron staff was used to key into the rudder head, this being the typical place a tiller connects to a rudder (Crothers 2013:313), with the tiller then being keyed into it. This configuration also made sense of the Copeland and Howe military conversion proposal of adding tackle to the auxiliary tiller to allow piloting from the main deck (Copeland and Howe 1861). Given the original configuration required the pilot to operate the tiller from what would be, in a combat situation, an exposed position, it stands to reason that the tackle would lead back to main cabin to give the pilot cover.

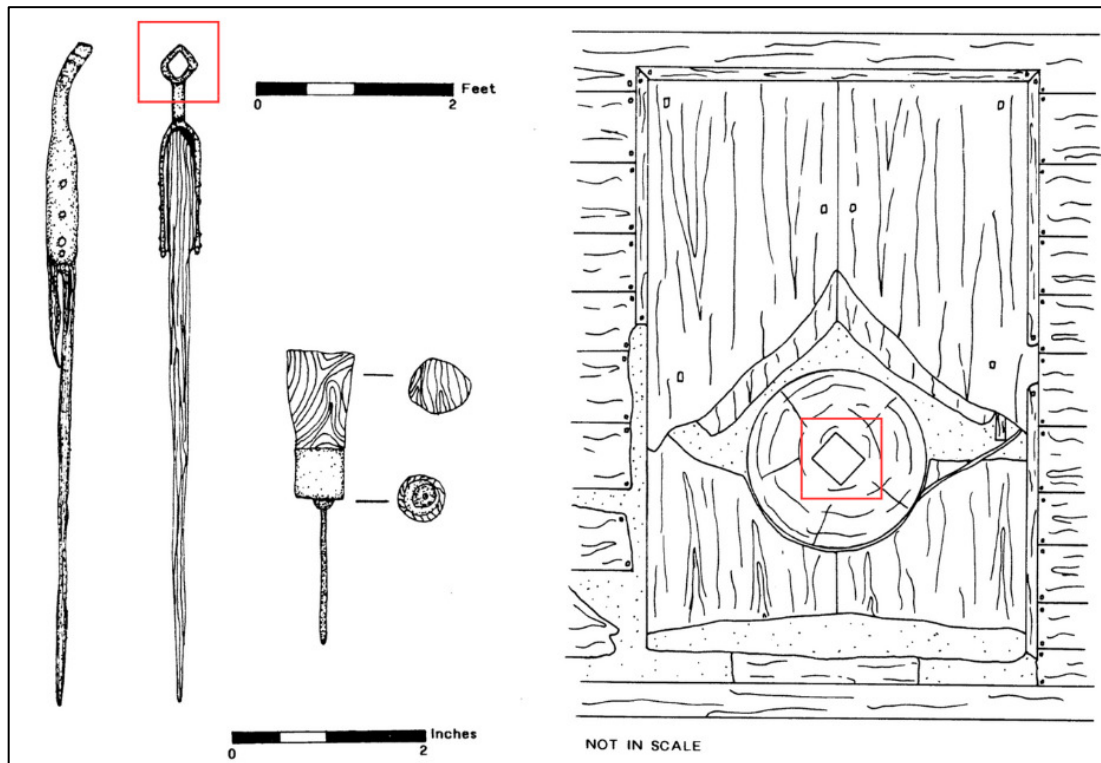


FIGURE 84. Auxiliary tiller and awl (left) and rudder head within access hatch (right) recorded on the *Southfield* remains. The red squares, placed by author, draw attention to the diamond shaped slots on the rudder head and auxiliary tiller (courtesy of James D. Spirek 1993:129,191; Images combined by author).

Within Rhino®, the tiller was traced from Spirek’s (1993:186) scaled artifact drawing of *Southfield*’s recovered auxiliary tiller and the iron staff being made from an extruded square (Figure 85). Finally, the existence of a square-rigged fore mast with a jib sail was noted in several sources as backup propulsion for the long trip from New York to Cuba (The Mariners Museum and Park 1939; Triebe and Wilde-Ramsing 1992:12). This mast was made using the “truncated cone” tool, with the mast partner then being placed on the deck with the mast step then being placed directly below it on the rider keelson. Supporting knees were created for both the mast partner and mast step. With the auxiliary propulsion and steering systems in place, the reconstruction of *Regla* was complete.

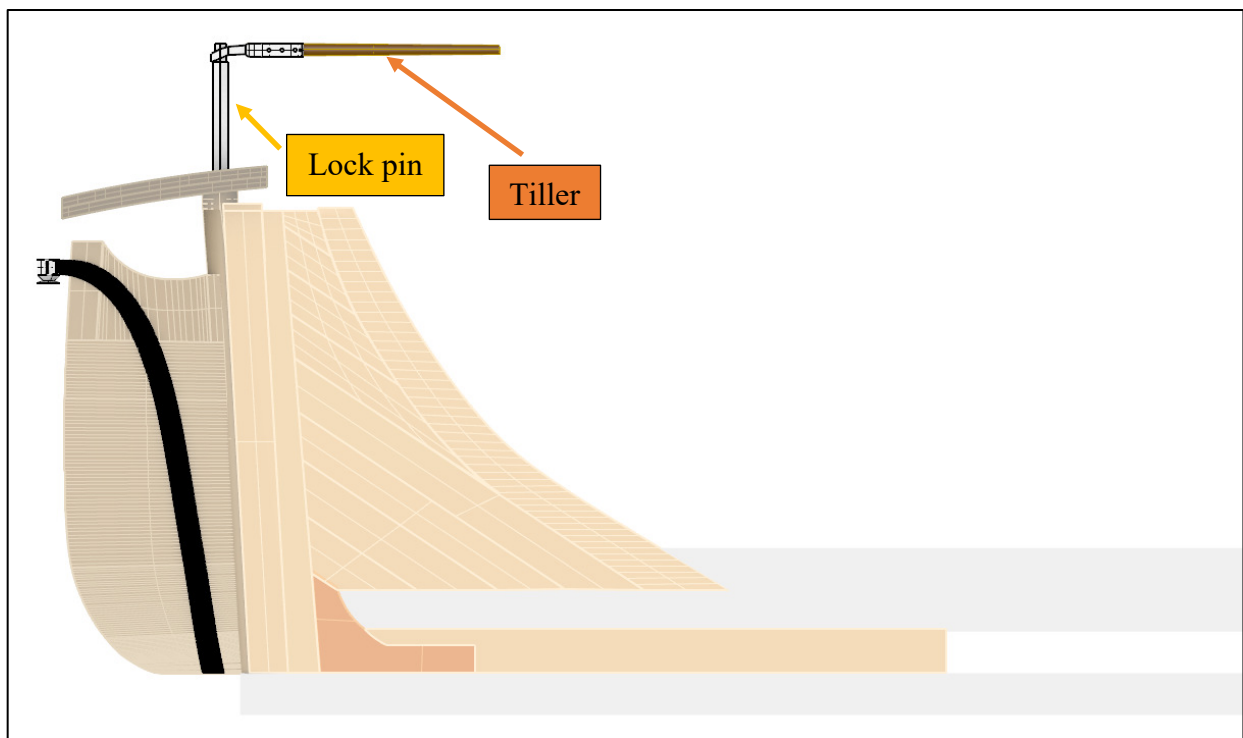


FIGURE 85. Auxiliary tiller assembly with main deck hidden with rudder hatch indicating deck level; in “Arctic” view (image and model created by author).

Conclusion

The above discussion has gone over the original construction and design of the New York built ferry *Nuestra Señora de Regla*. It described how the vessel was built, and the larger economic, social, and environmental processes which influenced its construction. In the foundation of the vessel, the frames, end post, and longitudinal support timbers assemblies were shown to be built thick to deal with ice and to support the overhanging deck along with the passengers who rode on it. The deck was constructed in such a way to provide a surface unimpeded by any extrusion from the hull including the framing or the paddle shaft. The machinery, particularly the radial paddle wheel, did not symbolize the pinnacle of contemporary marine propulsion technology. It instead represented machinery that was relatively accessible in operation and easy in maintenance. The superstructure was built to maximize passenger space and leave open lanes longitudinally for carriages and people to move from one end of the vessel to the other with ease. To accommodate the back-and-forth nature of this vessel's travel, a specialized rudder and steering system allowed one of the vessel's ends to easily be made the bow in an overarching design that was truly efficient. The following chapter discusses how these and other features of the original build were modified as *Regla* prepared to operate in new environments and contexts.

CHAPTER 6: Reconstructing *Commodore Hull*, *Waccamaw* and CFR0001

The following chapter describes the conversion of *Nuestra Señora de Regla* to the gunboat *Commodore Hull*, the post-war conversion to the working boat *Waccamaw*, and finally the state of *Waccamaw*'s archaeological remains via an integration of the photogrammetric model and the 3D reconstruction (representing CFR0001). Alongside this description of the material change of the vessel and the sources which informed their existence, how the 3D reconstruction was created within the modeling software Rhino® is discussed, as done in the previous chapter. Also like the previous chapter, the following discussion represents a synthesis of historical research, field work, and photogrammetric methodologies. The resulting models therefore visually illustrate site formation processes within the vessel's systemic and archaeological contexts, the analysis of which will happen in the following chapter.

The chapter is broken into two broad sections, the first regarding the ferry's conversion into the gunboat *Commodore Hull* and the second dealing with its post-war modifications into *Waccamaw*. Given these sections deal with conversions, they are each broken into three segments working top down starting at the superstructure, then moving to the deck, and concluding with steering arrangement/modifications made below the hull. Finally, the integration of the photogrammetric and 3D models will be displayed alongside a description of the *Waccamaw* site based on the results of the 27 October 2023 and 30 June 2024 field investigations. A final note, there are no plans specific to either conversion, so as with the reconstruction of the original build, a broad range of sources were used to create the best possible interpretation of conversions of the vessel with the best information available.

Military Conversion: *Commodore Hull*

To turn the innocuous ferryboat into the Union riverine fighting vessel *Commodore Hull* (Figure 86), significant changes had to occur to protect and sustain the officers and crew and to accommodate large weaponry, all the while keeping it maneuverable. Working from the superstructure down, how these changes were installed are outlined below, beginning with the superstructure, then moving to the deck, and ending with the steering arrangement and hold.

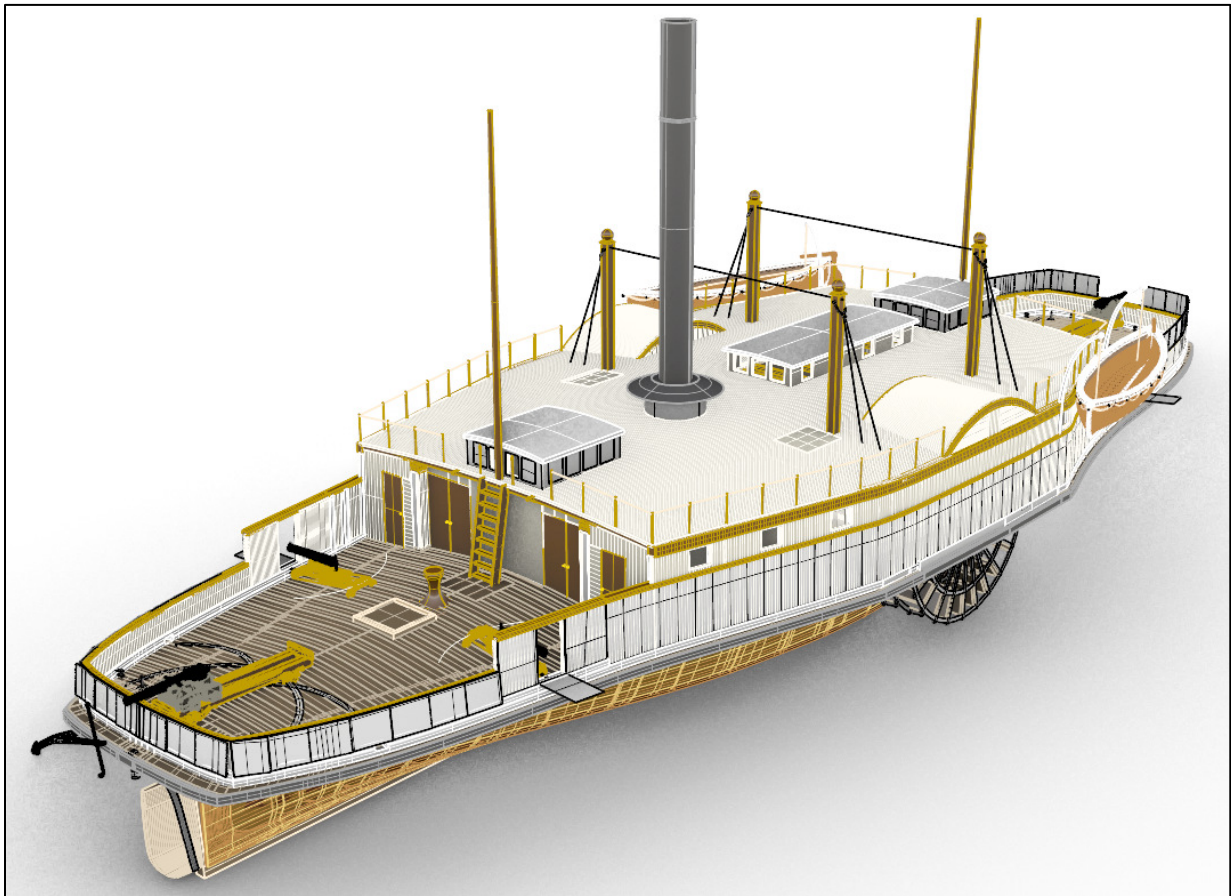


FIGURE 86. Interpreted 3D reconstruction of the Union gunboat *Commodore Hull* converted at the Brooklyn Navy Yard, commissioned 1862 (image and model created by author).

Superstructure

The first step of modelling required the overall reduction in height of the superstructure as specified in the Copeland and Howe proposal (1861). This was accomplished in three main ways. First, the promenade deck was completely removed with the gap for the stairs being filled

in using the “loft” tool, with the cross-chain braces and smokestack being reduced in height using the “trim” tool. Second, the pilot house was reconstructed, being made square and reduced slightly in height. Most importantly, however, it was moved inboard several feet and dropped down to rest on the main deck. The surrounding roof was trimmed using the new pilot house structure. Third, the main deck was dropped down in height from the previous 11 ft. to 8 ft. by extruding out a line that extended the length of the entire deck structure and then using the surface to trim the main cabin. These changes can also be seen reflected in the photograph below of an unidentified Union gunboat (Figure 87).



FIGURE 87. Photograph circa 1863 of unidentified union gunboat. Note the low height of the main cabin and the pilot houses dropped into the main cabin (courtesy of the Liljenquist Family Collection of Civil War Photographs, the Library of Congress Archives, Washington D.C.; reference # LOT 14043-2, no. 74).

With the height reduced, the main cabin foyers, outer railing and inner stanchions, and associated waterways were removed, reducing the length of the substructure. At this point, the sponson deck was reduced in width on either end of the paddle wheels to the ends of the sponson. The existence of such a modification on the converted ferries has been called into question in previous research (Parkoff 2016:47), however, several sources indicate its presence specifically for *Commodore Hull* and on other converted ferries. First, every depiction of *Commodore Hull* shows the vessel with its guards reduced, with two of the paintings being created by an Acting Second Engineer in the Navy, someone likely to have a decent understanding of vessel construction (Figure 88). Second was the reference in the *Westfield* conversion proposal to “reduce the guards and post under sponson their whole length” (Copeland and Howe 1861). The “guards” refer to the timber spanning the circumference of the deck beams (de Kerchove 1948:311) and the “post under sponson” likely refers to the sponson support struts. Finally, a painting of *Commodore Hull* (Figure 88) and several photographs (Figures 87 and 89) appear to have had their sponsons reduced in width.

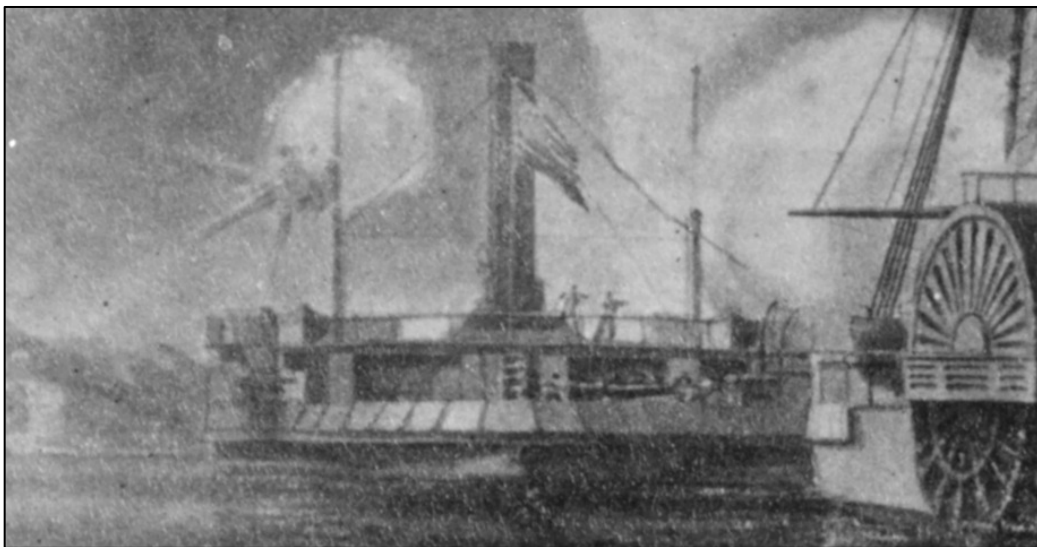


FIGURE 88. From “Capture of Plymouth, N.C. Oct. 1864” painted by Acting Second Engineer Alexander C. Stuart, USN. Painting zoomed in on *Commodore Hull*, note the paddle box extruding from the guard on the left-hand side (courtesy of the Surgeon H.P. Babcock Collection, U.S. Naval History and Heritage Command Archives; reference # NH 58943).

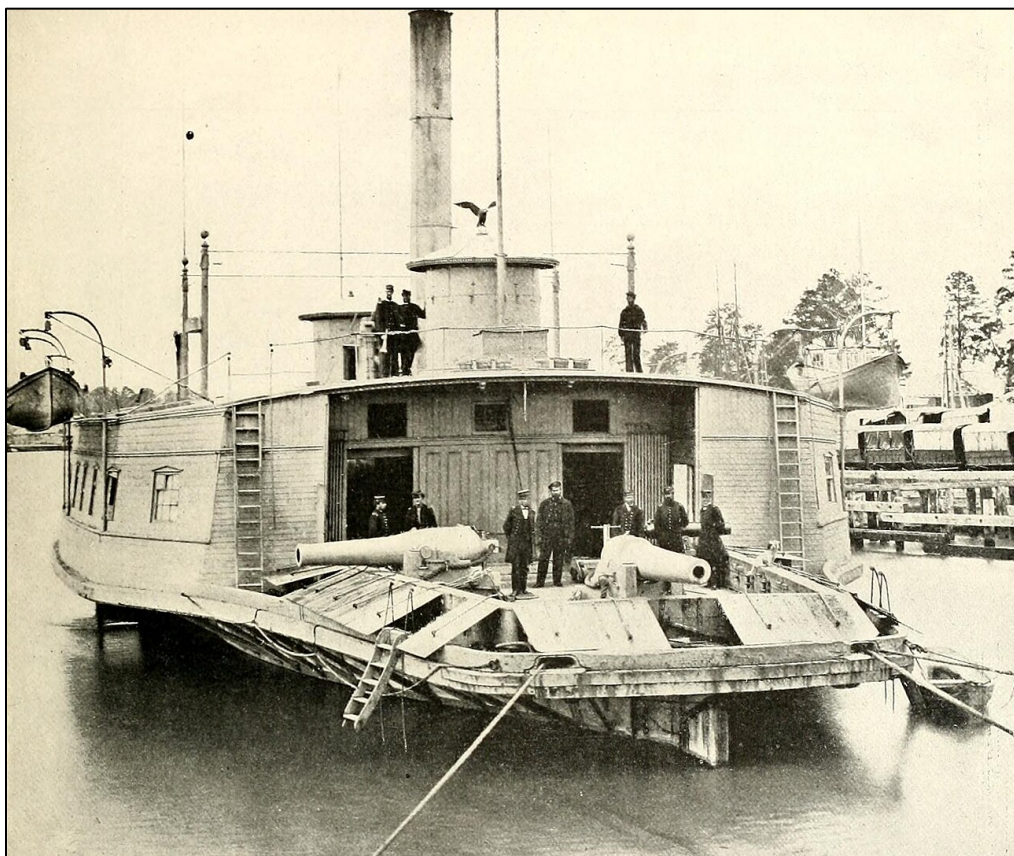


FIGURE 89. Photograph of converted unidentified ferryboat at the Pamunkey River, Virginia, in 1864, note reduced width of guards. (Courtesy of the Mathew Brady Photographs of Civil War-Era Personalities and Scenes Collection, the National Archives; reference # 524831)

This reduction of the sponson deck was modeled in Rhino® by using the “interpolate curve” tool to create curves from either end of the paddle wheel to the longitudinal end of the sponson deck on one side of the vessel. These curves were mirrored to the other side of the vessel, then extruded down to use the surfaces to trim the sponson deck and main cabin. The cabins bulkheads, bulkhead stanchions and beams, waterways, guards, and rub rails all had to be reshaped to fit the new cabin and deck structure with a new broadside bulkhead being installed on the quarters at either end of the vessel. Creating the new shapes for these components did not differ in methodology to the original structures (described in Chapter 5).

Two lifeboats were created again using 3D modeler axstream’s creation, only this time removing the rain cover and scaling them to a length of 24 ft. (Copeland and Howe 1861; Figure

90). Both were copied and hung off the side of the main cabin's roof on the engine side with the davits supporting them being copied from the originals, placed on the side of the bulkheads, and rotated to face outboard. Signal polls 9 in. in diameter and 30 ft. tall were then created with the same methods used to make the mast and railing which was created around the circumference of the roof. Finally, based on the photograph in Figure 87, a sky light superstructure was modeled on the main cabin's roof over the engine using the same methods for the modeling of the bulkheads and windows of the pilot houses. The roof was copied from one of the pilot houses and reshaped to fit the structure with the gumball extrusion tools. This structure was 19 ft. and 5 in. in length, 7 ft. and 6 in. in width, 2 ft. and 3 in. in height, and situated 5 ft. behind from the engine end pilot house. The finished converted hurricane deck can be seen in Figure 91.

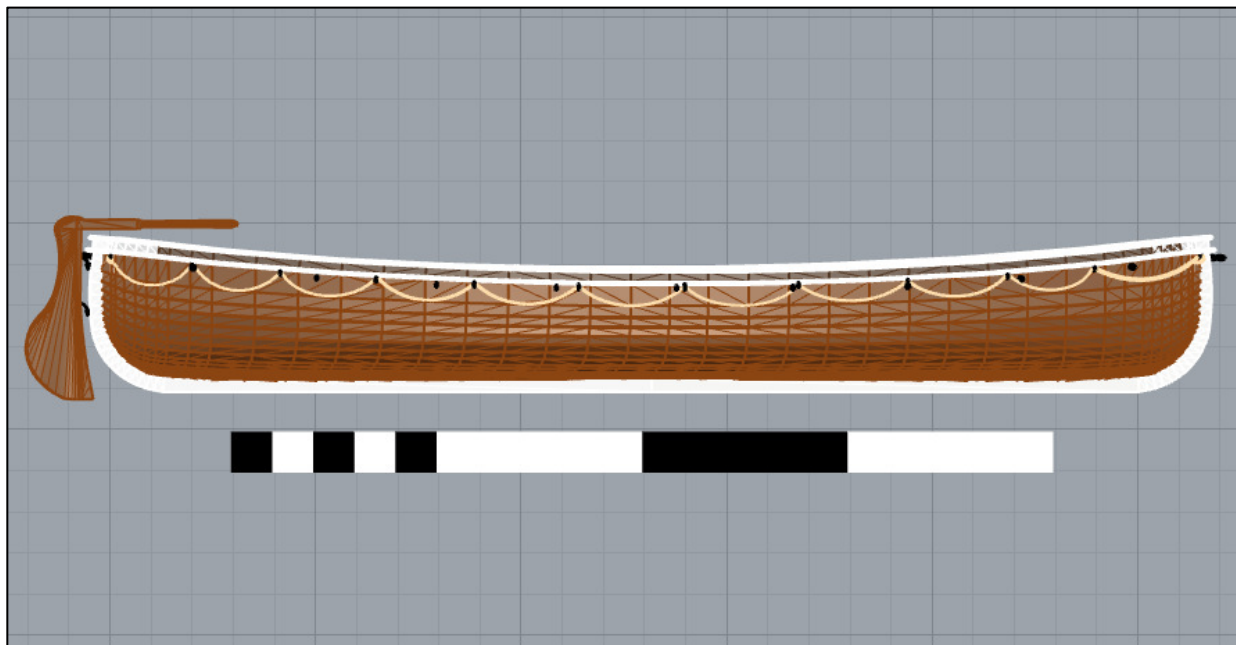


FIGURE 90. “Titanic Lifeboat” scaled out and stretched for military conversion; in “Shaded” view (courtesy of axstream, 2022).

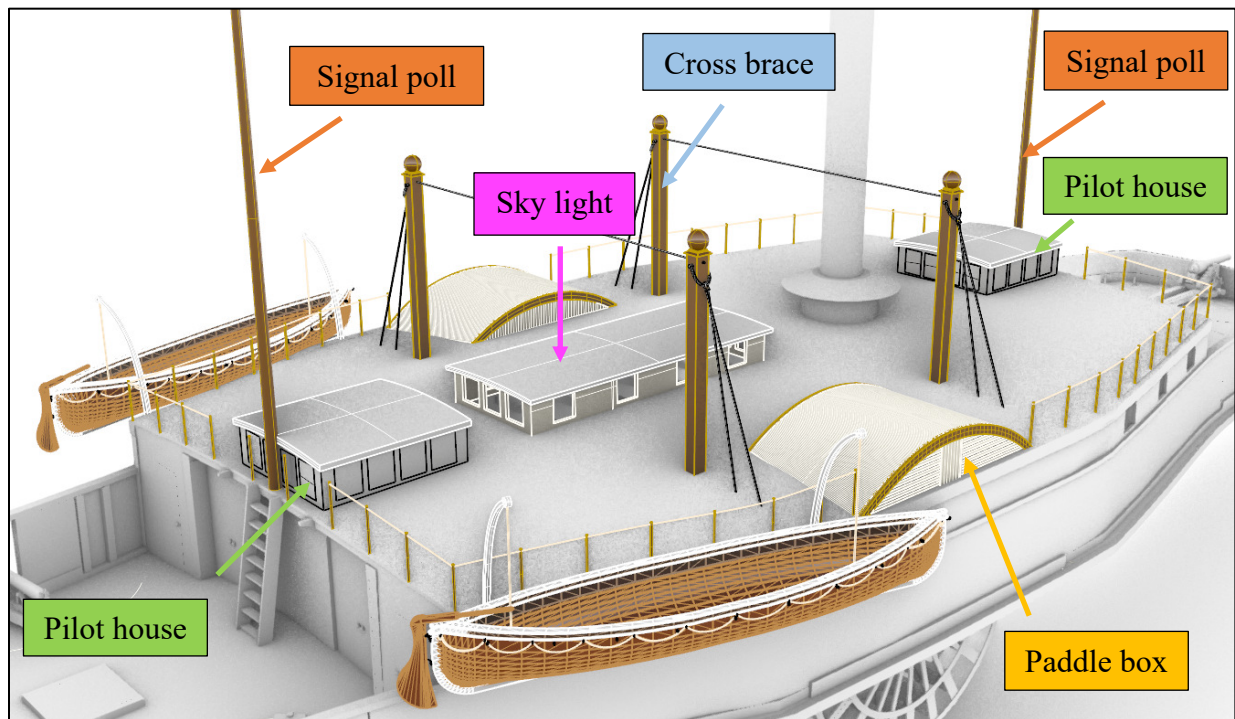


FIGURE 91. Converted hurricane deck for model of *Commodore Hull*. (Image and model created by author)

Within the cabin, five rooms and two storage closets were next to be built, with the carriage gangways being left open for the crew's sleeping quarters. Based on *Clifton's* deck plan presented in the previous chapter (Figure 16), the rooms consisted of an officer's water closet, wardroom, surgeon's room, 2nd and 3rd acting master's room, and 1st lieutenant's room. These were spaced out and divided with 2-1/2 in. thick bulkheads. Doors installed for each room were simply copied from the original pilot house structure. The storage rooms were on the in-board side of the paddle boxes with bulkheads and doors installed to enclose them. The machinery enclosure was then extruded out on either end to meet the back of the pilot houses. New doors, again copied from the original pilot house structure, were installed in the enclosure.

The entirety of the cabin was closed off at either end with bulkheads and doors installed on the previously open gangway. This was evidenced by all photographs of converted ferries obtained by the author, including Figures 87 and 89, and indicated in several primary sources

(Copeland 1861a; Saltonstall 1913:36). Ladders, one centered on either end leading to the roof, were then placed by copying the original pilot house steps and siding and adjusting them to the proper length and angle. Figure 87 was used as the main interpretive inspiration, given the similarity of ladder locations depicted in the Stuart painting of *Commodore Hull* (Figure 88).

A new paddle wheel support structure was then created replacing the A-Frame with a semi-circular timber supported by four king posts with two truss rods extending down to the spring beam. The possibility of a redesigned and reinforced paddle wheel support was first indicated in a report following *Commodore Hull*'s involvement in the early April 1863 Battle of Washington, North Carolina where the vessel was seriously damaged. Referring to damage inflicted by a shell hitting one of the paddle wheels, it was reported that, "Serious injury came from the shooting away of two of the king-posts, causing the large iron cross braces to come down on deck, thereby getting the shaft considerably out of line" (United States Department of the Navy 1899:682,692). In typical A-frame construction, there exists only one king post (refer to Figure 69), however, some paddle steamers with rounded paddle boxes had multiple kingposts (Figure 92). The above stated facts, alongside the consistent depiction of *Commodore Hull* with a rounded paddle box, informed the decision to reconstruct the paddle box like that of the ferry *Diana* (Figure 93).



FIGURE 92. Finnish paddle steamer *Diana*'s paddle box framing. Note the five king posts and flared after section (courtesy of Topi Sellman, Maritime Archaeological Society of Finland).

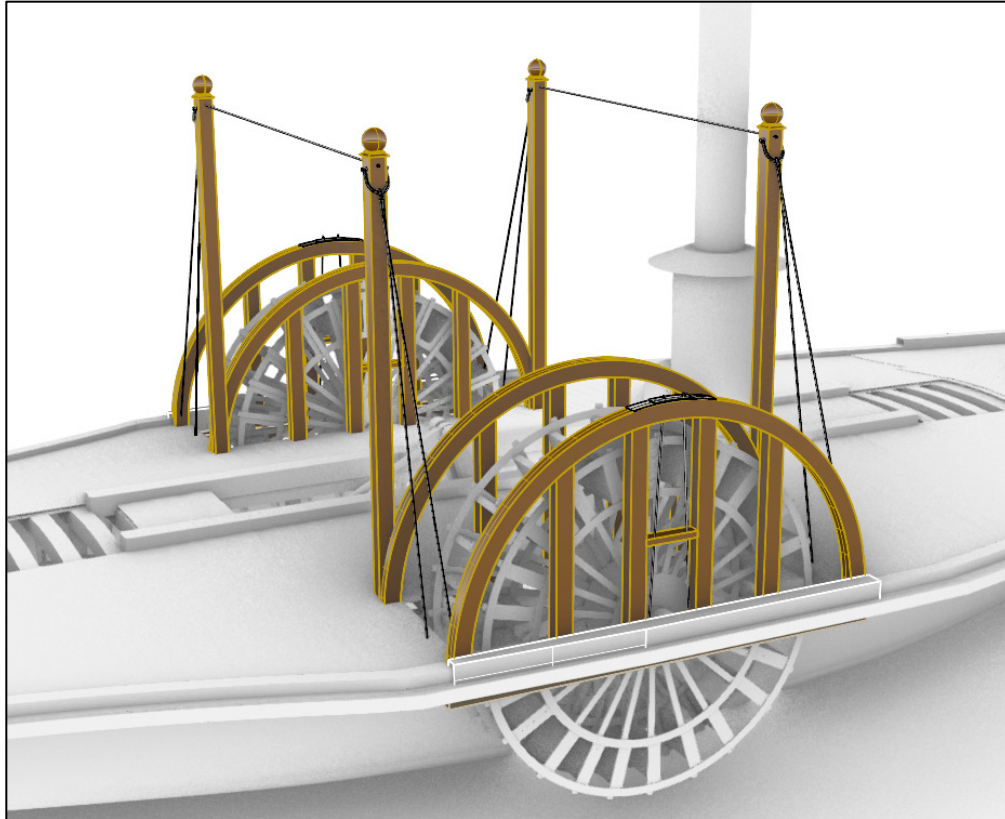


FIGURE 93. Interpretation of *Commodore Hull*'s paddle box framing. Note the absence of a flared end (image and model created by author).

With the paddle box converted, 3/8 in. thick iron plating (Browning 1993:88) was then added to the sides of the cabin, pilot house, and newly exposed smoke chimney (Copeland 1861a; Copeland and Howe 1861; Saltonstall 1913:37). The plating for the sides and quarter bulkheads was 5 ft. tall and created by extruding a curve interpolated from the waterway (Parkoff 2016:224). The plating for the pilot house was created by copying its surface then extruding the surface out. Finally, plating for the smoke chimney was created by extruding a circle down the chimney and extruding it out.

Deck

Deck modifications were next, including the conversion of the boiler ventilation grates into hatches (Spirek 1993:137), the installation of a new hatch on the engine end, a capstan and two anchors, armored bulwarks wrapping around the circumference of the deck, cannons, cannon

accommodations, and planking covering the sponson support struts. The infrastructure to turn the grates into hatches was already there so all that was needed was the removal of the grates and the installation of 9 in. tall and 6 in. thick coamings (Spirek 1993:137) and 3 in. thick hatch covers (Crothers 2013:245). The foremost hatch and associated coaming, deck beam, and header structure were then mirrored to the other side of the deck. The inboard hatch was removed to accommodate the ladder to the cabin's roof with the deck beam and planking under it being re-lofted.

The placement of the capstan was informed by the *Clifton* deck plan (Figure 16) and the remains of a large bitt noted on the centerline of the *Waccamaw* site. Therefore, the capstan was installed behind the newly made hatch on the boiler end which also determined the placement of the larger of two anchors placed on either end of the vessel. The capstan was sized to 2 ft. and 10 in. tall based on the capstan found at the *Comet* archaeological site (Russell 2004:71) and was made by first creating a 2 ft. and 8 in. diameter circle at the base and another 1 ft. and 8 in. diameter circle at the head. Several smaller diameter circles were created between these to give the capstan shape, with the entirety then being lofted together. To support the capstan, the 14 x 13-1/2 in. bitt was placed below it, extending from the rider keelson to the deck beam on which the capstan sat using the "corner to corner, height" tool.

Anchors, one 7 ft. long bower and one 5 ft. long stream anchor, were then placed at either end of the vessel. The style and location of the anchors was indicated by a photograph of *Commodore Perry* on the James River, Virginia, showing what is likely a stream anchor (Paasch 1885:102; de Kerchove 1948:736) on what is acting as the vessel's stern (Figure 94) with a larger bower anchor likely being present on the acting bow end. The anchors were copies from

the same GBL file of a photogrammetric model obtained on SketchFab.com (trivial.cat 2021) and created by user “trivial cat” (Figure 95).

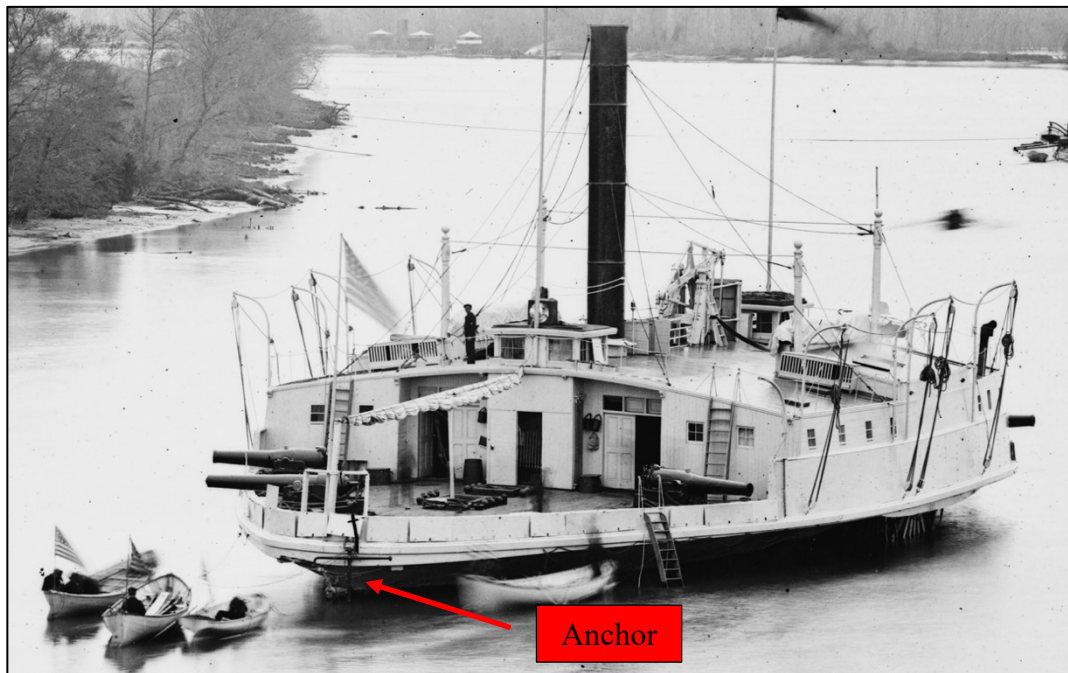


FIGURE 94. Converted ferry gunboat *Commodore Perry* on the James River circa 1865. Note the anchor on the vessel’s stern, would have been deployed in event of shifting current or tide to keep vessel from ground in narrow rivers (courtesy of Civil war photographs, 1861-1865 Collection, the National Archives; reference # LC-B811- 2687).

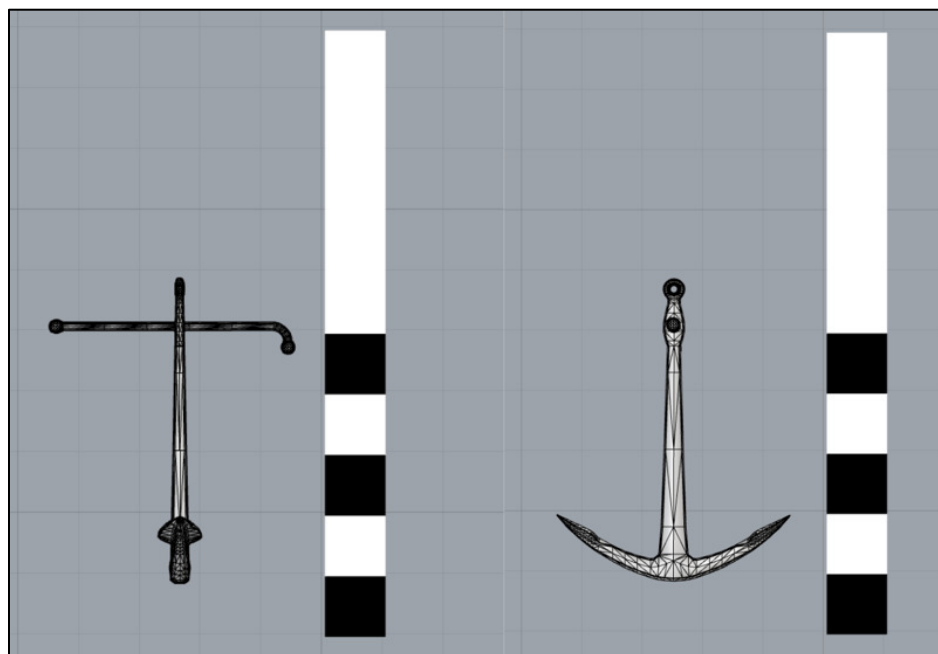


FIGURE 95. “Old rusted anchor” GBL shape of photomodel. 5 ft. stream anchor with scale (one square is 1 ft.); in shaded view (courtesy of trivial.cat 2021).

The armored bulkheads were created next and consisted of stanchions boarded over with 2 in. thick oak planks (Copeland 1861b) on either side and 3/8 in. iron plating covering the oak planks on the outboard side. Additionally, 3 ft. wide and 2-1/2 ft. long iron swing plates of the same thickness were connected to iron plating. Larger 5 x 3 ft. swing plates were placed in the open gap made on the broadside armored bulwarks. This assembly was placed on the waterways. The cannon accommodations were placed next, beginning with the gun deck planking as specified in the gunboat proposal letters (Copeland 1861a; Copeland and Howe 1861). This simply extended the sacrificial gangway planking thwartship so that the entire open deck was sheathed with additional planking. The gun deck planking was created by copying the floor planking, moving it up 3 in. and using the main cabin to trim it appropriately. The sacrificial planking within the cabin was then removed and the sponson supports were planked over with a 3 in. extrusion.

Six cannons were then placed, three on either gundeck. The largest guns, 30 pdr. Parrott rifles, were placed on pivot mounts at either end. Howitzers (24 pdr.) on slide mounts were then placed at the broadside swing plates (Saltonstall 1913:36; United States Department of the Navy 1921:63). Both the Parrott rifle and Howitzer models were downloaded from Thingiverse.com and created by user "Uhlán" (Figures 96 and 97). The cannons and mounts were brought into Rhino®, scaled based on dimensions provided in the *Ordnance Instructions for the United States Navy* (Wise 1866:68) and *Arms and Equipment of the Civil War* (Coggins 2004:145). They were then brought to their appropriate position on deck. The Parrott sat on iron tracks called runs, the shape of which was traced from a scaled gun deck plan of the frigate USS *Trenton* (Naval History and Heritage Command 1944). Breech works (Figure 98) then placed protruding from the waterway, one directly in front of each Howitzer, which was used as their pivot point, and six

were placed around the Parrotts, two for each pivot point. The breech works were traced from *Southfield's* scaled site plan (Spirek 1993:120) lofted and then extruded to 1/2 in., then placed in relation to the cannon (Figure 99).

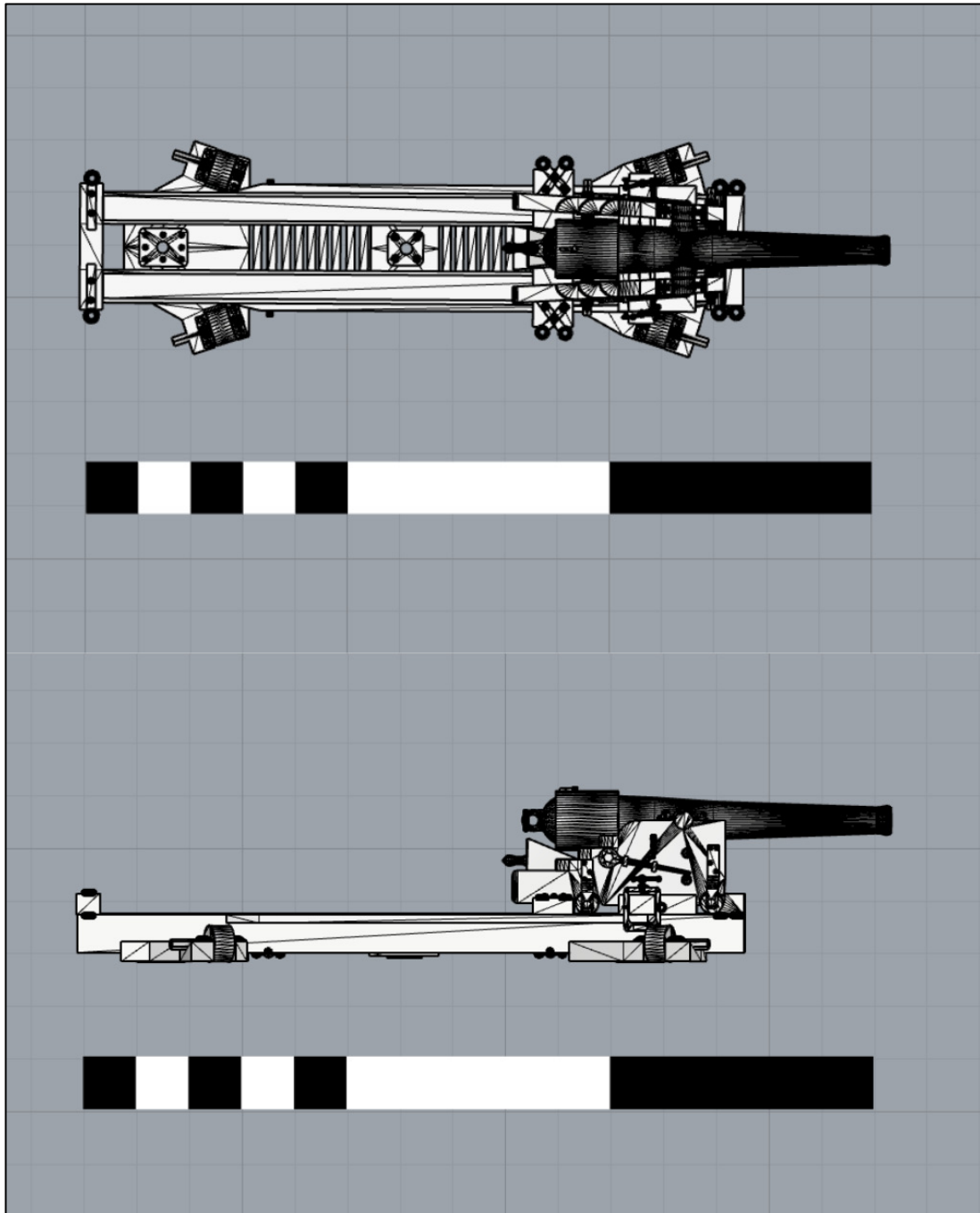


FIGURE 96. 30 pounder Parrott rifle obtained from Thingiverse.com with scale (one square is 1 ft.); in “Shaded” view. The Parrott’s slide carriages moved on iron rails called racers (Coggins 2004:142). The shape is based on USS *Trenton*’s armament arrangement plan (model courtesy of Uhlan 2024b, image created by author).

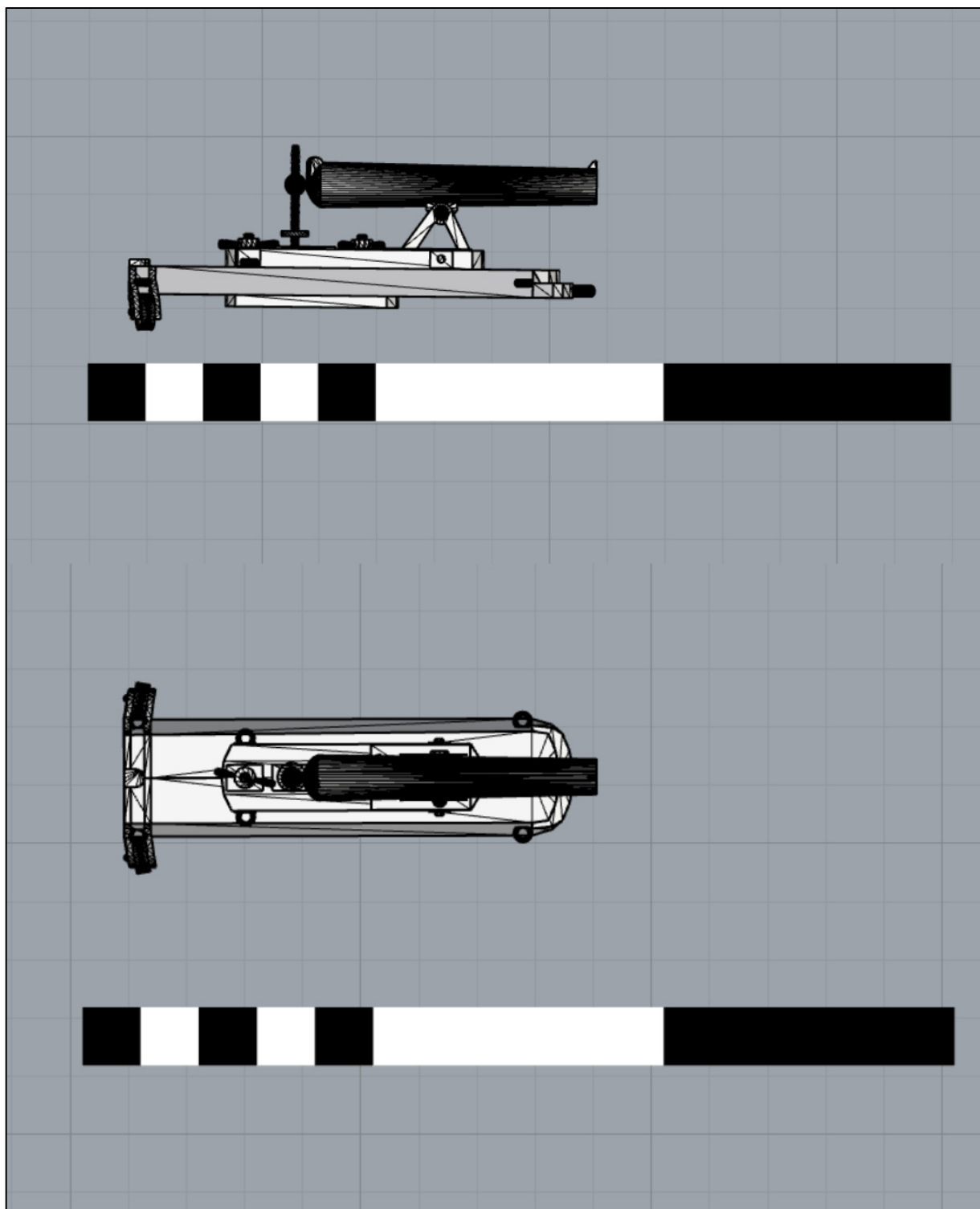


FIGURE 97. 24 pound Dahlgren Howitzer smoothbore cannon obtained from Thingiverse.com with scale (one square is 1 ft.); in “Shaded” view (courtesy of Uhlan 2024a).

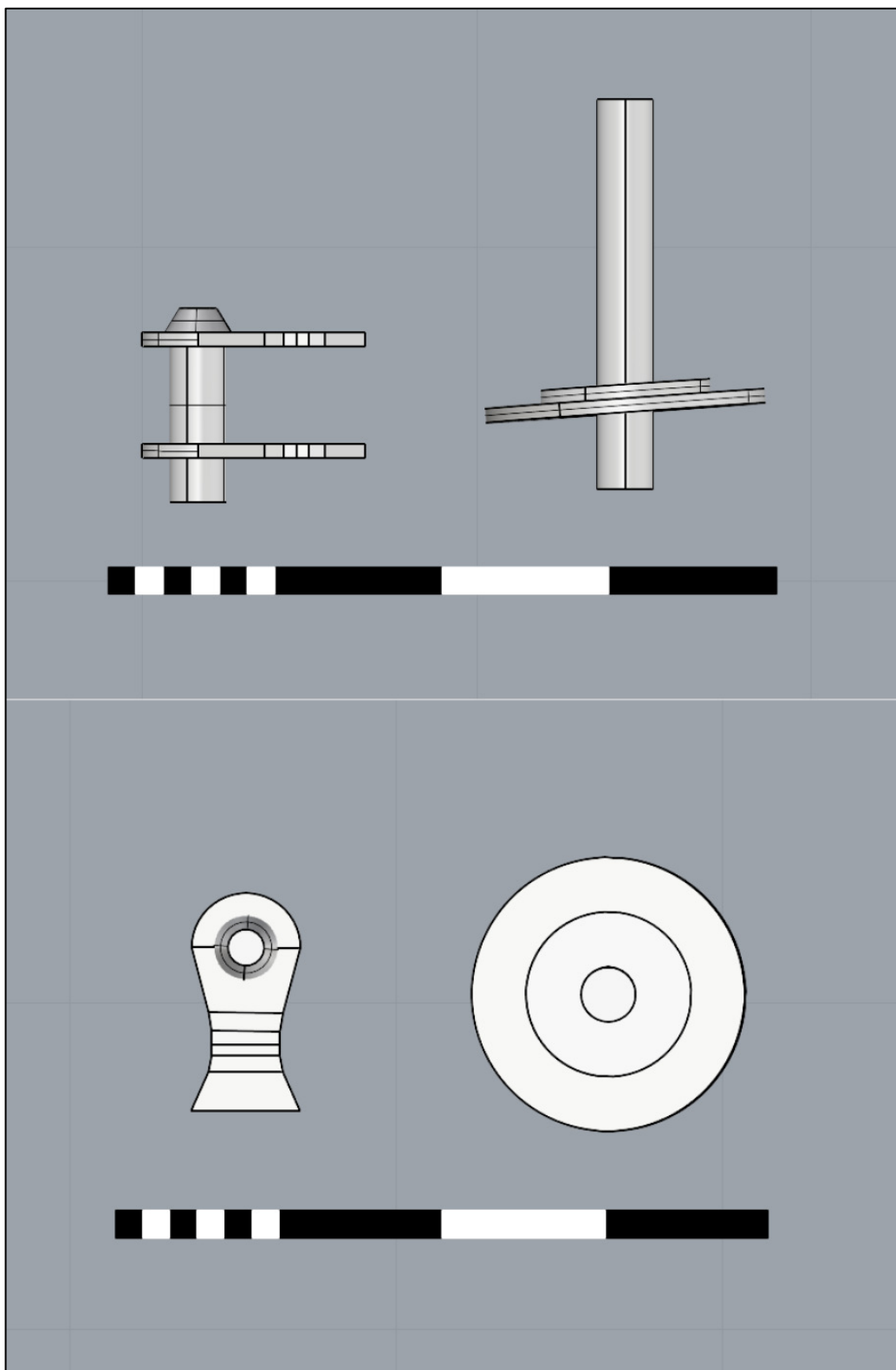


FIGURE 98. Breechwork (left) and pivot plate (right) for cannon with scale (one square is 1 in.); in “Shaded” view. Pivot plate size was interpreted from photograph of USS *Juniata* (1862) courtesy of Naval History and Heritage Command; reference # NH 52368 (image and model created by author).

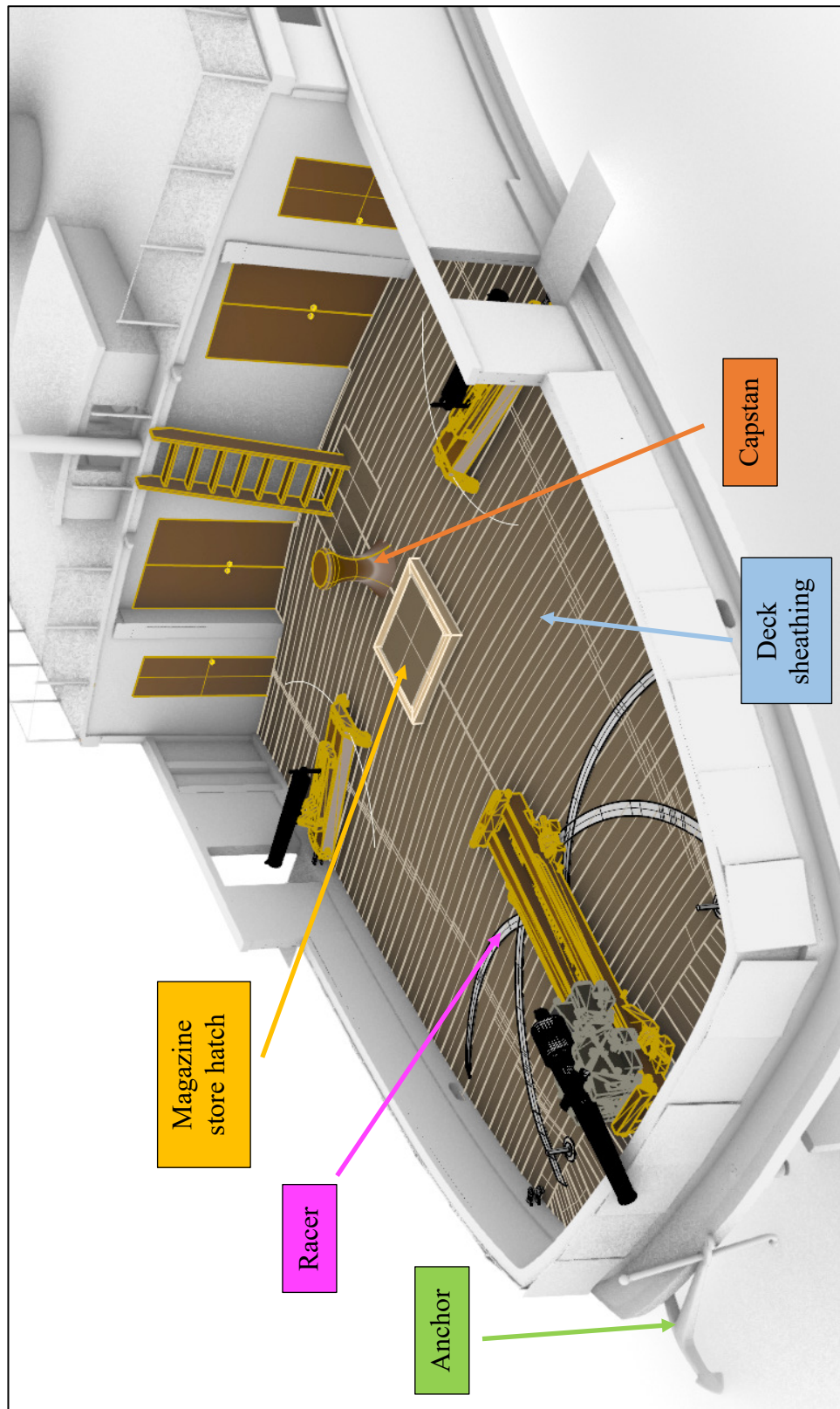


FIGURE 99. Interpreted converted deck of *Commodore Hull*. Note the capstan (dark brown) behind the magazine store hatch and anchor positioned at end. Curved lines at end of Howitzer slides represent the carriage's arch (image and model created by author).

The final conversion feature added in association with the deck was the planking placed to completely cover the sponson support struts. This feature was noted by Parkoff (2016:48) and was a recognizable feature in several photographs collected by the author. The purpose of such a modification for some distance ferries which plied the Long Island Sound was to give the hull “less resistance to the sea” (Russell 1861:113). While the benefit of less resistance to the water and riverine obstructions likely applies to the converted ferry gunboats, another purpose may have been to make the vessel more buoyant. As has been commented before (Browning 1993:155-156), the weight of the cannon and magazine stores at the extremities of the double enders could cause significant issues of hogging and sagging and excessive rolling when underway or when firing from some converted ferries. The added iron plate armor and additional stores for consumables likely contributed to overweighing issues as well. Planking would allow the vessel to displace more water when heavy laden as indicated in Figure 100.



FIGURE 100. Photograph of vessel stated as *Commodore Barney*; however, one can notice this is the same vessel as Figure 94. Note the acting stern end's low draught with water meeting the strut planking. This may have provided additional buoyancy (courtesy of the National Archives; reference # 2013647361).

Within Rhino®, the sponson support strut planking was created in the same manner as the ceiling and deck planking. First, the edges of the struts were lofted together, then the lofts were lofted together and joined, and finally the whole surface was extruded 3 in. out. The result can be seen in the figure below (Figure 101).

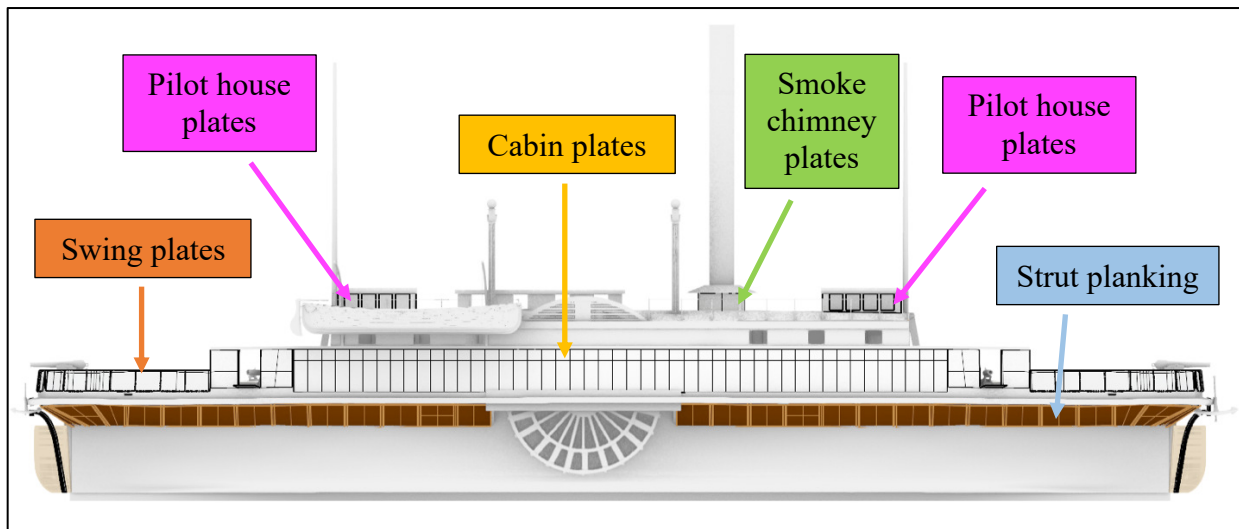


FIGURE 101. Profile view of *Commodore Hull* as interpreted by author. The strut planking (dark brown), rudders (light tan), and armor plating (grey) are in “Shaded” view (image and model created by author).

Steering Arrangement and Hold

The final conversion features modelled dealt with the adjusted steering arrangements and new magazine stores kept in the hold as specified by the *Westfield* conversion proposal (Copeland and Howe 1861). While no specifics were given as to what “new steering arrangements” meant, however, much could be inferred based on what changed with the superstructure. Given the pilot house was dropped down, the steering chain had to have a new path to the wheel. With the house now sitting on the deck, the chain that ran through the machinery enclosure was dropped below deck and run directly to the wheel offering a streamlined route compared to the original arrangement. The way the steering connected to the rudder remained unchained, but the top of the rudder was cut down several feet. This may have been done to accommodate the extra

planking across the sponson supports (Parkoff 2016:48). The modified rudder is represented in Figure 101.

The final significant conversion feature installed was the magazine store (Copeland 1861a; Copeland and Howe 1861). This was placed directly underneath the hatch and stood 7 ft. tall, 6 ft. long, and had 1/2 in. lead sheathing covering its interior. The width, 5 ft., was made as large as the hull would permit with the completed store then being mirrored to the other end. Sixteen 200 pound powder barrels were then placed inside both for a total of 32 barrels in the hold (Figure 102). The magazine store bulkheads were created in the same manner as the pilot house bulkheads, with the barrels being made in a similar manner to the capstan. Measurements for the bulkheads were derived from the unnamed Englis built gunboat proposal and information regarding the magazine's lining and powder barrels came from the *Ordnance Instructions for the United States Navy* (Wise 1866:55,60).

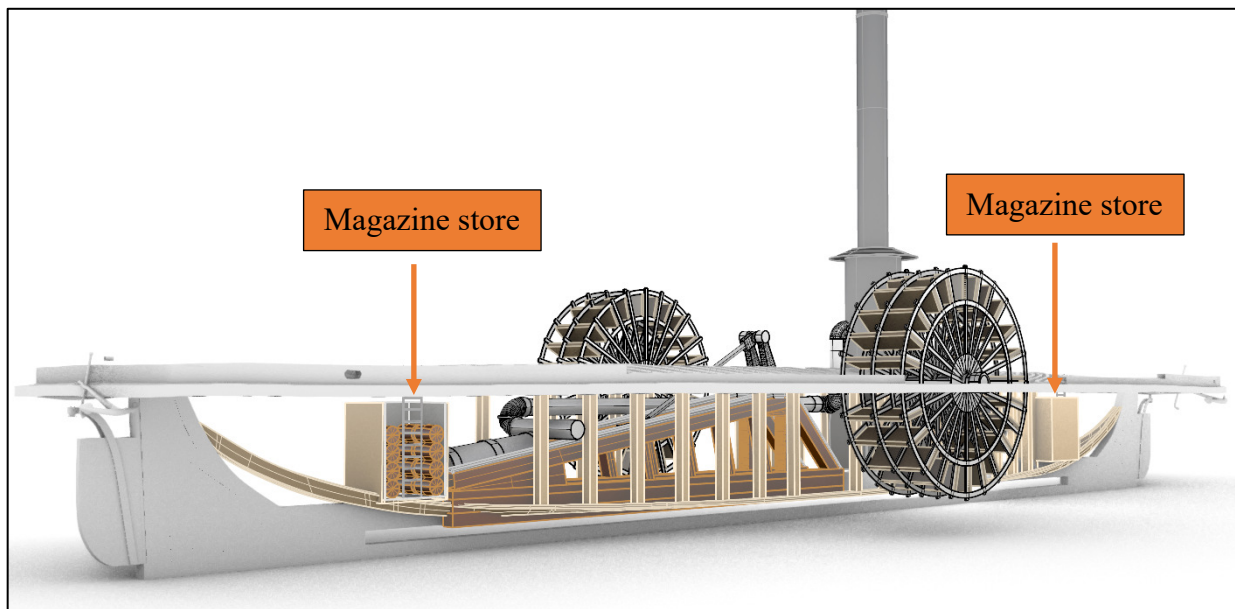


FIGURE 102. Interpreted magazine stores below deck, complete with ladder, lead lining, and power barrels (image and model created by author).

Post-War Configuration: *Waccamaw*

The post war configuration (Figure 103) represents the final working era of the vessel and had the least amount of information available to the material changes. However, primary and secondary sources indicated several key changes. These modifications are discussed in the same superstructure to hold order as were the military conversion features.

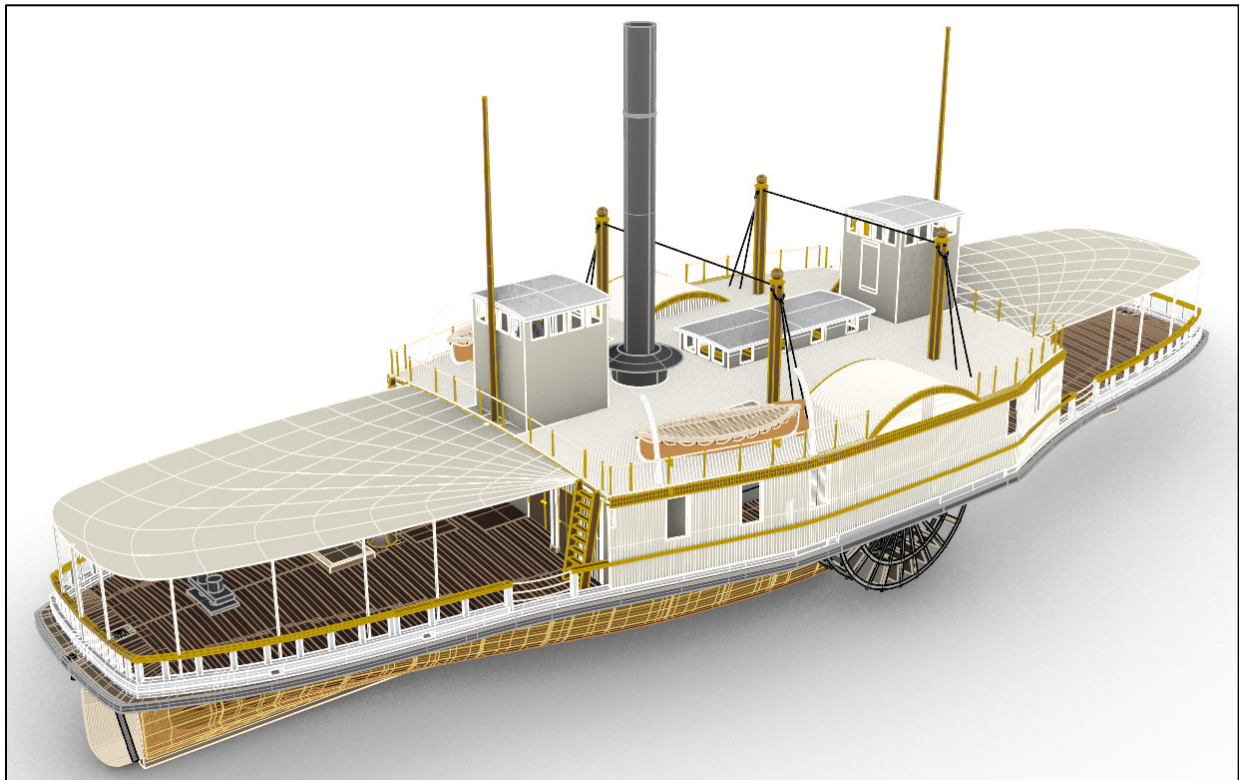


FIGURE 103. Digital reconstruction of *Waccamaw* as interpreted by the author (image and model created by author).

Superstructure

After removing all military related equipment, the first step was to raise the pilot back up to the roof of the main deck. Doors were reinstalled on the side of the pilot house in the same manner as the original build. No source found called for this specific change, however, it was known from contemporary newspapers articles that *Waccamaw* was charted for excursions for the entirety of its post-war life (*Daily Journal* 1867:3, 1871:3; *Evening Post* 1873a:2; *Wilmington*

Morning Star 1879:1) and occasionally included bands for entertaining guests (*Evening Post* 1873b:3; *Daily Journal* 1875b:1). Based on those facts, it was deemed appropriate to move the pilot house to a location on top of the main cabin to provide more cabin space to accommodate passengers and bands.

The lifeboats from original ferry construction (Figure 78) were placed on the boiler end of the vessel with the original configuration of its davits returned on either side. The railing, cross-brace chains, funnel, and steam chimney remained unchained. The length of the main cabin was then reduced using an extruded line as a cutting surface to create more deck space. This necessitated moving the pilot houses and engine sky light superstructure further inboard (Figure 104). The thwartship bulkheads that closed the gangways and passenger cabins were then moved in and trimmed to fit in their new position. New window openings were then trimmed out based on the same dimensions as the original build. This reduction of the main cabin and the upperworks was done in the summer of 1872 to “make her [*Waccamaw*] a more suitable boat for wrecking, towing and lightering” and to make the vessel “draw less water by about 11 inches, which tends greatly to improve her speed” (*Wilmington Morning Star* 1872a:1).

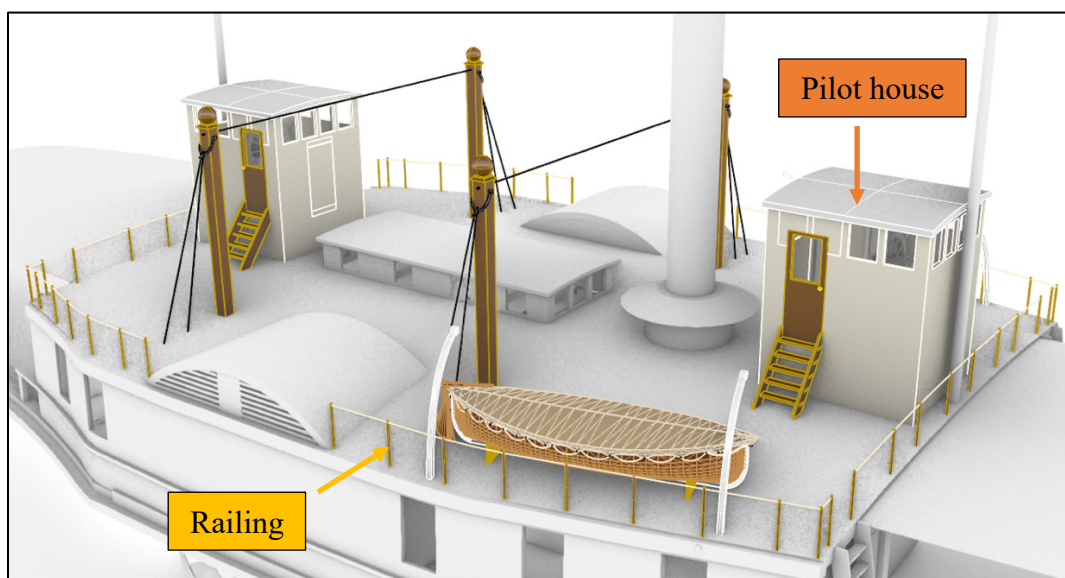


FIGURE 104. Interpreted hurricane deck of *Waccamaw* (image and model created by author).

Other modifications made in the summer of 1872 were the addition of three state rooms consisting of two berths each (*Wilmington Morning Star* 1872a:1). Four were installed within the old passenger cabins, two on the boiler end, and two on the engine end to add symmetry to the vessel's deck plan. 2-1/2 in. thick bulkheads were constructed from extruded lines to define the space of the rooms, as the bulkheads previously placed for the rooms of the military conversion were removed. With the rooms delineated, the berths were then sized based on dimensions provided by Crothers (2013:323), those being 24 in. in width and 6 ft. in length. Space was left at the end of the longitudinal bulkheads forward of the state room on the boiler end for hypothetical storage. Doors were appropriately placed for the new cabin arrangement, again being copied from the doors created for the original pilot house. The previous storage bulkhead placed inboard of the paddle box was removed to create more space within the cabin. For the same reason the original machinery enclosure was copied and pasted from the original model to replace the extruded enclosure created for the military conversion (Figure 105).

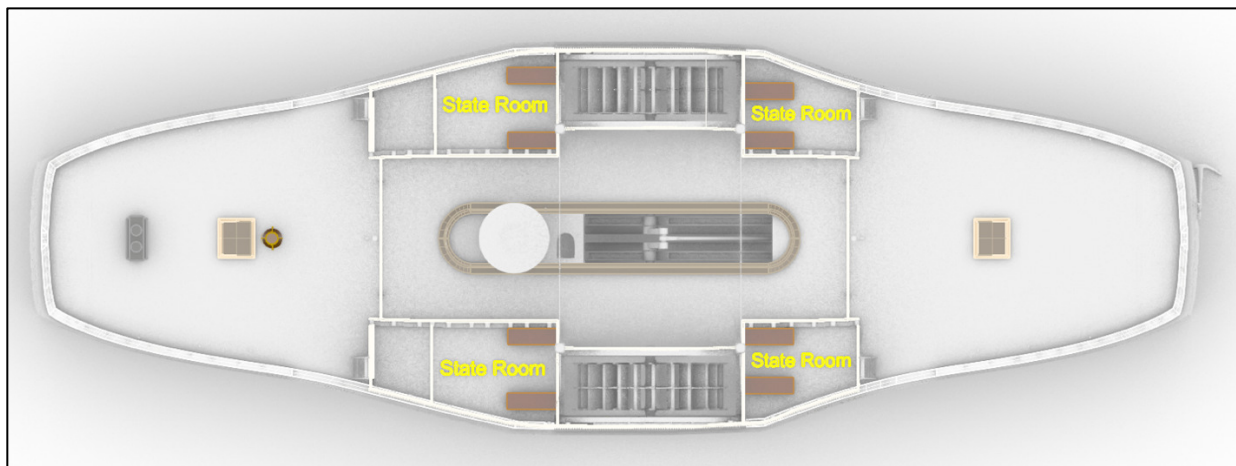


FIGURE 105. Interpreted deck layout of *Waccamaw* complete with four state rooms, two berths (brown) each (image and model created by author).

Awnings were the last post war conversion feature and were added to either side of the main cabin, as indicated in a 22 April 1871, newspaper article (*Wilmington Morning Star* 1871:1). The article also cites several other repairs and improvements that the Wilmington and

Smithville Steamboat Company made to *Waccamaw* including the installation of a new boiler and repairs made to the decks and saloons. The awnings were interpreted as extending from the main cabin between the ladders to the end of the vessel with the stanchion layout and canvas design based on photographs of several late 19th century passenger river craft (Figures 106 and 107). Awning stanchions were placed from the deck to awning and were created in the same manner as the stanchions on the promenade deck of the original build. The awning canvas was made using the “interpolated curve” tool to make half its outline. This awning curve was then mirror to the opposite side so a loft could be created, the resulting surface then being extruded to the appropriate thickness (Figure 108).

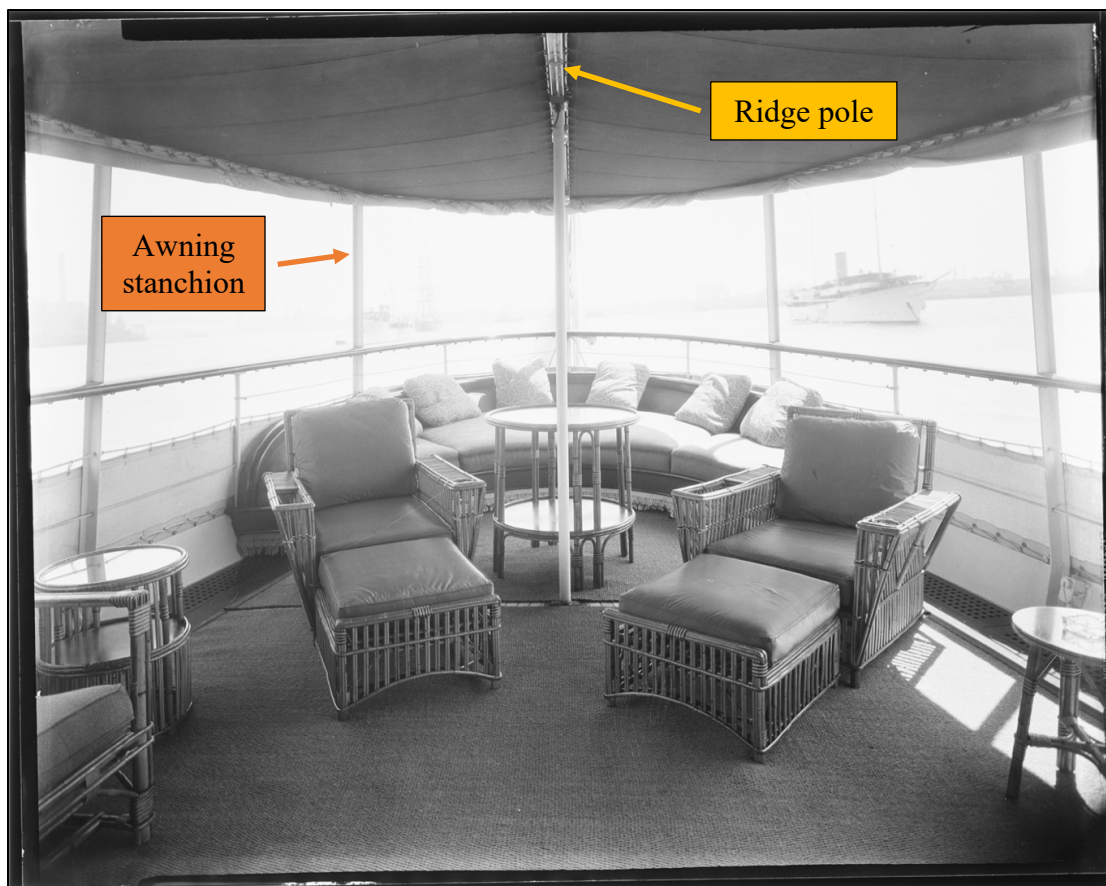


FIGURE 106. Awning of unidentified pleasure craft, note awning stanchions and ridge pole running the centerline of the canvas (courtesy of the E. P. Griffith Collection, The Mariners Museum and Park Archive; reference # MS0228-01-1041).

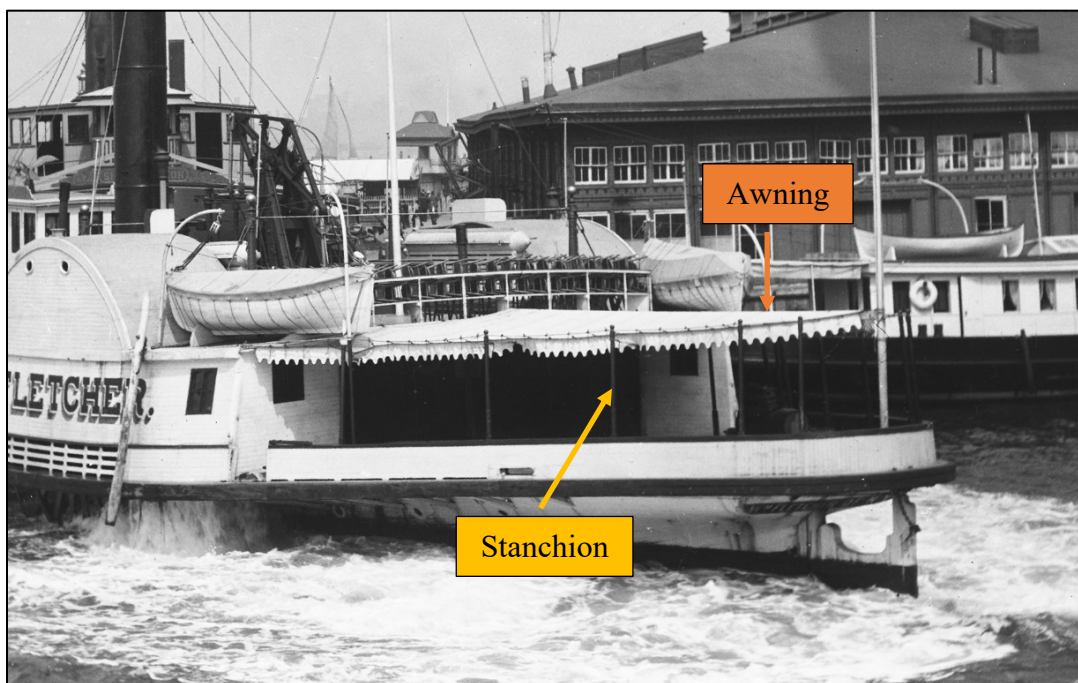


FIGURE 107. 1895 photograph of paddle steamer *William Fletcher* zoomed view on stern deck awning, note the general shape and style of awning canvas (courtesy of the Collection on Samuel W. Stanton, The Mariners Museum and Park; reference # MS0094-01-1432).

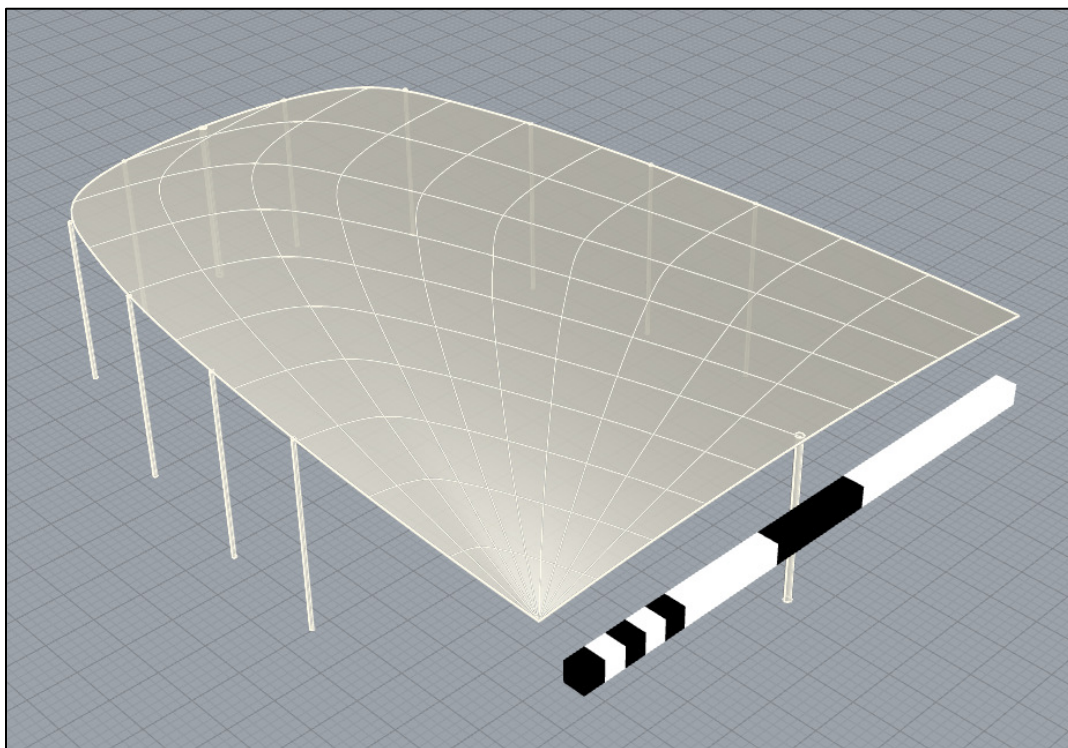


FIGURE 108. Awning canvas on stanchions, scale (one square is 1 ft.); in “Ghosted” view. The thickness of the awning canvas was $\frac{3}{8}$ in. based on information provided by the American Canvas and Awning Co., Petaluma, California (image and model created by author).

Deck

To make *Waccamaw* a suitable towing/salvage vessel, several pieces of equipment were essential. One, the capstan, remained from the military conversion leaving the addition of a towing bitt (Hardy 1927:151-152; de Kerchove 1948:784). The dimensions and general location for the tow bitt came from the scaled plan of the tow boat *Hercules* (1907). It was placed on the vessel's centerline in a thwartship direction 5 ft. from the bulwark. A circular rail with a 7-1/2 in. diameter, also derived from the *Hercules* plan, was then placed on the bulwark at the end of the vessel replacing the squared rail in the military conversion (National Park Service 1997). This would have acted as a tow rail which prevented the towrope or hawse line from damaging any projections on the deck (de Kerchove 1948:786). The stanchions under this rail were doubled to provide additional strength for towing line and chain.

The bulwarks were kept essentially the same with only the oak planking, and the iron plating, removed. Two more ports were also added on the quarters on each end of the vessel by extruding outlines of the fairleads placed on the original construction and using them to trim the waterway. Finally, the bulwarks were left open in the space previously occupied by the broadside swing plates with three pieces of line created to close them off. Given the historical record gives no indication that carriages were still being transported, yet there being ample evidence that it was involved in towing services (*Daily Journal* 1871:3, 1873a:4; *Wilmington Morning Star* 1872a:1), it is likely that the vessel's ends had a permanent bulwark enclosing its circumference. The bulwark, again, would have acted as the tow rail which was a standard piece of towing equipment (Figure 109).

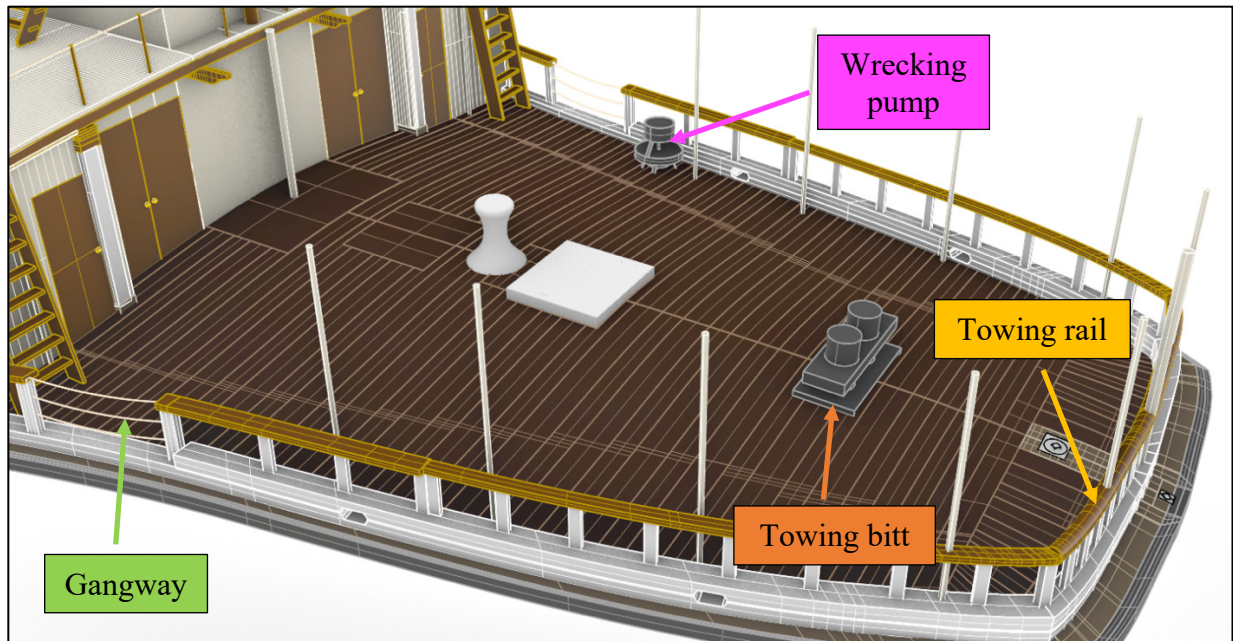


FIGURE 109. Interpreted deck modifications of *Waccamaw* in “Shaded” view. Note the towing bitt (dark grey), the rounded tow rail (light brown), new door and ladder locations (light brown), the awning stanchions (white), and wrecking pump (dark grey) (image and model created by author).

Steering Arrangement and Wrecking Pump

The last portions of the *Waccamaw* model were added below the deck beginning with the steering arrangement. With the pilot house moved up and inboard, the steering chain would have passed through the deck and up into the pilot house at a more inboard point. This was adjusted for by selecting the desired chain and rotating it so that it came to the wheel at the desired point. The steering chain needed to be covered as it passed through the deck beams and into the main cabin, however, so a metal pipe of 1 ft. and 9 in. in diameter was created by extruding a circle from the deck to the bottom of the pilot house. Such a feature was common on ferries as can be seen in Figure 110 and as represented in the *Ticonderoga* plans. The steering chain cover within the 3D reconstruction can be seen in Figure 111.

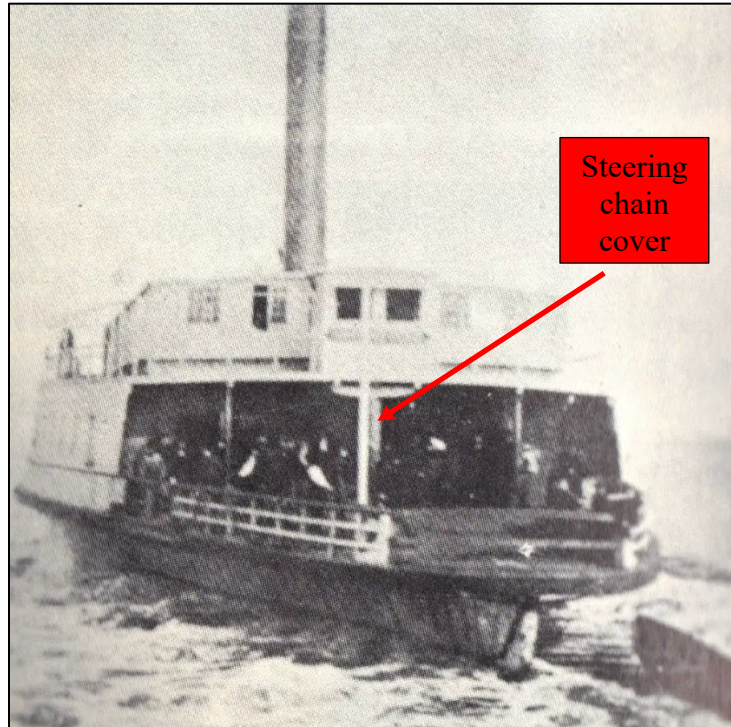


FIGURE 110. A photograph of the double ended ferry *Southfield* built 1857 by John Englis. Note the vertical pipe running from the deck to directly below the pilot house (courtesy of the New York Historical Society).

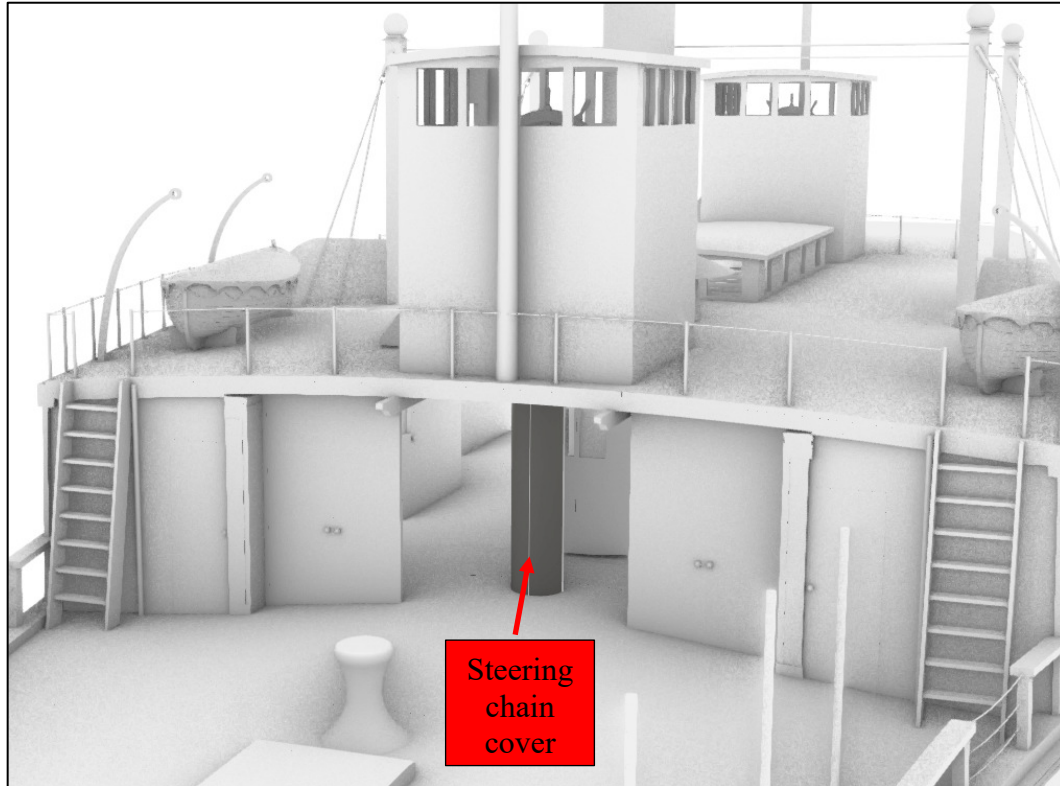


FIGURE 111. Interpreted steering chain cover 1 ft. 9-1/4 in. in diameter based on *Ticonderoga* plans (Image and model created by author).

Finally, a Worthington pump is known to have been installed on *Waccamaw* by local shipbuilder and merchant Benjamin Beery in late 1872 (Jackson III 2008:207,260). While it is not known exactly what type of Worthington pump was placed on the vessel, it is likely to be the “Worthington Steam Pump for Wrecking, Drainage, and Irrigation” found in the company’s 1883 catalogue (Worthington 1883:19; Figure 112). A basic representation of a Worthington Wrecking pump was created (Figure 113) with dimensions being determined from the Worthington catalogue (1883:19) and the reported output of the pump (Jackson III:207). The pump was then placed on the boiler end of the vessel close to where the Howitzers were positioned, an interpreted placement given the likelihood of the pump receiving its steam from the main boiler via a steam pipe running under the deck.

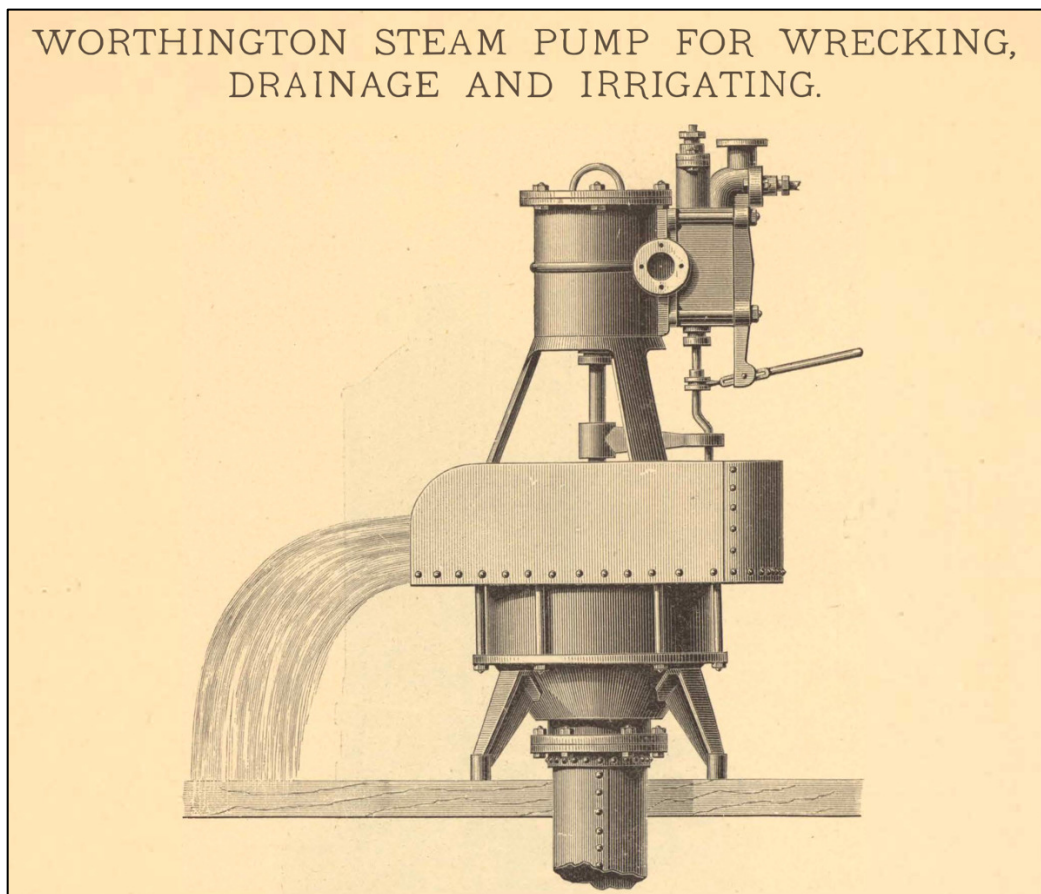


FIGURE 112. Drawing of Worthington Wrecking Pump from 1883 company catalogue (courtesy of Henry R. Worthington 1883:19).

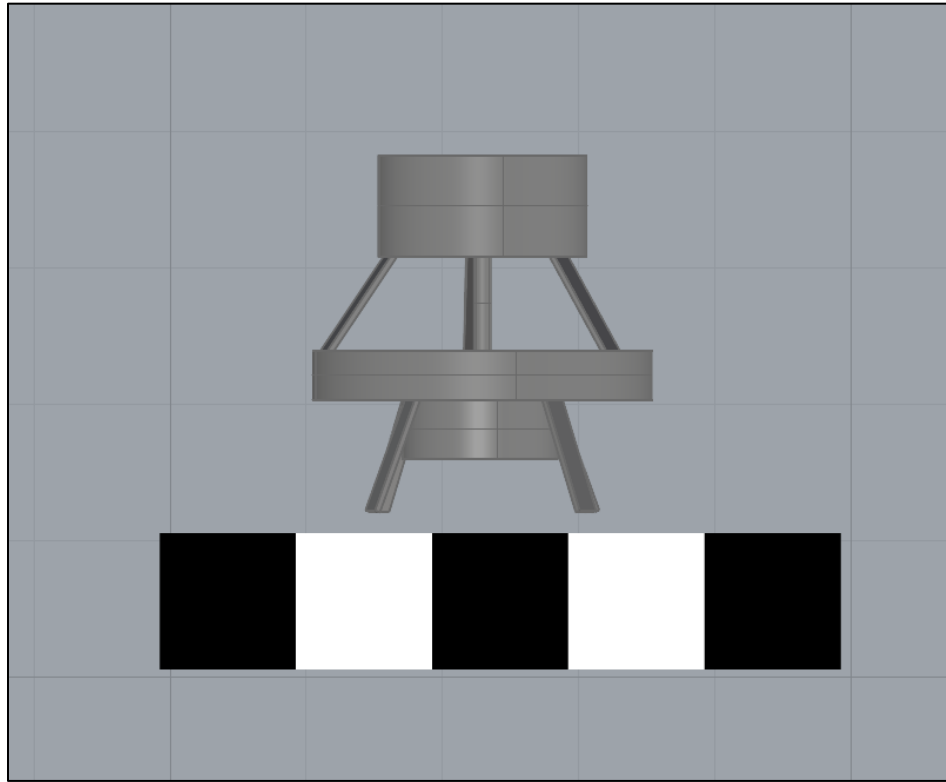


FIGURE 113. Representation of a Worthington Wrecking Pump with scale (one square is 1 ft.); in “Shaded” view. This was their second largest unit for this model (image and model created by author).

Deposition: The CFR0001 Site

The following segment describes the findings of the field work conducted at the CRF0001 site (Figure 114). This begins with a general site description and the likely orientation of the site *in situ* and is followed by a focused description of the nine points of interest which relay diagnostic construction and salvage information. Measurements stated below were collected through the scaled photogrammetric model, which provided measurements accurate within 2.716 mm. (7/64 in.), and those recorded by researchers at the site itself. Where available, data from the 2023 and 2024 field investigations are compared to previously collected data.



FIGURE 114. Location of *Waccamaw* wreck (yellow pin, approximate), parking (yellow polygon), and location in relation to the greater New Hanover county (top left) (image created by author).

Site Description and Orientation

The remains of *Waccamaw* lay about 460 ft. north, northeast of the Cape Fear Memorial Bridge on the bank of Eagles Island, North Carolina, located North Latitude 33°16'17", West Longitude 77°57'12" (North Carolina Underwater Archaeology Branch 2024:5). The vessel lays relatively parallel against the riverbank with exposed features running a total length of 122 ft. and 2-1/2 in., an extreme breadth of 41 ft. and 10 in., and a hull breadth of 27 ft. and 10 in. (Figure 115). This is about 6 ft. less in length than the last time this information was recorded in 1996, however, the hull breadth remains nearly identical with the same report, which states a remaining 28 ft. (Overton and Lawrence 1996:141). Within the 1975 NCDAH/UNCW field school report, the

breadth was stated as 28 ft. with the length being reported anywhere from 150 to 165 ft., likely erroneously as noted by the UAB within the site file (NCUAB 2024:5).

The centerline of the vessel, running parallel with the bank, points northeast at 40°, with the northern end being significantly covered by sediment and the southern end being more exposed. Given the eastern facing slope of the riverbank, it was considered probable that the vessel may be listing to this side. The first step in confirming this was to bring the photogrammetric model into Rhino® after having oriented it to be completely level in Metashape®. Then, the photogrammetric model was placed in “front view” and an angle was taken from the vertical engine bed timber with any deviation from 90° indicating the hull was in fact listing. A deviation of 6° was noted, confirming the list, which was then corrected to properly overlay the photomodel on the 3D model (Figure 116). To ensure this method did not rely solely on the vertical timber having remained at a right angle over the past 140 years, a log running perpendicular to the shoreline across the southwestern half of the hull was used as a horizontal reference.

When looking at the site plan (Figure 115), the remains of *Waccamaw*’s hull are significantly more intact and exposed on the southern end. Moreover, several features indicate that more of the hull remains intact below the sediment at the southern end as well. First, it was noticed once the photogrammetric model was brought into Rhino® that the remains of the boiler sat roughly a foot higher in the 3D reconstruction of the boiler than it should have. Indeed, the furnace hatches, based on the measured sketch of the horizontal firetube boiler installed on CSS *Lady Davis* (Figure 58), needed to be lowered. However, with the height of the vertical engine timber lining up appropriately with the reconstructed engine, the photomodel had to be angled longitudinally to lower the boiler remains to their proper position within the reconstructed boiler.



FIGURE 115. Site plan of CFR0001 – *Waccamaw* (image and model created by author).

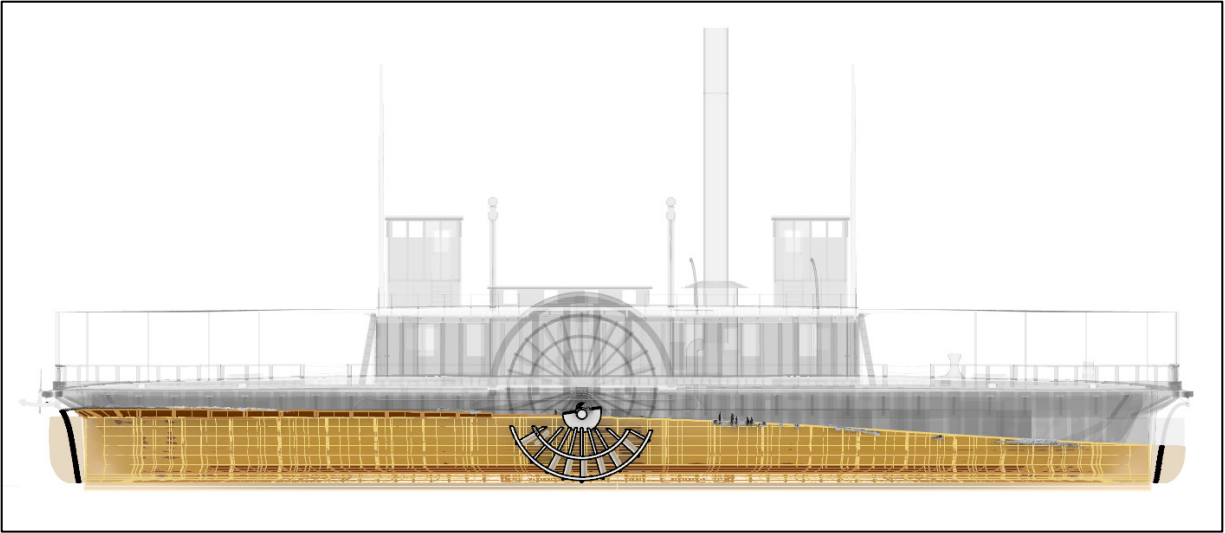


FIGURE 116. Profile view of photogrammetric model overlayed onto the projected remains of CRF0001. The above greyed out superstructure represents what had been removed due to various site formation processes (image and model created by author).

The second feature which indicated more of the hull remained below the sediment on the southern end as opposed to the northern end was the identification of a “made” breasthook. More detail as to how this determination was made is discussed below, however, what is relevant regarding the vessel’s orientation is that breasthooks were evenly spaced between the decks. Moreover, breasthooks placed lower in the hull were usually run up the side of the hull diagonally to support the cant frames (Crothers 2013:183). Since the breasthook on the CFR0001 site runs horizontally across the hull, it is unlikely to be a lower hull breasthook; rather, it likely represents one of those hooks placed between the deck beams and the hold (Figure 117). With vessels of a similar size and tonnage to *Waccamaw* having been reported to have three breasthooks spaced several feet apart (Kinnaman 2022:382), the breasthook taken by itself roughly indicates anywhere from 5 to 10 ft. of total buried structure. However, when taken into consideration with CFR0001’s boiler remains aligned in the 3D reconstruction, it is likely one of the uppermost breast hooks. Given this orientation, the amount of the vessel that has been removed or eroded away can also be projected (Figures 116 and 118).

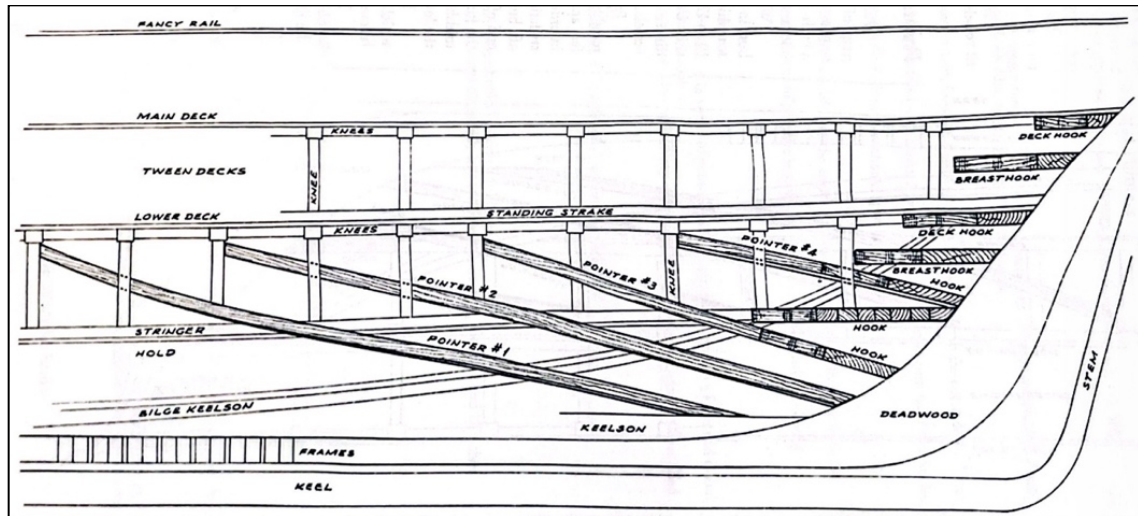


FIGURE 117. Location of hooks along stem of 19th century packet ship (courtesy of William L. Crothers 2013:183).

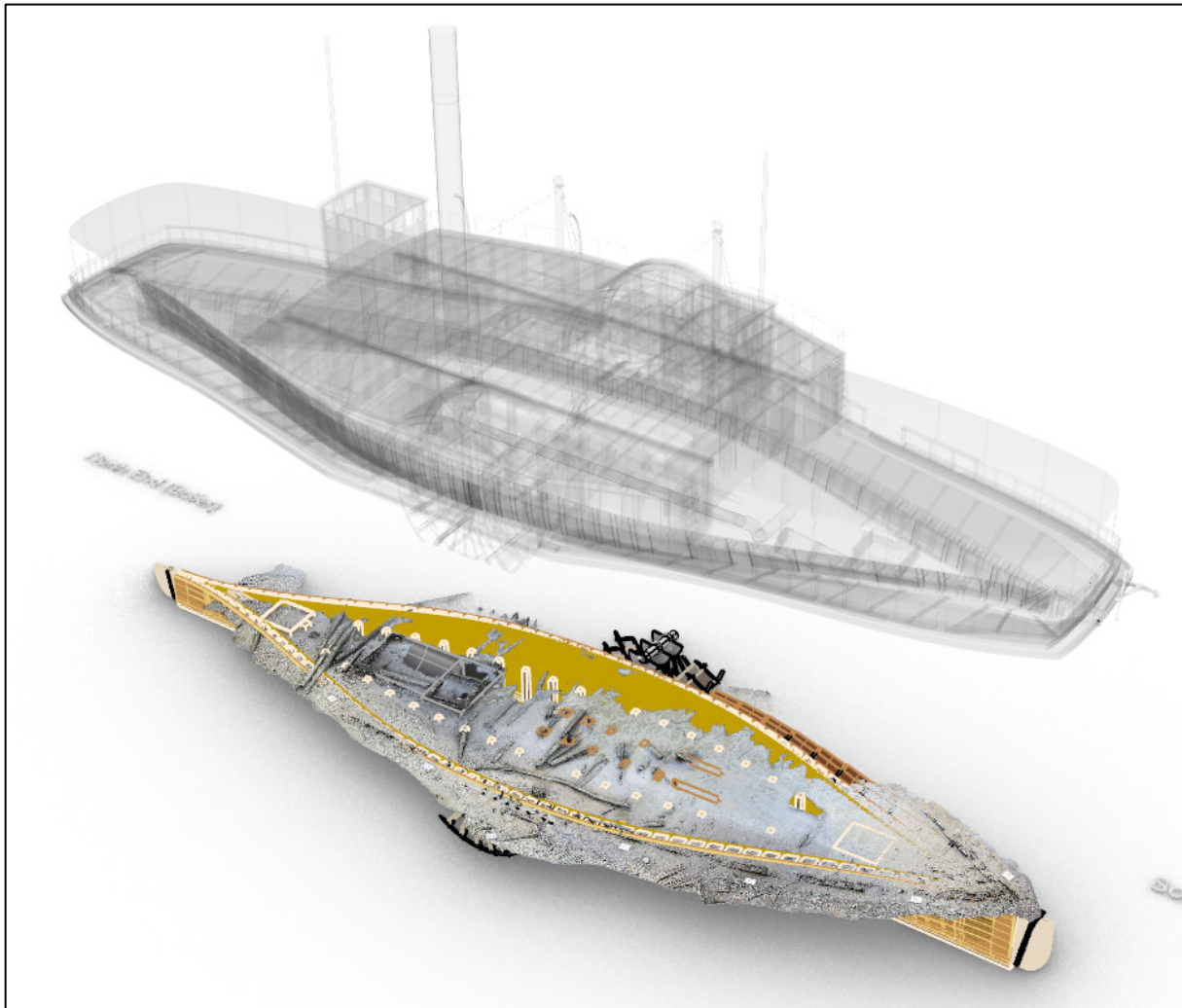


FIGURE 118. Projection of the amount of the vessel removed from the site (greyed out structure) based on the site orientation described above (image and model created by author).

Description of Features

With the site's orientation and layout defined, key features of the exposed remains are considered. These features are concentrated mainly along the centerline, eastern, and southern portions of the vessel (Figure 119). Beginning with the southern end and moving northward, the end post assembly and breasthook will be described first. This is followed by the descriptions of the framing and planking, the engine bed timbers, the paddle wheel remains, the boiler, the bitt and possible stanchion, and concluded with some notes on the northern extremity of the site. Tables are included in each segment to provide dimensions for each portion of the remains discussed.

End Post Assembly and Breasthook

At the southernmost portion of CFR0001 lies the remains of the end post assembly and what has been identified as a breasthook (Figure 120). The most southern piece is the end post itself with the outer hull planking keying in directly behind it in a manner quite similar to the 1853 American built clipper *Great Republic* (Figure 121). Behind the planking is the inner end post with a deadwood timber coming in directly behind it. This could possibly be a deadwood knee, however, with sediment covering everything except the upper most portion of the assembly, it is impossible to know for certain without excavation. Within the inner end post, several fasteners, which appear to be made of copper, are driven horizontally through the eastern outer planking into the inner end post. Ceiling planking then converges to the deadwood, again, in a manner like Figure 121.

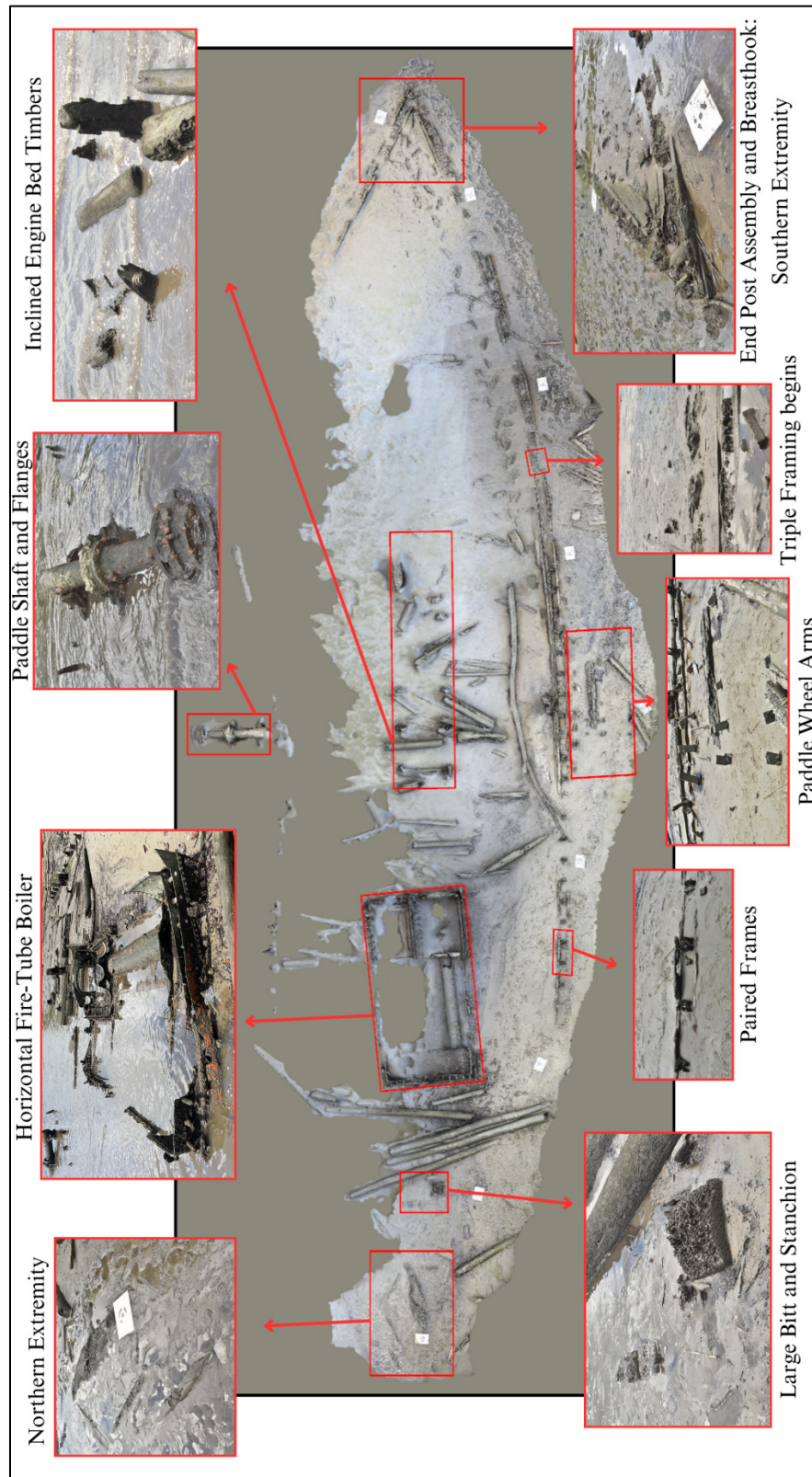


FIGURE 119. Site plan with key features demarcated with red squares. Arrows point to associated site photos (image and model created by author).



FIGURE 120. End post assembly and breasthook (photograph taken by author 30 June 2024).

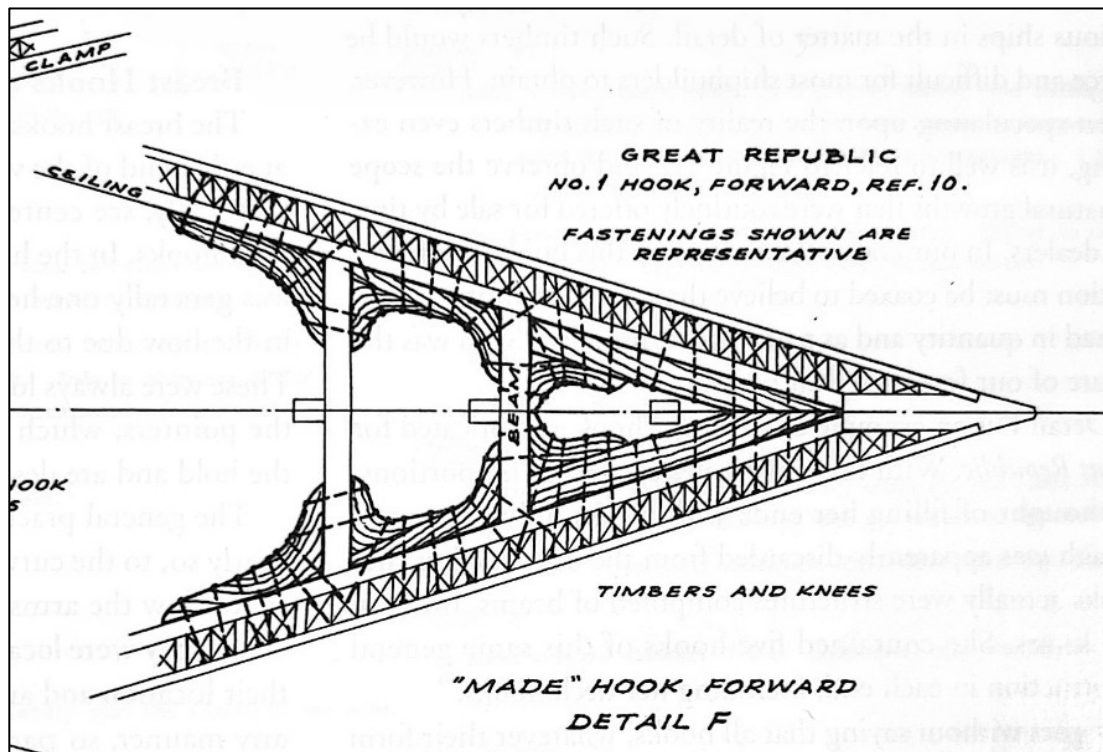


FIGURE 121. Top-down section view of a made hook within the hold of the 1853 clipper *Great Republic*. Note the ceiling planking sandwiched between the hook and the frames (courtesy of William L. Crothers 1996:249).

Regarding the breasthook, two pieces of evidence indicated that the two timbers splaying on either side of the hull and converging at the deadwood were indeed portions of a “made” breasthook (Table 5 for dimensions). First was its height within the hull as explained above in the determination of CFR0001’s orientation in the mud. It should be noted with this point that 1975 and 1990 field work photographs (Figures 19 and 20) also show that framing had at one point continued several feet above where this “made” hook lies, indicating it was not a deck hook, which were typically rounder, naturally made (explained below), and sat directly beneath the deck beams (Figure 117). The second piece of evidence was the above depiction of what Crothers (1996:249) terms a “made” hook. Broadly speaking, hooks are timbers in the bow or stern of a vessel that lay in a general horizontal plane and cross the centerline to connect at one end or the other. Hooks can be either natural, that is one solid piece of shaped timber or made from two pieces of shaped wood joined together by fasteners (Crothers 2013:181). As can be seen by comparing Figures 120 and 121, the latter closely resembles the former and is composed of two shaped timbers fastened together at the deadwood.

TABLE 5. Dimensions (feet and inches) recorded for the end post assemble and breasthook.

Feature	Molded	Sided
End post	6-3/4”	8-5/8”
Inner end post	7-7/8”	14” (Inboard) 9” (outboard)
Deadwood	4-1/2”	10-3/4”
Breasthook	Unknown – Sediment obstruction	8”

Framing and Planking

46 total frame stations were counted on CFR0001 from the southern to the northern end, each comprised of both standard paired frames and what appear to be tripled frames (Figures 122 and 123). The western side, or shore side, of the hull provided the most intact consecutive frame stations with the eastern side only having stations one through seven, 35 through 37, and 40

through 45 visible above the water. Stations one through 18 are all triple framed, that is, they include one additional frame alongside frame pairs. This 37-1/2 ft. of “triple framing” may not actually be three frames, but instead simply frame pairs with a filling timber placed on one side as has been noted in some vessels in Mallows Bay, Maryland (Nathan Richards 2024, pers. comm.). Paired frames of typical wooden ship construction of the 19th century (Crothers 2013:119) continue from frame station 19 to 46.

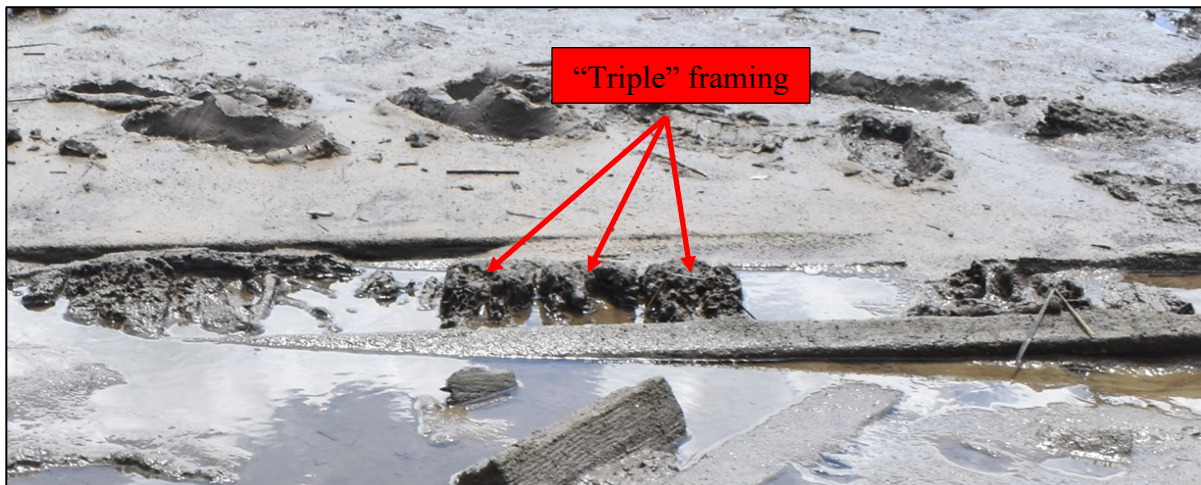


FIGURE 122. Triple frames/filler (stations 16-18 from right to left) on western side of hull (image taken by author 30 June 2024).

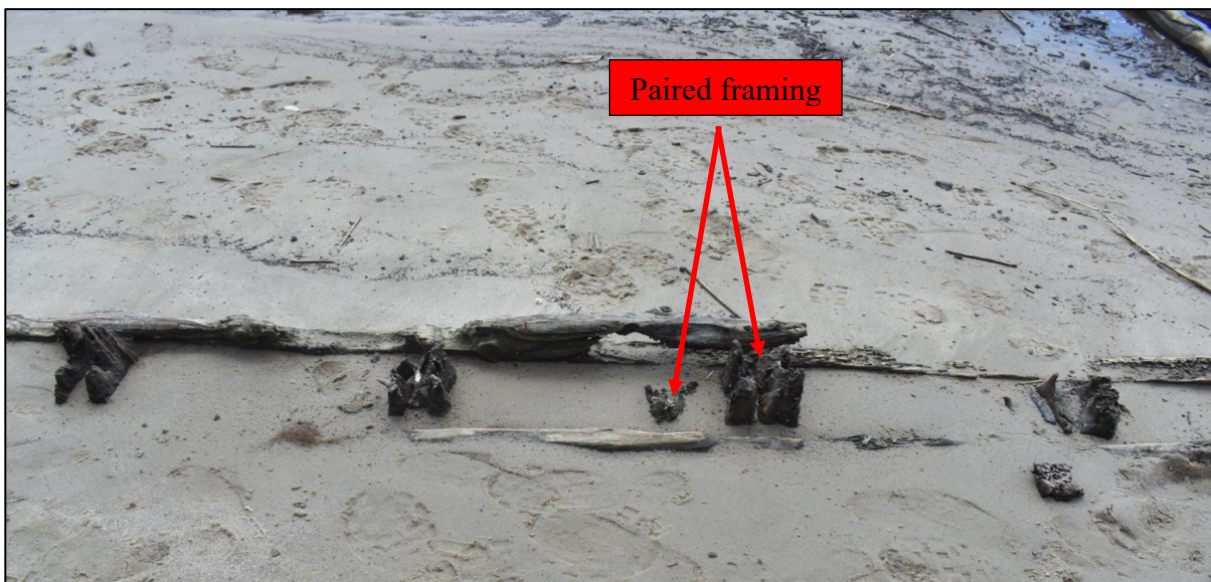


FIGURE 123. Paired frames (stations 40-43 from right to left) on the western side of hull (image taken by author 30 June 2024).

Planking on the site consisted of outer hull planking and ceiling planking both having of the same thickness. The width of the planking could not be determined as sediment precluded the acquisition of data, however, both ceiling and outer hull planking remains relatively intact on either side of the frames particularly to the west. Dimensions for the planking and frames can be viewed in Table 6.

TABLE 6. Dimensions (feet and inches) for frames and planking on CFR0001.

Feature	Sided	Molded	Room	Space
Triple/filler frames	6-5/8"	7-1/2"	1'8"	4"
Paired frames	5-1/4"	6-1/2"	10-1/2"	1'1-1/2"
Outer hull planking	3" (thick)			
Ceiling planking	3" (thick)			

Engine Bed Timbers

The remains of the engine bed exposed above the sedimentation and water consist of a total of eight timbers having a total length of 21 ft. and 5-1/2 in. and a width of 5 ft. and 3 in. The northernmost timbers were the canted supports and the horizontal brace between them and represent the end of the engine bed which supported the vertical timbers underneath the paddle shaft. The horizontal brace that spans the width between the canted support timbers consists of an iron rod 3 in. in diameter driven through both canted supports. An iron nut and plate (Figure 124) capped the western end of this rod on the outside face of the canted support and had wood below the rod that appears to have rotted away significantly. Two more vertical timbers stick up just above the mud, 3 ft. behind those in line with the paddle wheel. South of those timbers, the last exposed timber is the remnant of one of the long-inclined timbers that at one point rested on the vertical supports. This timber is on the eastern side and represents in the southern extremity of the engine bed. See Table 7 for the dimensions of the timbers and horizontal brace.

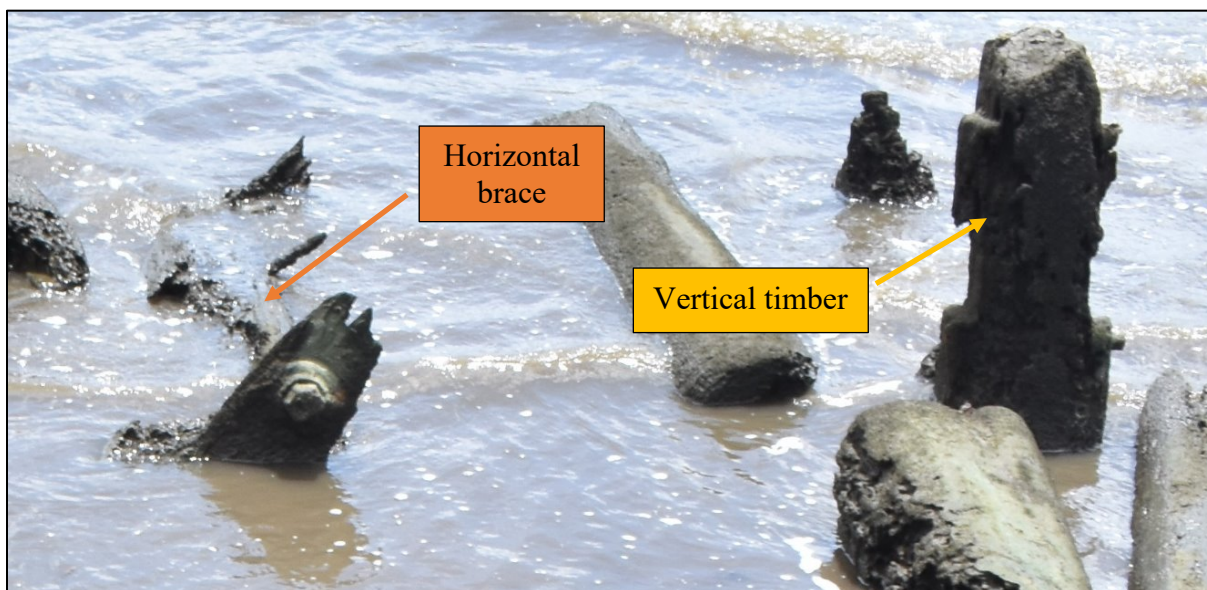


FIGURE 124. Canted support timbers and horizontal brace (left) and vertical timber (right) that would have been under paddle wheel shaft (image taken by author 30 June 2024).

TABLE 7. Dimensions for Inclined engine bed.

Feature	Sided	Molded	Other(type)
Canted Support Timbers	9-1/4"	11"	
Horizontal brace plate and nut			Plate – ½" (thick) 5" (width), Nut – 2" (diameter)
Vertical support timbers 1	7"	9-1/2"	
Vertical support timbers 2	7"	9-1/2"	
Inclined timber	10"	8-1/4"	3'6" (length)

Paddle Wheel Remains

Up 62 ft. and 4 in. north from the southern end at either side of the hull lay the remains of the paddle wheel. The remains consist of 14 iron arms and five iron rods on the western side of the vessel (Figure 125) and a 6-1/2 ft. length of paddle shaft with three eroded flanges spaced regularly. Regarding the western end, no portion of the shaft remains here, only the iron arms, to which the bucket planks may still be attached below the sand, and the iron rods that would have supported the arms against flexing. Furthermore, the number of arms, 14, has remained unchanged at least since the 1990 investigation of the site (NCUAB 2024:26). The top of the arms and the rods appear to have been evenly and uniformly cut, perhaps due to an effort to

remove the shaft. Also, two of the arms closest to the outer hull planking on the right-hand side of the photograph (Figure 125) have a circular chunk over half of their widths removed, possibly due to the use of a cutting or grinding tool. In fact, Overton and Lawrence (1996:141) stated that the “spokes of the paddle wheel and the exposed portion of the boiler had been cut off” sometime after 1924 based on a photograph of that year showing these portions remaining.

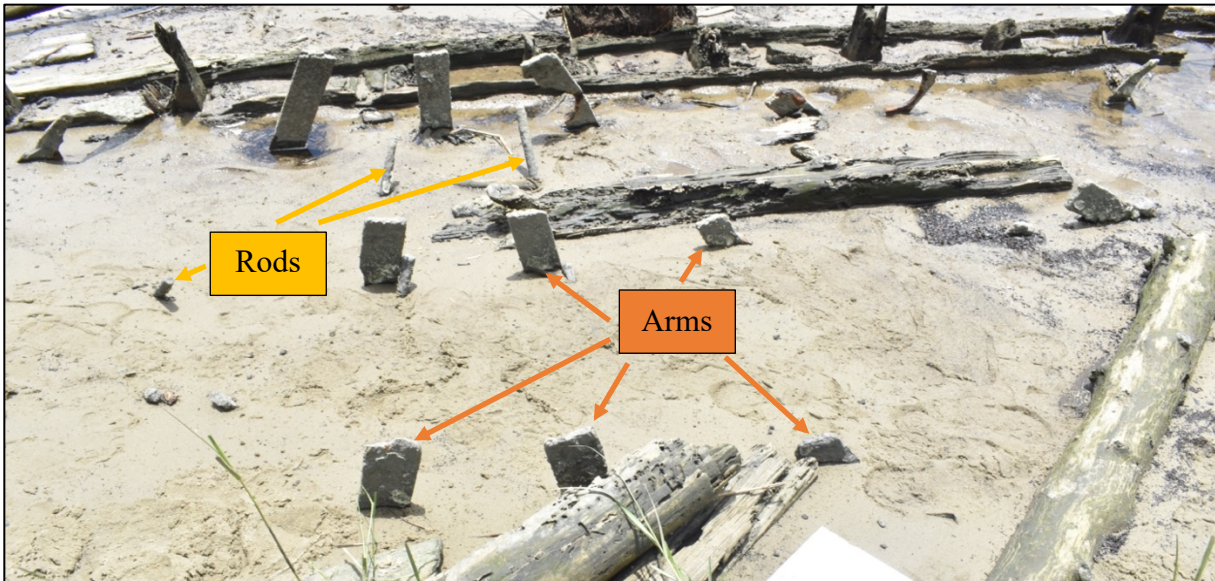


FIGURE 125. Paddle wheel arms and arm support rods on the western side of the hull. Note that not every arm or rod is pointed to (image taken by author 30 June 2024).

Moving to the eastern side of the hull, a portion of the paddle shaft remains lying perpendicular to the protruding frames with the easternmost end tilting downward into the water (Figure 126). Over the length of the shaft, three flanges remain with their diameter significantly reduced above the waterline. While it is not known for certain, it is likely that the wheel is supported below the water by the arms with the associated bucket planks possibly being submerged into the mud below. The shaft and flanges undoubtedly represent that of a radial, as opposed to feathering, paddle wheel. The radial paddlewheel was the earliest and most simple type of paddle wheel in the 19th century and consisted of stout cast iron hubs (flanges) which the arms, which radiated out from them, socketed into (Whittier 1987:36). Furthermore, the bucket

planks were fixed rigidly to the paddlewheel's arms and had no additional moving parts while the paddlewheel turned on its shaft (Cudahy 1990:127). The feathering wheel generally had only one large flange just outboard of the bearing and the shaft did not meet the spring beam at the end of the paddle box (Figure 127). Comparing Figure 126 with Figure 127 illustrates the difference between the radial and feathering wheels while also showing the similarity between the radial wheel and the remains of the shaft on CFR0001. Dimensions for the arms, rods, shaft, and flanges can be viewed in Table 8.

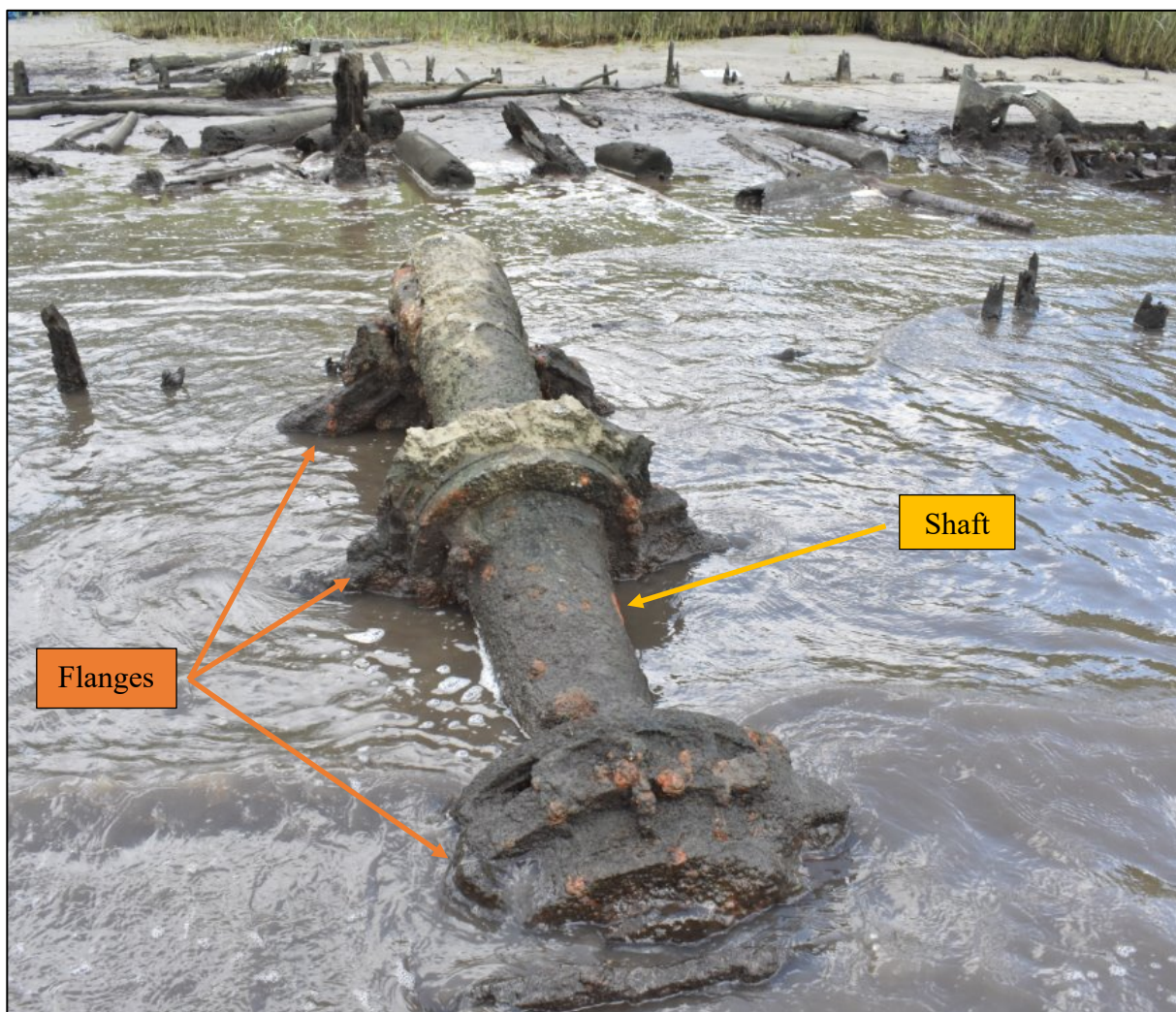


FIGURE 126. Paddle shaft and flanges on the eastern side of CFR0001 (image taken by author 30 June 2024).

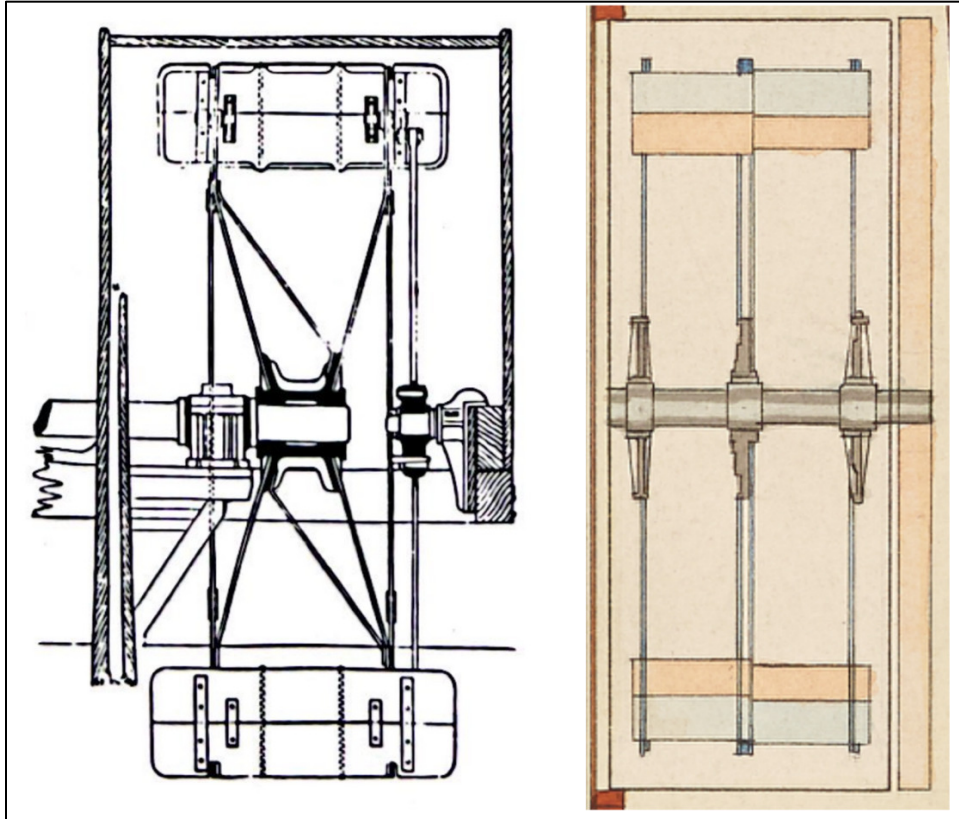


FIGURE 127. Section views of a feathering wheel (left) and a radial wheel (right). Note the large central flange and separation of the shaft in the feathering wheel versus the three evenly spaced flanges on a continuous shaft of the radial wheel (feathering wheel courtesy of Bob Whittier 1987:36 and the Mariners Museum and Park Archives; reference # MS0573/02-54).

TABLE 8. Dimensions for arms, rods, shaft, and flanges.

Feature	Length	Width	Thickness	Diameter	Other(type)
Arms and rods		3-1/2"	1/2"	1" (for rods)	
Shaft	6'6"			14-1/2"	
Flange (inboard)		8-1/2"		32"	2'9" (center-to-center spacing)
Flange (middle)				28-1/2"	
Flange (outboard)				22"	

Boiler

The remains of CFR0001's boiler (Figure 128) lay several feet northward of the engine bed at an angle, its northern end pointing slightly towards the shoreline and its southern end pointing slightly to the river. Furthermore, the boiler is significantly canted eastward as it slopes down the riverbank. The bottom several feet of the boiler remain with the outer casing, or water tank, of

the boiler encompassing the entirety of the inner components. Supporting and connecting the tank to the smoke box in the rear of the boiler and around the furnaces are a series of bolts of 1-5/8 in. in diameter. These bolts also would have provided support for the boiler as it strained from the pressure of the compressed steam while suspending the heated surfaces in the water which surrounded it. The boiler has two fireboxes sitting at the front, or southern end, with eight exposed bolts fixed between them in a space of 5-1/4 in.

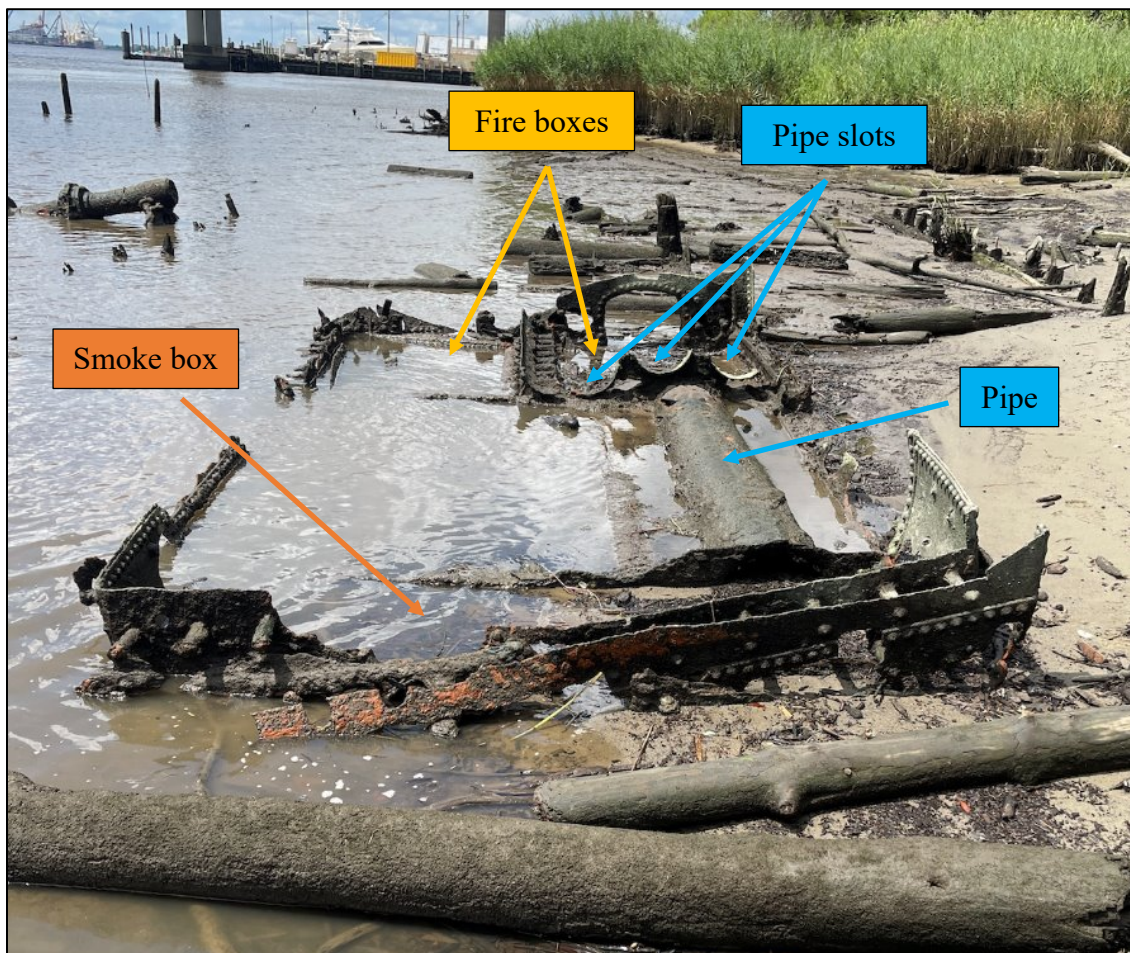


FIGURE 128. Remains of the horizontal firetube boiler on the CFR0001 site (image taken by Dr. Nathan Richards 30 June 2024).

Directly behind the westernmost fire box is a large iron pipe that leads to the smoke box 8 ft. and 8 in. behind it. It was not determined if another pipe remains next to it due to sedimentation, however, three half circle slots located in the back of the fire box above the

exposed pipe indicate the existence of three more pipes (Figure 128) of a smaller diameter ran back to smoke box as well. Such a configuration can be seen in the diagram of the horizontal firetube boiler below (Figure 129). Note that the configuration of the two fireboxes and the smoke box is nearly identical the boiler remains at CFR0001 and that there originally would have been several hundreds of tubes no greater than 3 in. in diameter running over the furnaces into the stack. This arrangement is noted in several historical treatises that describe low pressure firetube boilers (Murray 1852:35; Sennet and Oram 1899:60-62). Dimensions for the boiler and its components can be seen in Table 9.

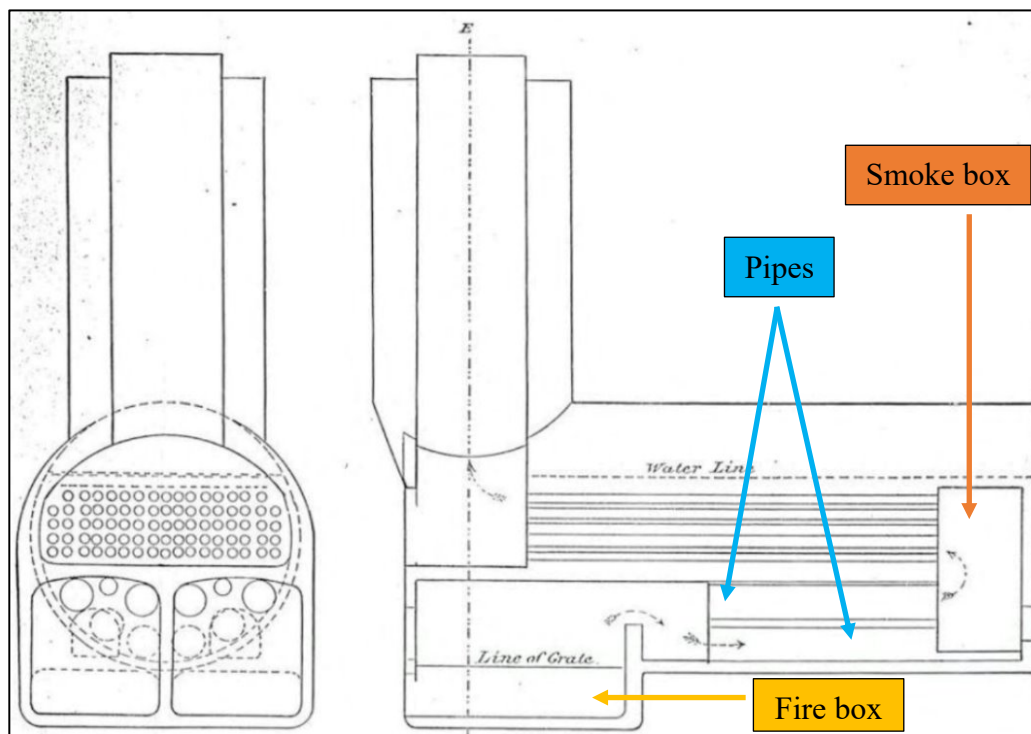


FIGURE 129. Diagram of a horizontal firetube boiler. (Courtesy of Bisbee 2012:197)

TABLE 9. Dimensions of the boiler remains on the CFR0001 site.

Feature	Length	Width	Thickness	Diameter
Overall dimensions	18'1-5/8"	9'8"	1/2" (water tank)	
Western Furnace	5'3-1/8"	4'5-1/4"	1/2"	
Eastern Furnace	5'3-1/8"	4'5-1/4"	1/2"	
Water tank bolts	4-1/2"			1-5/8"
Pipe				1'3-3/8"
Pipe slots on furnace				11-3/8"
Smoke box	2'7"	8'2-1/8"		

Bitt and Stanchion

Near the northern extremity of the vessel's remains lays what is likely a large bitt of 14-1/2 x 13 in. protruding several inches out of the mud. Just breaking the surface of the mud, several feet northeast of the bitt, protrudes the remains of what may be a 6-1/4 in. square stanchion (Figure 130). Bitts were strong posts of wood or iron used for belaying, fastening, and generally working line aboard a vessel (de Kerchove 1948:62) and are also used to support capstans or windlasses with the largest bitts getting up to 15 in. square (Crothers 2013:246). Given its location near the northern end of the hull and its size, this bitt may have been used to support a capstan or other type of winching device. Indeed, Figure 131 indicates the number of bitts concentrated at the bow of some mid-19th century vessels. Regarding the possible stanchion, its position indicates it may have been one of the winged stanchions following the centerline convergence of the eastern side bilge strake given this was typically where such stanchions were keyed into (Crothers 2013:194). Furthermore, its dimensions line up with the 6 in. square stanchions stated for the similarly sized United States Navy store ship *Relief* built by John Lenthall in 1835 (Kinnaman 2022:383).



FIGURE 130. Bitt (right) and possible stanchion (left) near the northern extremity of CFR0001. (Image taken by author 30 June 2024)

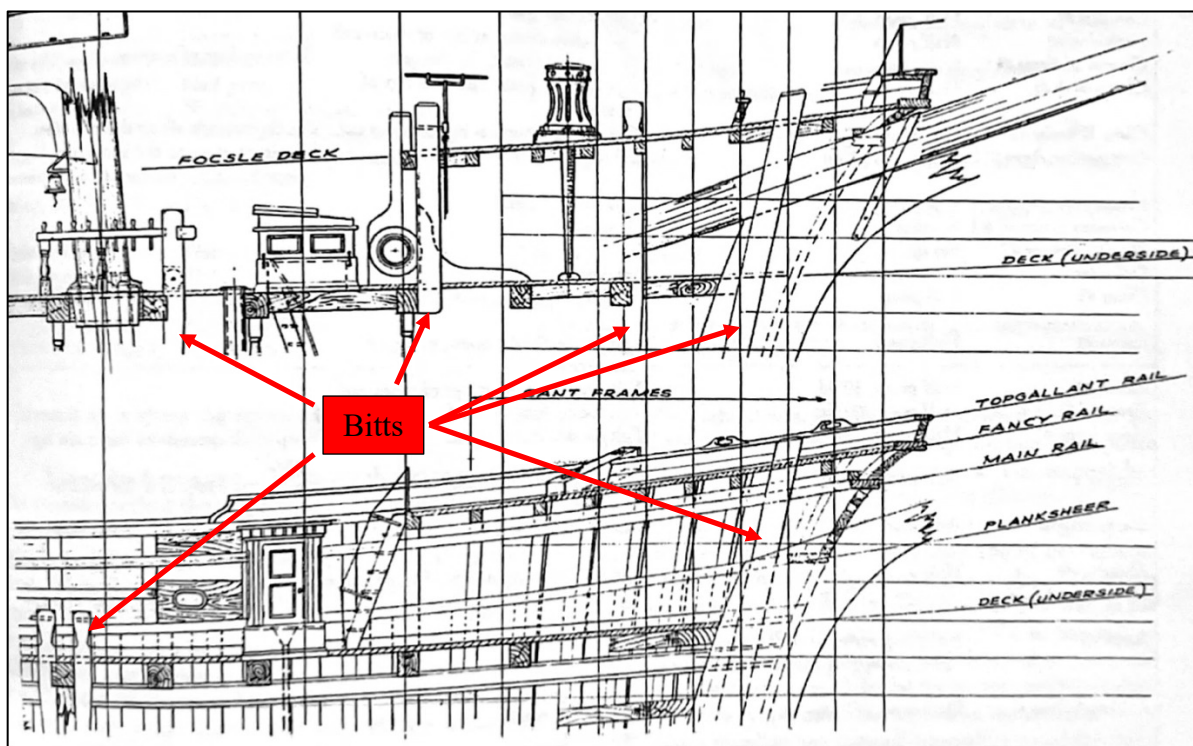


FIGURE 131. Profile of topgallant forecastle of a 19th century pack ship. Note the bitts by the fore mast, windlass, capstan, and bowsprit (courtesy of William L. Crothers 2013:299).

Northern Extremity

Little remains of the hull past the bitt described above other than what may be the remnants of the eastern side's outer hull and ceiling planking alongside a bitt laying on its side (Figure 132). The thickness of the planking matches that of the outer hull and ceiling planking mentioned above at 3 in. Furthermore, it appears to be coming towards the centerline of the vessel which makes sense given they lay only 9 ft. aft of the historically reported 133 ft. LBP length (MVUS 1885:378). Regarding the potential bitt, this timber appears to have been cut square, differentiating it from the myriad logs that have intruded into the site since it was laid up. Furthermore, the side that protruded through the mud was measured to be 16-1/2 in., which, while larger than the bitt discussed above and the range provided by Crothers (2013:246), is still within a reasonable range for such a timber.

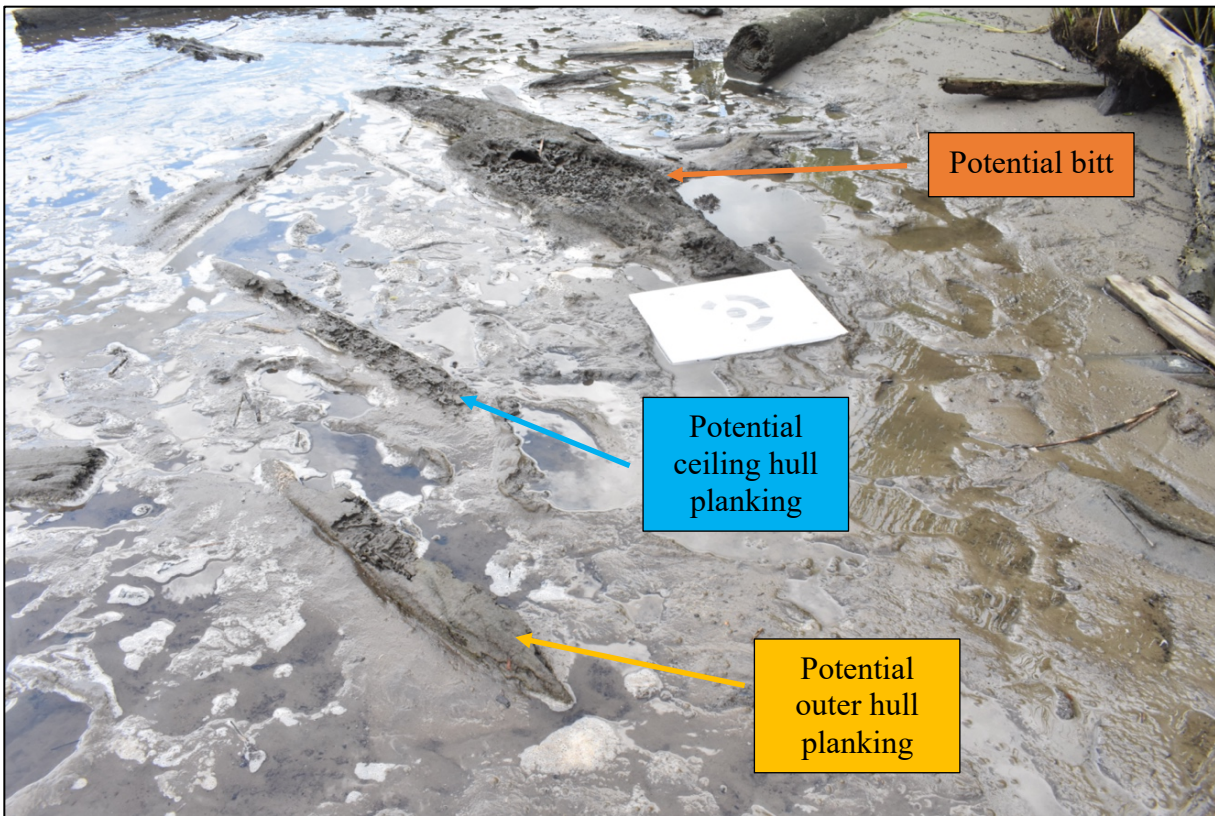


FIGURE 132. Potential outer hull and ceiling planking (left) and bitt (right) representing the northern extremity of the CFR0001 site (image taken by author 30 June 2024).

Conclusion

This chapter described the process and results of the 3D reconstruction of *Waccamaw* through the course of its various reuse-cycles as a culmination of the historical and archaeological methods described in the methodology chapter. This exercise illustrated how the vessel changed materially in response to the broader environmental, economic, societal, and technological processes occurring during its historical context. Furthermore, the results of the field investigation conducted on 27 October 2023 and 30 June 2024 were also described with comparison to past archaeological investigations when appropriate. This indicated that the site has deteriorated significantly since these investigations, with the reported length of the site being 6 ft. shorter with planking and framing particularly from by the breasthook at the southern end no longer remaining. The following chapter uses these results to test the behavioral archaeology

theories regarding technological change and site formation described in the theory chapter to see if generalizable patterns can be derived from the vessels use-cycles and transition from the systemic to the archaeological context (Figure 133).

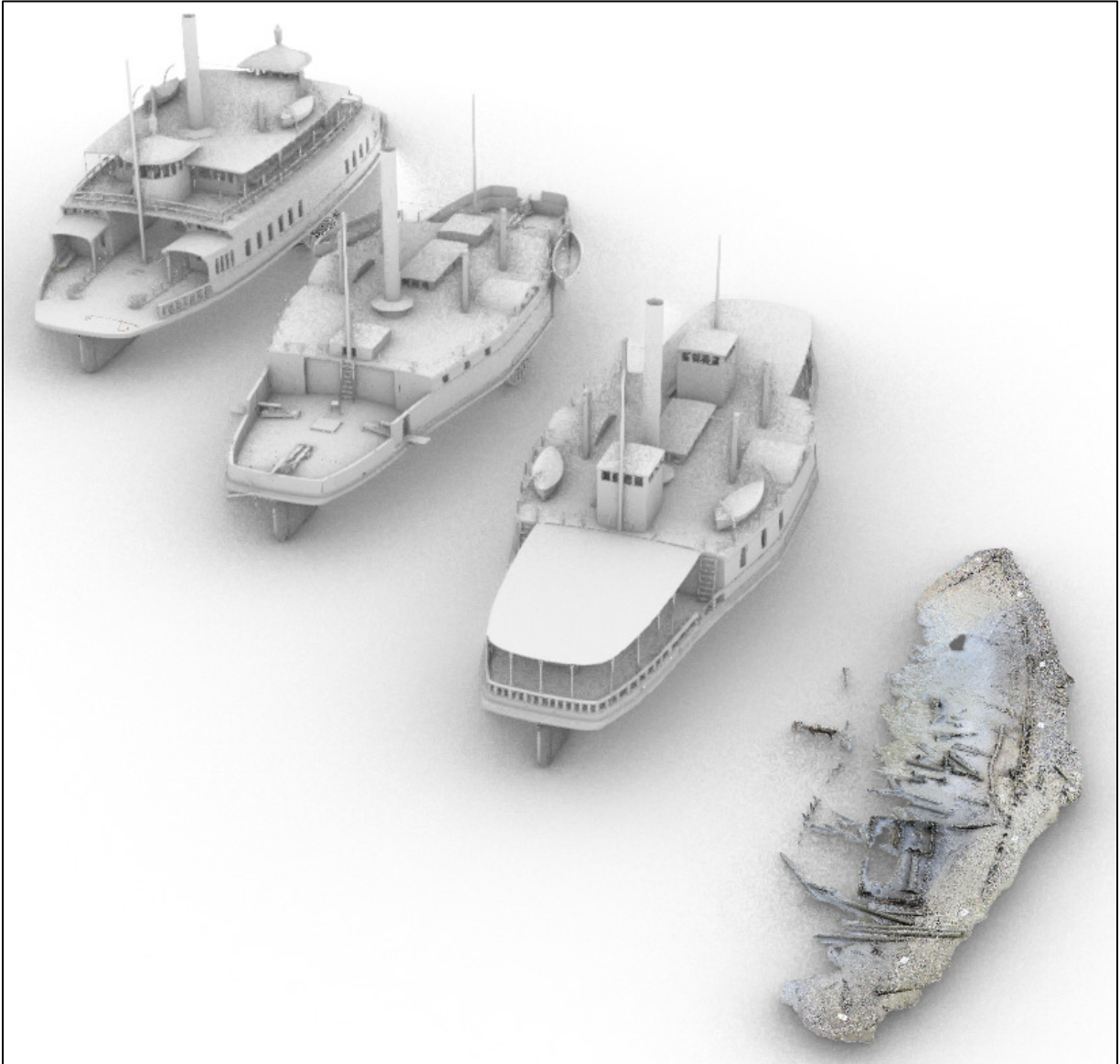


FIGURE 133. From left to right, *Nuestra Señora de Regla*, *Commodore Hull*, *Waccamaw*, and CFR0001 (image and model created by author).

CHAPTER 7: ANALYSIS

This study has thus far explained the theoretical background that informs interpretation and chronicled the broader historical context surrounding *Waccamaw*. Furthermore, the methods used in studying and recording the vessels remains, the results of this recording, and its material change via a historically and archaeologically informed 3D reconstruction were explained. This chapter endeavors to synthesize those topics to form a reasonable picture of the behaviors associated with the vessel's use, reuse, and discard by way of the primary and secondary questions.

The organization of this chapter is structured to reflect how the three broader processes of the secondary questions come together to form the answer to the primary question. Therefore, the chapter is broken into three sections beginning with an overview of the techno-social processes, followed by the techno-economic, and concluding with the environmental processes that affected *Waccamaw*. The order of these processes reflects the evidenced strength of their influence on the original construction, material change, and subsequent discard and abandonment of the vessel from strongest to weakest. It is also acknowledged that the material changes and reuse cycles noted are not the exclusive effect of one process or the other, indeed, most material changes discussed have multiple processual causes. However, an attempt was made to place a given design feature or material change within the section dealing with its most influential proximate cause.

The first two sections are broken down into two segments: the effects of the stated processes above the hull and those below. This segmentation reflects how the main deck and hull are treated as separate entities in use and reuse processes. The final section, environmental

processes, is again broken into two segments which deal with the environmental effects on the systemic and archaeological contexts of the vessel. This is because environmental forces are considered on two levels: their influence on construction decisions throughout the vessel's various use cycles (systemic context) and their influence on the CFR0001 site (archaeological context). Finally, all three sections reference the broader contextual history, the vessel's specific history, the archaeological evidence, and the relevant behavioral archaeological theory to explain each process's effect on *Waccamaw*.

Regarding theory, this analysis relies heavily on terminology developed by Michael Schiffer and Nathan Richards in the explanation of use, reuse, disposal and abandonment (Schiffer 1987, 2010, 2011; Richards 2008). The benefit of this is that it ties the history of *Waccamaw* to recognized patterns in archaeological study and simultaneously tests their validity. It should be noted, therefore, which terms will be regularly used in analyzing the processes that effected the vessel. They are as follows: systemic and archaeological context (Schiffer 1987:3-4; 2010:22), primary and secondary mercantile functions (Richards 2008:120), lateral and secondary cycling (Schiffer 1987:29; 2010:32-33), techno and socio functions (Schiffer 1987:14; 2011:23), primary, secondary, and tertiary salvage (Richards 2008:155-162), and primary and secondary refuse (Schiffer 1987:62; 1972:161). If these meanings require explanation, please refer to Chapter 2 or the publications themselves for clarification.

Techno-economic Processes

The following section describes the techno-economic processes which contributed to the formation of *Waccamaw* in the systemic and archaeological contexts. For this study, the techno-economic processes are defined as the proximate commercial industries, associated companies/individuals, and broader economic trends that materially affected or changed

Waccamaw through its use and reuse cycles. Yet, techno-economic processes did not just impact the private companies that interacted with the vessel, they also affected the federal government. Therefore, considering the use and reuses of *Waccamaw* in relation to both regional and national economic statistics illuminates how the economy materially affected the vessel.

Above the Hull

Across the three stages of this vessel's use cycles, it is the use of resource saving techniques and value maximization that defines the monetary considerations which influenced *Regla*'s original construction, subsequent military conversion, and post war reuses. The resources in question could be money, time, material, or the technological knowledge required to operate a piece of machinery. Value maximization refers to the level cost-benefit analysis involved in, for instance, the arrangement of space of the vessel, the technology selected in the vessel, or the way salvage occurred on the vessel's remains. Materially, this manifested in easily operated, repairable, and cost-effective techno-functional components. The material consequences of the monetary considerations made the vessel more accessible and reuseable. This is why, given the right social and economic circumstances, *Regla* became *Commodore Hull* and *Commodore Hull* became *Waccamaw*.

To begin, larger economic forces led the United States Navy to be frugal when converting ferries. The Navy, while understanding the necessity of building a large and diverse fleet to successfully blockade the South, had a limited budget. Indeed, a maximum of 15.1% of the total defense budget was spent on the Navy for the duration of the war (National Park Service 2011:2; Wild 2016). This, coupled with the challenges the United States Navy had in finding honest sellers and quality contractors meant that measures would be taken to save money in the conversion processes. This was accomplished mainly through the reuse of the original structure,

the preference of which is referenced explicitly in the Copeland and Howe conversion proposal for the New York ferryboat *Westfield*. They state, “As with the other boat [possibly *Ethan Allen* or *Commodore Perry*], the old materials to belong to us & to be used in the alterations as far as practicable” (Copeland and Howe 1861). This indicates that the reuse of original construction features in the conversion process was common and was likely expressly requested by the Navy given that the same letter states that their proposal follows the recommendations of the Board of Officers which inspected *Westfield* (Copeland and Howe 1861). Some modifications also stated within the proposal indicate the sometimes-makeshift nature of the conversion process. Examples of this are the proposed steering modifications for the auxiliary tiller and the shaving down of the rudder to make way for the strut planking (Parkoff 2016:48), as described in the previous chapter (Copeland and Howe 1861). Past archaeological investigations of *Westfield* (Parkoff 2016) and *Southfield* (Spirek 1993) provide additional evidence for how this frugal behavior took shape in practice.

On the *Westfield* remains, window weights (Parkoff 2016:92) were found from the original construction, providing material evidence that the gunboat cabin bulkheads were reshaped from the original instead of new ones being built from the deck up. Similarly, on *Southfield*, Spirek (1993:139) noted the bulwarks for the guns incorporated the original stanchions at the ends of the vehicle gangway. Additionally, the remains of the waterways from the original machinery enclosure, the remnants of the outer passenger railing, and the rudder complete with lock-pin assembly were recorded on the site (Spirek 1993:123-127,130-133). *Waccamaw*’s remains and historical evidence (e.g., Browning 1993:130,155) indicate another original feature likely to have been found “practicable” in the vessel’s reuse as a gunboat was the triple framing extending 37.5 ft. back from the vessel’s southern end. This may have aided in

supporting the weight and recoil of the cannon, a design feature common in purpose built military vessels. For example, the HMS *Terror*, a Royal Navy bomb vessel launched in 1813, was constructed with thick frames to accommodate the heavy recoil of its mortars mounted mid-deck. Interestingly enough, it is this construction feature that has been cited as a key reason for its secondary use as a polar exploration vessel, with its thick frames able to withstand the task of breaking sea-ice (Gibbins 2024:222).

Returning to *Waccamaw*, there are several reasons to believe that triple framing was an original feature. Firstly, there is direct reference to “the hull at each end consist[ing] of solid timber for 30 ft. towards amidships” (Spirek 1993:46) as being an original installation on *Southfield* to combat ice. Furthermore, there is a lack of reference to modification of the frames in any of the conversion proposals found by the author. Finally, and most importantly, the amount of time and money it would have taken to install additional frames would have been considerable, and with the Navy not interested in spending any more time or money than necessary on these conversions, it is unlikely they would have contracted such features.

The resource saving techniques employed in the conversion process as described above indicate that such vessels were not a priority of the Union Navy. This is further indicated when examining what the Union Navy was spending its money on during the Civil War. Figure 134 depicts the relationship between the United States Navy’s annual budget and how much money was spent to purchase New York double-ender ferries (top) versus building ironclads (bottom) before and after the Battle of Hampton Roads (the famed duel between the ironclads USS *Monitor* and CSS *Virginia*). As can be seen, most of the money spent on purchasing ferries was prior to the battle, as the Navy’s wartime budget was beginning to increase. Indeed, in this six-month period \$691,629 out of the \$1,075,447 total was used to purchase ferries, representing 14

out of the 20 ferries bought. Conversely, only \$527,284 out of the \$7,504,000 total was used to construct ironclads between September 1861 and August 1862 (prior to the Battle). This cost is associated with the launch dates of only two of the total 15 ironclads.

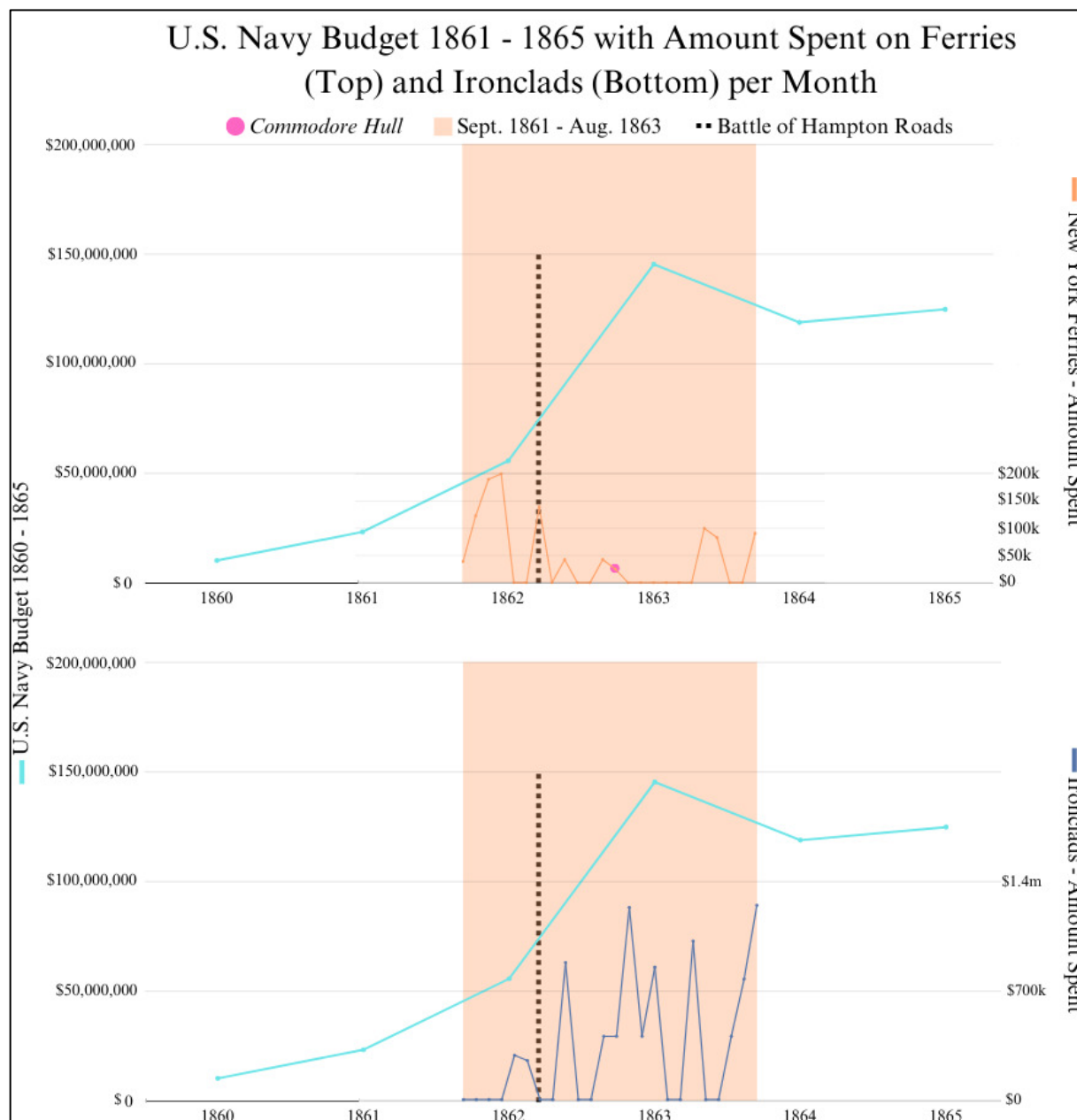


FIGURE 134. United States Navy's wartime budget related to amount of money spent on purchasing ferries (top) versus ironclads (bottom) before and after the battle of Hampton Roads (graphs created by author, United States Navy's war time budget data is courtesy of Naval History and Heritage Command 2016, ferry data courtesy of United States Department of the Navy 1921:59-243 and ironclad data and courtesy of United States Department of the Navy 1921:29-238 and Paul Silverstone 2006:4-12).

This data reflects the profound effect that the clash of the two ironclads over 8-9 March 1862 had on the monetary priorities of the Union Navy. The battle proved that specialized, purpose-built ironclad gunboats were the naval future for both sides, and the Union Navy's budget skyrocketed to construct a more proper defense against the now greatly feared Confederate ironclads. Therefore, money would not be used for converting civilian craft, but for building ironclads. This re-enforces the notion that converted ferries were seen as stopgaps, only necessary because, at the outset of the war, the Union Navy was underprepared and underfunded. Finally, *Regla* was bought on the downward trend of ferry purchases and therefore may have had resource saving techniques applied more vigorously when converted. Indeed, by saving money on such conversions, the Navy could focus its funds on the true purpose-built ironclad gunboats.

After the War, the United States Navy went into a large demobilization effort and by 1869, most of the vessels purchased were sold off (Silverstone 2006:x). *Commodore Hull* was one the first, being sold in at public auction on 27 September 1865 (United States Department of the Navy 1921:63). It ended up in Wilmington, North Carolina to go through two more secondary reuse cycles and a series of lateral use cycles (Schiffer 1987:29). In this stage of the vessel's life, it can be seen how the various owners attempted to extract the maximum value possible out of *Waccamaw* by using it in an increasingly varied manner as time went on.

Welcoming the newly renamed *Waccamaw* into its post-war life in the Cape Fear River was the struggling Wilmington & Manchester Railroad Company (W&M R.R.), which bought the vessel apparently on credit (*Daily Journal* 1869:3). While they originally purchased *Waccamaw* as a link between Wilmington and its rail line terminating across the Cape Fear River on Eagles Island (Jackson III 2008:260; Minford 2012:74), it also used the vessel for excursions down river to Smithville, modern-day Southport (*Daily Journal* 1867:3, 1868:3). Figure 135

indicates that Wilmington's economy and population rebounded after the Civil War. Nevertheless, W&M R.R. put *Waccamaw* up for auction in 1869 with it finally being sold in 1871 after the company went into foreclosure the year before (Minford 2012:75). This indicates that the broader economic recovery of Wilmington in the first five years after the war did not affect when the vessel transitioned into its next reuse cycle. Rather, it was the damage the Civil War had done to southern railroads and the inability of some rail lines to recover (Minford 2012:75) that is more directly connected with *Waccamaw*'s transition into its next use cycle. Indeed, somewhat ironically, it was the very operations that *Commodore Hull* and similar vessels participated in (as discussed in Chapter 3) that aided the downfall of the vessel's first post-war owner.

Waccamaw was subsequently bought by the Wilmington and Smithville Steamboat Co. (W&S) in 1871. W&S used *Waccamaw* mostly as an excursion cruiser continuing its regular trips to Smithville and adding new trips to the ruins of Fort Anderson and Fort Fisher, and to the beaches of Battery Buchanan (*Brunswick Beacon* 03/07/1991), perhaps taking advantage of the increase in Wilmington's population (Figure 135). It is also with W&S that the vessel begins new roles as a towing and salvage vessel which included regular trips to the mouth of the river. Modifications were made to improve passenger spaces (e.g., the state rooms), and towing and salvage capacities (reducing the circumference of the superstructure and the possible addition of a towing bit) (*Wilmington Morning Star* 1872a:1). Using Schiffer's understanding of reuse cycles, this stage of *Waccamaw*'s life could be considered a lateral cycle (Schiffer 1987:29), as it was still used as an excursion vessel only now with a different owner. Yet, it also fits Schiffer's criteria for secondary use: an object taking "on a new role without needing extensive modification" (Schiffer 1987:30). Using Richards' terminology (Richards 2008:129), this

transition could be seen primarily as a secondary reuse cycle where the vessel goes from having one secondary mercantile function to having two. While this provides some clarity as to how *Waccamaw* fits into Schiffer's notions of reuse, it points to a larger issue of applying concepts meant to describe the reuse of individual artifacts in the description of a vessel which is much more dynamic in its reuse cycles.

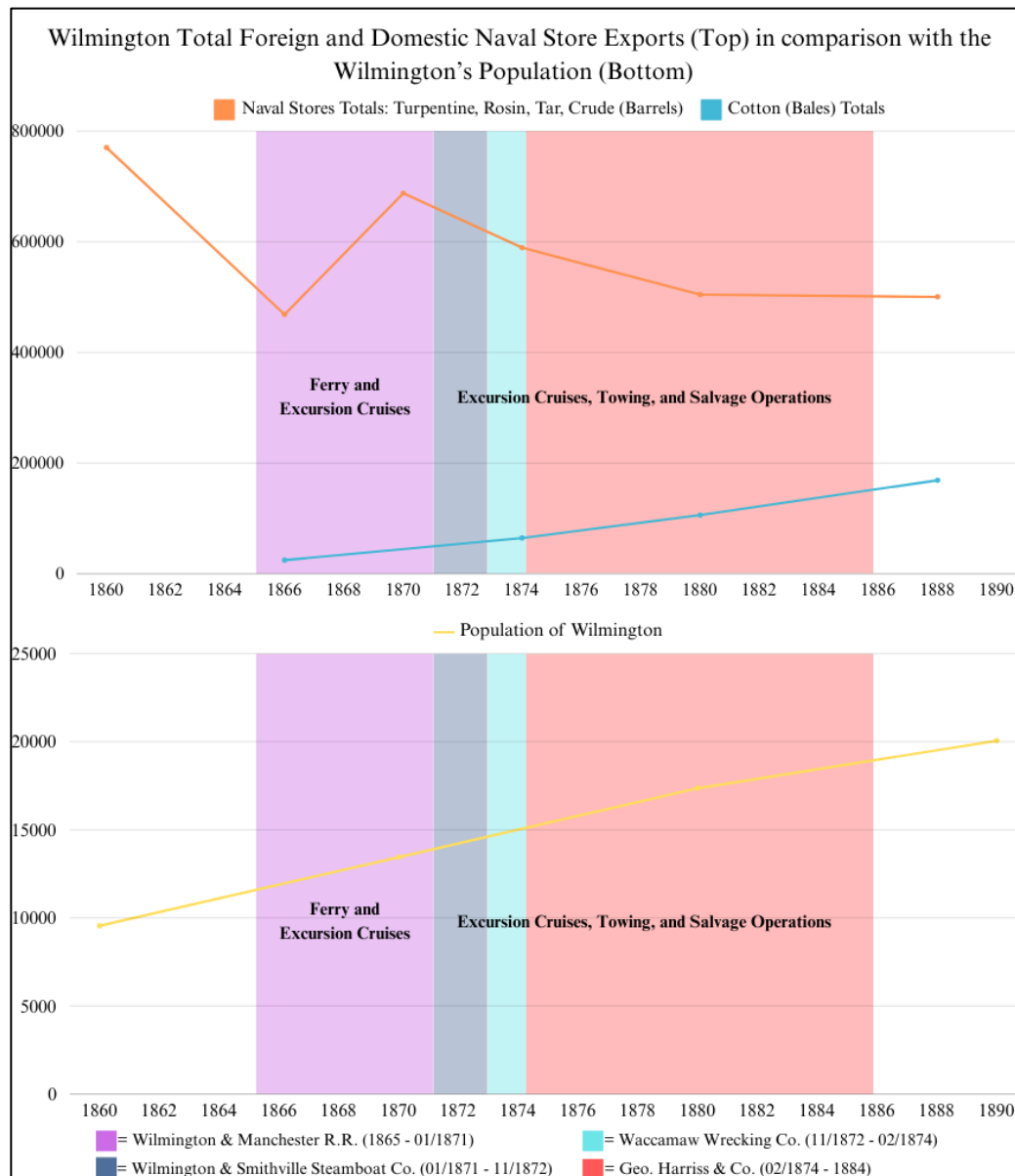


FIGURE 135. Total foreign and domestic naval store exports (top) and population (bottom) of Wilmington, North Carolina (graph courtesy of author, export data courtesy of Alan D. Watson 1992:108, population data courtesy of James Sprunt 1883:50 and United States Bureau of Census 1914:569).

Continuing, the vessel then moved into what can be considered its first true lateral cycle, as it would continue to work in same three industries (e.g., excursion cruises, towing, and salvaging) when it was sold to local businessman and entrepreneur F.W. Kerchner on 2 November 1872 (*Wilmington Morning Star* 1872b:1; Jackson III 2008:260). Kerchner was likely associated with the “Waccamaw Wrecking Company” (WWC) which utilized *Waccamaw* more consistently for towing and salvage while also maintaining its excursion routes. Referring again to Figure 135, Kerchner may have been trying to capitalize on the fact that Wilmington’s population was on the rise and money was still moving through the port at an increased rate in relation to cotton exports. This business venture appears to have proved unsustainable, perhaps due to an economic downturn, as indicated by naval store exports (Figure 135). Kerchner soon sold *Waccamaw* to George Harriss for its second lateral cycle and its final cycle of reuse within the systemic context, that is, when the vessel is considered as one artifact (Schiffer 1987:3,29). Harriss ran a “general commission and ship brokerage” business which contracted out the vessels he owned for excursion cruises and towing and salvage operations which ran from Wilmington to the sea (Reilly 1884:125). As can be seen in Figure 135, Harriss owned *Waccamaw* for at least a decade and was its last owner before the vessel entered the archaeological context.

Below the Deck

Moving back the clock, an understanding of the resource saving tactics and value maximization which effected the material change of the vessel below deck must begin with its basic dimensions when originally built as *Regla*. Figure 136 displays the average dimensions (length, breadth, draft, and tonnage) of New York operated double-ended ferries from 1840 to 1865 with *Regla*’s dimensions superimposed in purple on the 1860-65 bar. Referring to Figure 137 and Figure 138 in comparison with Figure 136, a correlation between New York’s rising imports,

exports, and population and the average dimensions of New York operated ferries can be seen. It is interesting to note that *Regla*'s dimensions lag the other boats significantly in each category despite New York's relative prosperity in 1861.

The reason for this almost certainly lies in the fact the *Regla* was contracted by a Spanish railroad company to operate in Havana, Cuba (United States Supreme Court 1882:92) and was therefore built for the economic conditions of Havana. *Regla*'s length is most comparable to New York City's average in the 1845 to 1855 range with its breadth, draft, and tonnage more closely resembling those New York averages from 1840 to 1850 (Figure 136). Looking at Figure 137, Havana's 1861 population sits right between New York City's 1840 and 1850 population at 39,378. Therefore, *Regla* was likely built to dimensions that would best suit it for the economic context of Havana in the early 1860s. Particular consideration of gross tons makes this connection clearer as this measurement was considered the best single-number expression of a merchant vessel's overall size, often being used as a surrogate for a vessel's carrying capacity (Cudahy 1990:186). Given that people were the "cargo" these ferries were built to carry, it is unsurprising that a fluctuation in ferry tonnage reflects a fluctuation in population and, more so, that *Regla*'s dimensions reflect the state of late 1840s New York City's economy, as this was equivalent to Havana's economy in 1861.

Behaviorally, this reflects value maximization on the part of the owners of *Regla*. Regardless of the vessel being built in New York City and in the style New York City ferries of the 1860s, they clearly understood the vessel needed to match their region's needs. Why spend more money to build, operate, and maintain a larger vessel that, while fitting more passengers, would not be able to maximize its space profitably? *Regla*'s original construction can therefore

be seen, economically at least, as the result of two separate systemic contexts (Schiffer 1987:3):
New York City in its design and Havana in its size.

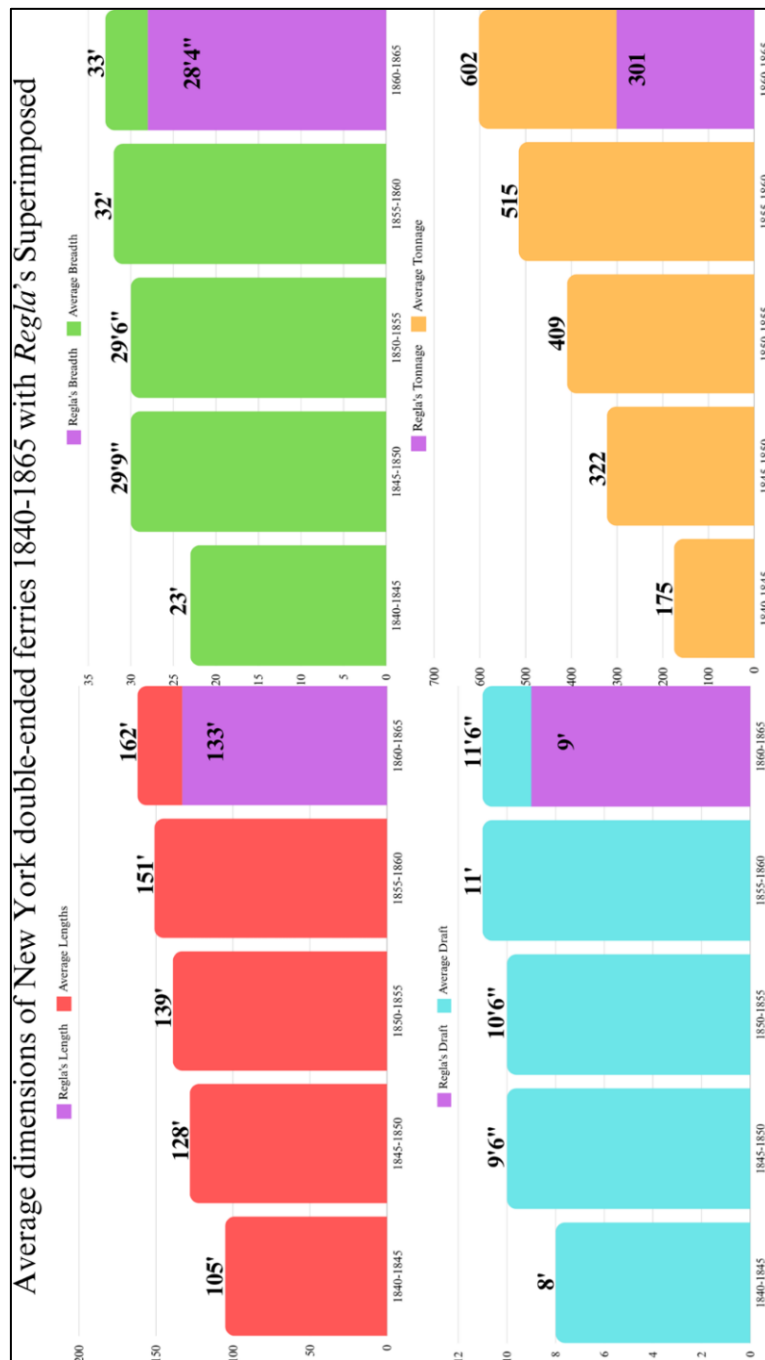


FIGURE 136. Average dimensions of New York double-ended ferries 1840-1865 with *Regla's* superimposed (purple). Length dimension for the averages represents waterline length, comparable to LBP which is provided for *Regla*. Gross tonnage listed for all (New York ferry dimension averages courtesy of Brain J. Cudahy 1990:368-463; *Regla's* dimensions courtesy of Merchant Vessels of United States 1885:378 and United States Department of the Navy 1921:63).

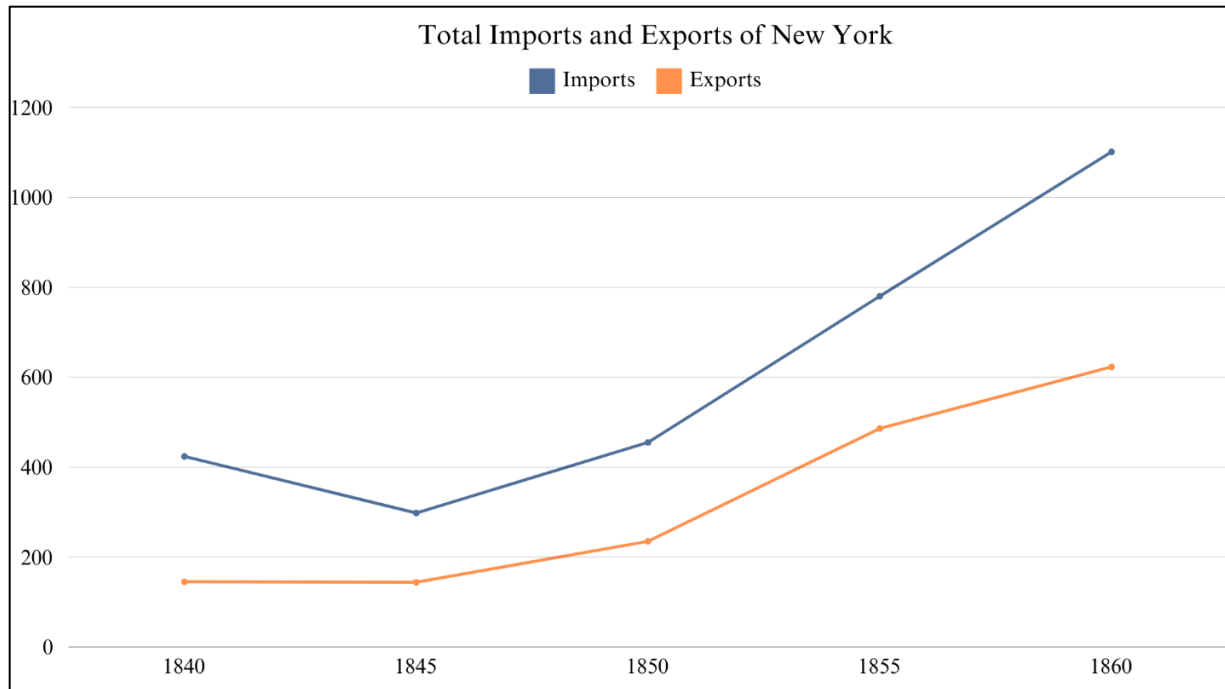


FIGURE 137. Total imports and exports of New York from 1840 to 1860 (graph created by author, data courtesy of Robert G. Albion 1939:390-391).

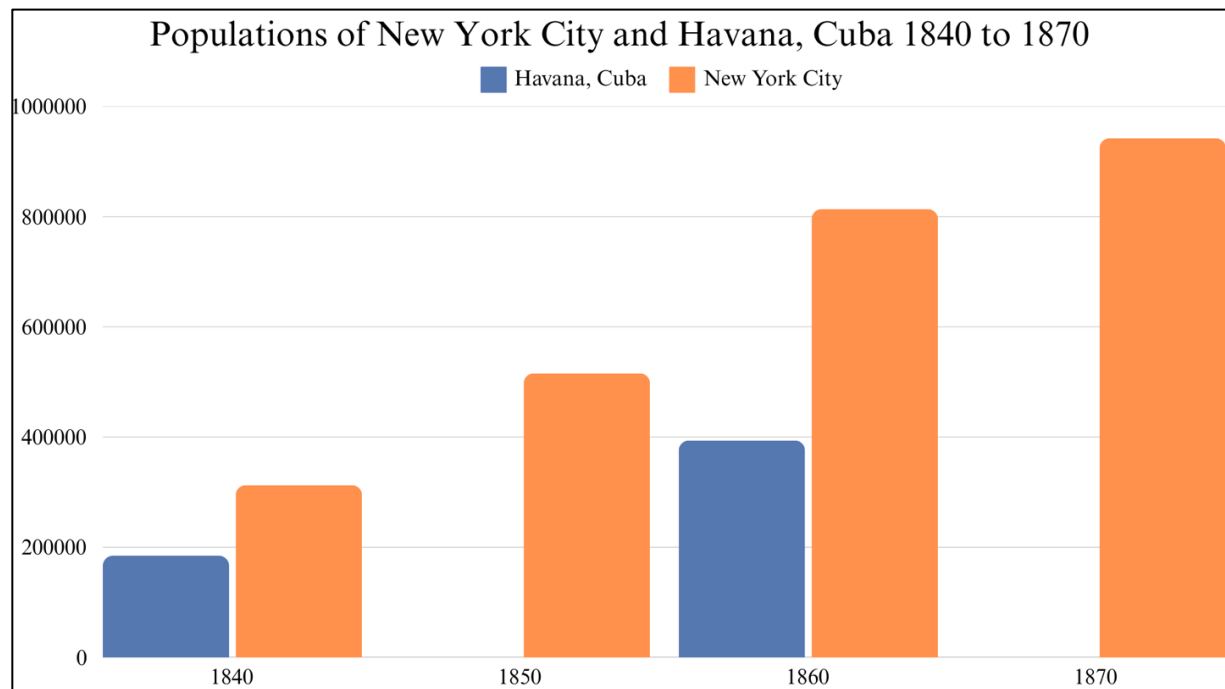


FIGURE 138. Populations of New York City, New York and Havana, Cuba from 1840 to 1870 (chart created by author, New York City population data from Courtesy of NYC Department of City Planning; Havana, Cuba 1841 population data courtesy of the Encyclopedia Britannica 1910:77, 1861 population data courtesy of United States Bureau of Census 1909:231).

For its time, the New York built ferry boat was a very efficient and economical tool for transportation. Coming from a tradition of practical shipbuilding and operation (Russell 1861:109; Theisen 2006:4-6), New York-based shipbuilders and iron works installed technofunctional features for ease of maintenance and cost effectiveness. The features common to New York ferries generally, and *Regla* in particular, included the radial paddle wheel, the gun tackle steering apparatus, and the rudder system. The radial paddle wheel was not the pinnacle paddle wheel technology of the 1860s and had the added disadvantage of taking up passenger space (Stevens 1893:193). Yet for what it lacked in efficiency and size, it made up for in ease of maintenance, operation, and cost effectiveness. Indeed, the more advanced feathering wheel required much more maintenance and upkeep. Furthermore, the cost to maintain the numerous parts and bearings on a feathering wheel was expensive, and if one portion of the mechanism broke, the whole wheel was liable to become inoperable (Murray 1852:109; Sennett and Oram 1899:312; Whittier 1987:36). On the other hand, the radial wheel simply had its buckets bolted to the arms that, when damaged, could be easily replaced by any member of the crew (Watson 1985:71), no specialized knowledge required.

Similarly, the gun-tackle steering arrangement, while an older technology with significant downsides, was easy to operate and maintain. By the 1860s, gun-tackle purchase steering mechanisms were being phased out in favor of mechanized and steam powered steerers in the United States (Bennett 1983:40), addressing the heavy steering caused by the weight and friction of the steering chain/cable in unpowered steering systems (Whittier 1987:40). Yet as evidenced by Russel (1861:119), gun tackle arrangements were common among New York ferries, most likely because of its simplicity of design and lack of specialized machinery (e.g., steering engine). Indeed, while gun-tackle arrangements required more effort to turn the rudder at the

helm, making them a particular challenge when approaching a pier or negotiating a twisting channel (Whittier 1987:40), no engineer was needed to maintain a steering engine, thereby saving both maintenance and personnel costs. Unlike the gun-tackle steering arrangement, the “lock-pin” rudder was a relatively new design (McKay 1839:75) when compared to the standard plug-stock rudder. It was simple in both construction and operation as described in Chapter 5. Therefore, it had the same benefits of economy and simplicity, which influenced the selection of the radial wheel and gun-tackle steering arrangement.

Most New York ferries of the 1860s utilized the walking beam steam engine because of its ease of maintenance and cost effectiveness. As Russel (1861:114) aptly states regarding the walking beam, “I have satisfied myself that it is cheaper in construction, lighter in weight, and more economical in management, less costly in repair, more durable, and better suited for high speed, than any of our own [British] engines would be.” This quote shows that ease of maintenance and cost effectiveness were contemporarily seen as major attributes to the walking beam engine. It is interesting to note that *Regla* did not have a walking beam engine, despite the benefits discussed above. This may be because it was designed for a foreign environment, as discussed in the environmental processes section below. Ultimately, the radial wheel, the steering arrangement, the rudder, and the engine all support the notion that value maximization and resource saving tactics were important proximate economic influences in the selection of techno-functional components installed on New York ferries.

Moving to *Waccamaw*’s post depositional history, portions of the vessel’s remains were brought out of the archaeological context and back into the systemic context. This is a common occurrence for artifacts generally (Schiffer 1987:4), and in the maritime world it often manifests as various forms salvage (Richards 2008:155), as is the case with *Waccamaw*. Figure 139

displays the features of the vessel that have the strongest evidence of salvage as described in the site description portion of the results chapter. This includes the boiler, and the iron portions of the paddle wheels, and engine. This apparent preference towards iron components, viewed alongside the broader pig and scrap iron market from 1880 to 1975 (Figure 140) exposes trends and suggests when salvage may have occurred. Furthermore, it gives evidence to the notion that “economic conditions and the prices of scrap material drive where and when salvagers carry out scrapping activities” (Richards 2008:149).

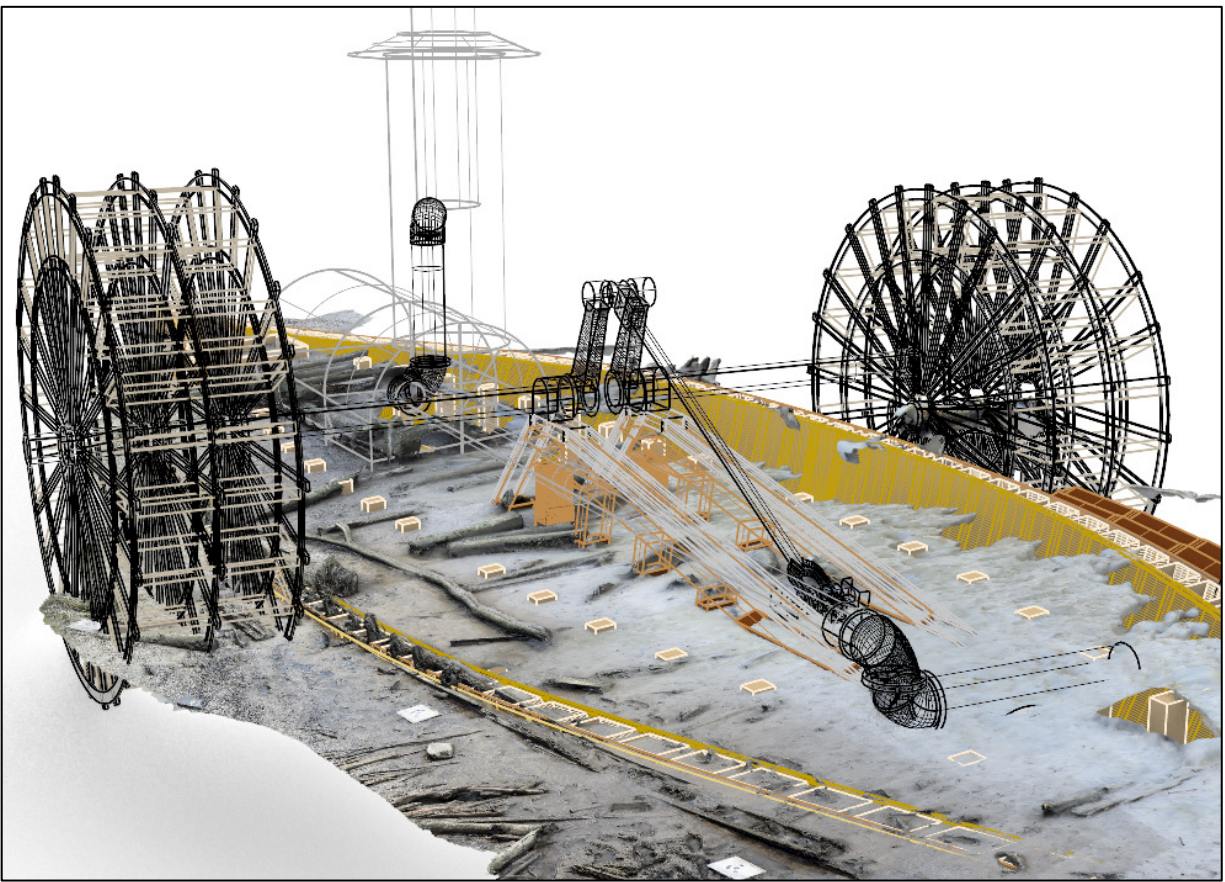


FIGURE 139. Overlay of photogrammetric model on top of projected remains of *Waccamaw*. Salvaged items are displayed in “Wireframe” view within Rhino® (image and Model created by author).

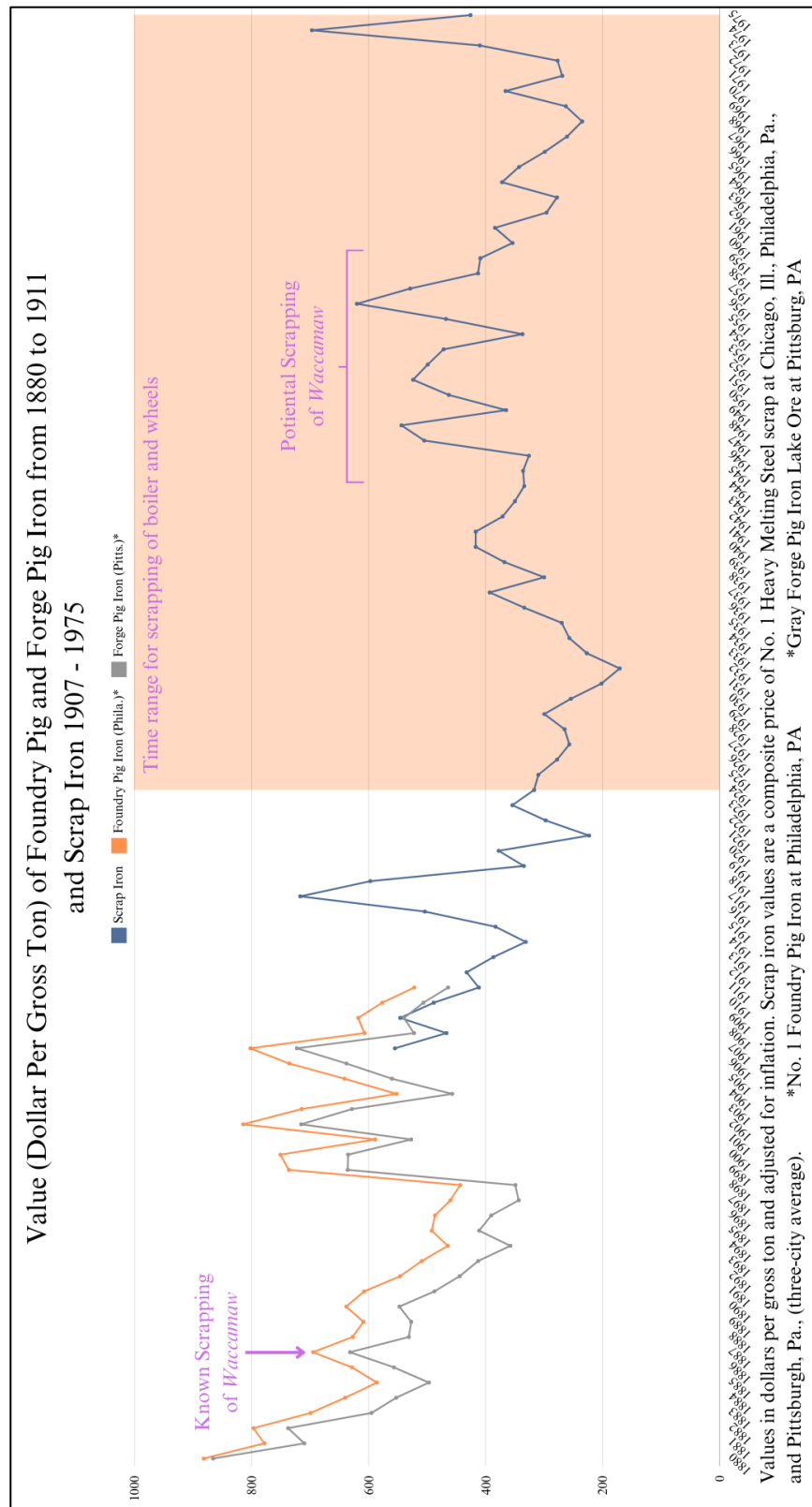


FIGURE 140. Value of Foundry Pig and Forge Pig Iron from 1880 to 1911 and Scrap Iron from 1907 to 1975 (scrap iron data courtesy USGS National Minerals Information Center Staff 2013:75, foundry and forge pig iron data courtesy of Peter Temin 1964:284-285).

First, the only confirmed date of salvage occurring on the vessel was in April of 1887, less than a year after *Waccamaw* had been burned down to the waterline. A local newspaper reported that a man was charged with stealing “iron work” from the vessel (*Wilmington Star* 1887; Seeb 2007:188). Yet, within the UAB site file it is noted that the boiler and the spokes of the paddle wheel were still present in a 1924 photograph of the site, suggesting that the charged man did not significantly scavenge iron from the vessel. Indeed, if it was a solo operation, it is likely that only objects which could be removed easily and without the use of expensive machinery were taken. Therefore, portions of the engine’s cylinder or piston may have been the target for the 1887 salvage, given the ability to deconstruct such components. Furthermore, a prior newspaper article indicated that the engine remained largely undamaged and intact after the 1886 arson event (*Wilmington Star* 1886; Seeb 2007:188). Referring to Figure 140, this attempted salvage may also have been a response to the spike in iron value in 1887, as indicated by the foundry and forge pig iron prices. The next instances of salvage would have taken place after the 1924 photograph and before 1975, given that year’s NCDAH/UNCW field school recorded those portions of CFR0001 as missing (NCUAB 2024:5-7). Furthermore, this salvage effort could have been between 1946 and 1958, based on the scrap iron value statistics (Figure 140).

Beyond the association of a rise in national iron prices and the salvage of iron from the CFR0001 site, what iron remained indicates a behavioral tendency to salvage the most easily accessible valued material. This is clearly indicated with the outboard portion of the paddle shaft and flanges remaining on the eastern side, the bottom of the boiler still in-situ, and the paddle wheel arms cut just above the sand on the western side. Indeed, all were protected from salvage and scavenging by environmental obstructions. The eastern side of CFR0001 is the site’s deeper

portion, making salvage of the paddle shaft and arms below the waterline difficult. Similarly, the portions of the boiler and the paddle wheel arms on the western side of the wreck which remain are almost entirely inundated with mud or covered by the sand from the riverbank. This manner of salvage is further evidence for value maximization and resource saving tactics even within the post-depositional systemic context. By salvaging the accessible iron components when they are at their relative highest value the salvors maximized their potential profit when selling while not expending excess time, resources, and money obtaining the comparatively inaccessible iron.

To conclude the economic processes section, several behavioral patterns can be addressed regarding the selection of *Waccamaw*'s techno-functional components, its reuse cycles, and its post depositional salvage. First, the key techno-functional components discussed were easily operated and repairable making the technological barrier to entry low for secondary uses. Furthermore, cost and time effectiveness were a core influence in how *Commodore Hull* was modified during the Civil War with as much of the original structure remaining as was "practicable." Second, *Waccamaw*'s reuse cycles in the systemic context follow the noted pattern that the secondary use of a vessel is usually a one-way trip towards its discard (Richards 2008:55,130). Indeed, two of the three secondary use cycles occurred post war with the vessel being used in an increasingly varied manner (e.g., excursion cruisers, towing, and salvaging) up to the time of its deposition. Lastly, the salvage which has been noted on *Waccamaw* was tertiary, that is, it occurred post abandonment, was opportunistic in nature, and was likely conducted by a new owner unrelated to any secondary or primary salvage attempts (Richards 2008:155). This is known by the 1887 newspaper report and the fact that the boiler and much of the paddle wheel remained in 1924 yet was gone by the NCDAH/UNCW 1975 field school.

Each of these patterns, in relation to *Waccamaw*, is the result of value maximization and resource saving techniques employed by those who affected the vessel materially.

Techno-societal Processes

The following section discusses the societal processes which determined *Waccamaw*'s original construction and reuse cycles. For this discussion societal processes are those proximate influences produced by the communities the vessel interacted with including the growing residential community of New York, mid-19th century American shipbuilders, and the United States government. Undoubtedly railroad companies, and private entrepreneurial communities also affected the material change of the vessel post war, but those changes, and their associated behaviors, were discussed in the economic processes segment given their base monetary natures. Furthermore, aspects of the vessel which made its design sociologically versatile, that is, easily adapted to meet the needs of its associated organizations and institutions, are the primary focus of the construction components and modifications discussed in this section. This section therefore begins with the design and modifications above the hull, and is followed by those below the deck, as they relate to the above stated societal influences.

Above the Hull

When discussing the social processes which effected the construction and modification of *Waccamaw*, there are explicit influences, such as the Civil War and the state of the United States Navy prior thereto, but there are also those which are more implicit. Those implicit influences manifest most clearly with the design of the vessel's main deck. *Regla* was undoubtedly built to serve a primary mercantile function as defined by Richards (2008:119-120) when originally built. As was also indicated by Richards (2008:128), a vessel's primary function greatly influences its secondary function in the process of reuse. Vessels of course have a greater or

lesser degree of adaptability depending on their design, for instance, it would be more difficult to convert a 19th century tea clipper into a whaler than say, a freighter. *Regla*, and all other 19th century New York style double-ender ferries, represent a vessel type that could be radically adapted to fulfill socially expressed needs. Speed and efficiency of transportation coupled with a supporting maritime infrastructure were most certainly the economic and technological factors influencing these vessels original design. However, in terms of sociological influences, John Englis, the builder of *Regla* (The Mariners Museum 1939), and the New York shipbuilders which preceded him, produced a deck that could be thought of as a blank slate or an open concept floor plan apt for subsequent secondary use cycles.

Edwin A. Stevens, the late 19th century New York Shipbuilder and grandson of John Stevens III, the man who pioneered in the double ended ferry design, stated, “the ferry-boat of to-day should be not only in its functions, but in its construction, a hybrid between a vessel and a truss bridge” (Stevens 1893:192). This quote provides wonderful insight into the mindset of the builder and indicates with what considerations such a deck design was created. While such bridges to New York City were non-existent when John Stevens developed this particular type of sponson deck, the central concept of providing an open, load-carrying platform for the transport of vehicles and people alike across a short distance over water was the same (Cudahy 1990:45). Yet, when deconstructed even further, both conceptually and materially, the deck could be compared to the forementioned open concept floor plan in that, once the walls (i.e. superstructure) are removed, it could be redesigned dramatically. This quality made *Regla*, and other double-ended ferries built in the New York tradition, easily adaptable and therefore fit for radical material changes in each secondary use cycle. This reality of radical redesign has been noted by historians of New York ferries such as Brian Cudahy who states that double-ended

ferries, whether dismantled to their waterlines for salvage purposes or otherwise, were often rebuilt so significantly different that later drawings or photographs of the same vessel are unrecognizable (Cudahy 1990:50).

The radical redesign of mid-19th century ferryboats as represented in *Regla* is illustrated in Figure 141. Comparing the images, we can see how space was redefined based on the social need at hand. The vessel's first secondary use cycle, from ferryboat *Regla* to gunboat *Commodore Hull*, was caused by the outbreak of the Civil War and the government's subsequent need for gunboats capable of penetrating the southeastern coastline. The individual military conversion components were techno-functional in nature, yet taken as a whole, the vessel was reimagined with a new socio-function: blockading gunboat. The vessel would therefore go into not just a techno-functional overhaul, but a socio-functional overhaul. The main cabin, once divided broadly between passenger space and vehicle space, now needed to accommodate a much more complex operational and social context. Indeed, space was no longer arranged based on the needs of transient passengers, but instead of the needs of a permanent crew with a strict hierarchical command structure. A similar reimagining of space for wartime need can be seen in the conversion of the French fishing trawler *Senateur Duhamel* into the British minesweeper HMS *Senateur Duhamel* during the Second World War (Sassorossi 2015:90-98).

The gangways which led carriages into the main cabin were converted into gun decks with powder magazines being appropriately placed on either side. The passenger cabins were divided by bulkheads to delineate the spaces needed for the functioning of a naval vessel, including officer and medical quarters. The gangways within the cabin became the crew's quarters consisting of hammocks that were taken down when underway (Saltonstall 1913:52). The pilot houses were lowered to sit just above the roof of the main cabin, providing protection

not just for the pilots, but also for the steering chain which now ran almost entirely below deck (Figure 142). Iron boilerplate armor was concentrated around the cabin, pilot houses, bulwarks, and steam chimney to protect the most vital functions of the gunboat. Those functions were to keep the crew protected while in combat and on station, to allow pilots to operate while under fire and change houses under the cover of the cabin, and to keep the steam flowing and thus the vessel moving when in battle.

When the vessel transitioned to its second secondary use cycle, from gunboat *Commodore Hull* to the working boat *Waccamaw*, the deck space was again redefined. The passenger clientele was significantly less transient than those for which the original superstructure was designed. Therefore, considerations regarding luxury and comfort for longer overnight trips were affected. Again, referring to Figure 141, shows how the interior passenger space was made more spacious. For instance, four state rooms replaced the naval personnel quarters to provide wealthier excursionists with a first-class experience, and the exterior deck space received a large awning for added comfort. Yet, for the first time in the vessel's life, it was no longer serving a singular purpose. Indeed, operating as a salvage and towing vessel, it now made regular trips to the sea. This socio-function meant the retention of the capstan and perhaps its strut planking, the former added for hoisting the anchor and the latter perhaps added for stability when used as a gunboat and the installation of a tow bitt and wrecking pump on one of the decks. As can be seen, the Socio-functional imagining and reimagining of the deck space and superstructure defined how individual techno-functional components existed and were arranged.

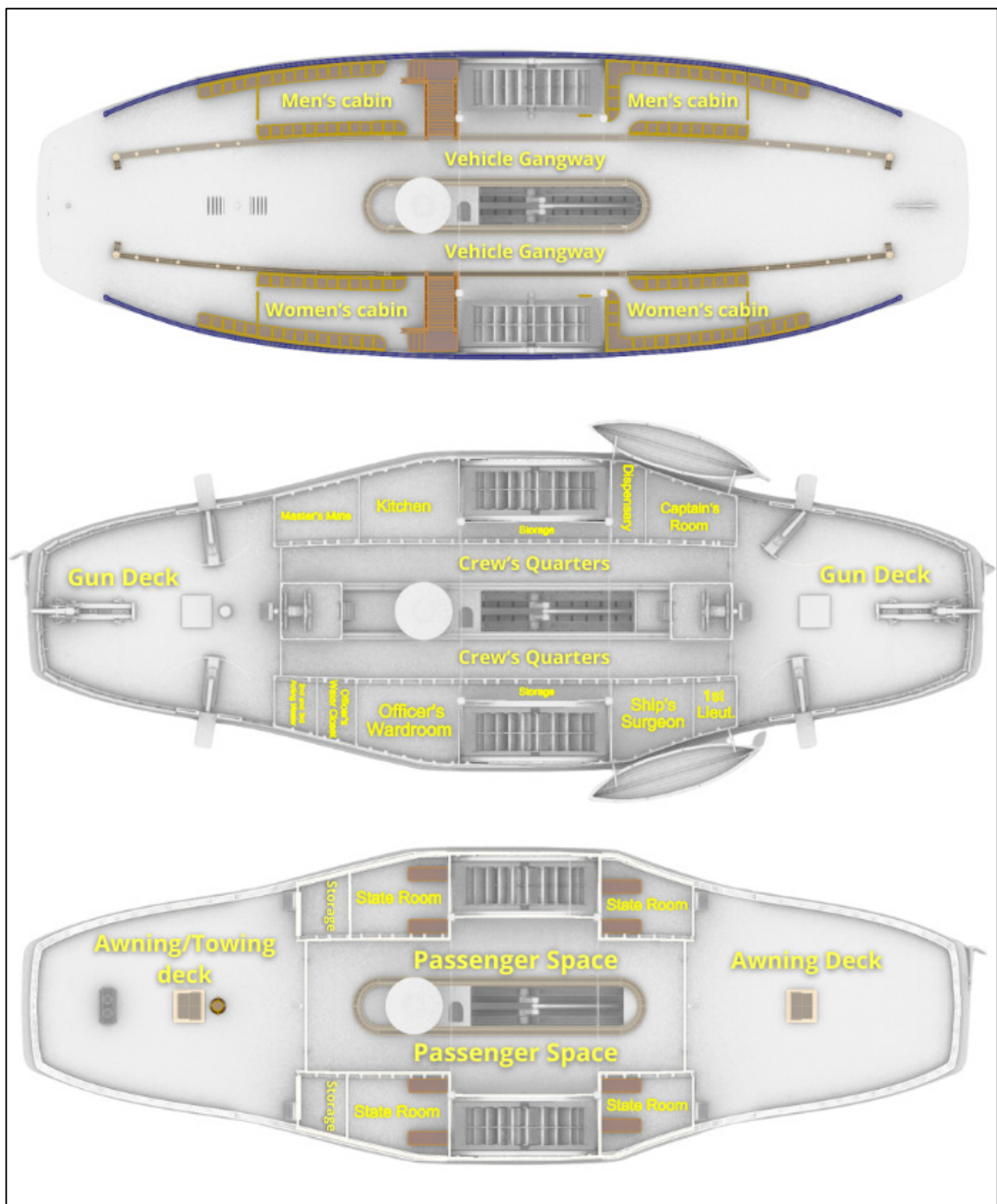


FIGURE 141. Plan view of the arrangement of space on the main deck of *Nuestra Señora de Regla* (Top), *Commodore Hull* (Middle), and *Waccamaw* (Bottom) (image and models courtesy of author).

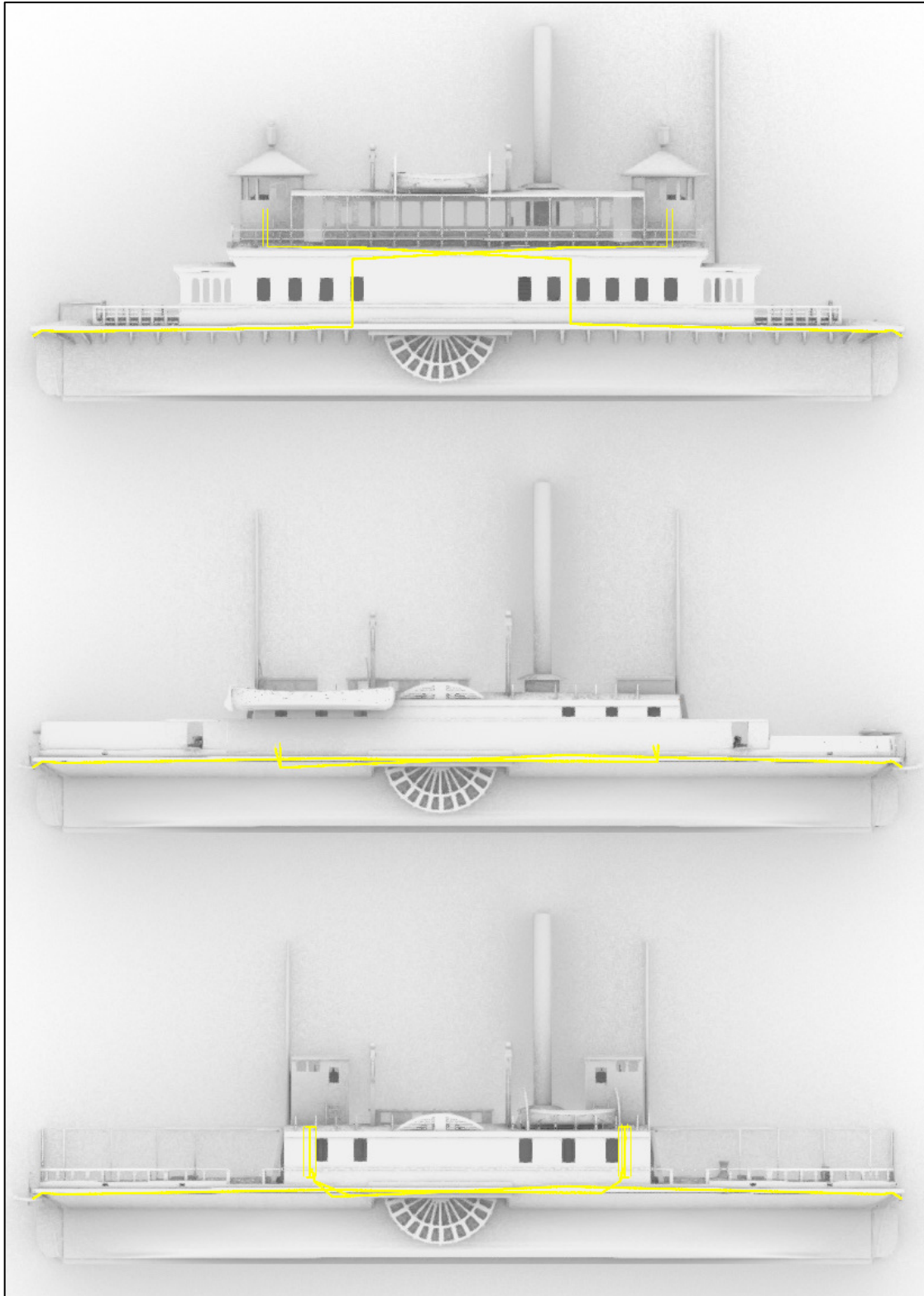


FIGURE 142. Depiction of how the steering arrangement (yellow) changed with the vessel's socio-function depicting *Nuestra Señora de Regla* (top), *Commodore Hull* (middle), and *Waccamaw* (bottom). Note the difference of arrangement between *Regla* and *Commodore Hull* indicating the need for protection (image and models created by author).

Below the Deck

Below the deck, the influence of social processes in the vessel's construction and reuse materially manifested in propulsion machinery, aspects of the hull's construction, and post-depositional uses. Beginning with the machinery, the horizontal firetube boiler and the radial paddle wheel present on the site were outdated technology by the time *Waccamaw* was laid up. In fact, the first boiler noted on the vessel while in its secondary use cycle as *Commodore Hull*, a drop flue type (United States Department of the Navy 1921:63), was even outdated by the 1860s (Evers 1878:135; Dean 1936:924; Whittier 1987:18). Beyond the economic and technological reasonings for the installation of such machinery (discussed in those respective sections), there is perhaps a broader sociological reason stated aptly by American shipbuilder Lauchlan McKay in 1839. In the below quote, McKay is discussing the United States' lack of technological advancement in steamboat construction when compared to Britain since Fulton built *Clermont* in 1807:

One reason for this backwardness upon our part is to be found in the nature of our government, which expends no money for experiments, grants no aid to science, and rests contented with the doings of the past. While the British Government has been liberal in expenditure, vigorous in encouraging improvements, and persevering in carrying every good suggestion into effect; ours has waited for individual wealth and individual enterprise to do everything that has been thus far accomplished, and has stood still in the march of an improvement which should have been peculiarly her own (McKay 1839:90).

Indeed, the use of outdated technology in American proximity ferries is also represented by the original installation of the vessel's radial paddle wheels. Those wheels, while certainly refined

over the decades, did not differ substantially from those installed on Fulton's 1807 *Clermont*, despite their relative inefficiency when compared to the feathering wheel (Sennett and Oram 1899:310-312; Whittier 1987:36). While the typical feathering paddle wheel (depicted in Figure 127 of Chapter 6) was available by the 1830s, one source indicates this style was not seen in New York built proximity ferries until the 1880s (Cudahy 1990:127). As stated by the above quote and indicated by the in-situ remains of *Waccamaw*, and the historical record, little effort was made to update the propulsion technology of this vessel style from the mid to the late 19th century. Socially, this may be the result of a lack of governmental investment in marine steam technology during the early to mid-19th century.

Social processes continued to affect the vessel after it was laid up in 1884 by its final owner, George Harriss (*Wilmington Star* 1886; Seeb 2007:158; Jackson III 2008:260) and significantly affect its current remains. Perhaps the most detrimental to the site's integrity was the reported vandalism which occurred to the site only two years after it had been laid up. In 1886, the *Wilmington Star* (1886) reported that *Waccamaw* was burned to the water's edge by "some boys who were seen leaving that side of the river in a small boat just before the fire broke out." If these boys did this to remove iron components or copper fasteners, this could be an example of illegal tertiary salvage because the vessel was abandoned but not yet part of the archaeological record (Richards 2008:155). Yet, given the statements of "some boys" as opposed to adults and "in a small boat" as opposed to some larger craft better suited for storing salvaged material, it may be more likely the result of an, at base, social process of illegal recreation as noted in Richards' study of Australian ships' graveyards (Richards 2008:162).

Environmental Processes

The following section covers the environmental processes (i.e. non-cultural forces) that both influenced decisions made regarding the design, construction, and reuse of *Waccamaw* and those that effected the location of remains and its deterioration. In this analysis environmental processes are considered affecting the vessel on two levels: first, the cultural decisions around its use, reuse, and deposition and, second, how it materially deteriorated during the systemic and archaeological context. A vessel's socio-function determines some of the environmental processes which will affect it. In the present case, the material changes made to *Waccamaw* in mitigation of environmental affects depended on its operational environmental, which itself depended on its socio-function. This section therefore begins with a discussion of decisions made in *Regla*'s construction to mitigate its specific environmental context after its initial socio-function was defined. Additionally, consideration is given to how those attributes translated to its reuse cycles, and what environmental considerations may have gone into its depositional location. This section concludes with a discussion of the non-cultural transformations that have occurred to the vessel's remains.

Systemic Context

American shipwright Lauchlan McKay aptly stated, "The leading consideration in the construction of steamers is the water in which they are intended to be navigated" (McKay 1839:90), a quote which indicates the environmental specialization that led steamboat construction since Fulton's *Clermont* in 1807. In the context of New York's inland waterways, nothing exemplified this more than the development of both the "distance" ferries which plied up and down the Hudson River and across the Long Island Sound and the "proximity" ferries, such as *Regla*, which plied short distances within New York's upper harbor. To reiterate from the

Chapter 3, the length to beam ratio of proximity ferries from 1840 to 1860 was between 4:1 to 5:1 and they drew an average of 10 ft. This left plenty of room for navigation in the upper bay which averaged around 17 ft. in depth, while accounting for the shallower end of that averaged around 12 ft. (Blunt 1822). These depths are comparable to the 10 to 15 ft. of water *Regla* was commissioned to operate in as a Union gunboat in the Albemarle sound and tributaries.

Furthermore, the ferry's design also owed much to the geographic layout of New York Harbor, with Manhattan Island being a central node separated from the adjacent highly populated landmasses that surrounded it by relatively narrow rivers. These environmental parameters required a design that could move as easily backwards as it could forwards. The double-ended hull design was well suited for such applications and had the further advantage of a large carrying capacity (via sponson deck) and small length to beam ratio. Indeed, *Regla*'s low draft and carrying capacity were cited as its most desirable qualities for military use by its captor General Thomas W. Sherman in December of 1861 (United States Supreme Court 1882:93). Furthermore, *Regla* was converted with the expectation that it would operate in narrow and shallow waterways, making a double-ended design quite desirable as discussed in Chapter 3. In terms of its use in Wilmington, shallow draft and deck space was also noted as several of its desired features for its work in wrecking and towing industries (*Wilmington Morning Star* 1872a:1).

Other environmentally influenced features, more specific to *Regla* when compared to contemporary New York proximity ferries also made it a desirable vessel for naval use, particularly in combat. This would namely be its inclined engine, which was largely unpopular prior to and at the time of *Regla*'s construction. Indeed, most contemporary ferries employed the walking beam engine (Figure 143). The advantages the inclined engine enjoyed over its older

relative the walking beam, have been previously discussed, however, another more environmentally influenced reason may have inspired its selection for *Regla*. After completion, the vessel would have to travel almost 1,300 miles of open ocean to reach its destination in the Bay of Havana (The Mariners Museum and Park 1939) and the overhanging sponson was outright hazardous in this environment (McKay 1839:89; Cudahy 1990:45). An engine that had its weight centered low in the hold and provided no additional complications to maneuvering, given the added windage of a walking beam engine, would likely be preferred for a vessel not built to handle the open ocean. With a \$50,000 price tag (United States Supreme Court 1882:104) and 10% of that being paid for insurance (The Mariners Museum and Park 1939), it would have been in the company's interest to do everything within its power to ensure the vessel made it to Cuba, and installing an inclined engine may have aided in that goal.

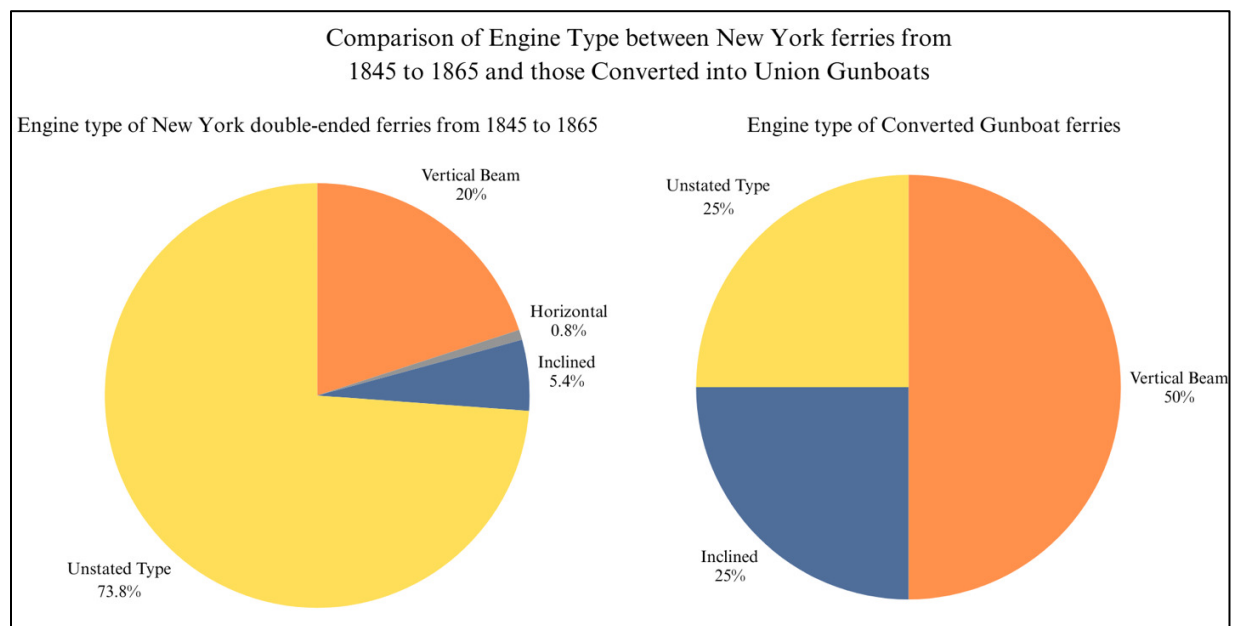


FIGURE 143. Comparison of engine type between New York ferries from 1845 to 1865 and those converted into Union gunboats (chart created by author, data of New York double-ended ferries courtesy of Brain J. Cudahy 1990:368-463; data for converted ferries from United States Department of the Navy 1921:59-239).

As can be seen in the above discussion (Figure 143), the United States Navy had a clear preference for inclined engines in the ferries they selected for conversion into gunboats. While

only comprising 5.4% of the engine types of New York ferries from 1845 to 1865 (as recorded by Cudahy 1990:368-463), at least 25% of the ferries converted had inclined engines. This represented most of the New York ferries with incline engines available for purchase by the Navy. The reason for this preference likely originates with the low center of gravity, decreased windage, and its position almost entirely within the hold, keeping it protected when under fire. A low center of gravity and decreased windage would also have been advantageous when the vessel was used in the towing and salvage business to provide extra buoyancy while making trips to the rougher coastal waters (*Daily Journal* 1873b:4, 1875a:1; *Wilmington Morning Star* 1877:2; Reilly 1884:125).

We can see how the length to beam ratio, the draft, and the engine are examples of *Regla*'s initial operational environment influencing its design with its initial design then influencing its next operational environment, the Albemarle Sound and associated tributaries. This above process likely compounded, as structural modifications made during its first secondary use cycle (gunboat conversion) could translate to its post war secondary uses (excursions, towing, wrecking). This was perhaps the case with the sponson strut planks, which were likely installed to make *Commodore Hull* less resistant to and more buoyant in the water given the increased draft caused by the cannon and armament while generally protecting against riverine obstructions as discussed in Chapter 3. Similarly, the reduction of the sponson and superstructure (Figure 144) also aided in mitigating the non-cultural effects of added material culture. That is, cannon and armament added the physical effect of an increased draft which was then mitigated through reducing material above the waterline.

These features were also beneficial for *Waccamaw*'s operations in the open ocean post-war, as a reduced sponson would create less sinking danger when rolling (Cudahy 1990:45) and

the strut planks would lessen the effect of rough water. In this way a techno-functional feature installed in a vessel's first secondary use may influence what reuse cycle it goes into next. This of course does not apply only to those techno-functional features selected to mitigate environmental processes, but also those selected for economic and societal processes. However, the environmental considerations in the addition/subtraction of material from the vessel provide a clear example. Furthermore, the above discussion ultimately supports the idea that a vessel's primary function will correspond in some formal way (e.g., the vessel's shape, size, weight, color, hardness, and chemical composition) to its reuse cycles given the requisite influence of techno-economic and techno-social processes as first noted by Richards (2008:128).

Cultural Deposition and the Archaeological Context

Environmental processes were also key in the discard (c-transform) and deterioration (n-transform) of the vessel. To reiterate from the theory chapter, the transition of an artifact from the systemic to the archaeological context is called cultural deposition, and generally includes the processes of discard, abandonment, or reclamation (Schiffer 2010:34). Unfortunately, the trend of little historic documentation being recorded in the event of a vessel's discard, abandonment, or reclamation holds true for *Waccamaw* (Richards 2008:11). However, without information as to how the vessel was abandoned, past studies and theory, combined with site evidence, give us enough to make an educated hypothesis based on its location.

First, CFR0001's remains lay almost completely inundated by a mixture of mud and sand that makes up the riverbank. Such a substrate has been noted as a desirable quality when beaching a vessel with the intention of not damaging the hull while allowing it to settle into the substrate, thereby making it less likely to float away (Richards 2008:172). Furthermore, the documentary evidence available indicates that the superstructure, paddle wheels, wrecking

pump, engine, and boiler were present on the site when it was originally laid up (*Wilmington Star* 1886, 1887; Seeb 2007:188; Jackson III 2008:260). This additional weight would likely have made the vessel settle more quickly and deeper into the substrate, providing an explanation as to why no methods of placement assurance were detected on or near *Waccamaw*'s remains.

Vessels that have been deliberately abandoned typically experience primary salvage where the original owner removes the most valuable components from the hull prior to laying it up. This is done in a manner that allows the vessel to be moved to a final resting place before further salvage occurs (Richards 2008:155-156). The fact that the boiler, paddle wheels, wrecking pump and engine remained on the site at the time of deposition indicates that the vessel was originally mothballed, meaning that the last owner intended to run this vessel again, perhaps after needed repairs. An example of this can be seen with the James River Reserve Fleet in Hampton Roads, Virginia (United States Department of Transportation 2020). Yet apparently nothing happened to the vessel, and after two years it was suspiciously burned to the waterline and subsequently abandoned.

This could also provide further clarification for Seeb's conclusion that the Eagles Island Ships Graveyard represents the rare instance of primary refuse (e.g., the abandonment of artifacts at their location of use (Schiffer 1987:62) within an active industrial zone (Seeb 2007:203-204). If *Waccamaw* was originally mothballed rather than abandoned, then its subsequent abandonment in the active industrial zone of Eagles Island was not entirely intentional. This would have then given owners of other damaged or otherwise unusable vessels precedent to abandon their vessels in the same location, conforming to the pattern of clustering that has been associated with secondary refuse (Schiffer 1987:62).

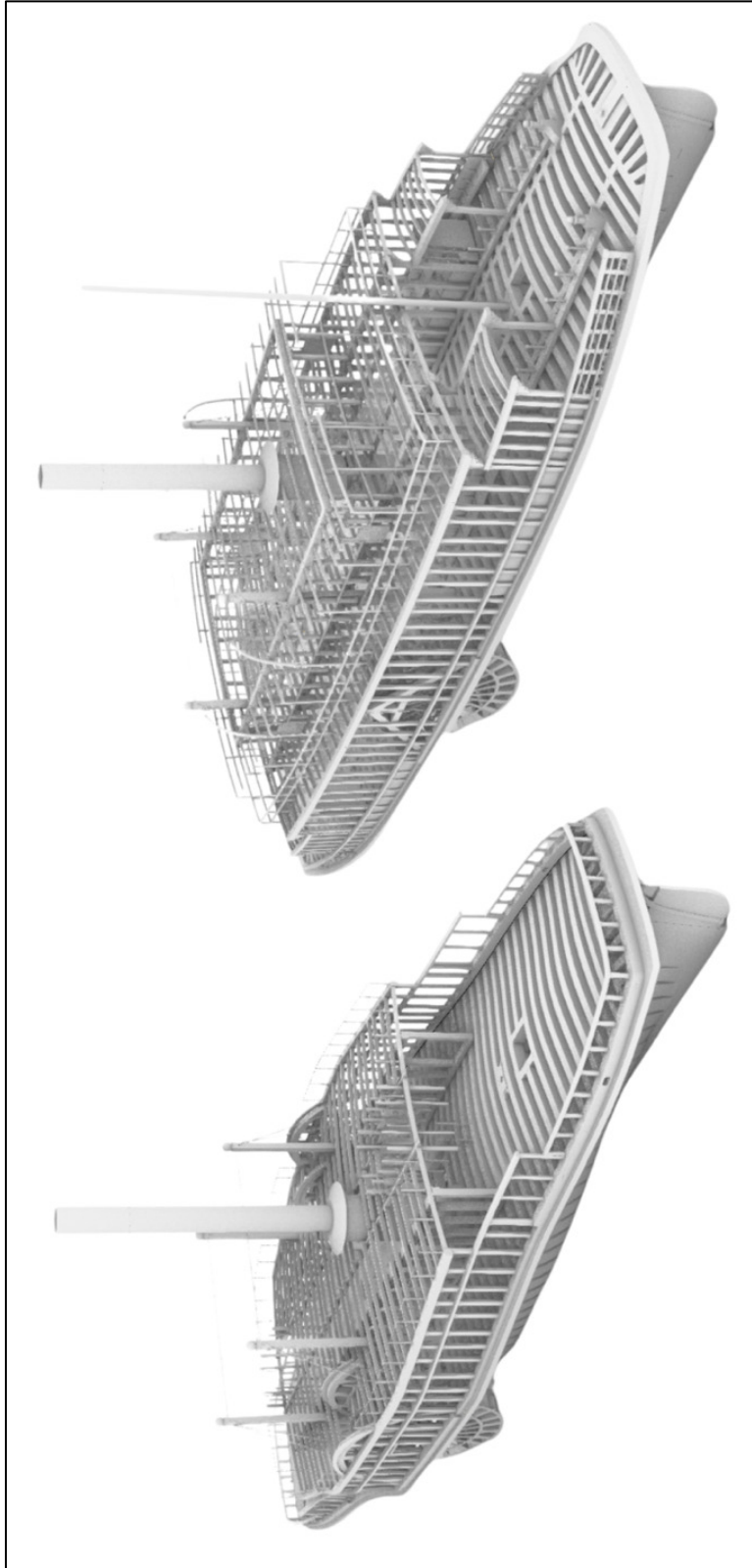


FIGURE 144 A modification made in part to compensate for the addition of a substantial amount of weight via armor plating and cannon, necessary for a vessel intended for shallow waters. Reducing height also reduced windage of vessel (image and model courtesy of author).

With the vessel abandoned, it would then transition into the archaeological context where mainly non-cultural processes affected it. The primary non-cultural processes are physical and biological forms of deterioration as defined by Ward et al. (1999:562-563). The intertidal nature of the Cape Fear River, alongside the numerous severe storms that have affected the area in the past years, have significantly degraded what currently remains of the CFR0001 site. Intertidal zones promote the movement of sediment resulting in both erosion (via abrasion or scouring), and silting (Ward et al. 1999:562). *Waccamaw*'s remains have clearly experienced significant silting since its deposition in 1884 as much of the hull is inundated by sand and mud, similar to the remains of an 18th century coastal freighter recorded on the bank of Pembroke Creek in Edenton, North Carolina (Rodgers and Corbin 2002:231-233). This process combined with biological deterioration via boring insects likely caused the further reduction of the hull's wooden remains (Schiffer 1987:177; Ward et al. 1999:563) to its current level which is just above the mud line.

Figures 145 and 146 provide evidence of this non-cultural degradation with the former showing the engine bed from 2007 (top) and from 2024 (bottom). As can be seen, the large, inclined timber on the eastern side of the wreck no longer remains and the vertical and forward inclined timbers have been significantly reduced in size. The latter figure draws attention to evidence of environmentally-derived deterioration and borer insects at the exposed southern end post assembly. Evidence of borer insects (teredo navalis, wharf borer (*Narcerdes melanura*), or otherwise) was present on the western, shore side framing as well. This indicates that previous interpretations that the southern end post assembly was cut for salvage purpose is incorrect (Seeb 2007:186; 2013:229). Indeed, this indication becomes stronger when referencing the 1975 and 1990 site photographs displayed in the methodology chapter (Figures 19 and 20). In the former, a

portion of what is likely the end post can be seen laying on top of the mud directly in front of the southern end post assembly.



FIGURE 145. Incline engine bed remains from the CFR0001 site, Eagles Island, North Carolina. Colors match the frames, yellow is associated with the smaller forward inclined timber and pink is paired with vertical timber (top image is from 2007 ECU field survey courtesy of East Carolina University's Eagles Island Ships' Graveyard Heritage Trail Flyer; bottom photograph taken by author, 27 October 2023).



FIGURE 146. Southern end post assembly, note the evidence of degradation via borer insect on portions circled in red (image taken by author 30 June 2024).

Conclusion: Understanding behavioral patterns

The above analysis synthesized the information divulged in previous chapters to understand how the techno-economic, techno-social, and environmental processes affected *Waccamaw*, and other New York double-ended ferries converted into gunboats. Techno-economic processes displayed how broader economic trends of importation, exportation, population, and governmental budgets affected the dimensions of the original build, the nature of the vessel's rebuild as a Union gunboat, its lateral cycling as a Wilmington working boat, and when/how salvage was conducted. Furthermore, the manner of selection of techno-functional components in *Waccamaw*'s original design and reuse, alongside the likely manner of its salvage, indicate frugal behavior manifesting as resource saving techniques and value maximization. The techno-socio processes determined the primary function and secondary uses of the vessel with the former producing a deck that was socially and economically versatile, that is, able to change specialization quickly and cheaply with no major dissection needing to occur. Indeed, the beauty of its design lay in its ability to remove any past socio-function built into the superstructure quickly and easily leading to radical redesign of the deck structure. Below the hull, social influences such as the attitude of the United States government and the American shipbuilding community in developing steamboat technology and illegal recreation had significant effect on what propulsion technology was installed and how the vessel was treated once laid up in its final resting place. Finally, the environmental processes which affected the vessel within the systemic and archaeological context were first determined by social need. Once this need was defined, certain design features and techno-functional components needed to be taken into consideration. Similarly, techno-social and economic processes influenced the location of its final resting place and, thereby, the deterioration the site has experienced since its deposition.

Ultimately, analysis of these processes illustrates the inseparable relationship between technology and the social and economic context an artifact is used in, hence the use of the terms techno-economic and techno-social. Furthermore, environmental processes also have a significant influence on what techno-functional features are added, removed, or kept while influencing the way the vessel was reused. In the following chapter, the conclusions of this study are reviewed with the primary and secondary questions alongside the limitations of the research and what future research should occur.

CHAPTER 8: Conclusion

This study has utilized behavioral archaeological theory to provide explanations of how *Waccamaw* was used, reused, and abandoned in a manner that connected it to patterns noted in the historical and archaeological records. More specifically, site formation theories dealing with pre and post depositional use cycles were applied in explaining the original construction and material changes that occurred to the vessel since its construction to the present-day. The goal of this was to connect the original construction and material change to the human behaviors that enacted them. These behaviors were then placed into context with the broader techno-economic, techno-social, and environmental processes to examine their influence on the behaviors. Consequently, a core component of this study was to provide a detailed 3D reconstruction of *Waccamaw* via Rhinoceros® 3D so the specifics of how it was built and modified through the course of its life could be known intimately. With the remains of the vessel available and easily accessible on the bank of Eagles Island, North Carolina, the double-ender's post-depositional "life" was also able to be analyzed via photogrammetric model. Furthermore, from the photomodel a scaled site plan was produced and overlain on the 3D reconstruction to understand what features were represented in-situ versus what was known from the historical record (as depicted in the 3D reconstruction). The overlay also allowed for an enhanced interpretation of the non-cultural processes which affected the site and a projection of what may now remain below the mudline.

Before moving forward with the above stated goal of the study, the theoretical background needed to be established, which was done in Chapter 2. Theory revolved chiefly around Michael B. Schiffer's explanation of site formation theory (1972; 1987; 2010) and

Nathan Richards' understanding of vessel abandonment and salvage (2008). Both archaeologists have the explicit goal of deriving behavioral traits from material culture, making their theories evidently applicable to this study. Schiffer provided the concepts of systemic and archaeological contexts, artifact functions (e.g., socio-, techno-, and ideo-), and reuse cycles (e.g., secondary, lateral, and recycling) vital in framing what artifact reuse patterns were exhibited in *Waccamaw*. Richards applied Schiffer's concepts within the maritime industry to develop the concepts of primary and secondary mercantile and support uses, and primary, secondary, and tertiary salvage. In addition to Richards (2008), processual theorists I.K. Ward (Ward et al. 1999) and Martin Gibbs (2006) provided key concepts in understanding the non-cultural transformation processes which were to be considered.

With the relevant archaeological theory described, the broader historical context which surrounded *Nuestra Señora de Regla (Regla)* and its transition to *Commodore Hull* was discussed in Chapter 3. The focus on these two periods of the vessel's life allowed for a thorough discussion of the environmental, economic, technological, and social processes which influenced the development of the double-ended ferry in New York and their conversion into Union gunboats. Furthermore, while the North Carolina history discussed focused on the Antebellum and Civil War periods, it set the stage for analyzing the vessel's post war use, abandonment, and salvage in Wilmington North Carolina.

Chapter 4 then described the historical research, fieldwork, and analytical methodologies. Historical research considered contextual and construction sources that described and depicted the operations of ferries, gunboats, towboats, and salvagers and what features were typically installed in accordance with their tasks. With no photographs or plans ever found of *Waccamaw* from any stage of its use, these primary and secondary sources were instrumental in building the

3D models. Field work accomplished the goals of acquiring adequate data to create a complete and scalable photogrammetric model of the vessel's remains while collecting photographs and measurements to compare with previous archaeological investigations. The photomodel used for this study came from the 30 June 2024 dataset, but the attempts to create and rectify a photomodel from the 27 October 2023 dataset were also described. The chapter concluded with a brief description of how the resulting photogrammetric model would be used with the 3D reconstruction in the analysis of the reuse and salvage of the vessel.

Chapters 5 and 6 described the methods and results of the 3D reconstruction of the vessel from its original construction as the 1861 ferryboat *Regla* to its post war modifications as the working boat *Waccamaw*. Chapter 5 dealt solely with the original build starting with John Englis' original offset measurements for *Southfield*'s waterlines given its similarity in design and builder. Chapter 6 dealt with *Regla*'s conversion to the Union gunboat *Commodore Hull* and its post-war modifications as *Waccamaw*. A broad range of sources from scaled architectural drawings and archaeological reports to contemporary treaties and photographs were used in the vessel's reconstruction at all phases of its life. Chapter 6 concluded with a report on the CFR0001 site which included an interpretation of previously unidentified remains, portions which had likely been salvaged, and a projection of what likely remains below the surface currently and how much was removed. The interpreted projection of what remains below the surface and what no longer remains constitutes the fourth and final 3D reconstruction of the vessel.

Finally, Chapter 7 presented an analysis of the historical and archaeological record as reconstructed by the previous chapters. In answering the primary research question, the secondary questions acted as pieces of a puzzle that, once put together, created a complete

picture of the behaviors associated in the vessel's material change. To reiterate, the secondary questions are as follows: what are the techno-economic processes, what are the techno-social processes, and finally, what are the environmental processes? The order in which the secondary questions were addressed reflects the strength of their proximate influence on the vessel's use cycles, transition from the systemic to the archaeological context, and post-depositional salvage. The primary question which these secondary questions answer is thus: using *Waccamaw* as an example, what were the processes involved in the transformation of civilian watercraft for military use, their reversion to their previous civilian purpose, and final deposition during the 19th-century?

The techno-economic processes, while perhaps not as fundamental in deciding the use and reuse of the vessel as the social processes, had the most influence on how the vessel's construction and material change was carried out based on documentary evidence. Indeed, it was shown that resource saving techniques and value maximization were the behaviors associated with the economically influenced material change of *Waccamaw*. These behaviors manifested both above the hull and below the deck as easily operated, repairable, and cost-effective techno-functional components and modifications.

Above the hull, the way ferries were converted was largely dependent on the United States Navy's budget and spending priorities. The Navy reused as many components as practical when converting the ferryboats and, once it was clear more specialized technology was the future for naval superiority in the Civil War, they de-prioritized the conversion of civilian craft. Post-war it was seen that the manner of *Waccamaw*'s reuse likely corresponded to the broader economic changes which affected Wilmington with its secondary uses and lateral cycles corresponding to dips and rises in population and exports of the city. Below the hull it was

shown how the original builders constructed a vessel was in line with the economic conditions of its intended area of use instead of its area of construction, indicating a tendency towards value maximizing behavior when designed. Furthermore, the propulsion and steering mechanisms were selected based on their cheapness in construction, ease of maintenance, and simplicity of use. Finally, the post depositional salvage of CFR0001 reflected a preference for iron components that were easy to access with the exposed wood showing little sign of salvage. Temporally, the 1887 salvage corresponded to rises in iron prices nationwide, indicating that later salvage of iron material may have been associated with similar rises in iron prices. Taken as a whole, it can be seen how these interactions with the vessel relate to resource saving techniques and value maximization.

It was noted that there were explicit and implicit techno-social influences that affected the vessel's use cycles. Those explicit influences were broader social events that had a core influence on the vessel's first secondary use cycle, such as the Civil War and the state of the Navy prior to the conflict. Indeed, without the poor state of the United States Navy prior to the Civil War nor the Navy's focus on power projection in the oceans surrounding the Americas, *Regla* may not have been needed in the war between the states. Yet the implicit social influences also had a very important role in the design of the vessel and type of machinery selected in the original build.

Techno-social processes were the most fundamental influences on the vessel's use and most dramatic reuses (e.g., from ferry to gunboat and from gunboat to working boat). Above the hull, it was shown how once the vessel's socio-function was determined, the techno-functional components and arrangement of space could be established. Behaviorally, the vessel was treated as a blank slate with its owners incorporating their perceptions of utility, protection, and luxury

within the vessel's construction to a greater or lesser degree depending on its use. Below the deck it was shown how a lack of governmental investment in steamboat technology in the early to mid-19th century may have influenced the selection of relatively outdated propulsion technology. Furthermore, it was noted how more isolated social processes such as recreation had a dramatic influence on what remains of the CFR0001 site currently.

The final process discussed considered environmental influences on two levels: their influence on decisions made in the original design and subsequent modifications of the vessel within the systemic context, and their effect on the vessel's remains within the archaeological context. Regarding the former, it was shown how the efforts to mitigate environmental conditions influenced its subsequent use cycle. For instance, the vessels triple framing installed for ice protection lent it towards carrying cannon and resisting their recoil when fired. Additionally, the installation of an inclined steam engine lent it towards naval service in a combat environment given its position under the deck. This compounded, as modifications made for its military conversion, such as the strut planking and reduction of the sponson deck, may have influenced the decision to make *Waccamaw* a salvager which regularly ventured into the open ocean. Furthermore, environmental conditions such as the river's substrate may have been considered when the vessel was laid up. With the Cape Fear River's soft, muddy bottom, and much of *Waccamaw*'s machinery and superstructure likely remaining, there would have been a level of placement assurance for the vessel as it could settle deeply into the mud. Behaviorally this represents iterative adaptation in the use of a tool, where a modification installed in one use cycle proves useful in another, thereby lending the tool towards a specific task.

Within the archaeological context, the intertidal nature of the river, its substrate, and biological degradation had a significant effect on the condition of the vessel's remains as they

currently exist. Much of the wooden remains still exposed are just over the sediment line with the heavy silting caused by the moving tide preserving the hull's remains below given the substrate's anoxic nature. Yet this moving tide, in combination with debris floating down river, biological damage via boring insects, and the constant wetting and drying of the wood, has likely been the main driver in the reduction of the hull's remains seen since the site's first archaeological investigation in 1975.

This study and its analysis were not, of course, without its limitations. Beginning with the 3D reconstruction, no construction plans or photographs were ever found through the course of historical research. This means that the 3D reconstruction of the vessel is in some respects a general representation of a vessel and conversion type, heavily shaped by the construction information known from other ferries, ferry gunboats, towing, salvage, and excursion vessels. This is particularly the case for the reconstruction of the vessel's last use cycle as *Waccamaw*, where the only specific information found was from contemporary newspaper articles and directories. This does not, however, detract from the model's interpretive value and it still represents an accurate reconstruction of the vessel through its stages of use. The interpretation of vessel's remains, and the determination of conversion features were similarly limited given the lack of constructional information specific to *Waccamaw* and its original hull construction. Furthermore, the site clearly experienced accelerated degradation since 1975. The wooden remains above the mudline in particular are reduced significantly, limiting the ability to interpret the vessel's construction based on what is exposed.

Future research into *Waccamaw* would therefore benefit from limited excavation to better understand the construction of mid-19th century double-ended ferries. There are few examples of this vessel type known in the archaeological record and there are limits to what is available in the

historical record as well. Trenches across the southern end post assembly, alongside the framing on the western wide, and along the centerline would provide construction information not readily available elsewhere. Regarding broader research interests, the use and reuse cycles of New York style ferryboats converted into gunboats for the Civil War would benefit from a more concerted look into their post war use. This would give further insight into whether the cycles *Waccamaw* experienced were common, and furthermore, whether post-war use patterns of ferries generally were commensurate with those of vessels in other temporal and geographical contexts. This would lend further credence to the behaviors noted in *Waccamaw* and may provide further clarification of how a vessel type influences the nature of a vessel's reuse when compared to other types.

To conclude, the life, deposition, and salvage of *Waccamaw* displays how the original design and material change of an artifact relays important information regarding the context in which it existed that is not readily available in the historical record. More importantly, it relays potentially generalizable information about human behavior given similar proximate historical stimulants. Techno-economic processes promoted the use of resource saving techniques and value maximization behaviors evidenced by the original construction, gunboat and post-war modifications, and its post depositional salvage. Techno-social processes were fundamental in determining the way the vessel was used and the location it was used in while reflecting perceptions of utility, protection, and luxury. Finally, the environmental processes worked on two levels. First, it influenced the decisions made on what construction features were needed to mitigate their effects, which in-turn influenced their next operational environment. Second, non-cultural processes were shown to be instrumental in the deterioration of site since its first archaeological recording in 1975. Ultimately, *Waccamaw* represents a highly versatile,

adaptable, and accessible vessel that proved useful in every season of mid to late-19th century American history.

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APPENDIX A: HISTORIC DOCUMENTS

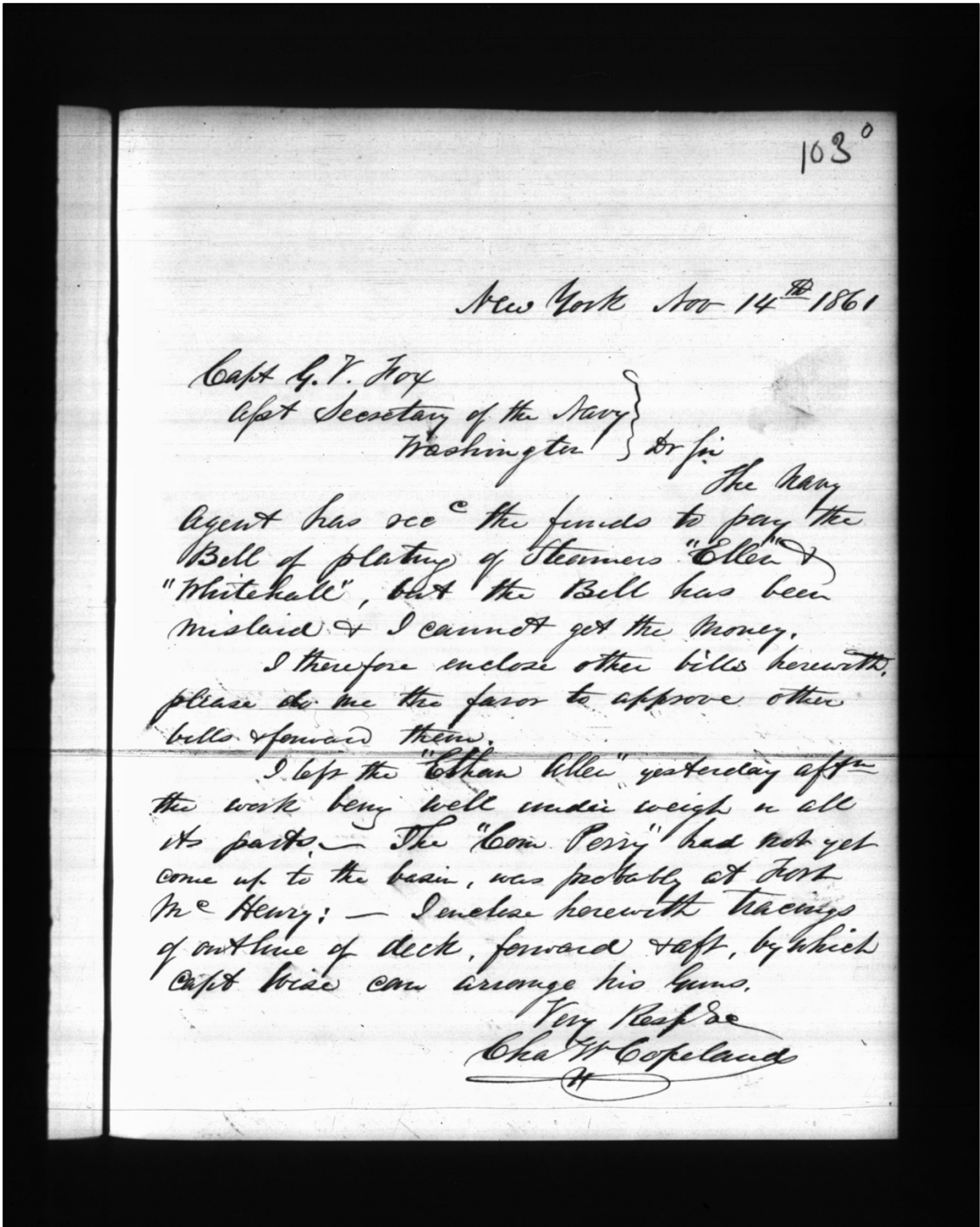


FIGURE 147. Chas W. Copeland letter; 14 November 1861: page 1. For transcriptions of Copeland (1861) and Copeland and Howe (1861a; 1861b) see Parkoff (2016:243-245; 247; 250-251) (image courtesy of the National Archives, Microfilm 124, Roll 390, Washington, D.C.).

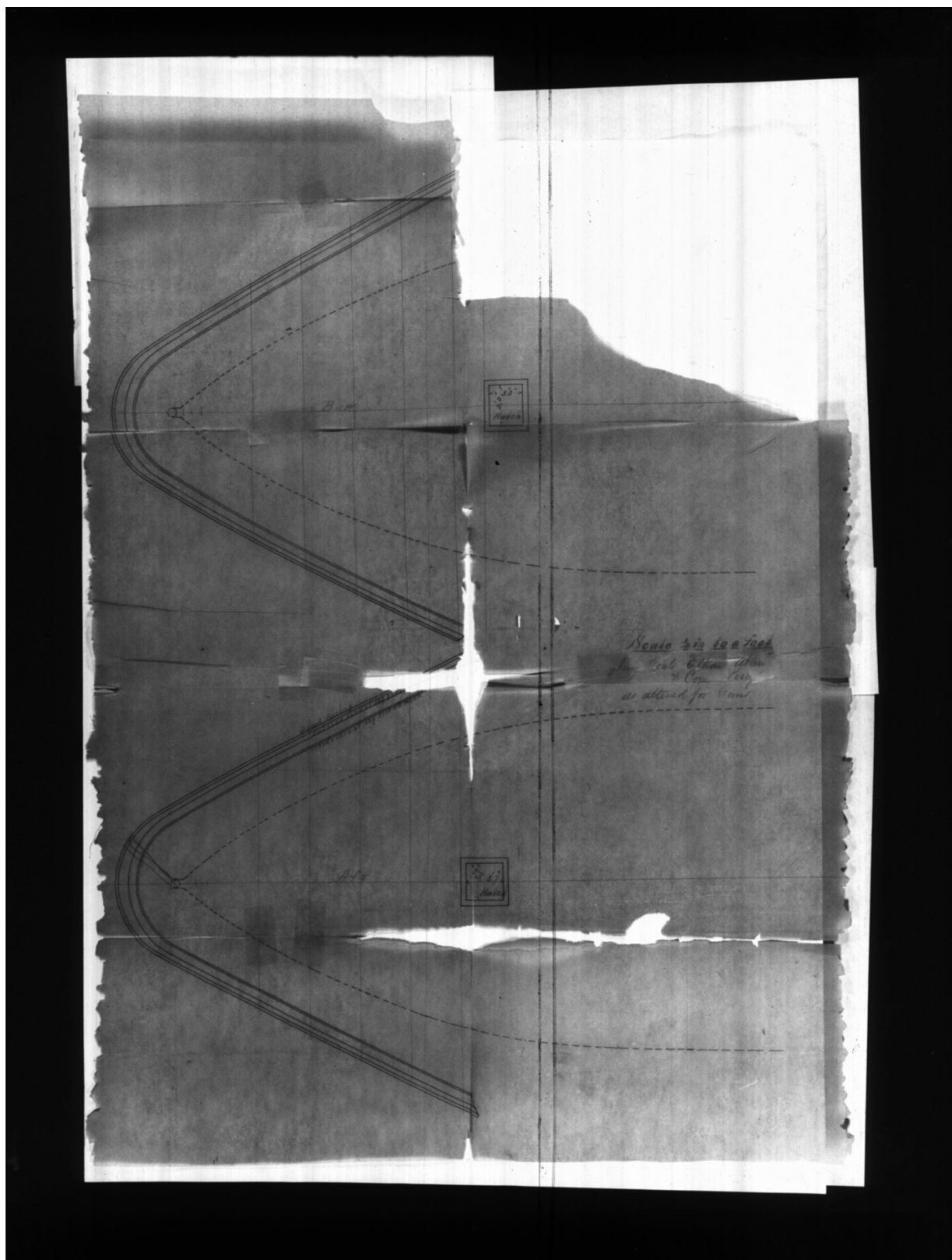


FIGURE 148. Chas. W. Copeland letter; 14 November 1861: page 2. Entitled, "Ferry Boats "Ethan Allen" + Com Perry" as altered for Guns" (image courtesy of the National Archives, Microfilm 124, Roll 390, Washington, D.C.).

New York Nov 14th 1861

Capt G.V. Fox
Asst Secretary of the Navy
Washington

Dr Sir

The Navy Agent has rec the funds to pay the Bill of plating of Steamers "Ellen + Whitehall", but the Bill has been mislaid + I cannot get the money.

I therefore enclose other bills herewith. please do me the favor to approve other bills forward them.

I left the "Ethan Aleen" yesterday afternoon the work being well under weigh in all its parts ~ The "Com Perry" had not yet come up to the basin, was _____ at Fort McHenry: - I enclose herewith tracings of outline of deck, forward + aft, by which Capt Wise can arrange his Guns.

Very Respse
Cha W Copeland

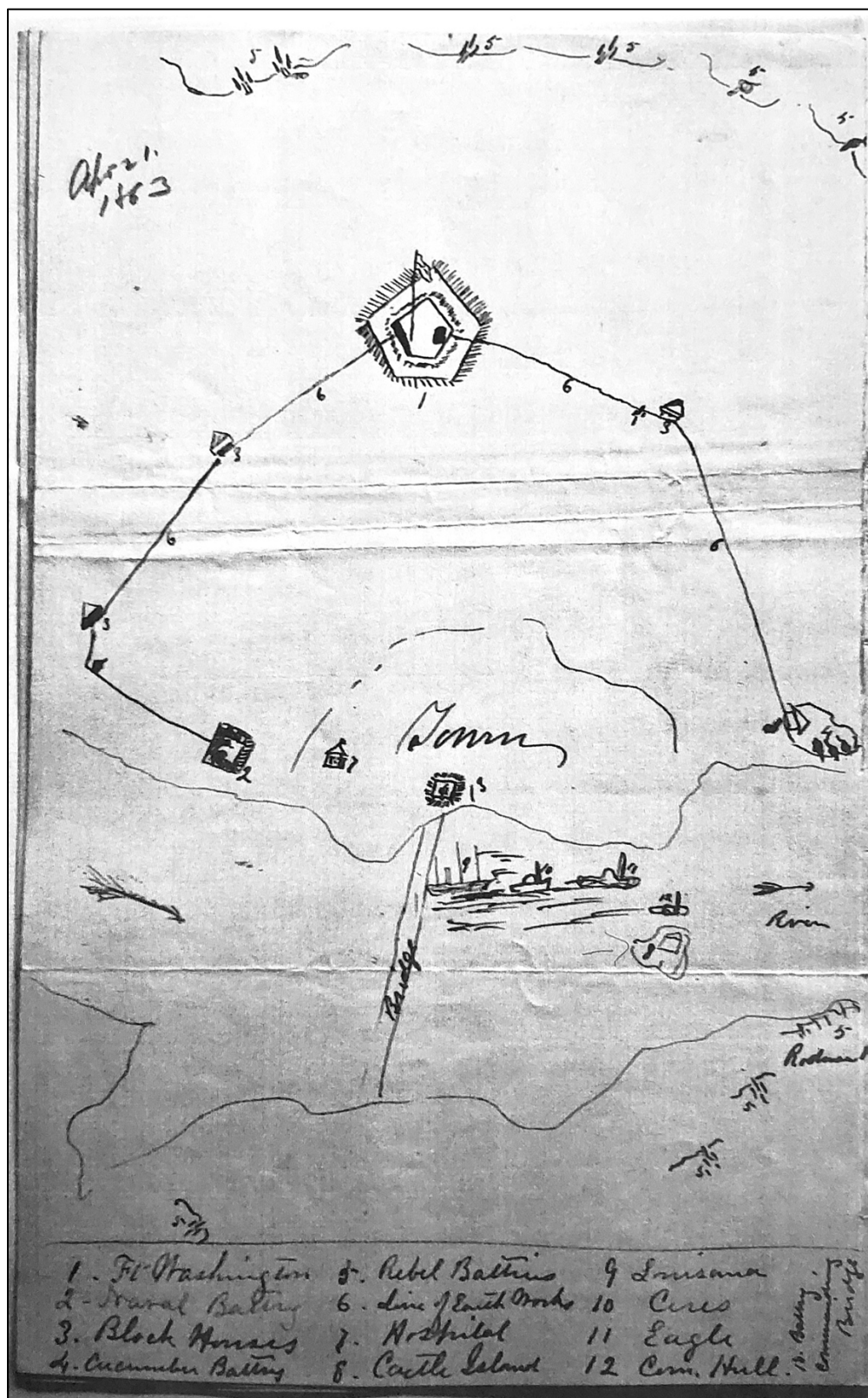


FIGURE 149. Sketch of Union and Confederate Encampments during the Battle of Washington, North Carolina; dated "Apr 21 1863". Note sketch of *Commodore Hull* (Number 12). Unknown Author (courtesy of the George H. and Laura C. Brown Library, reference # not established).

APPENDIX B: SITE FORMS



**ECU Program in Maritime Studies
Equipment Checkout Form**
(TO BE SUBMITTED TWO WEEKS PRIOR TO CHECKOUT)



1. NAME: Thomas Fossdick
2. EMAIL: Fossdick122@students.ecu.edu
3. PHONE: 540-414-3246
4. SUPERVISOR: Dr. Nathan Richards
5. PROSPECTUS ACCEPTED? YES ☒ NO ☐
6. PERMISSIONS: PERMIT #: _____

PROPERTY OWNER: _____

7. PROJECT TITLE/DESCRIPTION:

Photogrammetric Survey of Waccamaw located on the bank of Eagles Island, North Carolina in the Cape Fear River. This is a non-disturbance survey which will have the primary goal of collecting targeted photogrammetric data of the remains of the New York built ferry Waccamaw. Additionally detailed photographs & measurements will be taken of specific portions of the hull which may provide information regarding modification, salvage, environmental deterioration.

(LIST REQUIRED EQUIPMENT ON REVERSE OF THIS FORM)

8. PROJECT DATES: Oct. 27th, 2023
9. DIVE OFFICE APPROVAL NEEDED? YES ☐ NO ☒
10. DATE OUT: 10/27/23
11. DATE IN: 10/27/23
12. SIGNATURE (STUDENT): Thomas Fossdick
13. SIGNATURE (ADVISOR): Nathan Richards
14. SIGNATURE (STAFF ARCH.): [Signature]

RETURNED 10/30



ECU Program in Maritime Studies
Equipment Checkout Form
(TO BE SUBMITTED TWO WEEKS PRIOR TO CHECKOUT)



EQUIPMENT REQUESTED ROSTER

- ✓ 1. 9 Photogrammetric targets
- 3400 2. DSLR still camera w/ batteries x2, charger, monopod
- 10 - 3. GoPro w/ batteries x2, charger, selfie stick
4. 30m Keson measuring tapes x2
- ✓ 5. Rhino Ruler (inches & metric) x2
6. Scales: small, medium, large
7. N-Arrow x2
- ✓ 8. Site Bearing Compass x2
9. GPS - 665R
10. SD READER
11. 2 TAPE MEASURES
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____



ECU Program in Maritime Studies
Equipment Checkout Form
(TO BE SUBMITTED TWO WEEKS PRIOR TO CHECKOUT)



1. NAME: Thomas Fosdick
2. EMAIL: Fosdick+22@students.ecu.edu
3. PHONE: 540-414-3246
4. SUPERVISOR: Dr. Nathan Richards
5. PROSPECTUS ACCEPTED? YES ☒ NO ☐
6. PERMISSIONS: PERMIT #: NC UAB TO BE INFORMED (NO PERMIT NEEDED)
- PROPERTY OWNER: N/A

7. PROJECT TITLE/DESCRIPTION:

War-time Ingenuity in a New Era: The
Conversion of Civilian Ferries into Union
Gunboats

- Taking photogrammetry data {corentioned,
sealed photographs of the Waccamaw
site [UAB site #0001CFR] on the bank
of the Cape Fear River, Eagles Island.

(LIST REQUIRED EQUIPMENT ON REVERSE OF THIS FORM)

8. PROJECT DATES: June 30th, 2024
9. DIVE OFFICE APPROVAL NEEDED? YES ☐ NO ☒
10. DATE OUT: 6/30/24 11. DATE IN: 7/5/24
12. SIGNATURE (STUDENT): Thomas Fosdick
13. SIGNATURE (ADVISOR): [Signature]
14. SIGNATURE (STAFF ARCH.): _____



ECU Program in Maritime Studies
Equipment Checkout Form
(TO BE SUBMITTED TWO WEEKS PRIOR TO CHECKOUT)



EQUIPMENT REQUESTED ROSTER

- ✓ 98 1. Photogrammetry Targets x 9 NoA : 9
- ✓ 1 2. DSLR - Nikon D3400 ELER
- ✓ 1 3. - monopod
- ✓ 1 4. - batteries x 2
- ✓ 1 5. - chargers
- ✓ 1 6. GoPro Hero 10 Black
- ✓ 1 7. - Selfie stick
- ✓ 1 8. - batteries x 2
- ✓ 1 9. - chargers
- ✓ 1 10. Tape Measures x 2 - 30m Keson tapes ELER
- ✓ 1 11. GPS ELER
- ✓ 1 12. Rhino rulers - inches & metric x 2 ELER
- ✓ 1 13. North arrows kit - 1 small North arrow
- ✓ 1 14. Scales Kit - ✓
15. Machetes w/ lanyards x 3 1
16. ~~Storage crates x 2~~
17. _____
18. _____
19. _____
20. _____

Site: CFR-002-Uacanna Camera: DSLR Nikon D3400
 Name: Thomas Fossick & Chris Triplatt

bow
 8.43m
 Starboard
 10.17m
 Stern

Photo #	Description	Date	Bearing	Scale	By
1	Aft boiler	10/27	120°	50cm	CT
2	boiler hot air tube		120°		CT
3	" "		120°		CT
4	Stoke box		130°		CT
5	" "		130°	30cm	CT
6	Stoke box N		40°		
7	" "				
8	Stoke box W		305°		
9	" "		305°		
10	boiler hot air tube W		310°		
11	" "		310°		
12	Aft boiler W		305°		
13	" " W "		305°		
14	Port Mid Aft Funnels		160°		
15	" "		160°		
16	Port Mid Aft Funnels LS		40°		
17	" "		40°		
18	Port Side Wheel ES		125°		
19	" " ES		125°		
20	" "		50°		
21	" "		50°		
22	" "		245°		
23	" "		245°		

max breadth: 12.9m
 w/ pabble
 hull breadth: 8.6m

Length: 41.5?
 can't find
 definitive
 marker for stern

