Reconstruction of the Tranter's Creek Vessel and Investigation into Its Sinking

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ABSTRACT

The Pamlico River begins about half a mile upstream from Washington, North Carolina where Tranter's Creek flows into the Tar River. In the mouth of Tranter's creek, the remains of a vessel lie on the bottom. This vessel is a mystery: the name and the type of vessel are unknown, as is the date and reason for its sinking. This thesis explores these questions with an emphasis on a conjectural hull-form reconstruction and a timeframe for when it sank. This thesis is the first step in building a database of reconstructed North Carolina wrecks and abandoned vessels. Four feasible hypothetical models of the hull form of the Tranter's Creek Vessel were constructed for this project. Basic analyses including tonnage and primary hull coefficients were performed on the models. The study was not successful at identifying the vessel but did discover that it is likely the vessel was sunk in its location as a river training structure for the navigable channel of the Tar-Pamlico River. This suggests the vessel may have never been complete enough to name, particularly with the current lack of evidence of use in a systemic context. Another aim of this project was to assess the accuracy of goniometric measurements in adverse water conditions

(low to zero visibility in this case), particularly in regard to building viable models from those measurements. Being able to develop a plethora of viable models which had to be narrowed down to four indicates strongly that not only is goniometry sufficiently accurate in low-to-zero visibility conditions, but that hull reconstructions from partial, unraised archaeological remains are useful as well. Goniometry would be particularly good for rescue archaeology on low-visibility sites. This study concludes that more reconstructions of this and as many other North Carolina "wrecks" be made to advance the overall study of local vessels, shipping, and communities.

Reconstruction of the Tranter's Reconstruction of the Tranter's Creek Vessel and Investigation into Its Sinking

A Thesis

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The author would also like to thank Richard Schaeffer, head of copy editing at the Society for Historical Archaeology and Research Director and Senior Historian Historical Perspectives, Inc. Dr. Schaeffer's assistance in properly citing some of the more complicated sources used in this thesis has been invaluable.

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Introduction and Background

Some academic projects are meticulously planned and precisely executed on a very strict, nigh-inflexible framework toward a specific, unchanging goal. Every step is pre-planned and calculated to help prove a certain hypothesis, or to prove the need for the authorization of funding or further research on a study. Other projects by necessity must be more flexible. They begin with a goal and then outside factors force changes in the goals, and sometimes the evidence – or lack of it – forces a study to move in unforeseen ways.

This thesis is of the latter.

A thesis focusing on a vessel reconstruction had been planned since late 2019. Discussions on possible vessels that would be a good subject for a full reconstruction were underway by early 2020. In the middle of these discussions, the world went into lockdown as COVID-19 spread across the globe. Every idea that had been under consideration had to be abandoned because fieldwork was impossible, and there was no way to predict when the freeze on field archaeology might lift. The vessel chosen for this project– referred to in the study as the Tranter's Creek Vessel or TCV – is one that sank at the confluence of Tranter's Creek and the Tar-Pamlico River, Beaufort County, North Carolina, just upriver from the town of Washington, North Carolina (Figure 1). Officially named site 0003TRR (Alexander, et. al.2014:3) it was selected because it was decided that it was "COVID-proof"; enough archaeology had been done on the site that a viable reconstruction was believed to be possible without further archaeological fieldwork. This proved to be true, and the result is this thesis.

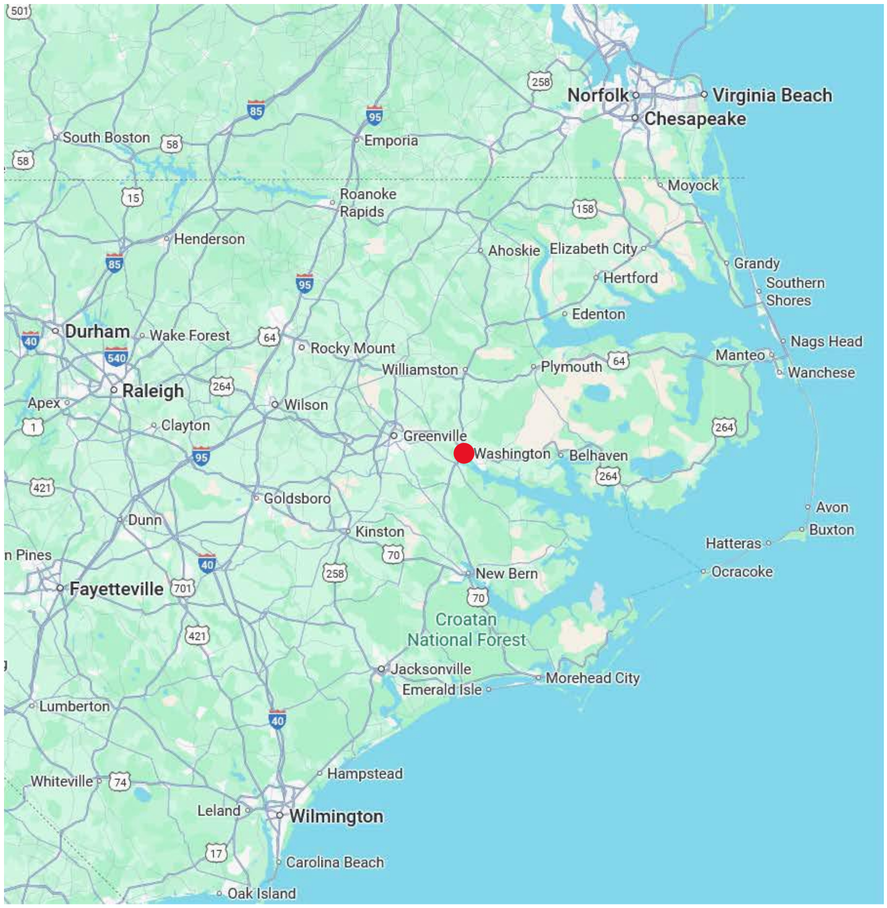


Figure 1. Geographical situation of Washington, North Carolina. Washington, North Carolina (red dot in the center of image) and its geographical relationships to Wilmington (south) and Raleigh (west), North Carolina and Norfolk, Virginia (north by northeast), Pamlico Sound, and the Atlantic Ocean (east) (Courtesy Google Maps 2025).

The reconstruction and hydrodynamic analyses of the vessel are the core and primary purpose of this study. Led by the results of that reconstruction, it was hoped that the vessel could be identified and a reason for sinking determined as a secondary general purpose of this study. This is indeed what happened, at least in part, though the conclusions the evidence led to were not entirely what was expected. The result is a useful, albeit still incomplete understanding of the vessel at site 0003TRR.

There were five sources that formed the foundation of this project. Without these specific sources this project may not have been completed. The most critical source used was the report of the 2014 East Carolina Field School that studied site 0003TRR. This was the source for all measurements and construction information on the vessel. It was not the only source used in the reconstruction; drawings of vessels determined to be comparable in shape and proportion were also used to inform the models. However, the field school's work was the foundation of this thesis and was invaluable in identifying and choosing those comparable vessels.

In investigating the identity of the vessel and the cause for its sinking, *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* and *Official Records of the Union and Confederate Navies in the War of the Rebellion* were the foundational sources. It was hoped they would reveal either the name of a vessel that sank there during the war or mention that there was a wreck there already, but this was not the case. Ironically, but most usefully, it was the lack of information of any wrecks from these exhaustive sources that helped guide the identification portion of this project.

With the help of Mr. Stephen Farrell of the Brown Library, Washington, North Carolina, what is thought to be the earliest map marking the wreck site was found. This map was crucial to dating the wreck when combined with the "negative space" from the Civil War documentation. Having this date allowed for a more focused and specific set of search criteria for the attempt to identify the vessel as well as aiding in the reconstruction itself. This was the most important source for this project after the field school data.

The last of the core sources was the United States Army Corps of Engineers' Annual Chief's Reports. These reports mention river improvement projects on the Tar-Pamlico River and may have led (had the Corps of Engineers responded to inquiries) to detailed information that could have definitively proven the wreck's year, type, and name if it had one. When combined, these five sources led to other, corroborating sources and gave direction and refinement both to the reconstruction and on what to investigate further or abandon.

This thesis is structured into five chapters with multiple subdivisions.

Chapter One of this project is the **Introduction**, which includes not only the opening remarks, but three background sections. *Research Questions and Archaeology* provides a discussion of what the research questions and goals for the project were at the start with broad overview of the techniques the field school used. *Comparable Vessels* explains the concept and reason for their use on the reconstructions. *Historical Background of Washington* is a brief history of the town from 1771 to the early 20th century. The focus in this section is the shipping and shipbuilding of the town and the events of the Civil War and how they impacted Washington through the second half of the nineteenth century. This is to provide context.

Chapter Two is **Archaeology, Theoretical Framework, and Methodology**. The first of its two sections describes the 2014 Field School. This section covers all the archaeological information from the site used in this study and is divided into three subsections: "Overview," *Construction of the Vessel*, and an explanation of *Goniometry*. The remaining section is *Theoretical Frameworks* discussing the Philosophy of Shipbuilding and Abandonment Theory.

The third chapter, **Reconstruction of the Vessel**, is the central chapter to this project. Its first section, *Software Used*, is a brief overview of the CAD and analytical programs used for the reconstruction. *Preliminary Modeling* describes the process of building the first model (presented at the 2022 North Carolina Maritime History Conference). *Creating the Final Models* and its four subsections Addressing the Sternpost, Developing the Narrow Beam Models, Developing the Broad Beam Models, and Modeling the Transoms for all Models describe the process for developing the preliminary model into the four finished models used in this thesis. *ORCA Analyses* relates the findings of analyzing the reconstructed hull forms in ORCA 3D.

Chapter Four, **Investigating the Wreck and Suspected Post-Abandonment Use**, is a single section. This chapter discusses the research and theories about what the vessel is and why it is there – and why a name for the vessel is still unknown at the time of this writing. The chapter also details what the author currently believes is the most likely timeframe for the vessel's sinking and reason why the vessel is in its current location.

The final chapter, **Conclusions, Discussion, and Further Research** is of three sections. *Re-examining the Research Questions* does exactly that; it discusses the findings and alterations to the original research questions. *Future Research Opportunities* is a discussion on avenues of research that will hopefully be pursued in the future, followed by brief *Closing Remarks.* Two appendices follow the thesis: Appendix A is the goniometry table from the field work and Appendix B is the full summary tables generated by the ORCA analyses of the hulls. Only the summary tables are in Appendix B because they contain all pertinent information to this study that ORCA generated.

Research Questions and Archaeology

The primary goal of this project was to produce an analyzable, plausible reconstruction of the Tranter's Creek Vessel. The primary question this thesis seeks to answer is: what was the hull form of the vessel? With this question answered and the vessel's hull reconstructed, four sub-questions were answered: What were the approximate shape, dimensions, displacement, and hydrostatic properties of the Tranter's Creek vessel when afloat? With these questions addressed, the question of the vessel's likely intended operating environment and function was answered. The purpose of the reconstruction is not to provide conclusive answers, but to take a first step in building a database of reconstructed North Carolina wrecks/abandoned vessels – a database that is sorely needed for the study of North Carolina vessels.

There were a set of secondary goals with more questions that this thesis hoped to answer. These are less critical than the reconstruction at this stage but will be relevant to future research. The foremost of these was trying to find the name of the vessel and why it sank. The details of why no name was found will be addressed later and are related to the author's theory of why the vessel sank where it did and when. This study will also discuss how close to true-life accuracy can be expected from data recorded in the field in low-visibility conditions as opposed to fully excavated, raised, and conserved artifacts that can be reexamined for years. That leads to this study's final question: what are the implications of all this for future excavations, methodology and studies?

The recording methods used by the 2014 East Carolina University field school, the results of which are the foundation of this reconstruction, were a combination of archaeological techniques, all of which were negatively impacted at times by low visibility at the site. The archaeology team used photography and both baseline-and-offset and goniometer measurements to create scale maps and drawings of the Tranter's Creek Vessel. The drawings and the goniometric tables generated by the measurements were the primary data for the reconstructions used in this thesis. This data was then plotted into a digital modeling environment (also referred to as "virtual space" or "virtual environment" in this thesis) using the drafting program Rhinoceros 3D. Once all the data was plotted in the virtual modeling environment, there was still missing information. This information was filled in by a combination of data from comparable vessels, trial and error to see what worked with the data as well as what worked with the software, what seemed most likely based on known North Carolina vessel data, and informed guesswork. This data on known North Carolina vessels is largely from a database of thousands of registered vessels built in North Carolina. The database was compiled by the late Dr. William Still and is based on the vessels' registration records rather than field recordings. While useful, the database also left other questions unanswered which will be discussed toward the end of the paper. Once viable models were built, the hulls were analyzed by ORCA 3D, an add-on program to Rhinoceros that analyzes the hull form to provide information such as tonnage, waterline, various hydrostatic coefficients, and other information not relevant to this study.

Comparable Vessels

Due to the deteriorated condition of the TCV, comparable vessels had to be used to help "fill-in" gaps in the data. Once the goniometer data had been plotted, the general curvature of the turn of the bilge was looked at. The TCV goniometer data suggested a broad, flattish bottom, so vessels resembling that shape with similar proportions were considered. Flat-bottomed vessels often operate in shallow waters, which makes sense given where the wreck is located; the North Carolina sounds are a generally shallow water environment, extremely so in some areas. Since no reconstructions of larger North Carolina vessels and lines drawings of them have proven elusive, vessels from the Chesapeake Bay (a similar shallow-water environment) were chosen as the best comparable option. It is the closest option both in similarity and geographical proximity; comparable vessels should come from the nearest environment in both senses (Stewart 2022, pers. comm.) The actual vessels chosen for this are discussed below.

Historical Background of Washington

In 1771, planter James Bonner was granted permission to found a new town at the Forks of the Tar (Saunders 1890:152). Bonner wisely chose location just below the point at which most coastal vessels could proceed no further upstream into the region where the Pamlico River becomes the Tar River (Paschall 1976:2). The new town was laid out in half-acre lots and grew quickly (Worthy1976:8). The town was referred to as "Washington" for the first time in a document in Halifax , North Carolina dating to 1776 (prior to this it was called "Forks of the Tar") and consisted of sixty lots and a church (Paschall 1976:2; Snyder 2005:22). That same year, the locally prominent Blount family outfitted and launched four privateers against British shipping in support of the American Revolution (Edwards 2015:16). It appears these privateers were not very successful, as at least two of them were captured, though there is a New Bern record of one prize from an unnamed privateer being taken to Washington (Edwards 2015:16 referencing the Coor Letter to Governor Burke 1781).

In 1783, the post road that ran south to New Bern was shifted west to run through Washington. It had previously run through Bath, requiring travelers to turn east and proceed south via a ferry across the Pamlico River. The shifting of the road to the narrower crossing of the Pamlico at Washington facilitated faster travel between Elizabeth City and New Bern overland (Paschal 1976:3). This helped stimulate even more growth in the already prosperous little town. That year, Johan David Schoepf, a German traveler heading south from New England, spent adequate time in Washington observing the town and its patterns and remarked that the "primary industry…is shipbuilding…" He also described the cyclical trade between Washington and several New England ports. In the fall, New England vessels would arrive in Washington bearing "…cider, cheese, gingerbread, apples, rum, sugar, iron-ware, and trinkets." These ships would spend the winter in the south, and head north out of Washington loaded with "…pelts, pitch, tar, and the like." Schoepf attributes much of this trade to the numbers of New Englanders that had settled themselves in the Washington area (Snyder 2005:23; Schoepf 1911:125). It is actually Schoepf's observation on the maritime trade which is more important, as even at the shipbuilding industry's peak, it was never truly the "primary industry." However, maritime trade, via local vessels or outside vessels, was the lifeblood of Washington from its start. Schoepf's observations suggest a robust coastal trade well before the end of the Revolution, and the Blounts' records indicate Washington was already part of trade networks stretching from the Caribbean to Italy (Edwards 2015:28). Between 1785 and 1788, one of the Blount brothers toured Europe establishing contacts and connections for their Washington-based trading company (Edwards 2015:17). It appears that Washington shipping had a long reach.

The tireless work of internationally-minded merchants like the Blounts bore fruit for Washington. In 1783, Washington was finally granted its articles of incorporation (Paschall 1976:2). Another of the Blounts introduced legislation to have the Beaufort County seat moved from Bath to Washington, which was finalized in 1785 (Edwards 2015:40). By 1789, Washington had a comparable population to both New Bern and Wilmington (Edwards 2015:18). Washington was given federal status as one of the five federal collection districts in North Carolina and was made one of three federally-authorized North Carolina ports of entry in 1790 (Snyder 2005:24). The Washington customs house reported 130 vessels entering the town in 1796 (Worthy 1976:11). The town was growing in size and prosperity, and "By 1800, the pattern of Washington's business and social life had been set and for the next 60 years…" (Paschall 1976:5)

Washington kept growing as the nineteenth century dawned. The period leading up to the War of 1812 was prosperous, but understandably, stagnated during the war. However, in 1812, the Fowle brothers from New England moved to Washington, and they would have an impact on the area for decades (Worthy 1976:10). By 1818, the Fowles had established a shipyard on Castle Island, and so were directly adjacent to the Washington waterfront, with river channels on either side of the island (Worthy 1976:11). Washington was significant enough that in 1825, the

Marquis de Lafayette visited the town named after his friend and mentor (Worthy 1976:11). In the 1830s, lumber mills and turpentine distilleries were built in and around Washington, and ship construction increased, stepping up dramatically in the 1840s and reaching its pre-Civil War zenith in the 1850s (Worthy 1976:11; Snyder 2005:26). Trade increased as well. Flats and barges plying the Tar River as far upstream as Tarboro brought goods and materials from the interior, some of which were processed in Washington before shipping while others were shipped out as soon as they arrived. Other goods presumably came down Tranter's and Bear creeks from the various plantations and mills on those navigable streams (Bridgers Jr. 2013:212-214). Enough commerce came down Tranter's that in 1829, a "Bill to incorporate a company to improve the navigation of Trantors [*sic*] Creek from Meyers Mill in Beaufort County to its headwaters" was put forth (Bridgers Jr. 2013:215).

The Fowle brothers built a prosperous international shipping business that competed with and complimented established merchants such as the Blounts (Paschall 1976:5). Washington merchants were not the only shipping interest represented in Washington. One resident remembered during her childhood in the 1850s seeing sailors from New England and Europe in Washington, recalling that the Portuguese sailors were particularly common (Meyers 1976:36). In 1857, the United States experienced a major recession. Most of North Carolina was minimally affected by it, but due to the intensity of Washington's shipbuilding and trade connections, it was hit hard. The 1850 federal census listed twenty-three ships' carpenters in Washington (free carpenters; enslaved carpenters were not counted). By 1860, that number had dropped to only five. Shipbuilding all but stopped, though Washington's yards and three marine railways stayed solvent with repair work (Still 1981:36-37).

Washington had not yet recovered from the recession of 1857 when the Civil War began in 1861, and the opening of hostilities dealt the town an even worse blow. Immediately, the shipping firms in Washington lost their trading connections in the North and almost as immediately began losing their trade to Europe and the West Indies as the Union blockade began to coalesce (Still 1981:37). In 1861, the Washington shipyard of Joseph Farrow had begun a sixty-foot schooner and two gunboats contracted by the Confederacy. Later that year the Confederate Navy ordered two more warships from Washington Yards (Still 1981:37).

Washington was a gateway position to Norfolk, Portsmouth, and Richmond Virginia due to the sounds and the canals that connected them to the Elizabeth River that flowed past Norfolk into the James River and then into the Chesapeake. As soon as North Carolina joined the Confederacy in 1861, state officials began planning the defense of the North Carolina coastline.

Their strategic view centered on the sounds and coastal plain as the extreme flank of Southeastern Virginia's defensive complex. The Confederacy's ability to move large numbers of men by water into Suffolk, the city of Chesapeake (adjacent to Norfolk), and Norfolk itself from the Albemarle Sound via the Dismal Swamp Canal and the Albemarle and Chesapeake Canal were deemed crucial to the defense of Norfolk and Richmond (United States War Department 1882:682). The nearby rail hub at Kinston linked into "the great railroad from Richmond to New Orleans" (United States War Department 1882:682). Control of the rail lines meant troops could be rapidly shifted hundreds of miles north or south. Little Washington's proximity to Kinston meant that it was either a bastion of security or of threat to the rail lines, depending on who held it. Washington was a surprisingly strategic place to both Union and Confederate aims. The ports needed to be kept open and Washington was still one of the most important ports in North

Carolina along with Wilmington, Elizabeth City, and New Bern; all of which were part of the greater defensive and supply complex of Southeastern Virginia (Quarstein 2021).

The first Union attack on Washington occurred on March 20, 1862 (United States War Department 1883:269). It appears that this was a raid, but by the end of the month, Federal forces had returned to occupy the town (United States War Department 1883:385). The schooner on the stocks was completed by freed black carpenters for the Union Navy. One of the two gunboats was still on the stocks and destroyed there. The other incomplete gunboat had been launched and towed upstream but was burned by the retreating Confederates to prevent it from falling into Federal possession (Still 1981:37-38). Later in 1862, the Union Army gunboat *Picket* blew up at Washington (Warren 1976:40). Union and Confederate raids went back and forth multiple times in 1862, one Confederate raid carrying off "four old brass 6-pounders that were captured by us [Federal forces] at New Berne [*sic*]" (United States War Department 1887:4; 7; 8; Warren 1976:38). During this time, Union gunboats plied up and down the Pamlico into the Tar. Intentional obstructions in the Pamlico are mentioned sporadically throughout the year's military correspondences, mostly during the Siege of Washington and are visible on the map below (United States Naval War Records Office 1899:656, 658, 660-661, 668, 676-677, 685-688).

The first skirmishes of the "Siege of Washington" began on March 30, 1863. This was a concentrated push by Confederate forces to retake the town and lasted more than two weeks, ultimately ending in their failure to re-capture the town (United States War Department 1887:211-217; 218-219). Local tradition in Washington holds that Union troops had word of Confederate forces building fireships that were going to come down from Tarboro to try and dislodge them as part of the siege, though the fireships never materialized (Stephen Farrell 2023, pers. comm.). As a result of the siege and the constant threat of further action by Confederate forces (real or rumored), Washington was fortified significantly.

By 1864, Washington had become less important strategically. As the Union blockade became increasingly effective over the course of the war, with Sherman's forces burning through the southeastern section of the Confederacy and advancing toward North Carolina, and Grant's forces encircling Petersburg and Richmond, the Union had a decreasing need to hold Washington. After the fall of Plymouth, North Carolina (on the Roanoke River) on April 20, Union leaders decided to abandon Washington to the Confederates. Confederate forces besieged the town April 27, a day after Union forces received the order to evacuate (North Carolina Department of Natural and Cultural Resources 2016). Union forces withdrew from Washington on the afternoon of April 30, 1864, burning the town in the process (U.S. Army staff believed it was intentional vandalism by enlisted U.S. troops) and the town was re-occupied by Confederate forces (United States War Department 1891:311-312).

Reconstruction was a difficult time for Washington. The 1870 Census lists only the Farrow shipyard as still in operation (Still 1981:39). Shipping began to recover faster than shipbuilding, however. The herring and shad still ran in the late winter, the trees still yielded lumber, tar, and turpentine, and while new, locally-built vessels may have been rare for most of Reconstruction, there was still demand for the goods that could be shipped out of Washington. A steamer built in 1860, *Cotton Plant*, had returned to the area and was beginning to make regular runs between Washington and Tarboro by the end of 1866, and around the same time, there were steamers beginning regular routes between Norfolk and Washington (*Tarboro Southerner* 1866:2, 3). In 1874, the first recorded post-war ship was built in Washington: an 80-foot paddlewheeler commissioned by Old Dominion Steamship Company (Still 1981:39). Many more ships ordered by non-local interests would follow over the decades.

Outside interests had moved into the area after the war, and the Jamesville and Washington Railroad and Lumber Company (incorporated 1869) was created primarily to harvest the prime forestland the area had to offer. Washingtonians were not interested in the logging operations of the "Yankee enterprise" until 1877 when the company was granted right-of-way through the town to the waterfront (Worthy 1976:66). The company built a narrow-gauge rail line and was the first foray of railroads running into Washington; it would be years before a full-gauge line would run through the town. Interestingly, the railroad helped increase Washington's importance as a shipping hub and boosted construction of new vessels. Washington's mercantile zenith, as remembered by some locals, was from about 1895 to 1920 (Ellison 1976:91).

In the 1870s, Washington began to grow as a major shipbuilding town again. It was not local shippers looking for vessels, however; this time it was companies from outside the area. Old Dominion Steamship Company, Norfolk and Southern Railroad, and other such companies contracted Washington yards to provide them with new, typically steam-powered, and later, gasoline-powered vessels, though sailing vessels seem to have still been in some demand. Washington was a cost-effective solution for companies that needed to rebuild or update their fleets after the economic difficulties of the previous twenty years. While construction of wooden vessels declined in other areas, it was growing faster than ever before in Washington. In the first half of the 1890s, the total tonnage of ships being constructed in Washington eclipsed the town's pre-war peak in the 1850s. Still reports (as did some locals he spoke to) that the town's slow decline in shipbuilding began about 1895 until the United States' entry into World War I. However, repair work remained in high demand as late as the 1930s. With the decline in the use of waterways as the primary shipping routes as more rail lines were grafted into the network, more roads for automotive traffic became available, and a recession in 1920, shipping and the town's importance as a supply hub declined into effective non-existence (Still 1981:40-48).

Chapter 2

Archaeology, Theoretical and Methodological Framework

2014 Field School

Overview

The proper name for the Tranter's Creek Vessel is its site name: 0003TRR and it has been the subject of multiple underwater archaeological projects by East Carolina University and other agencies. An East Carolina University (ECU) field school lasting three weeks from the end of May into June 2014 documented the vessel and its site. The field school was led by Dr. David Stewart, Dr. Jennifer McKinnon, and Dr. Calvin Mires (Alexander, et. al.2014:3). The stated purpose of the 2014 field school was: "…to create an updated site map and establish a more thorough understanding of the construction of the vessel…" (Alexander, et. al. 2014:3).

The recording methodology of the 2014 field school used photographs, scale drawings and baseline and measurements to document the hull structure. To record the hull shape, measurements were taken by a device called a goniometer. All measurements were in metric and drawings done in a 1:10 scale (Alexander, et. al. 2014:9). The field school struggled with the water conditions, however. The site is located in a "blackwater" area meaning the water is stained by tannins leaching out of oak and other tannin-rich trees into the water, giving it a dark, visual quality akin to beef broth. The silt on the riverbed is very fine, ranging between 20 to 40 millimeters deep, sitting on a black, clay-like mud. This was easily disturbed, obscuring visibility to a meter or less, forcing "…a large portion of the work [to be done] by touch only" (Alexander, et. al.2014:10).

To create the updated sitemap to the chosen scale, target areas were induction-dredged 30 to 60 centimeters deep to clear off as much of the bottom material as possible, and then the site was measured using offsets from a 48.80-meter baseline oriented to 250 degrees on the compass, running along the spine of the vessel (Alexander, et. al.2014:11-12). The archaeology team sifted the dredge spoil through a 6mm screen which found metal fasteners and wood fragments. The wood found in the dredge spoil was deposited at the 45-meter mark on the baseline, moving it well aft of the vessel itself (Alexander, et. al.2014:12).

Mapping of the site was done by measuring offsets from the baseline. Students in the field school divided up into teams responsible for 2-meter sections of the baseline with a few teams being given a specific spot of interest on the vessel so as to record that part in greater detail rather than mapping. The maps were drawn at a scale of 1:10 on mylar sheets. Each team's map was "collated" with all the other sections of map and drafted into a "unified site map…" (Alexander, et. al.2014:12). Annotated drawings of the ceiling planks were made after the successful removal of the planks from the wreck. The profile drawings of the bow and stern were done using vertical offsets to obtain measurements, rather than goniometer readings; the same 1:10 scale was used for these drawings (Alexander, et. al.2014:12).

At the conclusion of the field school, all artifacts not being preserved and taken for further study were put back onto the site. The planks and other timbers were affixed to the wreck again, and all evidence of the archaeological work was removed except for the identification tags the students had attached to the various timbers (Alexander, et. al.2014:14-15). Aside from the odd pleasure-boat hitting the wreck, this is how the site has been left.

<u>Construction of the Vessel</u>

The fasteners used on the TCV were a combination of square iron nails and spikes, round iron bolts, and treenails. The field school did not get a length measurement from any complete fasteners. The spikes on this vessel are 1 centimeter in cross section and "up to" 10 centimeters long (Alexander, et. al.2014:20). The last 1 to 2 centimeters of the nails tapered to a point "a few millimeters thick" (Alexander, et. al.2014:20). The iron bolts are reported by the field school to be the most commonly used type of fastener for the centerboard trunk (Alexander, et. al.2014:20). The bolts average 35 to 55 centimeters long and 2 to 3 centimeters in diameter. In the stringers, the bolts were usually paired (Alexander, et. al.2014:20). The treenails were described in the archaeological report as wood treenails wedged with an iron wedge, though it may have been discolored hardwood (Stewart 2025 pers. comm.). Treenails averaged around 3 centimeters in diameter and the wedges were about 0.5 centimeters thick (presumably at the thicker end) (Alexander, et. al.2014:20). Once saturated, the treenail expanded, making a tighter seal to the plank it was driven thorough, and tightening around the wedge (Alexander, et. al.2014:20). Treenails were used on stringers, frames, and ceiling planks (Alexander, et. al.2014:20). They probably went through to the hull planking as is discussed below.

The field school defined the bow section as: "…the existing structures forward of the 14m mark on the baseline to about 10m" (Alexander, et. al.2014:15). The actual structure of the bow is broken off the main body of the wreck between the forwardmost preserved frame (SB50) and the stem (Alexander, et. al.2014:15). The keel, keelsons, frames, and ceiling planks all survive into this section, providing a good deal of data about the bow, even with the incomplete stem (Alexander, et. al.2014:15).

The keel of the vessel was largely intact and exposed at the 10 meter mark of the baseline. The keel had a sided measurement of 52 centimeters, moulded of 25 centimeters and is 22 meters in total length. It is rabbeted to accept the garboards (Alexander, et. al.2014:15). The total number of sections that make up the keel is unknown, as most of it remains buried. In the exposed section at the 11.90 meter mark there is a scarf joint, L-shaped on the top and Z-shaped on the side (Alexander, et. al.2014:15).This is the point at which the keel begins to curve upwards into the stem, but no part of the keel or stem survives above the level of the keelson, and it only survives to between 1.3 and 1.4 meters forward of SB50 (Alexander, et. al.2014:15). At a point 40 centimeters forward of SB50, there is a rectangular notch “35cm by 10cm deep” cut into the keel (Alexander, et. al.2014:15). The field school assessed the notch as being too shallow to be for receiving a frame and describe its purpose as “unknown” (Alexander, et. al.2014:15-16). A keel shoe (an outer, sacrificial layer on the bottom of the keel) is attached to the keel but is broken off (Alexander, et. al.2014:16).

The TCV has one keelson and three sister keelsons surviving; two sister keelsons on the better-preserved starboard side and one to port (Alexander, et. al.2014:16). It likely had two sisters to port, with the second one being destroyed over the years. All the keelsons have vertical iron fasteners driven through them tying them to the frames with the keelson also being attached to the keel by these fasteners. The sister keelsons have horizontally-driven iron fasteners which fix the starboard sisters to each other and then to the main keelson. The port sister keelson is fastened to the keelson with horizontal iron fasteners as well, but the report is not clear if any of the fasteners from the starboard sisters reach through to the port keelson. There is evidence in the form of fastener holes that suggest a second port sister may have once existed. The port keelson and main keelson “sit together with a ‘Z’ scarf” (Alexander, et. al.2014:16). No mention is made of either of the starboard sisters doing this, or any other information about the scarf. The bow section of the keelson has two mortises present, which the report interprets as maststeps. (Alexander, et. al.2014:16). However, they cannot accurately be called maststeps at this time, as there is insufficient evidence of their purpose (Stewart 2025 elec. comm.). There is a notch on the keelson to accommodate a centerboard trunk to allow the pivoting centerboard to pass between the keelson and the starboard sister keelson (Alexander, et. al.2014:16).

Much of the sternpost is well preserved but does not survive to the transom. It has broken off the spine of the TCV, but still sits upright, angled slightly to port (Alexander, et. al.2014:16). The sternpost consists "…of three vertical timbers 25cm wide" (Alexander, et. al.2014:16). These are all set into a notch in the keel "which is 15 centimeters molded and 10 centimeters sided" (Alexander, et. al.2014:16). The keel comes to a square cross section at its aft end changing over to a skeg after the end of the keel (Alexander, et. al.2014:16). There are three surviving iron gudgeons on the sternpost, with one about 25 centimeters above the silt of the river bottom (Alexander, et. al.2014:16). The hull planking is flush with the rabbeted sternpost and sits in the rabbet of the upper face of the keel (Alexander, et. al.2014:16). The planks are fastened to the inner sternpost with iron fasteners (Alexander, et. al.2014:16).

The vessel has thirty-three surviving sets of frames, with the best preservation on the starboard side of the vessel. The forwardmost is frame 50 (SB50) and the aftermost is frame 83 (SB83). The frames on the starboard side have surviving futtocks on some frames in addition to the floors (Alexander, et. al.2014:16). The floors cross over the keel as a continuous timber, between the keel and the keelson. The futtocks are separate timbers, alternating fore and aft of the floors in "frame sets" (Alexander, et. al.2014:16-17). The frames are attached to the hull planking, stringers, and ceiling planking with a combination of wedged treenails and iron fasteners (Alexander, et. al.2014:17). On the starboard side, frames 70 and 74 have treenails through the molded sides, the treenail in frame 74 is wedged on the aft-facing surface. These are the only known examples of this on the TCV, but there may be others missed due to the poor visibility (Alexander, et. al.2014:17). The frames vary in size. Floors range between 15 and 20 centimeters, tapering to 12 to 20 centimeters toward the ends of the floors. The sided measurements of the floors do not appear from the field school report to have a taper, and range between 10 to 20 centimeters. The futtocks average 10 to 14 centimeters sided, but no molded measurement is given in the field school report (Alexander, et. al.2014:17). The distance between the floors range between 25 and 55 centimeters and spacing between the frame sets at the futtocks is 15 to 50 centimeters (Alexander, et. al.2014:17). Some of the variation can likely be attributed to degradation of the timbers over the years (Alexander, et. al.2014:17), but some of the variation is likely due to being built that way.

The hull planking survives to about 3 meters up the starboard side. Included here is the table “Hull Seam Measurements” from the report (TABLE 1: Alexander, et. al.2014:17). Due to the conditions, these were the only measurements taken of the hull planking; they had to be done by feel rather than sight (Alexander, et. al.2014:17).

Frame Number (Edge)	Distance Along Baseline	Measurements in cm
52 (Forward)	13.00m	136, 150, 170, 185, 220
53 (Aft)	13.55m	136, 150, 185, 220, 240,280
56 (Forward)	14.75m	155, 190, 225, 248, 285
59 (Aft)	16.50m	125, 140, 160, 200, 240, 265, 280, 300, 325
62 (Forward)	17.45m	130, 170, 205, 240, 260, 280, 300, 320, 340
65 (Forward)	18.65m	121, 133, 197, 207, 215, 229, 243, 265, 295, 315, 330, 340
70 (Aft)	N/A	130, 145, 158, 169, 191, 207, 240, 265, 282, 307, 329
78 (Aft)	25.49m	31, 54, 145, 151, 175
82 (Aft)	28.20m	13, 35, 62, 92, 110, 127, 139, 156, 168, 196, 221, 238, 264, 276

Table 1. Hull seam measurements from Alexander, et. al.2014:18 (Table by Author)

Much of the ceiling planking is intact, but the bow and stern areas have suffered considerable damage. To the outboard side of the sister keelson are four ceiling planks, then two stringers, then two more ceiling planks survive furthest outboard (Alexander, et. al.2014:18). The four ceiling planks nearest the sister keelson average 25 centimeters molded by an average of 4 centimeters thick. The stringers average about 9 centimeters sided and the outer ceiling planks average 25 centimeters molded by 6 centimeters thick (Alexander, et. al.2014:18). The lengths of the ceiling planks vary considerably. The ceiling planks are butted end to end against each other, but the stringers are scarfed together with "Z" scarfs (Alexander, et. al. 2014:18). The ceiling planks curve towards the keelson as it nears the stern of the vessel, "each plank thinning at the aft end" (Alexander, et. al. 2014:18). The ceiling planks nearest the keel taper to points across their width and thickness, but the planks further from the keel have squared ends. The squared ends of these outboard planks suggest a transomed stern (Alexander, et. al. 2014:18). This is likely, but not definite, as more planking higher up the hull would be needed to confirm or contradict the idea of a transom-stern (Alexander, et. al.2014:18). The ceiling planks were fastened to the frames with a combination of square iron nails, round iron spikes, and wedged treenails. The field school report theorizes that the treenails were driven in last and through all layers, from hull to ceilings, but state that further excavation is the only way to confirm the theory (Alexander, et. al. 2014:19).

The centerboard location is on the starboard side of the keel, rather than through it (Alexander, et. al. 2014:19). As mentioned earlier, there is a notch in the starboard edge of the main keelson to accommodate the centerboard passing between it and the innermost starboard sister keelson. The port side of the centerboard trunk survives and is made up of vertically-stacked timbers with a sided dimension of 9 centimeters per timber. These are fastened vertically with 3-centimeter diameter iron bolts (Alexander, et. al. 2014:19). The notch in the keelson accommodates this side of the trunk. On the port side, there is a stanchion forward of the trunk and one aft of the trunk. The forward stanchion's forward surface is at 17.19 meters on the baseline and the aft stanchion "begins at 22.30m along the baseline" (Alexander, et. al. 2014:19).

The forward stanchion is 54 centimeters deep into the mud of the river bottom. A timber with a 10-centimeter sided measurement “fills the gap” between the main and innermost starboard sister keelsons (presumably the back edge of the centerboard notch) (Alexander, et. al. 2014:19). Previous work on the site reported a timber filling the same space at the front of the centerboard notch which is no longer present (Alexander, et. al.2014:19). The centerboard survives, at least partially; most of what remains is covered by sediment and was not excavated in this field school. The exposed areas show 3-centimeter diameter bolts that attach the timbers of the centerboard together (Alexander, et. al.2014:19). These timbers run longitudinally and are 4.55 meters long with a sided measurement of 5 centimeters (Alexander, et. al.2014:19). No molded measurements are given. A slight curve at the bottom-front corner of the centerboard was recorded by the field school, but they could not find the shape of the aft corner “due to the narrow space available” (Alexander, et. al.2014:20).

Goniometry

The frames of the vessel were recorded using a device called a goniometer, and this is what provided the most important data for modeling the frames. This device was chosen because of the poor visibility conditions of the site; many of the measurements were taken by feel. This lack of visibility renders standard baseline offsets ineffective. According to J. Cozzi in his paper “The Goniometer: An Improved Device for Recording Submerged Ship Wreck Timbers,” a goniometer is constructed by affixing a level to one of the arms of a protractor or bevel gauge. One arm needs to have a spirit level or waterproof digital level. The length of the gauge’s arms need to be known, as these are an integral part of plotting the points later (Cozzi 1998:66). In the field school’s case, the goniometer was built using a Digital Protractor 360 and the arm length was 17cm (Alexander, et. al.2014:14).

The idea behind the goniometer is that "…the attitude of a segment of timber can be determined by creating a triangle of known dimensions, one of whose sides is horizontal, while another is against the timber surface." (COZZI 1998:66). In other words, one arm rests against the surface being measured (or on a stand resting against the surface), and then a vertical measurement of the height between the end of the horizontal arm (held level in relation to the Earth, hence the level) and the end of the other arm (the one following the angle from the previous point to the next point) is measured (Figure 2).

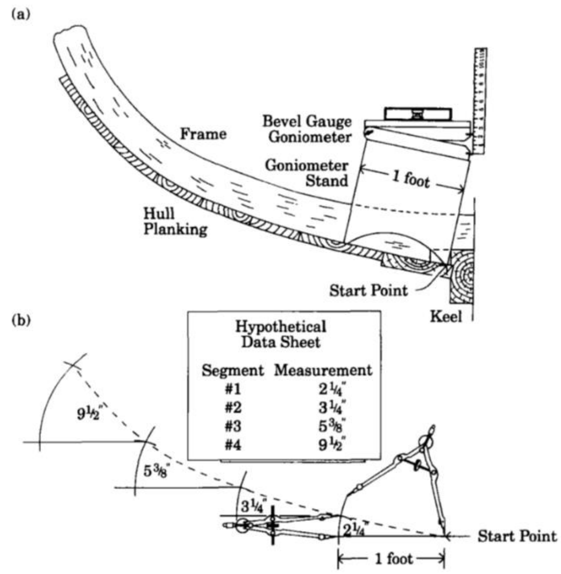


Figure 2. How to record and draft with a bevel-gauge goniometer. (a) Record a timber curvature as a series of segments using the goniometer to determine the attitude of each segment. Note the use of a stand to fit in between framing station. (b) Draft the data by using compasses set at the length of the goniometer, and at the length of each measurement for the scale being used.

Figure 2. Using a goniometer and drafting curves from the measurements (Cozzi 1998:67).

The frames on the TCV were in many cases still covered at least partially by the ceiling planks. These were held on by treenails and iron fasteners and had to be removed before goniometer measurements could be taken. The iron fasteners came out easily. However, because of the treenails, the planks proved to be stubborn and could not be easily pried off. Eventually the treenails had to be sawn through or broken to get the ceiling planks up, which were placed back into position after recording work was completed. Once the planks were removed, the students taking the goniometric measurements recorded the frame number they were working on and measured along the curve of each frame (floors, and where possible, futtocks). This gave them the angle from one point to the next along the frame. They also noted the "horizontal reading" and if the goniometer was facing forward or aft for each frame's measurements (Alexander, et. al.2014:14)

It is the goniometric measurements and the measurements taken along the baseline to locate the frame positions that are most critical to this study. A common practice in ship reconstruction is to take measurements from the rabbet on the keel to the inside of the hull planking. This is because vessels recorded *in situ* are typically resting on their sides or bottoms, and the inside of the hull planking is accessible whereas the outside of the planking is often not. This should be kept in mind when reading the results of the reconstruction. Because of this the reconstruction also follows the lines of the inside of the hull. The physical vessel would be about 4 inches wider on the half model, or 8 inches wider for the full model, taking into account the thickness of the hull planking. The reconstruction method began with the archaeological data including the goniometer data along with information gleaned from comparable vessels to fill in gaps in the data. While a computer model cannot reveal some things that a physical replica could (Steffy 1989), it is useful and expedient, particularly regarding broad hypothesizing and analysis of the vessel's design. Initial preference was given to data that helps in plotting probable length and midships shape. Once the length and maximum beam were determined, additional transverse sections were added to the model, and finally the height of the sheer line from the keel interpreted. These plots formed a point cloud. Once the point cloud was connected into a "wire-frame" model, the reconstruction was given a solid digital hull (the inside surface of the hull).

Once the model was fully constructed, the lines were analyzed for technical and some performance data. It is through ORCA that the questions of displacement, volume, draft, and hydrodynamic qualities were answered.

Software Used

The modeling program used in this project was Rhinoceros 3D, version 7. Rhinoceros is a CAD program aimed at crafters and designers; it is often used by naval architects in ship design and analysis. It was one of the first programs of its kind to accurately model complex curves, such as are found in ships. While Rhinoceros does come with a suite of analytical components for boat and ship design, these were not used. Instead, a plug-in program called ORCA 3D, designed specifically to be used with Rhinoceros was chosen. This program provides a full analytical suite designed specifically for boat and ship design. While both programs proved to be adequate for the task, they were not ideal, as they are both intended for design rather than reconstruction.

Theoretical Frameworks

Philosophy of Shipbuilding

The theoretical framework for this reconstruction was based on the work and theory of J. Richard Steffy and Fred Hocker, one of Steffy's students. Steffy is arguably the father of the field of modern vessel-reconstruction archaeology. He not only wrote the literal textbook on how to reconstruct vessels and what questions to ask of the archaeology in that pursuit, but he also laid the framework for how the reconstructions inform investigators about the people who built and used them (Hocker 2004). Steffy was not the only person working towards accurate ship reconstructions, however. Indeed, it was through an unexpected relationship with archaeologists George F. Bass and Frederick van Doorninck, Jr. – and later Michael Katzev – that Steffy was brought into academia. Steffy, Bass, and van Doorninck, Jr. would go on to found the Institute for Nautical Archaeology (Bass 2008: 393-394). Others had been examining and reconstructing archaeological vessels as well. There were in fact, legions of archaeologists, historians, anthropologists, and inspired amateurs, (as Steffy himself once was) trying to piece archaeological evidence together into feasible models and drawings of vessels. A complete list would require a series of historiographical books and is too much for this study. A very few examples follow.

The Sutton Hoo Ship has been studied since 1939 (Phillips 1940) and reconstructed many times since, including a full-size, physical reconstruction intended to be used in real-world sailing experiments beginning in 2026 (Carver 2026). The wrecks of *Vasa*, the Skuldelev ships, and a Hanseatic cog at Bremen were all discovered in rapid succession over thirty years before Steffy published *Wooden Ship Building*. All of these vessels were in such a state of preservation, they were able to be raised and rebuilt with the original timbers, However, new methods of conservation and preservation had to be developed for the vessels to survive being exposed to air again after centuries on the seabed, as well as ways to permanently display them to the public (Hoffmann 1986). Such a task is much more daunting than building a model either physically or digitally. Ole Crumlin-Pedersen focused his long career (Damgård-Sørensen 2012) on northern European vessels and was a champion of experimental archaeology as a research tool (under which analytical model-building can be included). His research was primarily on lap-strake Nordic vessels, including – but by no means limited to, the Skuldelev ships – as well as cogs including the previously mentioned Bremen and other cogs (Crumlin-Pedersen 1986; 1995; 2000). While not specifically relevant for this project, Crumlin-Pedersen, Jonathan Adams, and Peter Marsden (Blackfriars 1) have been inspirational to the author and therefore indirectly impacting this study. Adams and Marsden in particular because Adams' book *A Maritime Archaeology of Ships: Innovation and Social Change in Medieval and Early Modern Europe* (2013) was this author's first exposure to an explanation of how to study vessels and relate that to a broader socio-economic context. Marsden was inspirational for his work on Blackfriars 1 with Caroline Cladwell who made the reconstruction drawings for his *Ships of the Port of London* books (1994). Blackfriars 1 is quite possibly this author's favorite archaeological vessel, and why a reconstruction was considered for his thesis at all. There are simply too many works by the highlighted researchers and too many other researchers to mention beyond this brief sampling.

There is more to reconstruction as a field than simply reconstructing a vessel from extant remains, however. As Steffy himself explained, reconstruction "…is not merely determining information about the ship's structure. … [it is] an all-inclusive description of the ship as a venture" (Steffy 1994:5). The description of a ship as a "venture" includes the purposes of the those who contracted its construction, the knowledge and cultural biases of the builders (and possibly buyers), what needs the vessel filled in its society, a view of the economy, commodities available, and a host of other socio-economic questions. After that comes the changes and damage inflicted on the vessel by its crew, enemies, and nature—both intentionally and accidentally (Steffy 1994:5, 6, 85; Hocker 2004:2). Hocker further articulated how vessels relate theoretically to the people and societies that built and used them. According to Hocker, the "philosophy of shipbuilding" is an analytical tool; it helps us to understand not only the "how" of a ship's construction, but the more important question of why it was built and why it was built in its particular form (Hocker 2004:1). The design of a ship can (and should) reveal a great deal about a society, either broadly or locally. Such things as culture, socio-economic standing in a region, even how low or how prestigious merchants, sailors, and shipbuilders were can all be answered in full or in part by the design of a ship.

According to Hocker, "a purely technological approach puts ship-building in a vacuum where voices do not carry" (2004:2). More will certainly need to be done than merely a hull reconstruction and investigation of why the vessel sits where it does; but not here. This thesis is intentionally not taking those steps because they are steps that are best served by having their own theses or dissertations. Information has been recorded; that step seems satisfactorily complete for the time being. This thesis is the first project of its kind for a North Carolina vessel that the author and his adviser are aware of and is the next step in the process of analyzing the archaeology. There is currently no database of reconstructed vessels surveyed from North Carolina waters, and this early step must be built upon. Others will hopefully build upon it both to decipher deeper details of the Tranter's Creek Vessel and to use it as a tool for deeper investigations into shipping, vessel building, and life in Washington, Beaufort County, and the larger Albemarle-Pamlico region.

Abandonment Theory

The Tranter's Creek Vessel has typically been referred to as a "wreck." It is referred to as a wreck on maps and charts, the 2014 field school that worked on the site, as well as in places in this study (Alexander et. Al., 2014; USCS 1872). However, it is most likely not a wreck and is more likely to fall under the heading of "abandoned" or "discarded." The author favors "discarded". The ideas on abandoned and discarded vessels play heavily into the theoretical and methodological framework on figuring out the likely reason for the TCV being on the bottom and why at that specific location.

Dr. Nathan Richards draws a contrast between wrecked vessels and abandoned/discarded ones. His claim, synthesizing various definitions of "shipwreck," is that "catastrophic events" are the core of what makes a vessel a wreck (Richards 2022:7). In other words, the crew or owners did not intend for the ship to be destroyed. He does concede that most wrecks (that are not raised and reused as vessels) are abandoned eventually, but that is more a consequence of inaccessible location or being wrecked or damaged to the point they are lost. This is what Richards refers to as *catastrophic abandonment* which is to save the lives of people on board (2022:8). There is also *consequential abandonment* which is to save lives or things around the vessel. One example is the *General Knox* which caught fire at a New York dock and was scuttled immediately to save the surrounding vessels and waterfront (Richards 2022:9). A deliberately abandoned or discarded vessel, on the other hand, is one that has been purposely discarded in some manner that is "…premeditated in every sense" (Richards 2022:10). There is no immediate danger or catastrophe; it is a purely intentional act. According to Richards, abandoned vessels and wrecked vessels are two entirely distinct classes of vessel loss and need to be treated as such (2022:8). The most important reason for this in relation this study is the "…act of discard occurs with the intention of creating a new function for the vessel following its deposition" (Richards 2022:10).

Richards goes on to point out a problem that vexed this project on many levels: intentionally discarded vessels can be difficult to research beyond the physical remains. He claims that intentionally abandoned vessels often do not have many, or sometimes any, documentary sources (Richards 2022:11). While only part of the challenge, this has been an issue on this project. Site formation processes also posed questions in the reconstruction process that were not wholly answerable.

Site formation processes are everything that happens to an artifact in its archaeological context from the moment of deposition (through loss or discard) till the moment of recording (Schiffer 1996:3-4). If the artifact is not removed for preservation, these processes will continue after the excavation is concluded. There are two types: cultural and noncultural or natural processes. Noncultural/natural process are environmental – wave movements, erosion from sediment, decomposition by various biological means, etc. These processes can also aid in preservation, such as sediment deposition or encrusting by non-destructive creatures or chemical reactions. Cultural processes are all site formation processes which were caused by humans. These can be unintentional or unknowing changes to the artifact while *in situ* (or altering the site around an artifact) or intentional disturbances, such as grave robbing (Schiffer 1996:7-11). Like natural processes, cultural processes do not have to always be destructive; the grave of England's King Richard III being unknowingly preserved by a parking lot built over it is a good example of an unknowing preservative cultural process (Bryner et. al., 2013). In regards to the TCV, the sediment has both eroded and preserved various parts of the vessel, which are examples of the natural processes. One of the most common cultural processes in regards to the TCV is that it has been hit repeatedly by outboard motors with parts of the propellers sometimes embedding themselves in the timbers, becoming part of the site (Stewart 2023 pers. comm.). The most important distinction to keep in mind about site processes are that noncultural/natural processes are to a large extent predictable, whereas cultural processes are not (Richards 2022:53-54)

Richards describes that there is a correlation between vessel abandonment and economic fluctuations; in leaner economic periods ("famine") there is a higher rate of abandonment depositions than in more flush ("feast") economic periods (Richards 2022:104-106). There are also areas – "graveyards" – where abandonments take place more commonly than in other places. In Richards's study, he focused on vessels in Australia where there are legal areas set aside for discarding vessels (Richards 2022). These boat graveyards can be near to navigational channels, but the abandoned hulls are not in the channels as they would become an obstruction to navigation and need to be removed (Richards 2022:84-85). The TCV is not in the Tar-Pamlico navigational channel, but it does block the navigational channel going into Tranter's and Bear Creeks, and it is situated on – or has become – the bar at their mouth. The fact that the TCV was never moved is worth considering, particularly when taking into account *post abandonment use*, that is the discarding of a vessel with a planned purpose for it after its sinking (Richards 2022:137). The implications of this will be discussed later in the study.

Structure minimization and hull reduction are the taking away of parts of a vessel being discarded specifically to reduce its physical presence in its final position (Richards 2022:147). The idea is that after whatever salvage is to be done, the part of the vessel to be sank will be made as small as the plan for discarding it requires. For example, the hull could be broken down further so that it is not unstably straddling an undulation on the riverbed or seabed. Perhaps it needs to be shortened vertically so that it does not extend up to be an obstacle or become an eyesore by breaking the surface of the water (Richards 2022:147-148). One method of minimizing the imposition of a discarded vessel can be the driving in of pilings to prevent a vessel being pushed off its resting place by currents, storms, or other factors (Richards 2022:170-171). The possibility that this was done with the Tranter's Creek Vessel will be touched in Chapter 4.

Chapter 3

Reconstruction of the Vessel

The reconstructed model of the Tranter's Creek Vessel is the core of this study, and it is hopefully the first step in building a database of North Carolina reconstructions. Having discussed the historical context, how the archaeological data was acquired, and the theoretical frameworks helping to guide the reconstruction, it is time to consider the actual methods and process of building the models.

Preliminary Modeling

The first step in taking the field school data and turning it into a model was to create a new layer in Rhinoceros called "Baseline" and lay out the baseline to match the one used by the field school, then create a new layer named "Perpendiculars", and add perpendiculars to the baseline in the virtual space (Figure 3). These perpendiculars delineate the forwardmost and aftermost points of the surviving hull. The distance was set to 24.435 meters between the forward the aft perpendiculars, to match the field school data. It is important to note, the baseline is not referred to as the keel as the actual keel would have been below this line. All measurements are from the edge of the 10-inch moulded keelson and yield dimensions from the rabbet on the keel to the inside of the hull (the "moulded" beam).

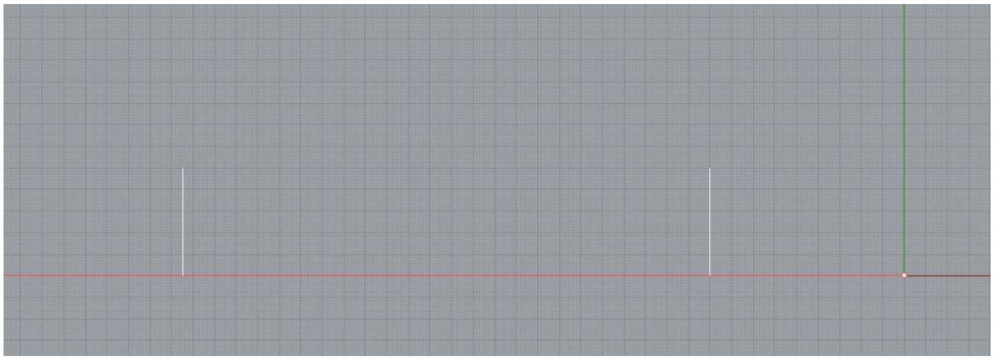


Figure 3. Baseline (red) and perpendiculars (white) with origin (marked by white point)on right.

All recorded frames were on the starboard side of the vessel due to their higher level of preservation than those on the port side, so it was decided that the starboard side was the one reconstructed. Because ships are roughly symmetrical, the starboard half-breadth model can be mirrored to give a full-breadth model. No vessel is perfectly symmetrical in the real world, but in a practical sense, they are symmetrical enough that mirroring the two halves is usually acceptable; it was for this project.

The next step was to take the goniometer measurements for each frame and plot them at the appropriate locations. The distance between the frame stations along the baseline vary somewhat. To mark the locations, a sublayer named “Frame Locations” was created in the “Baseline” layer. The “Polyline” command was selected in the new sublayer, and with “Osnap” (an option that automatically snaps the start point to an endpoint, placed point, or intersection) turned on, the first line was based at the intersection of the forward perpendicular. The appropriate length measurement was typed into the command bar, and the line drawn. This was only to identify correct location on the baseline for the frame station. The command “Point” was selected and in this sublayer, a point was placed at the end of the line that was just drawn, then the measuring line was erased. This process was repeated until all station points were plotted along the baseline (Figure 4).

Figure 4. Top view of frame locations along baseline with origin on left.

The goniometer points and the way Rhinoceros reckons angles are opposites of each other; that is to say, a conversion had to be applied to properly plot the real-world angles into the virtual environment of the model. The conversion formula was 180 - *x* degrees where *x* was the angle given by the goniometer. The result of that calculation (done on all goniometer points before plotting them in Rhinoceros) allowed for accurate plotting of the frames in the digital format. To plot the points of the frame curves, a new layer , "SB50," (the forwardmost frame) was created and the "Polyline" command was selected in Rhinoceros with "Osnap" still turned on. The first prompt Rhinoceros gives is "Start of Polyline." The start point of the line was placed at the appropriate point on the baseline. The next prompt the program gives is "Second point of Polyline." Each point along the curve of the frames was measured 17cm apart along the full length of each frame, so at this prompt "0.17" was entered (the virtual space for the model was formatted to meters, so the units of measurement did not need to be defined individually, but everything had to be input as meters). This limited the line to be drawn to 0.17m or 17cm. Rhinoceros again prompted for a second point, and this time the angle was entered. The angle was "constrained" using the "<" symbol. For example, if one needed to input a 45-degree angle, the user would type "<45" and the program would automatically snap the angle of the line to multiples of 45 degrees. Rhinoceros prompted again for a next point, and with both the line length and angles defined, the cursor was put into an approximate location, and using the left-click on the mouse, Rhinoceros created the line at 17cm long and whatever the specified angle was. A new sublayer named "SB50 Goni Points" was created and the "Point" command was selected, and a point at the end of the line snapped into place. Using the points instead of the layout lines helped in limiting the visual clutter of the modeling process. The layer with the layout lines was then turned off (Figure 5). The surviving futtocks were plotted in the same fashion in their own sublayers.

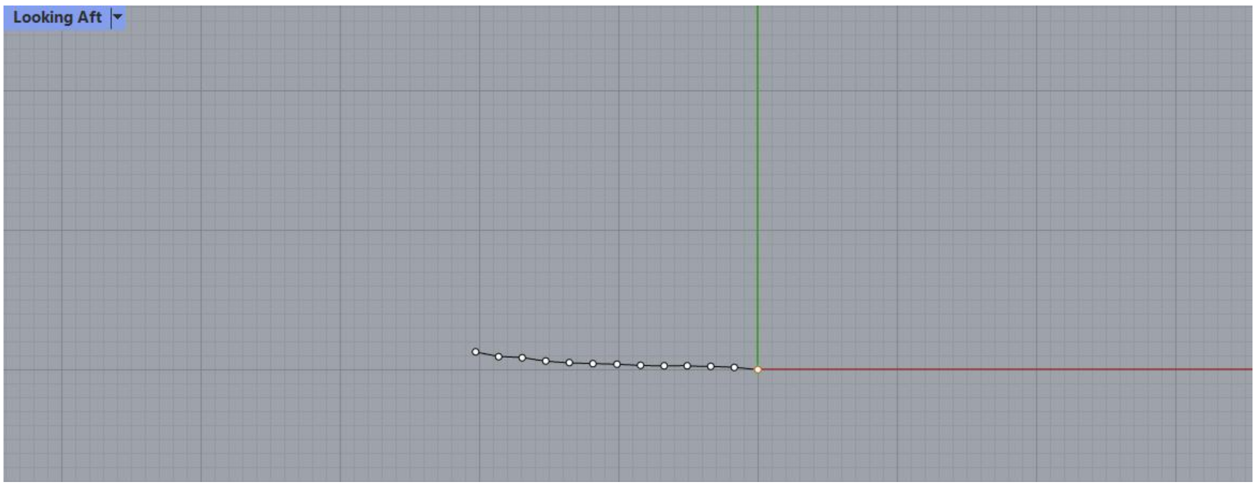


Figure 5. "Looking Aft" view of SB65 plotted as it was recorded *in situ.*

The plotting of the goniometer points yielded a model of the frames *in situ*. This model was made as a reference visual. It also served as a trial run for getting familiar with these commands in the modeling program for the hypothetical reconstructions (Figure 6).

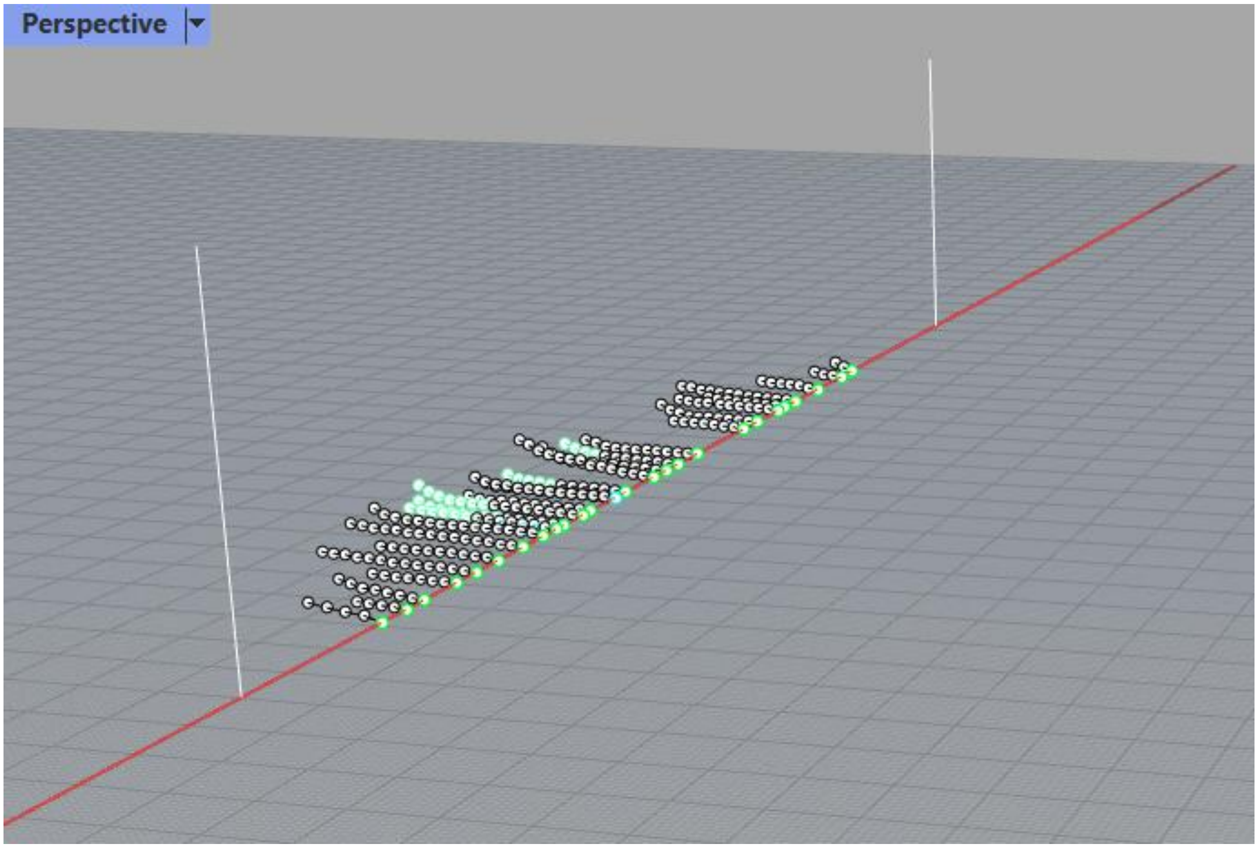


Figure 6. Plot of the *in situ* frames with surviving futtocks.

After the goniometer points of all the frames and futtocks were plotted, it was time to model the stem and sternpost of the vessel. The first step in modeling the stern was to decide if the vessel was double-ended, or if it had a transom (for example, a canoe stern versus an 18th-cenury frigate stern). There is no surviving transom on the vessel, but the shape and the run of the *in situ* planking was more indicative of a transomed vessel than a double-ended one. Therefore, all versions of the model were built with a transom atop the sternpost. A section of the sternpost survived down to the keel, and in the field, and it was recorded as raking backwards at a 120-degree angle. This is the angle used by many model iterations, including the first preliminary model. However, since only the lower section of the sternpost survives, other, similar vessels would have to be utilized to estimate the overall height of the stern as well as the transom shape and dimensions.

The remainder of the stem and a transom for the stern had to be modeled. A comparable recorded vessel was needed to fill in the information missing from the archaeological record. The goniometer data from the TCV indicates a vessel with minimal deadrise. *Sunny South* (Figure 7) was chosen as the comparable vessel because it was a flat-bottomed vessel designed to work in a similar environment and matched the shape and proportions of the goniometer data well, though *Sunny South* is a bit smaller than the TCV. To help fill in the missing archaeological data, an image of *Sunny South'*s lines (Chappelle 1973:85) was imported to the TCV model's virtual space and scaled to match the TCV data.

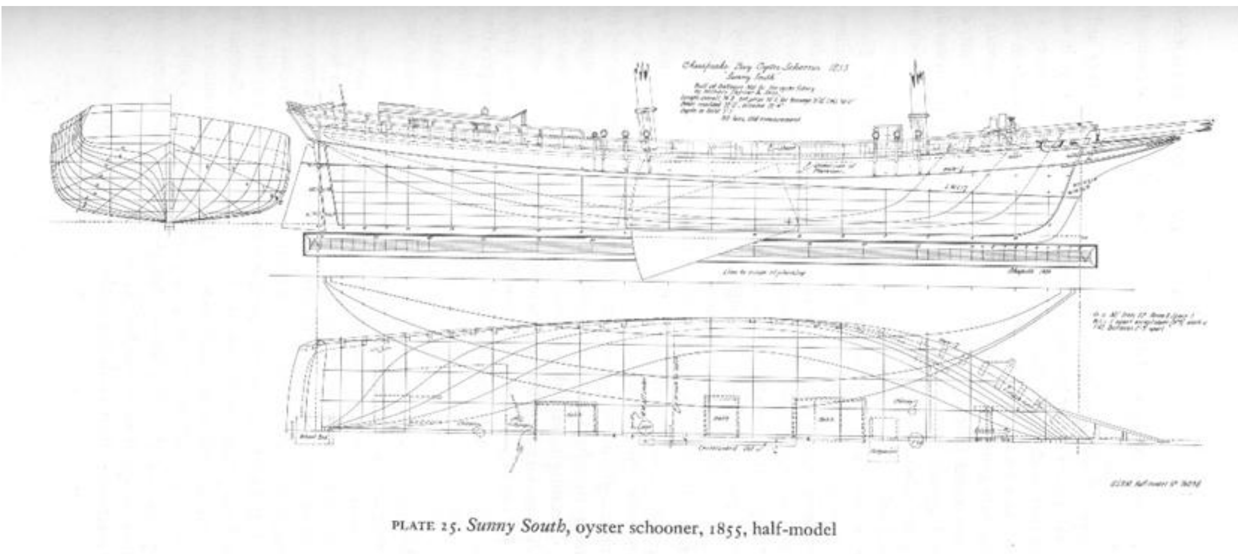


Figure 7. Lines drawing of *Sunny South* (Chappelle 1973:85).

The recording and drawing of *Sunny South* had been done in imperial units, and that needed to be adjusted for. The image was imported to Rhinoceros under the "Background Bitmap" drop-down menu and choosing the "Place" command. The 120-degree *in situ* angle of the TCV sternpost was at a shallower angle than the sternpost on *Sunny South* (c. 100 degrees). This will be addressed further later in this thesis. Because *Sunny South* was slightly smaller than the TCV, the proportions were scaled up to roughly match the *in situ* dimensions of the TCV using the “Scale” command in Rhinoceros. *Sunny South* had a sternpost height of about 10 feet 3 inches, but due to the TCV being about 10 feet longer, the sternpost height was raised to 10 feet 6 inches (3.2 meters).

To reconstruct the stem of the TCV, the drawing of *Sunny South* was shifted forward to the point along the baseline which corresponds to the approximate point where the stem begins. The stem’s lower edge was the forwardmost preserved point of the TCV hull (Figure 8). A new layer called “Reconstructed Stem” was created in Rhinoceros. A sublayer named “SM Projected H1” was created under “Reconstructed Stem.” Rhinoceros has a command called “Interpolated Curve” which allows a user to select points and the software will draw an algorithmically-faired curve through them. The initial curve was drawn by selecting the “Interpolated Curve” command in the sublayer, tracing the side view of the field school drawing, and then projecting that curve to a point 3.2 meters or 10.5 feet. This gave a simple up-sweeping bow which would be used as a point of reference. The remainder of the shape was reconstructed based on the stem of *Sunny South*. A loose tracing of *Sunny South*’s more complex stem was blended into the tracing of the lower stem from the Field School drawing (Figure 9).

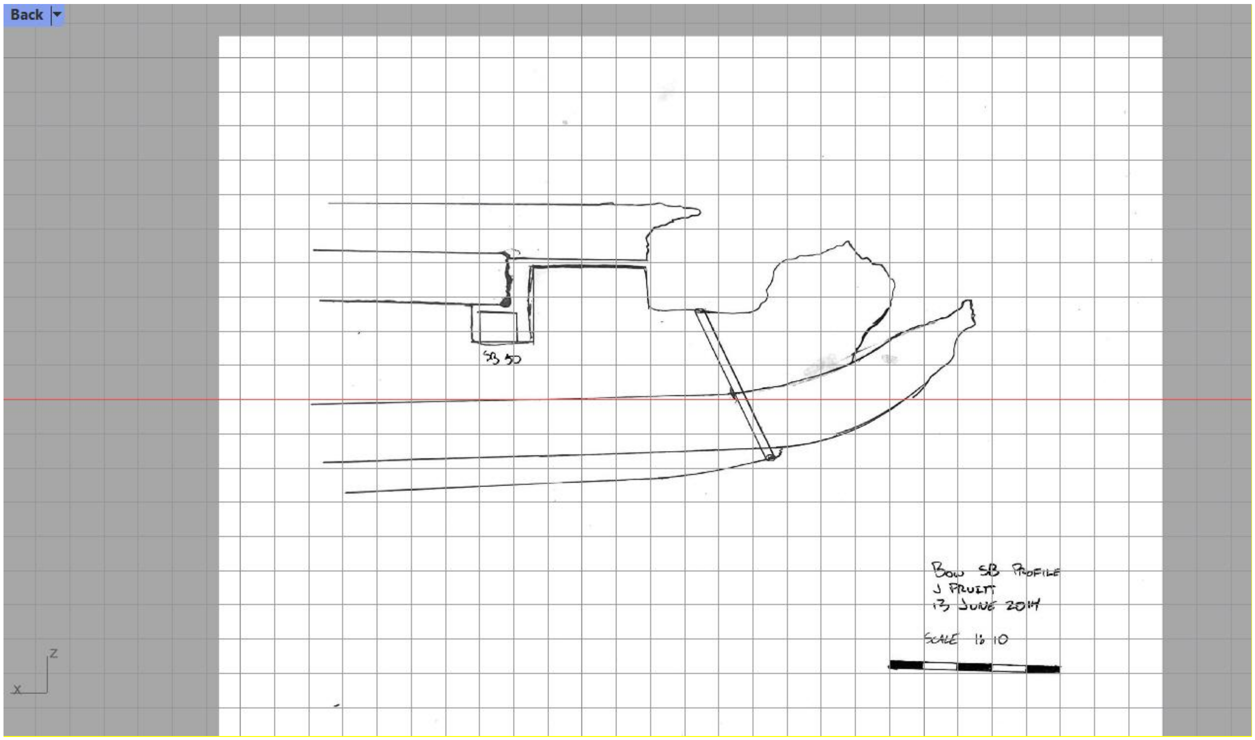


Figure 8. Field School drawing of extant portion of bow positioned on baseline.

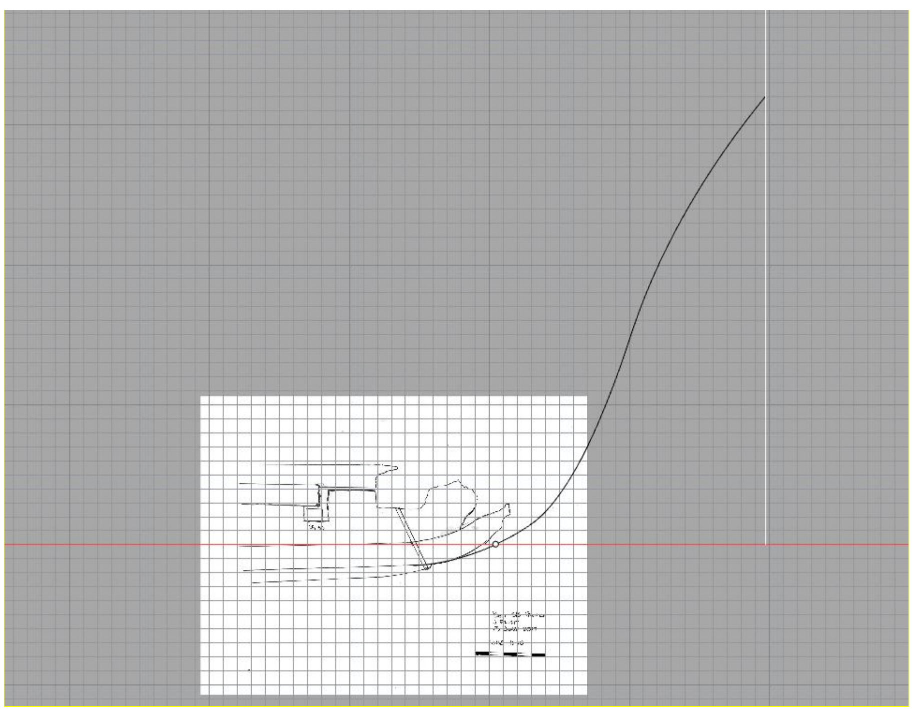


Figure 9. Stem reconstruction using the Field School drawing.

Reconstructing the sternpost and transom was the next step. Just as with the stem reconstruction, a new layer was created and the sternpost began at the aftermost point of preserved hull. This was drawn in a side view by tracing the field school drawing, then projecting that, again to a height of 3.2 meters or 10.5 feet. The shape of the transom at this stage was also based on *Sunny South;* however this early version of the transom was reconstructed in-line with the sternpost. The transom projects aft of the rear perpendicular; the aft perpendicular marks the furthest extent of the sternpost, not the overall extent of the vessel. The *Sunny South* drawing was loaded into the "Looking Forward" viewport (the images are only shown in the viewport they are inserted into) and the drawing was moved to align the top of Sunny South's sternpost and the model's sternpost. The shape of the transom was partially traced (the whole transom was unnecessary) using the sublayer "Traced *Sunny South*" under the layer "Reconstructed Transom." *Sunny South*'s port half of the transom is the one shown in the overlain drawing. To put the traced section of the transom on the starboard side of the TCV model, the "Mirror" command was used to generate the transom on the starboard side and the then the port half of the tracing was deleted as it was no longer necessary (Figures 10 and 11).

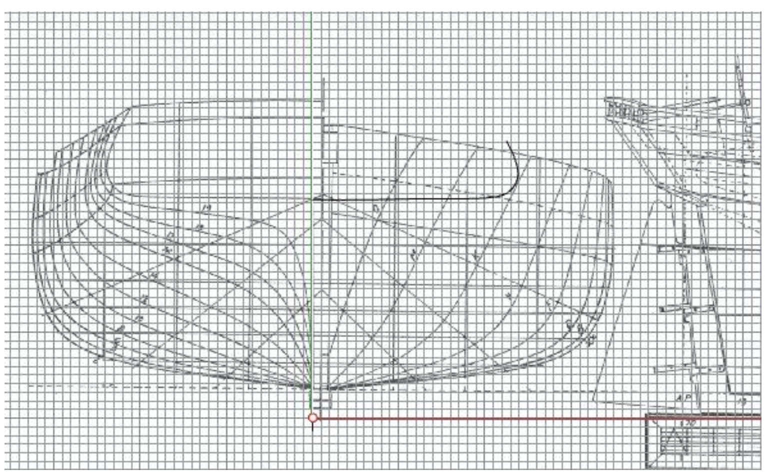


Figure 10. Alignment of the preliminary TCV transom next to *Sunny South*'s transom. Reconstructed transom segment (right side of *Sunny South*'s centerline) and the sternpost section of *Sunny South* to the left.

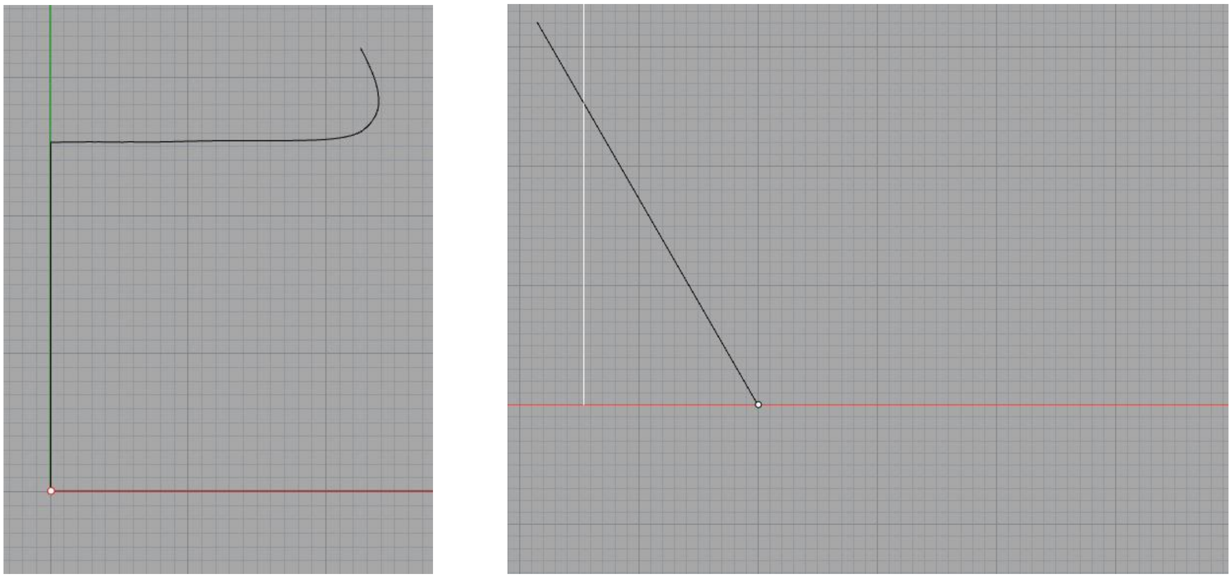


Figure 11. Sternpost and transom, 2 views. “Looking Forward” view (left image) and the sternpost and transom extending beyond the aft perpendicular looking from starboard (right image).

Having the stem and stern roughed-in revealed some approximate information about the Tranter’s Creek Vessel. The resulting length between perpendiculars came out to 24.435 meters or almost exactly 80 feet, though the transom protruded beyond the aft perpendicular, creating an overall length of 24.828 meters or 81.5 feet (the beak at the bow was not modeled). The angle of the transom at that point was still in line with the sternpost, which is probably not how it would have been when the TCV was afloat; this was accounted for and changed as later model iterations were refined. There were a number of vessels recorded in Dr. Still’s database of North Carolina-registered vessels with a similar length to the TCV, and their beams were typically between 21 and 24 feet with some outliers both narrower and wider. The database also showed that vessels of around this size typically had an 8-foot depth of hold. With the length, beam, and depth of hold numbers, the fore and aft extremes of many of those vessels were approximately 10.5 feet tall, lining up nicely with the raw archaeological data and fit reasonably with *Sunny South*, suggesting the model was proceeding in a viable direction. Now all that remained for this preliminary model was to refine the goniometer data into frames rather than *in situ* plotted points and to create and fair the hull.

The location of each frame (these points may also be referred to as stations, section curves, or sections interchangeably throughout this study) could now be laid out along the spine. For the preliminary model, only frames SB57, SB65, and SB79 were reconstructed, the rest would be a consideration for later models (Figure 12). These three frames were selected as they were some of the best preserved with more preserved data points than many other frames. Smoothing out ("fairing") the goniometer points using the "Interpolated Curve" command into sectional shapes was the next step in building the model. This specific curve command (there is more than one) was chosen because typically it most accurately reflects the curves found in ships. It is a simple operation but does not necessarily yield useable curves on the first attempt…or tenth. If the curve is not viable, the solution is trial and error adjustments. The first step is looking for goniometer points that are visibly likely wrong. This can be due to site formation processes, mismeasurement, or entering data incorrectly into Rhinoceros. When a suspected wrong curve was found, another curve was created as a new hypothesis. Sublayers were created for each of these hypothetical curves. After getting one or more initially plausible frame shapes, the user moves to the next frame and repeats the process. One cannot assume a frame created in isolation is correct, however, so the next step is comparing the hypothetical sections by eye to each other to see if any stand out as obviously wrong in relation to the rest of the frames. This is done in the view "Looking Forward" or "Looking Aft." This is a rough estimate only, looking for very obviously wrong frames.

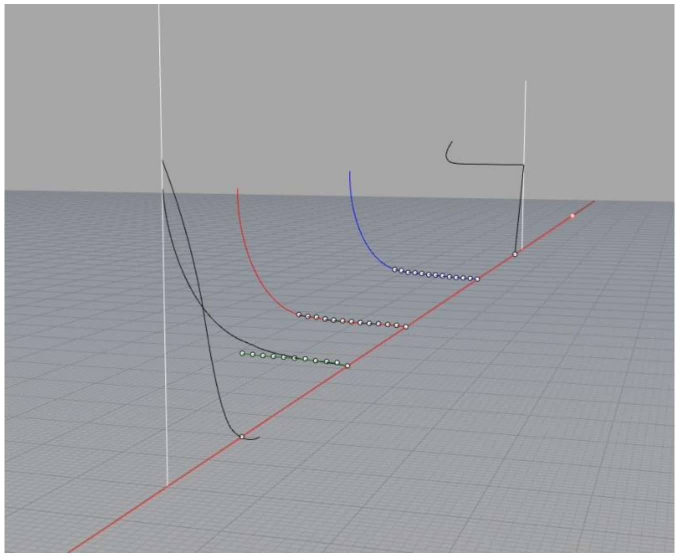


Figure 12. Completed preliminary frames, SB57, SB65, and SB79. Note that the goniometer points on the forwardmost frame (SB57) are flatter than the hypothetical reconstruction. This would be a deciding factor in making broader beamed models.

With these frames reconstructed, the hull needed to be faired and frames refined. The "Loft" command in Rhinoceros was used for all hull reconstructions throughout the project. Wood has a limited number of ways in which it can bend and twist into a desired shape, and the "Loft" command is generally good at representing this. Unfortunately, even when the frames look viable to the user, they are not always so, and lofting the hull onto the frames will reveal when the frames are not viable (Figure 13). Trial and error is, again, the process for fairing the hull. If the hull does not look fair, and the user did all the steps correctly, the model is very likely wrong, so the user must choose one or more different frame hypotheses, loft the hull again, and check for fairness.

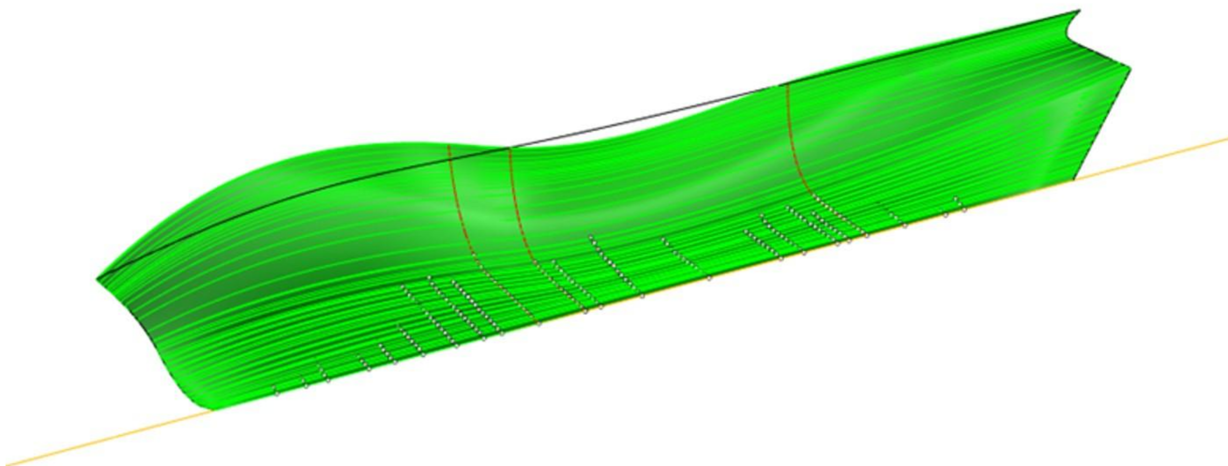


Figure 13. What can go wrong? When frames look viable but are not, the hull lofting will typically reveal it as with this extremely unnatural bulge in the forward third of the model.

Often, this means going back and making new frame hypotheses. Sometimes the hull would turn out fair but was bulging far out beyond the most likely dimensions. Eventually a plausibly-shaped, feasibly fair hull that fit the stem-frames-sternpost-transom system and was within the parameters suggested by Dr. Still's database was completed. This preliminary interpretation was presented at the NCMH conference in Swansboro, North Carolina in December of 2022 (Figure 14).

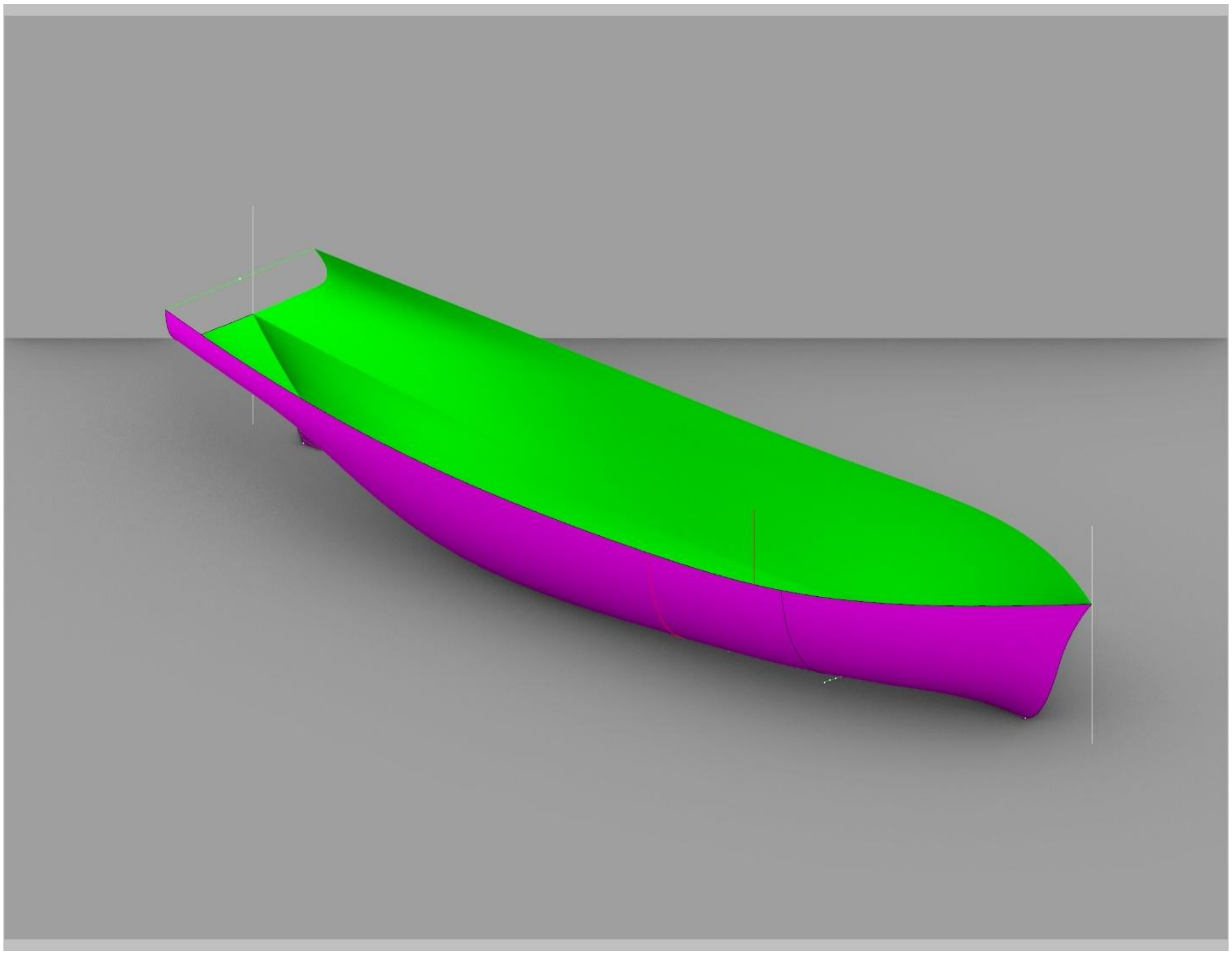


Figure 14. Finished preliminary hull model, full beam. Vertical white lines at the ends are the perpendiculars.

During the creation of this preliminary model, doubts arose primarily in regard to the beam and fineness of entry at the bow due to the inconsistency of the frames. Some of the frames forward of SB65 suggested a wider beam than the preliminary model yielded. While it is possible that the wider beam is correct, it is not necessarily likely. Some of the frames aft of SB65 also suggested a wider hull. This was the cause of months of debate, discussion, brainstorming, and over 100 models between the author and his advisor, as it – as well as the sternpost angle question – had to be taken into consideration.

Creating the Final Models

The first concern to address was the sternpost angle. The preliminary model had been constructed using the 120-degree sternpost angle recorded by the field school. Photographs and lines drawings of similar vessels from the 19th century suggested that this angle had a high likelihood of being wrong, and that there was a good (but not certain) chance it was more vertical. One possibility could be that a mistake was made in the measuring of the sternpost angle due to the low visibility on site. Another possibility is that the student who drafted the final drawing took a shortcut and used a 30-60-90 triangle (yielding the 120-degree angle) rather than lining up the drawing to the actual measured angle. Regardless of the reason, after measuring the approximate sternpost angle on the drawings of *Sunny South* and *C. Chase*, another Chesapeake schooner from the oyster fisheries, an angle of 100 degrees was thought more likely to be closer to what the TCV had when floating.

<u>Addressing the Sternpost</u>

After much discussion, it was decided that models with both 100 and 120 degree sternposts should be constructed largely because the 120 degree angle as recorded might have been correct rather than being mis-recorded or angled outward due to site formation processes. The vessels *Agate* of 1853, *William T. Thorndike* listed 1856, and *Flying Fish* from 1857 (*Chappelle 1973:82, 87, 95*) were referenced in addition to *Sunny South* and *C. Chase* for the 100-degree sternpost examples. While something nearer to 100 degrees was seen more often in the record, regardless of bottom shape, lines drawings of vessels with sternposts well over 100 degrees were found; however, they appear to be less common. Of these more raked sternposts, *Hobah* (1878) and *Clara May* of 1891 (Greenhill 1988:68, 236) were the closest in hull shape to the TCV. Hull form was chosen rather than similar operating environments because there were far fewer examples with the greater-than-100-degree sternpost found, and these were the best fit. The issues with the 120-dregree comparables are addressed toward the end of this study. The height of the sternpost was left at 3.2 meters (10.5 feet), the same as the preliminary model. The length from stem to transom using the 100 degree sternpost angle was 77.22 feet (23.538 meters). The transom atop the 100-degree sternpost was also modeled on that of *Sunny South* and *C. Chase*, but at this stage, was left in-line with the sternpost; it was not intended as a final transom, rather it was a placeholder.

The next step was reconsulting Dr. Still's database. With the new length of about 77 feet established, vessels in the database between 74 feet and 80 feet were chosen, allowing a plus or minus 3-foot margin of error. A subset of 128 vessels from the database fell within this range. After eliminating steam-powered vessels (the TCV showed no evidence that it had an engine or was in the process of being refitted for one) and removing two vessels with depths of hold so shallow it raised suspicion that the database or original records may be incorrect, 188 vessels remained as viable. A new subset of vessels listed as "Schooner," "Schooner X" (a type Dr. Still did not explain in the database or his books), and "Sharpie Schooner" was created, but with the length range narrowed down to between 76 and 78 feet. There were 14 vessels that fit those criteria. Checking the beams of this new subset suggested that the beam was most likely between 19 and 24 feet, or approximately a 3:1 length-to-beam ratio. The most common beam of the 14 remaining vessels was 23 feet, occurring 5 times. There were 2 vessels at a beam of 22 feet and 2 more at a beam of 24 feet. With 9 of 14 falling within a 2 feet range, the focus would be entirely on building models between 22 and 24 feet in beam. An adjusted beam was calculated; again, reconstructing only the starboard side due to its higher level of preservation. This left measurements of 10 feet, 7 inches (3.226 meters), 11 feet, 1 inch (3.378 meters), and 11 feet, 7 inches (3.531 meters). The next step in the process was to evaluate the frames' shape interpretations which had been called into question during the preliminary modeling process.

Frame SB65 stood out as being one of the widest frames, if not the widest, which suggested that it might be the midships frame. SB66 sits abaft of SB65 so closely that it might be a sistered frame to it, and both frames' data points match very closely. Taken together, they reinforce the idea that SB65 is the midships frame. The remaining frames were thus split into two groups: those forward of SB65/66 and those aft of it.

Because some deformation is obvious in the frames, an initial assessment had to be made about which frames were probably more correct and which were more likely to be more distorted from site formation processes or incorrect measurements. To make this easier, the forward frames were examined separately from the after frames. Deciding which frames more accurately represented the vessel's dimensions while afloat would either help support the idea of SB65/66 being the midships frame or suggest a different frame was more likely and suggest a plausible beam. Comparison of the forward frames revealed that a shape based on frames SB57, SB60, and SB65/66 suggested a narrower hull (collectively referred to as the "narrow set"), similar to the preliminary model. A shape based on frames SB53, SB54, SB55, SB58, SB59, SB61, SB62, and SB63, on the other hand, suggested a wider beam (collectively referred to as the "wide set"), though how wide was unknown. It was decided to make a narrower-beamed model and a broader-beamed model since the *in-situ* frames indicated both were possible. Combined with the decision that both a 100-degree and 120-degree sternpost angle would be modeled, the total number of models to be included for the reconstructions and analyses would be four.

Developing the Narrower Beam Models

The narrow set was modeled first because it was suspected to be the more accurate representation of the frames. Frame SB60 (narrow set) has 13 goniometer points, giving it more measured points than many of the wide set frames. As the modeling progressed, frame SB59 was revisited to further investigate whether it suggested a wider beamed vessel or if it indicated that the frames may have sagged outward over time. When SB59 was compared directly to SB60, the first 6 goniometer points match well between the two frames. However, past the sixth point, SB59 appears to have pushed out while retaining its basic shape. The other possibility is that SB60 has been pushed *inward* after point 6 while retaining its basic shape. Dr. Stewart favored the idea of SB59 being partially collapsed outward. This was the problem: When comparing these frames to the wide set, it suggests SB60 is the misleading frame, and when comparing them to the narrow set, SB59 appears to be the misleading frame. This question is currently unresolved (and may be forever) and is one of the reasons the author chose to include both wider and narrower beamed reconstructions. It was time to return to Dr. Still's database to cross-reference the rough beams.

In the course of building the models and researching other parts of this project in Fall 2023, the vessel's most likely *terminus post quem* date was determined to be 1871, as is discussed later in this study. All vessels with a date post-1871 were eliminated. The length parameter was changed; since a precise length for the vessel is impossible to determine due to the missing upper stem, missing transom, and questions about the actual sternpost angle, the range of lengths was adjusted to include vessels between 72 feet and 84 feet. This left 227 possible vessels. Taking only those vessels from before 1871 and eliminating all steamers, 187 vessels remained on the comparable list. There was no narrowing of the list of vessels by type due to the traditionally loose application of the term "schooner" in North Carolina; any sailing vessel that fell in the length range was now included.

Taking frame SB65/66 to be the midships frame, it was redrawn to fit a maximum beam of 23 feet (22 feet plus 1 foot to account for the keel's sided measurement). The archaeological data about the turn of the bilge is incomplete, so *Sunny South* and *C. Chase* were used as examples as their midship sections are similar to the shape the goniometer data suggested for TCV. It should also be remembered that it is unknown how much of the upper end of the frame is missing – that had to be extrapolated as a "feasible" reconstruction. Section H on *Sunny South* was used to help reconstruct frame SB53 and was adjusted to fit the TCV's slightly wider 23-foot beam. This was initially done by making SB53 the same proportion to the TCV's beam and length as station H on *Sunny South* (the closest station to SB53's proportional location down the length). This yielded a half-model measurement of 9 feet, 4 inches (2.84 meters). However, SB53 still was too wide for the 23-foot beam (Figure 15).

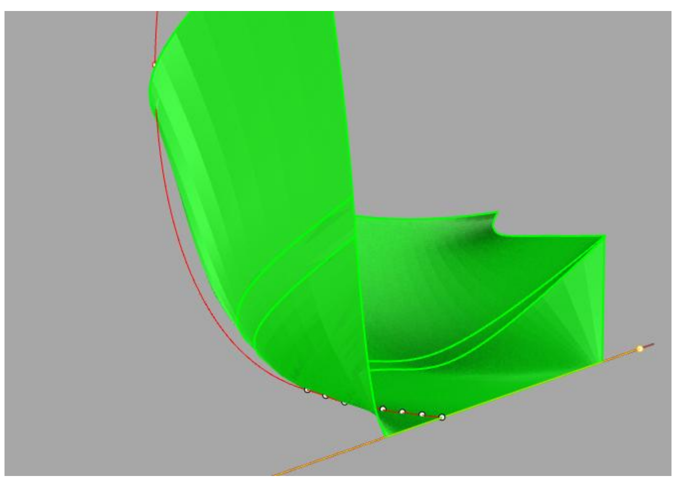


Figure 15. Frame SB53 extending past the hull on 23-foot beam. This was solved by manually drawing the frame to follow the lofted hull form.

To redress this, a hull model was lofted using frames SB57, SB65/66, and SB79 (this command can be used as the Rhinoceros version of running a ribband, not only for assessing hull shapes). This showed the approximate hypothetical extent of SB53, which was then redrawn to fit by blending the goniometer points from the TCV and station H of *Sunny South*. The difficulty is in the way Rhinoceros calculates lofts. As stated above, the program does a generally good job of estimating the way wood can be twisted and bent, but it does not fully take into account all the real-world factors such as thinning a plank in strategic places or using heat to increase the wood's elasticity, or a particular wood's compliance or resistance to bending. Because of this, Rhinoceros had to be "tricked" into calculating the hull correctly at this stage.

With this new hypothesis for SB53, the hull was re-lofted using frames SB53, SB57, SB65/66, and SB79. Frame SB57 was now causing the hull to bulge too far out at this station. It may seem counter-intuitive, but since SB53 was not traced from a curved line used as a ribband, but rather rebuilt using the loft that showed the upper extent of SB53, frame SB57 now distorted the new hull model. As a result, frame SB57 was simply left out because trying to force Rhinoceros to reconcile this with the model was not deemed critical to the project and was a reasonable compromise (Figure 16). This provided a solution to one of the concerns with the December 2022 conference model.

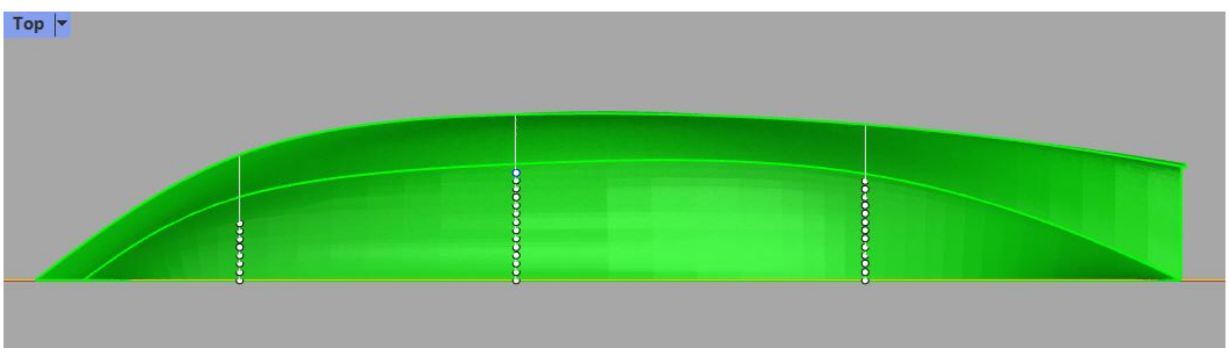


Figure 16. Top view of lofted 3-frame hull. Left to right: SB53, SB65/66, SB79. Conformity to the hull shape is partially indicated by the frame lines being visible in this view. Note that the vessel reaches its maximum beam aft of SB65/66.

The shape of the hull aft of SB65/66 looked mostly good at this point. It had a plausible rate of narrowing to the transom, and the lower hull fit the goniometer points for the extant floor timbers well. The only issue significant enough to require further attention was that the hull continued an outward curve slightly aft of SB65/66. This was most likely because there were no frames in the mid-afterbody in this rendering to “reign in” the curve as there would be before hull planking went on in the real world. The difference between the maximum beam and SB65/66 was approximately 3 centimeters. The argument could be made, however, that a 3-centimeter difference on a vessel that has taken some 150 years of abuse is absolutely acceptable and might have even been within acceptable tolerance when built – if a less than 2-inch variance was noticed at all by the builder. However, since by definition the midships frame is the widest point of the hull, this was deemed unacceptable for this model, and had to be reconciled.

When comparing the frames in the afterbody of the vessel, none were found to be acceptable to use to pull in the model’s curvature, either because the frames were too distorted or did not have enough data to make a plausibly accurate frame reconstruction. The solution used for this model was to create a phantom frame between SB68 and SB69. This was done by copying the shape of the midship section (SB65/66) and pasting it to the place where the most “pushing out” occurred, which was between SB68 and SB69 (Figure 17). The layer for this was named “SB68 INTERPRETED” and is in between SB68 and SB69 in the layers list. Its height was fitted to the height of the hull at that point.

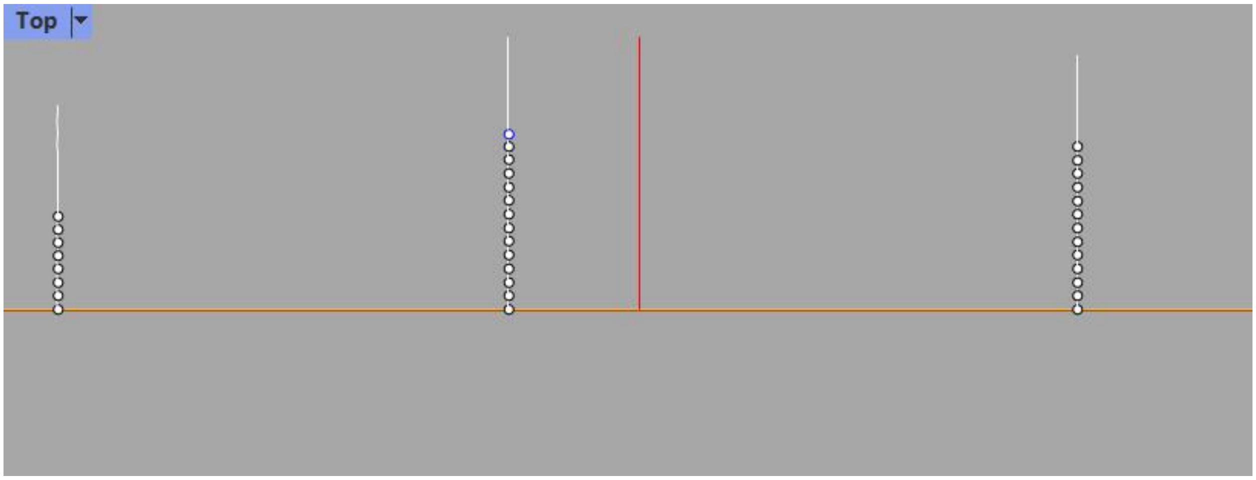


Figure 17. SB68 INTERPRETED. SB53, SB65/66, SB79 are shown in white, SB68 INTERPRETED is shown in red. Note that SB68 INTERPRETED is a copy and paste version of the reconstruction of SB65: they are intentionally identical.

This was deemed to be an adequate solution to the problem given the lack of preservation in the aft section of the vessel, as the physical hull had to do something similar in this area when the vessel was afloat (quite possibly SB69). Frames SB77 and SB79 are in reasonably good condition but are too far aft to significantly force the hull into a realistic shape. Once SB68 INTERPRETED was constructed, a new hull model was lofted using frames SB53, SB65/66, SB68 ITERPRETED, and SB79 (Figure 18). This satisfactorily eliminated the curvature problem. The same frames were used when lofting the 120-degree sternpost model. The transoms for both the 100 and 120 degree sternpost models still needed to be reconstructed, but at this point, the focus was shifted to the wider beam models and working out their bluffer bows.

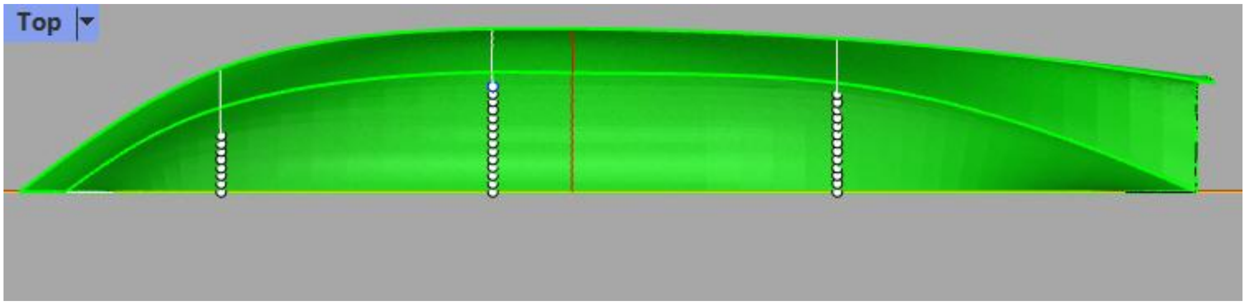


Figure 18. "Top" view of hull with SB68 INTERPRETED pulling the hull in so that maximum beam is not aft of SB65.

<u>Developing the Broader Beam Models</u>

The purpose of the broader, more bluff-bowed models is to make alternative models that fit the data from comparable vessels, the database, and from the TCV archaeology. The idea behind the broader models is based on the possibility that the frames have not slumped outward, rather some may have been bent inward. This might be due to a number of factors, such as how the vessel went down, other vessels striking it, the TCV's own weight pressing down on an uneven riverbed, or a multitude of other factors. Because most of the frames show at least one section crushed out of line with the rest of the frame, the idea that the wider frames may be correct and the narrow ones incorrect cannot be dismissed and must be addressed. From an original design and construction perspective, a bluff bow for a shallow-draft vessel of this size makes sense as that may reduce the possibility of nosing into the bottom while increasing carrying capacity for a given draft (this is addressed in later sections). The biggest challenge with the broader models was in deciding which possibilities to exclude. With the condition of the *in-situ* frames, a much wider variety of beams and bluffness could have been included in this project. It was decided to restrict the broad beam models to a size that was at the high end of Dr. Still's database, but not so big that it would have been an outlier.

For the initial broad-beam attempt, SB65/66 was again selected as midships frame but this time set out to 24ft. Multiple hypotheses were constructed for frames SB57, SB65/66, and SB79. All of these turned out to be dead ends: the models were not different enough in beam or in bow profile to be relevant for this study, or as much as was suspected they should be from the forward frames. The issue was SB65/66 as the midships frame. As a result of that, experimentation began with the idea of using the extant forward and aft frames in the same manner as frame SB68 INTERPRETED, but along with other possibilities for the midships frame. In the real world, the frames will "reign in" a wooden plank's natural bending tendency – a tendency which Rhinoceros will sometimes exaggerate. That was the purpose of creating SB68 INTERPRETED in the narrower models; that frame helped control the model's tendency (algorithmically simulating a wooden plank's tendency) to problematically bulge too far outward at that point. The extant frames were used on the broader models; a phantom frame was not required as on the narrow models. The narrower models were reconstructed using a single midships frame with SB68 INTERPRETED, whereas the broader models were reconstructed using a frame forward of midships, and one in the afterbody and trying different frames as possible midships frames. Looking at the preliminary results using frame SB57 and SB79 as the control frames, it began to appear that for the bluff-bow theory to be viable, the beam would have to be bigger, but not dramatically so.

Rather than try and achieve a specific target beam as before, a maximum allowable beam would be set so that the entry of the bow would be the focus, as a more bluff entry was always suspected as a possibility. A 25-foot beam seemed the widest likely possibility from the data in Dr. Still's database, so that was chosen as the approximate maximum beam constraint. Narrower was acceptable, but not more than a few inches broader. The depth of hold would be kept at 8 feet (2.44 meters), the same as the depth chosen for the narrower beamed models. This was in the middle of the range from the database, but the common depth of hold for a vessel of this length could have plausibly been anywhere between 6 and 9 feet, according to the database. When comparing the frames, SB54 to SB59 looked as if they had more deformation (SB54 and SB57 also had fewer data points). Frames SB53 and SB62, however, looked viable.

Frames SB53 and SB62 were the most complete of the "wide set", so they were the frames chosen to be the forward control frame and midships frame respectively for the bluff models. These frames lined up very well to each other and SB78 (which had an adequate number of goniometer points recorded) in the aft section lined up plausibly with both and so was chosen as the aft control frame (Figure 19).

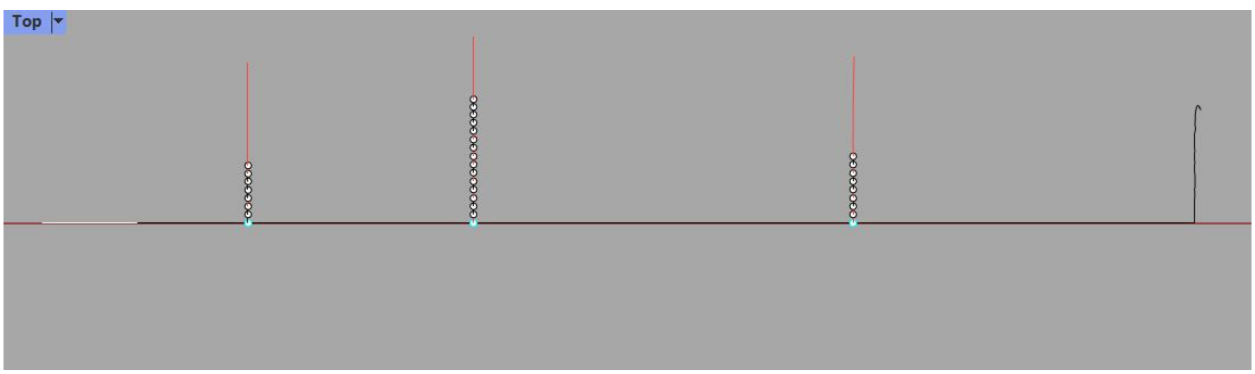


Figure 19. "Top" view of (left-to-right) SB53, SB62, SB78, and preliminary 100-Degree transom.

All three frames had a few goniometer points which were obviously deformed out of line with the other points in the frame, but only a few. Because none of the frames survived to full height, the frames' end points would need to be hypothetical. The height of the sheer at all three frame stations was taken from the narrower models (there was no reason to suspect they would be different enough to be concerned with on wider models) and those heights became the hypothetical endpoints for SB53, SB62, and SB78 on the broader models. The "Interpolated Curve" command yielded full-height frames which could then be lofted. Upon lofting the hull, the curves seemed viable for both sternpost-angle models, and the beam came out to 7.58 meters or 24.88 feet. It was not necessary to use SB68 INTERPRETED as a phantom frame to pull in the afterbody in this model. With plausible models for both the bluff and fine entries and both sternpost angles, all that remained was modeling the transoms (Figure 20).

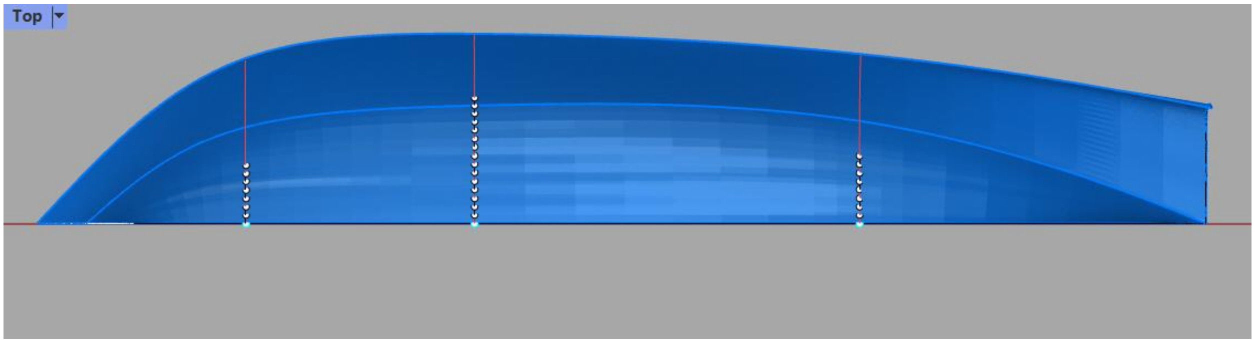


Figure 20. "Top" view of broader-beamed model with the hull lofted. Still using preliminary transom.

Developing the Transoms for all Models

Building the transoms for the models was relatively simple. The shape of the starboard half of the transom had already been defined, but it had always been modeled in-line with the sternpost. Historically, this is not how transoms were built on vessels of this size; the transom typically extended aft of the sternpost at a different angle. Extending rearward from the sternpost is the counter, that is a continuation of the upward sweep of the aft third of the hull. This (along with the square plank ends) is why the run of the planking suggested a transom; the planking shape looked as if it would extend past the sternpost. At the end of the counter, the transom proper began, changing to a steeper angle, though not an angle matching the sternpost.

The same comparables that suggested the sternpost angles also demonstrated a range of angles for the transom section, between 117 degrees and 137 degrees in relation to the baseline for the transom itself. The counter typically could not be measured precisely from the drawings available for this project. This was either due to the drawing being too small to measure or, more often, because the counter was curved rather than straight due to being planking rather than a straight timber. Rhinoceros, via the "Loft" command, automatically faired the straight counter used for the models, though the curve of the counter that far aft in the models is slight. The few examples with a greater than 100-degree sternpost typically had a transom angle closer to 135 degrees, but the 100 degree sternpost examples covered the whole range of transom angles. Most were between 123 degrees and 130 degrees. Because all the angle measurements were approximate, and because these would not have a major impact on the overall model, 125 degrees was chosen for the transom on the 100 degree sternpost models and 135 degrees was chosen for the 120 degree sternpost models. Rather than measure out the approximate length of the counter and then convert it to metric and then scale it to the TCV model, the length for the model's counter was found by measuring the approximate proportions in the lines drawings of the counters in relation to the height of the vertical portion of the transoms. There was a range, but a counter length of around one-half of the height of the transom was common, so that proportion was chosen. Since the transom's height in the model was not being changed, only its location and angle, this was more expedient than conversions and scaling. The transom height on the TCV is 0.786 meters in height, and applying the data discussed above gave a length of 0.393 meters for the counter. At this point, the more realistic transom model could be built.

To build the transom model, new layers were created in Rhinoceros. A layer for the counter named "Counter" was created with the sublayers "Counter Construction Lines" and "Counter Recon" (as in reconstruction). A construction line was started at the top of the sternpost with a constrained angle of 170 degrees matching that of *Sunny South*. A point in the same layer was placed along this line at 0.393 meters from the top of the sternpost. That point represented where the vertical section of the transom would be relocated to. A line in the "Counter Recon" sublayer connected the sternpost to the construction point (Figure 21). This was done for all four models.

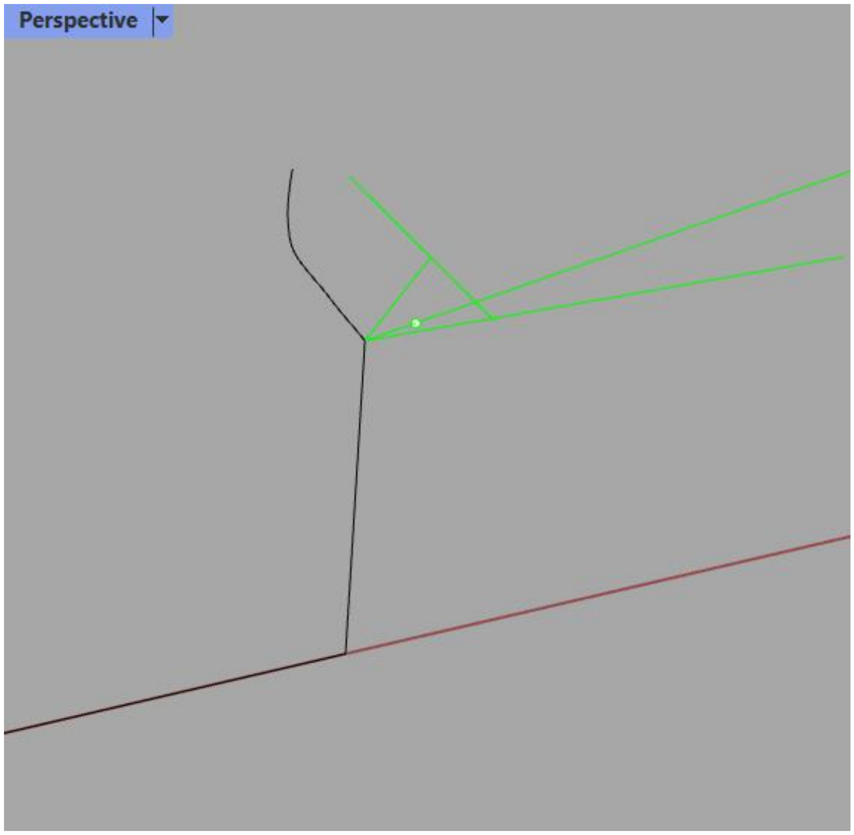


Figure 21. Counter angle construction lines (in green). Note the green dot (point); the as-yet undrawn counter ends there and the transom begins. The T-shaped pair of lines at the top delineate the angle the transom will be adjusted to.

The next task was to adjust the transom angle. Two new layers, “125 Deg Construction Lines” and “135 Deg Construction Lines” were created. A temporary construction line was started at the top of the sternpost, constrained to either 125 degrees or 135 degrees depending on the model, and drawn with an unmeasured length. This was a reference line for rotating the transom. The transom was selected and using the command “Rotate,” the transom was rotated to match the angle of the construction line. Rhinoceros automatically “snaps” to the line (if that parameter is chosen), so the angle was not approximate, but exact. After rotating, the transom was again selected, the “Move” command used, and the transom relocated to the end of the line of the counter. The final reconstruction was ready. New layers named “FINAL Correct Transom 100 Degree SP” and “FINAL Correct Transom 120 Degree SP” were created. In those layers, each reconstruction of the sternpost to transom was merged into a single, integrated “curve” as Rhinoceros calls it (Figure 22). With that done, the final lofting was applied to all four models (Figures 23-26) and lines drawings generated (Figures 27-30). All four models were then ready to be analyzed by ORCA 3D.

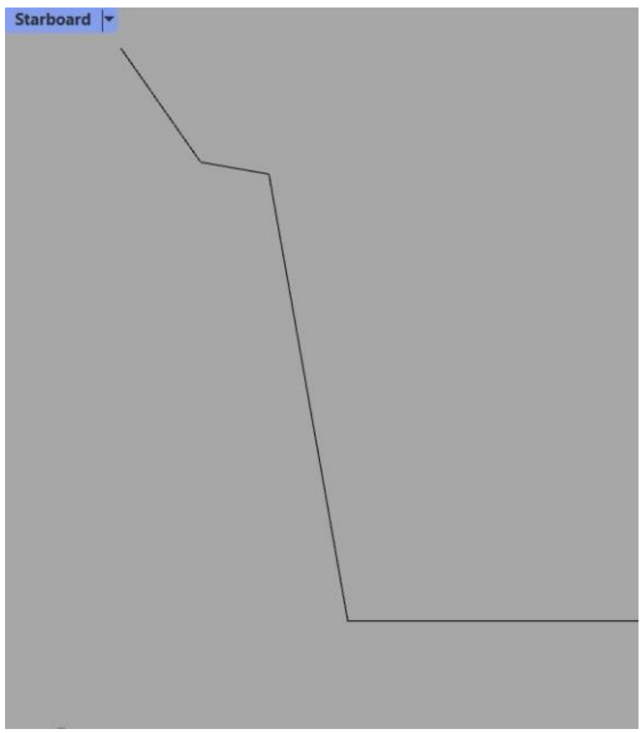


Figure 22. Starboard view of reconstructed stern. Sternpost-counter-transom (from bottom, moving vertically and to the left). The spine is extending off the right side of the image.

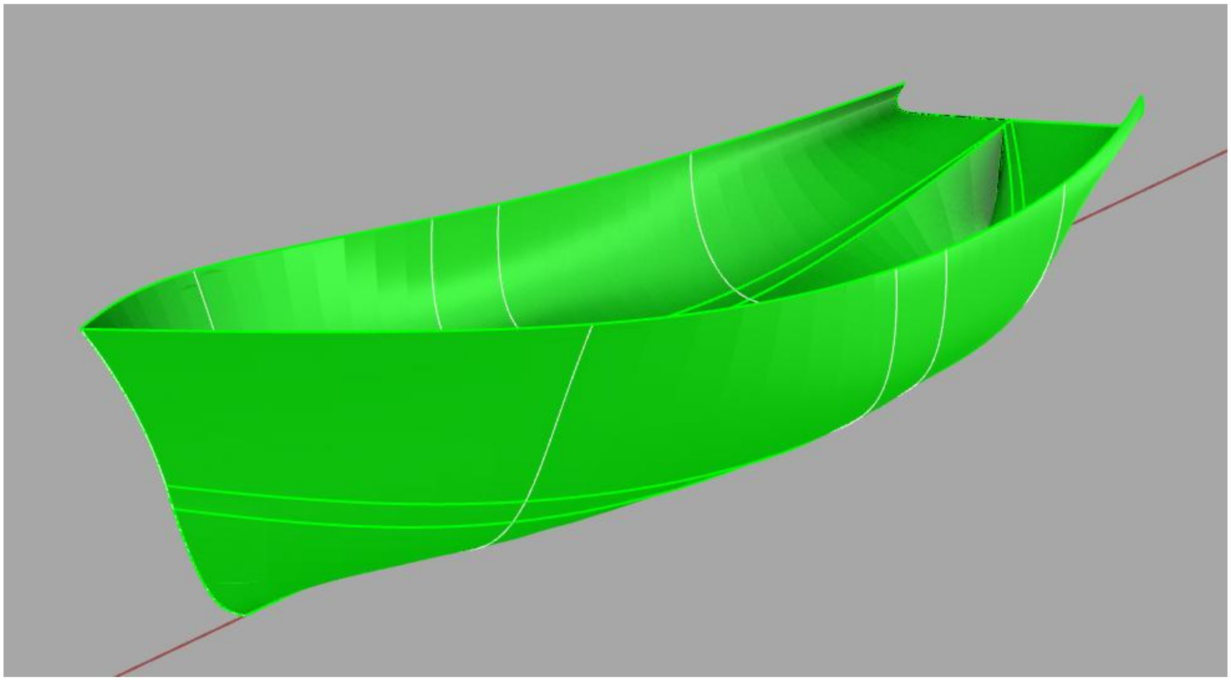


Figure 23. Narrower beam, 100-degree sternpost. Full beam hull model.

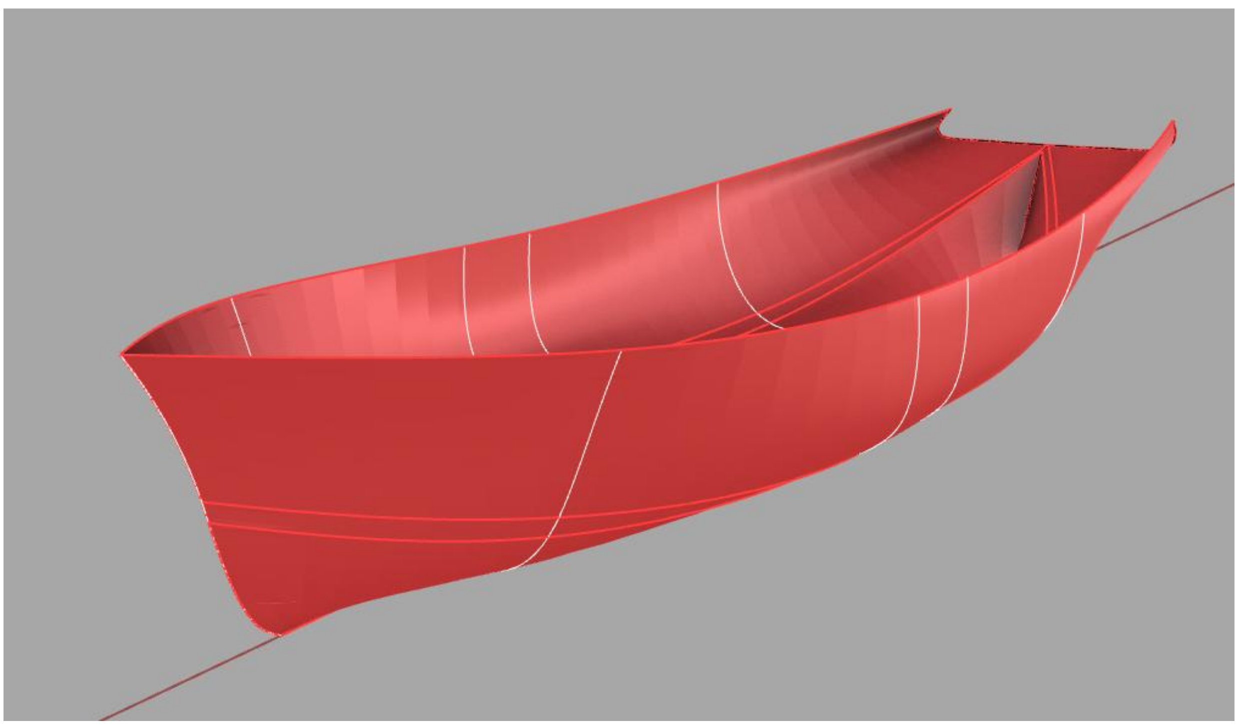


Figure 24. Narrower beam, 120-degree sternpost. Full beam hull model.

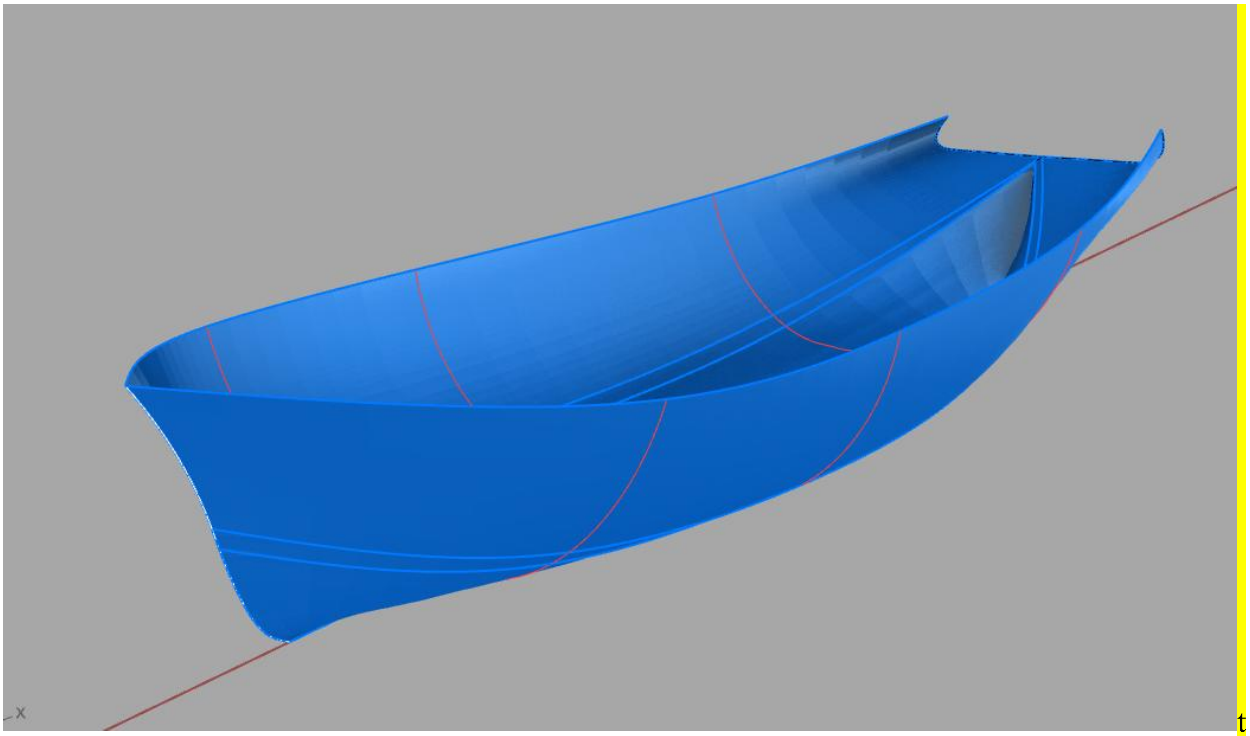


Figure 25. Broader beam, 100-degree sternpost. Full beam hull model.

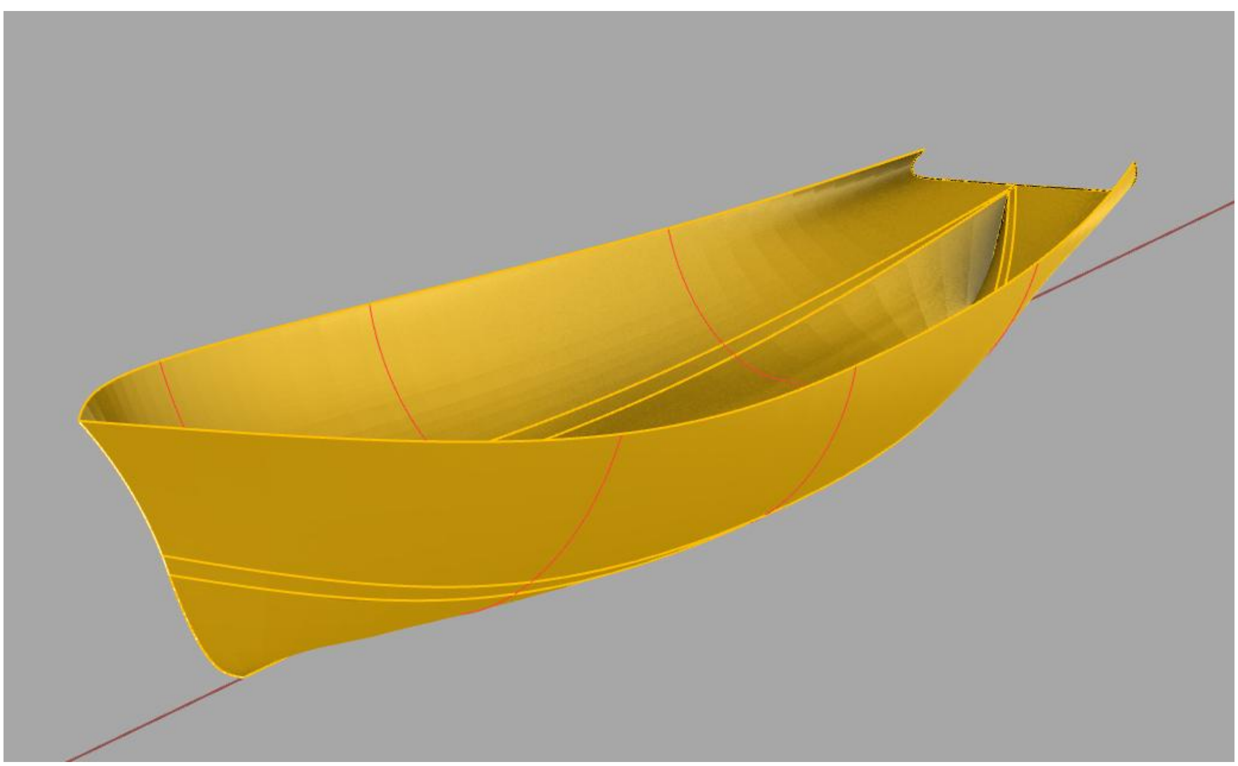


Figure 26. Broader beam, 120-degree sternpost. Full beam hull model.

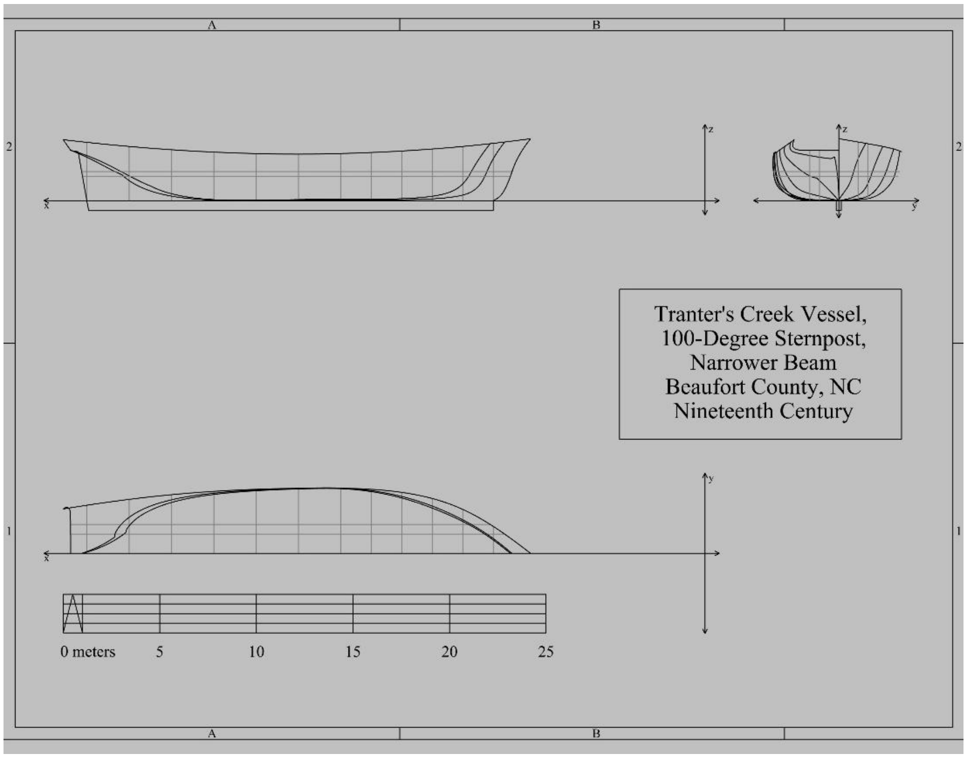


Figure 27. Lines drawing of narrower beam model with 100-degree sternpost.

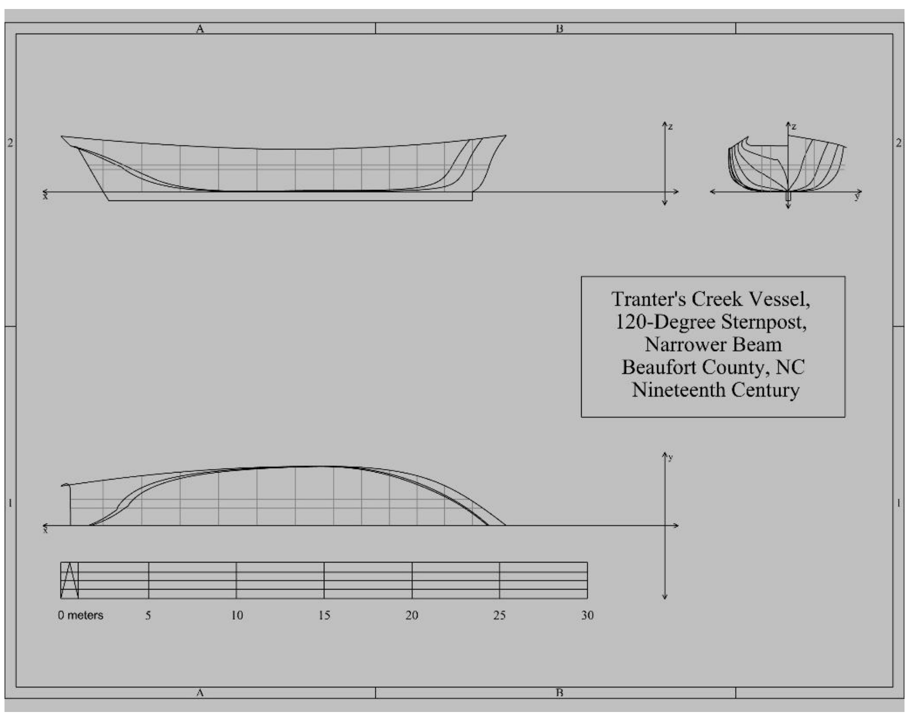


Figure 28. Lines drawing of narrower beam model with 120-degree sternpost.

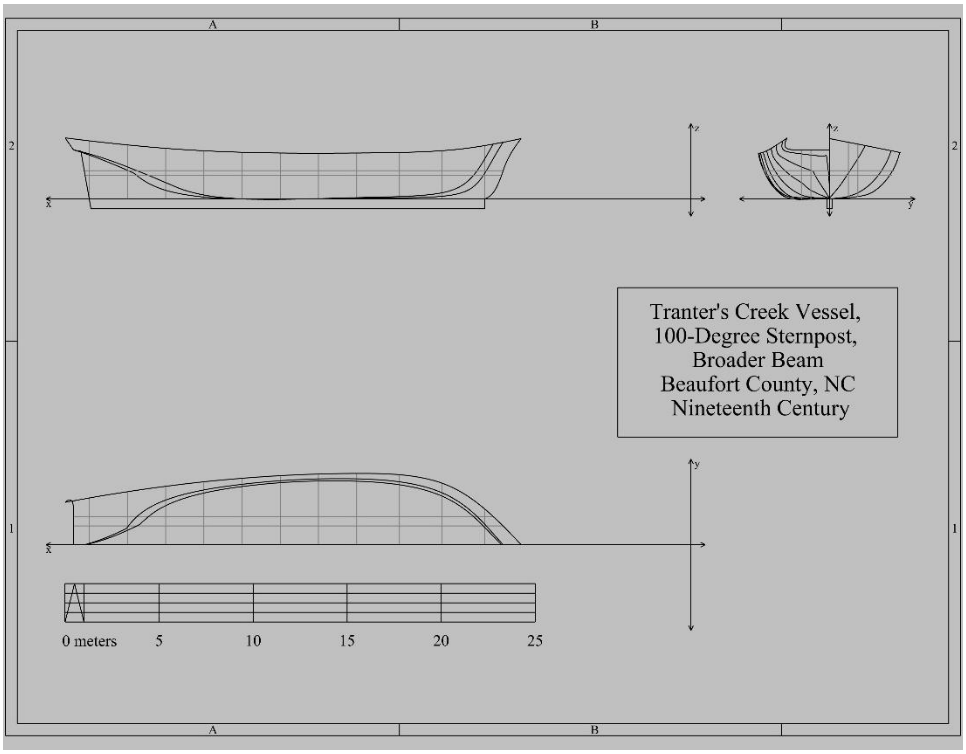


Figure 29. Lines drawing of broader beam model with 100-degree sternpost.

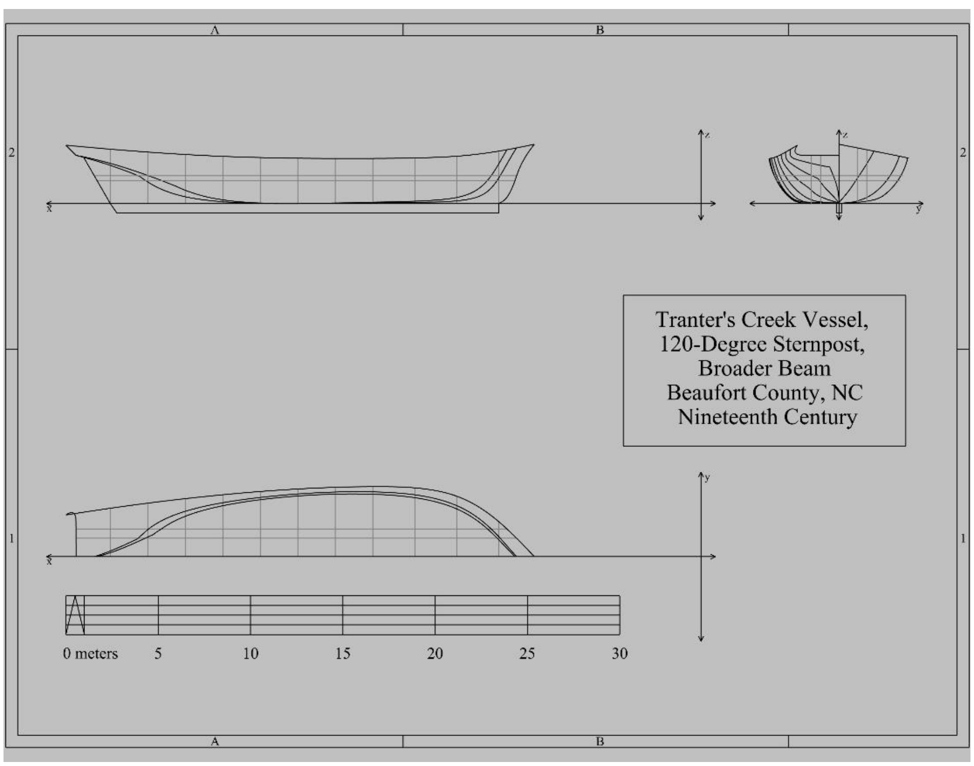


Figure 30. Lines drawing of broader beam model with 120-degree sternpost.

ORCA Analyses

As previously mentioned, each of the four models had six analyses run on them. In truth, more were run, but they yielded no relevant information, sometimes no information at all. These unused analyses were, however, valuable in learning to communicate with ORCA to get viable, useful results. ORCA required information about the draft of the vessel; the program is optimized for designers of vessels who have a draft they want to achieve, not reconstructors working from limited data sets. Draft was initially one of the things the author had hoped to find out from ORCA as an analytical result. Because that parameter had to be provided to ORCA rather than given by it, draft information required a bit of trial and error until plausible numbers were achieved. Given the shallow waters of the region and the typical drafts found on coastal, shoal-draft schooners, two likely draft depths were chosen: 1.25 and 1.50 meters (4.10 to 4.92 feet). Another data point required was "trim." ORCA would not give any information without this parameter being defined. Vessels have a vertical angle they sail or motor forward with (like the angle of attack on an airplane), and this is called *trim*. Trim is a constantly changing variable in the real world; any repositioning of internal weight (particularly cargoes that slosh around) and wave action affects trim on a second-by-second basis. ORCA – out of necessity – analyzes trim as a static rather than constantly changing variable. After measuring the comparable vessels, three trim angles were chosen; there does not appear to be any design-standard trim angle in the comparable vessels, and all the measured angles were approximate. Trims of 1, 1.5, and 2 degrees were used for the ORCA analyses to cover the broadest practical possibilities. ORCA extrapolated the dimensional information details of the curves directly from the model in Rhinoceros.

Three analyses per model, per draft were run, totaling the aforementioned twenty-four. For the full coefficients data, the summary tables that ORCA generated in the analyses are included in Appendix B. What will be covered here is the mean of all trim angles for the Block Coefficient and the mean of all trim angles for the Waterplane Coefficient for the four models (Table 2). The other information generated by the ORCA analyses will not be covered here as they say little about overall tonnage for a given draft. All the Coefficient information ORCA generated is in the ORCA documents in the appendix, however. For this study, the tonnage is the most important calculation, and that will be discussed for all permutations (Table 3).

The average Block Coefficient and Waterplane Coefficient for the narrow-beamed 100-degree sternpost models at 1.25 meters draft are 0.502 and 0.754, respectively. The averages for the same model at 1.50 meters draft are 0.529 for the Block coefficient and 0.778 for the Waterplane. The narrow-beamed model with the 120-degee sternpost at 1.25 meters draft had an average Block Coefficient of 0.498 and Waterplane of 0.753. The same model at 1.50 meters of draft had a Block Coefficient of 0.524 and Waterplane of 0.777. The broad-beamed model with the 100-degree sternpost and a draft of 1.25 meters had a mean Block Coefficient of 0.470 and a Waterplane of 0.751, and at a draft of 1.50 meters had Block and Waterplane coefficients of 0.490 and 0.778, respectively. The same beams with the 120-degree sternpost yielded a Block Coefficient of 0.464 and Waterplane of 0.748 at the 1.25 meter draft and a Block Coefficient of 0.483 and Waterplane of 0.774 at 1.5 meters of Draft. The following table is the Block and Waterplane Coefficients.

Coefficients	*Narrow 100 Deg SP 1.25m Draft*	*Narrow 100 Deg SP 1.50m Draft*	*Narrow 120 Deg SP 1.25m Draft*	*Narrow 120 Deg SP 1.50m Draft*	*Broad 100 Deg SP 1.25m Draft*	*Broad 100 Deg SP 1.50m Draft*	*Broad 120 Deg SP 1.25m Draft*	*Broad 120 Deg SP 1.50m Draft*
C_b	0.502	0.529	0.498	0.524	0.470	0.490	0.464	0.483
C_{wp}	0.754	0.778	0.753	0.777	0.751	0.778	0.748	0.774

Table 2. Table of Block (C_b) and Waterplane (C_{wp}) coefficients. (Table by author).

This data, in particular the Block Coefficient, indicates that the TCV was optimized for shallow water. It appears the client or builder chose to sacrifice some speed and speed and efficiency of moving through the water to gain a shallower draft for a given burthen. Below is the ORCA-generated table with all twenty-four displacements calculated for each trim at each draft for each sternpost angle.

Trim Angle	*Narrow 100 Deg SP 1.25m Draft*	*Narrow 100 Deg SP 1.50m Draft*	*Narrow 120 Deg SP 1.25m Draft*	*Narrow 120 Deg SP 1.50m Draft*	*Broad 100 Deg SP 1.25m Draft*	*Broad 100 Deg SP 1.50m Draft*	*Broad 120 Deg SP 1.25m Draft*	*Broad 120 Deg SP 1.50m Draft*
1.0 Degree Trim	131.52t	160.67t	134.62t	164.69t	127.37t	157.55t	129.50t	160.48t
1.5 Degree Trim	143.95t	173.79t	147.75t	178.63t	139.42t	170.60t	142.15t	172.27t
2.0 Degree Trim	156.87t	187.50t	161.47t	193.30t	152.10t	184.46t	155.54t	189.02t

Table 3. Table of displacement weights in metric tons. (Table by author)

The data is interesting. It is no surprise that the analyses run using the deeper draft show greater displacement than the shallower draft analyses of the same sizes and trims. Nor is it surprising that the 120-degree sternpost angles give heavier displacements than their 100 degree counterparts. How much difference that change of sternpost angle made *is* surprising, however. In each case it is multiple tons of additional carrying capacity. More surprising is that the narrow beam models all are of greater displacement than the broad beam models. This is counter-intuitive; one would think the broader beamed models to be more voluminous and therefore able to carry more weight at a given draft. The opposite is true here. It is not clear at this time why that is. Confirming why this is falls outside the scope of this project; the primary goal of this project was to find the hull shape, draft, and tonnage for this vessel. It is discussed as potential future research in Chapter 5, however.

Chapter 4

Investigating the Wreck and Suspected Post-Abandonment Use

Early on, the location of the Tranter's Creek Vessel, when viewed against the events of the Civil War in and around Washington, suggested that it could be a remnant of the war. Given its location obstructing the navigable Tranter's Creek that helped to control access to the Greenville Road which crossed the creek, it was certainly possible. Confederate forces did at times hold various parts of the upper reaches of Tranter's Creek, and blocking the ability for the Confederates to send raiders out of the creek in boats could have been a consideration. The author initially gravitated toward the idea of the TCV being a war-scuttling for several reasons. One of these reasons was that the TCV does not sit in the shipping channel of the Pamlico, but it sits directly adjacent to it between the navigation channel and the north bank which blocks the navigational channel up Tranter's Creek. After many conversations between the author and his advisor, it was decided a vessel sailing upriver was unlikely to unintentionally sink completely out of the Tar-Pamlico channel, at least at the angle the TCV sits at. The vessel's size and its orientation across the channel coming in from Tranter's Creek suggests that it was not trying to go up the creek when it ran aground. It looks like an intentional sinking rather than an unintentional wreck. This is where Nathan Richards's abandonment theories come into consideration. Since the vessel did not appear to have been lost due to misadventure, the various theories of intentional discard had to be examined. Post abandonment use seems to be most the logical possibility.

It is currently the belief of the author that the Tranters Creek Vessel was intentionally sunk by the Army Corps of Engineers (CoE) in 1871 as an improvement to Tar-Pamlico navigation. The evidence suggests that this is the most likely reason for the vessel to be where it is and that 1871 is the most likely year. Figure 31 shows an 1872 map of coastal survey done in December 1871 through February 1872 shows a "wreck" at the location of the TCV (United States Coastal Survey 1872). Before this map, no as-yet found records of any kind show or describe a wreck or obstruction in this location. As mentioned earlier, this is where the *terminus post quem* date comes from.

Figure 31. *Washington and its Environs*. (Courtesy University of Alabama). Location of "wreck," "stakes," and "fisheries" are upstream (left side of map) and circled by author.

No records yet discovered from the Civil War mention the sinking or scuttling of any vessels in this part of the Tar-Pamlico. Records do indicate that when Confederate forces abandoned Washington in March of 1862, a partially finished vessel was towed well upstream of the Tranter's Creek Vessel's location and burned, but with no record of it ever being washed or towed downstream (United States Naval War Records Office 1898:151). The closest incident found to a sinking at Tranter's Creek during or after the war was the September 1862 explosion of the U.S. Army gunboat *Picket* at Washington. General Foster (commander of the Union force at Washington) claimed, “The guns have already been recovered; the machinery can certainly be saved, and possibly the hull raised and repaired” (United States War Department 1887:5-7). Picket has also been located in the Tar River near the old U.S. 17 bridge. It is in the wrong location and still has many of its fittings (Boyd 2026), so cannot be the TCV. Commander R.T. Renshaw, commander of the Union gunboat *Louisiana*, reports capturing an 80-ton schooner at Tranter’s creek. Renshaw claims that it “has never been masted” and displaced 80 tons (United States War Department 1899: 35). However, it is unlikely to be the TCV as Renshaw reports the vessel to be of significantly lower displacement than the calculations ORCA produced for this project. It is possible, but it currently appears highly unlikely. It is not impossible that the TCV actually sank in its current location during the war, but such records have not yet been found by the author. It is also possible that it is a civilian wreck dating to after the war, but it was not feasible to work through the microfilm/microfiche collections of the local newspapers. Given the angle of the vessel adjacent to the Tar-Pamlico channel and across the Tranter’s Creek channel, along with the unlikelihood that a vessel of that size would be trying to go up Tranter’s Creek, the idea of a search through the microfilm collection was abandoned for this study.

The Army Corps of Engineers stands out as the most likely candidate for sinking the TCV for a number of reasons.

The idea that this may have been a CoE navigation channel improvement originated from seeing the 1872 map and connecting it with some of the more passive techniques for keeping channels open. Among many other duties, the Corps of Engineers is responsible for the maintenance of all commercially-navigable channels in the United States’ territorial waters (United States Army Corps of Engineers 1993:4). On some of the navigable rivers, the CoE maintains a variety of river training structures to passively "…create and maintain a safe and dependable navigation channel" (United States Army Corps of Engineers 2006:5-1). This is done by using structures to slow down or redirect the process of silting-in of a channel or of erosion, therefore reducing the various channel and riverbank maintenance operations required (United States Army Corps of Engineers 2006:5-1, 5-12). These are used in varying forms in navigable rivers across the United States.

The location of the TCV on the 1872 map stood out; the "wreck" is marked where Tranter's Creek empties into the Tar-Pamlico (the start of the Pamlico section) at a sharp bend in the Tar-Pamlico navigational channel. The author and his advisor had often discussed why a wreck would be left obstructing the mouth of the otherwise Navigable Tranter's Creek. There is an island directly adjacent to the wreck site that does not appear on earlier maps, including the 1872 survey map. On that map, there is a "fishery" listed near to the wreck and dots that appear to be labeled "stakes" directly next to the modern navigable channel between "wreck" and "fishery." Similar dotted notations are made at the mouth of Tranter's Creek just before Bear Creek joins it (Figure 32).

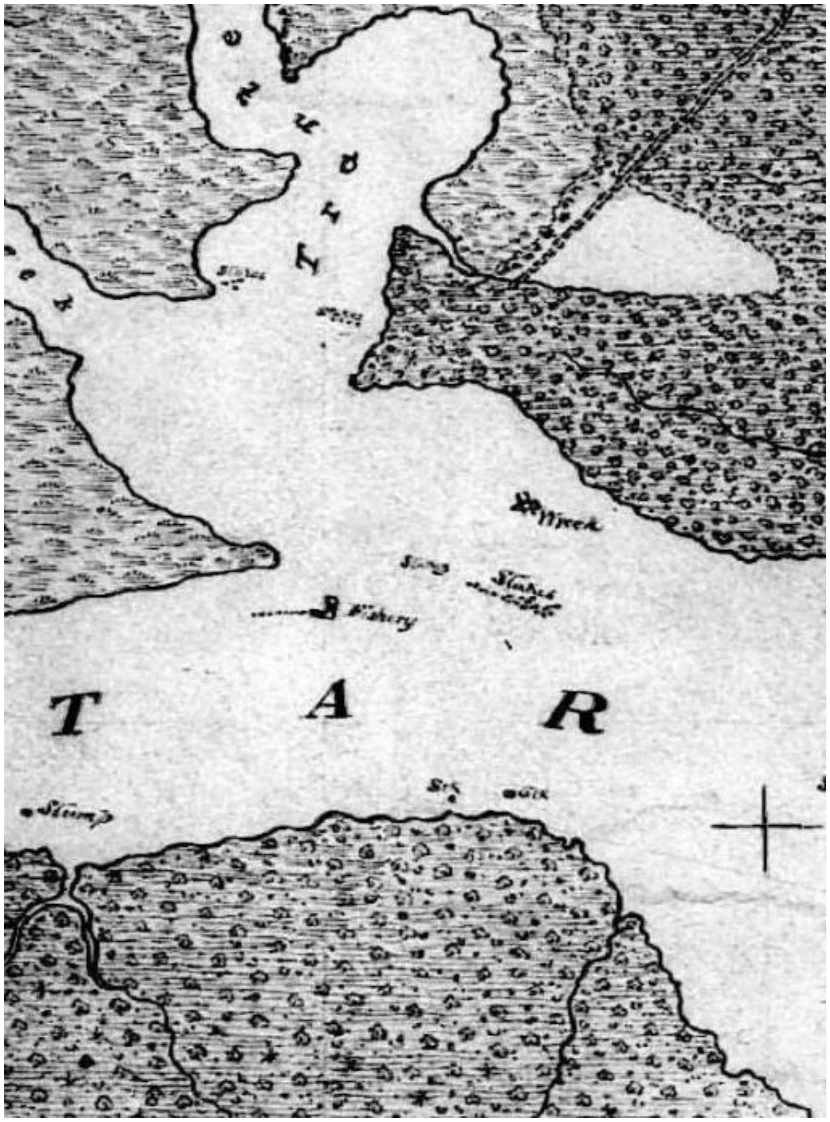


Figure 32. Detail of *Washington and its Environs* focusing on the confluence of Tranter's Creek and the Pamlico with "wreck," "stakes," and "fishery" documented at the site.

Whatever the purpose for the stakes being there (they are not listed in any Civil War documentation as barriers that the author has found), the stakes would reduce the amount of sediment flowing into the Tar-Pamlico, particularly as sediment built up on the upstream side of the stakes and likely trap sediment falling out of the water column of the Tar as it changed direction. The location of the TCV, next to the stakes adjacent to the fisheries means that the vessel was unlikely to be pushed into the navigational channel by floodwaters. The stakes may have been driven in place for fishing nets, not necessarily to hold the TCV in place, but they would still work as a barrier to the vessel being pushed out of place by floodwaters coming in from Tranter's Creek or the Tar. Vessels are sometimes sunk as breakwaters and barriers to aid shipping (Richards 2022:10, 180). The TCV's location may trap the sediment coming from Tranter's Creek and choking the Tar or it may disrupt the flow of both bodies of water enough that sediment falls out of the water column and settles; this seems to be the origin of the present island (Figure 33).

Figure 33. Google Maps screen capture (current photo is from 2023) showing current island, micro-island (circled yellow) and approximate location of vessel (pink oval). Just above the island. The U.S. Route 17 Bypass bridge is visible to the extreme right of the image. (Courtesy Google Maps 2025)

The earliest clear overhead photo that could be found at this time is from 1999 (Figure 34). The changes in the series of historical photos from Google Earth could be partly due to the water level in the photo taken as much as silt accumulation or washout. There is at least a chain of small islands spanning the approximate shape of the current island. Between the 1999 and 2005 (Figure 35) images, there is an apparent filling-in of the island, but this may be due to higher than normal water levels when the 1999 photo was taken. There is very little change from

2005 and 2009 (Figure 36) The 2017 photo (Figure 37) is included because the water was unusually clear, and the underwater portion of the island is visible in the photo giving an impression of how the silt from Tranter's Creek settles (Figure 37). Unfortunately, no clear photos were available from before 1999, and no chart of soundings of that location from the nineteenth century has been found.

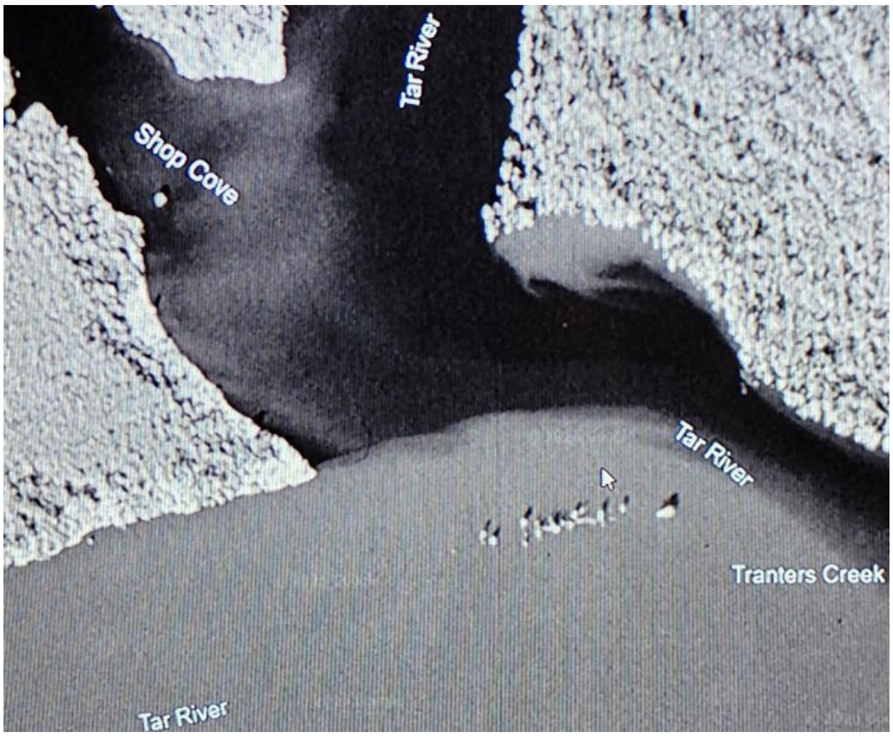


Figure 34. Aerial photo from 1999. The island is more of an archipelago in this image, possibly due to higher water levels when the photo was taken. (Courtesy Google Earth 2026)

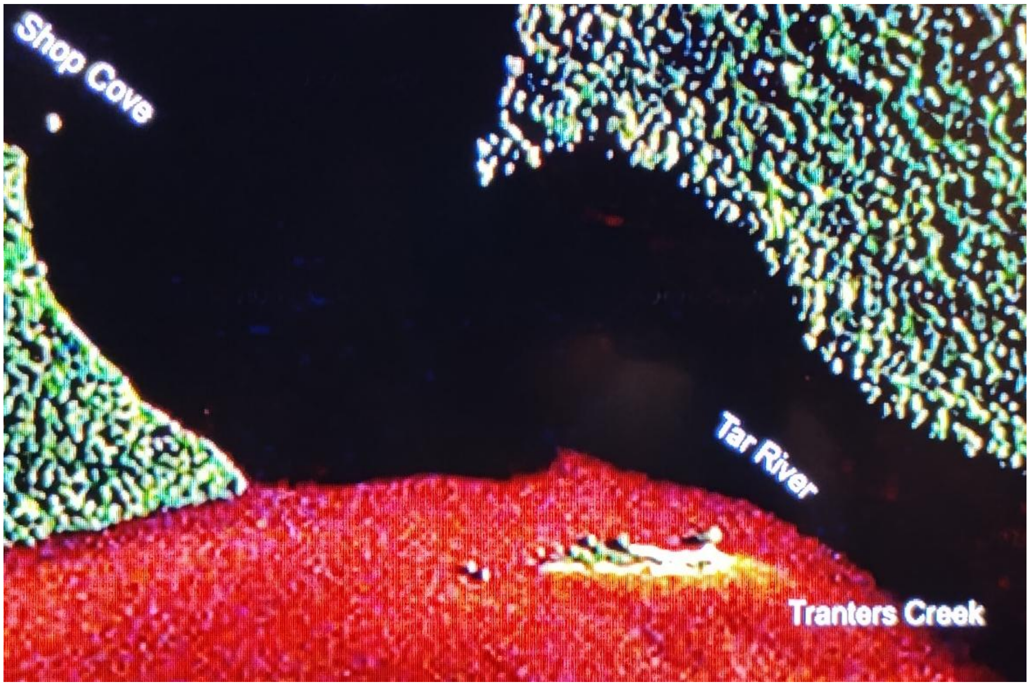


Figure 35. Aerial photo from 2005. The island is in its approximate current shape. The reason for the red water in the image is unknown, but is more likely due to the camera rather than actual water color. (Courtesy Google Earth 2026)

Figure 36. Aerial photo from 2009. Little change in the island, though the water seems clearer so some underwater mass of the island is visible. (Courtesy Google Earth 2026)

Figure 37. Aerial photo from 2017. The unusually high visibility below the water reveals the shoaling that spreads both up-current and down-current from the island, likely due to the pressure of the outflow of Tranter's Creek pushing sediment out and being deflected in both directions by the island. (Courtesy Google Earth 2026)

The Tar-Pamlico navigation channel butts against this island and the shoals that have formed around it. In fact, looking at the satellite view on Google Maps and zooming in shows that the shoaling roughly follows the curve of the navigation channel (Google Maps 2025). A micro-island has formed on the shoal upstream of the main island which would only serve to further protect the Tar-Pamlico navigation channel from sediment coming from Tranter's Creek and trap sediment from up the Tar – particularly as the micro-island's shoal and that of the main island silt-in towards each other. Taken as a whole, it appears the CoE was trying to ease maintenance of the Tar-Pamlico channel. Evidence from the Corps of Engineers itself was now required.

The 1866 Annual Report [to Congress] of the Chief of Engineers included a list of projects for which money had been "appropriated" in 1852 but never undertaken, including the entry: “Improving [the] Pamlico river [*sic*], North Carolina” (United States War Department 1866:7) The plan seems to have been from the start to improve the navigable channel all the way to Tarboro. The 1880 Chief’s Report (Part I) states funds appropriated in 1879 had been used in work removing “…obstructions both natural and artificial, from the town of Tarboro, N.C., to the point where it assumes the name ‘Pamlico,’ near the town of Washington, N.C.” and in the “…construction of a few simple jetties” (United States War Department 1880:122-123). The report does not say where the jetties are located. Unfortunately, while many of the Chief’s reports are digitized and available online, the 1871 report is not, and it is the one most likely to describe the sinking of a vessel at that point – if they chose to be that specific (the reports are often vague on specific aspects of larger projects). The 1871 report has an active link but goes to the year 1880 Part I Chief’s report. The author was unable to access the 1871 report in any format, and the Corps of Engineers has not replied to any inquiries made by the author or his advisor. As a result, it cannot be confirmed that the CoE sank anything at all in that spot, but it seems a strong possibility from the evidence.

This is not by any means conclusive. However, it is currently thought to be the most likely possibility. That could change with future research, however. The identity of the vessel is currently unknown – if it was, in fact, a completed vessel. Unless some documentation naming the vessel is found, the state of the TCV’s completion may never be known. Given the shallow water, any salvage operations would be able to take as much of the vessel as desired. The fact that it was not dismantled entirely and salvaged completely even though it blocked the navigable channel into Tranter’s Creek can be viewed as another piece of support that the vessel sits there as an intentional object (Richards 2022:85,147-156).

Chapter 5

Conclusions, Discussion, Further Research

Re-examining the Research Questions

The first problem this study set out to solve was the hull form of the TCV. The form, as suspected, was that of a fairly flat-bottomed cargo vessel. This study produced four plausible shape variations for the hull. It is somewhere between approximately 25.26 meters and 25.38 meters (82.87 feet to 83.27 feet) in length. The beam of the vessel is most likely between 6.82 meters and 7.58 meters (22.38 feet to 24.87 feet). Displacements for the models ranged from 127.37 tonnes to 193.30 tonnes. What *was* surprising is that the narrower beamed models have a higher displacement at every depth, sternpost angle, and trim than their broader beam counterparts as is discussed below.

The intended operating environment of the vessel was most likely shallow coastal waters, but it could make it to the West Indies. Such blue-water journeys are entirely plausible, given the presence of a centerboard trunk indicating the TCV had a relatively deep centerboard, and that the large Core Sound sharpies (hard-chined, flat-bottomed, shallow-draft vessels) at the end of the 19th century were making the journey to the Caribbean when it was not fishing season (Alford 1997:62-71). That said, the TCV seems to have been optimized for coastal waters. It was probably intended as a cargo vessel, but it could have been an oysterman from the Chesapeake, though it is unlikely that it was in the Carolina sounds oystering. Oyster fishing did not begin in North Carolina on a wide-spread commercial scale until the 1880s (Jackson 2021:20). Additionally, the northern Pamlico was not particularly good water for oyster production as the water was too fresh for good oyster beds that far north. All of that assumes that the TCV is a wreck rather than an intentional sinking. If it was indeed an intentional sinking, then it could have been a part-time oysterman or buy-boat from somewhere else. The hull and archaeology, however, do not indicate fishing of any sort as its primary purpose.

Unfortunately, archaeology has uncovered little evidence in or on the wreck (other than the hull shape itself) to suggest what the vessel's primary purpose was. There were no marks found that are consistent with hauling cargo, no bits of oyster shell, no fishing tackle, or anything else. As far as the evidence of the vessel's vocation is concerned, it is effectively sterile. The lack of visibility may be hiding marks or debris in the surviving timbers that could indicate the vessel's use. Perhaps such evidence has been scoured away by the silt and debris that naturally flow down the Tar-Pamlico or Tranter's Creek along with disturbances and damage caused by recreational boaters passing over or striking the TCV. Scavenging and salvage may have removed any traces of equipment the vessel once bore. It is equally possible that the vessel may not have ever been finished and so was never equipped; maybe it never became a vessel, just an unfinished hulk that was repurposed and sunk for the benefit of other vessels. Unfortunately, at the time of this study, there is no way to know for certain.

One of the questions this study hoped to answer was whether it is worth attempting to reconstruct vessels from very degraded sites such as the TCV site or if it is largely a wasted effort. In short: yes, it is worth the effort. There is a lot of archaeological data not present on the site or at least not yet discovered. Maybe the data for more refined reconstructions is there under the water, but that will require more archaeology in the future. Admittedly, this meant that a fair amount of information had to be pulled from other vessels of comparable shape and proportions, but modeling the wreckage as it sits yielded information that helped to determine what sorts of vessels would be acceptable comparables. With the frames modeled, a sense of the turn of the bilge could be determined along with the general flatness of the hull which led to *Sunny South* which informed models and raised new questions and suggested other viable comparable vessels. Along with Dr. Still's database, this allowed the creation of multiple reconstructions that fit the archaeological remains of a vessel in a very degraded state. The models in the study are by no means definitive but are a good starting point. This is a first step in building a database of reconstructed North Carolina wrecks/abandoned vessels. It can lead to better understanding of North Carolina boat and ship building, waterborne commerce, and allow comparing or contrasting design features with South Carolina and Chesapeake vessels.

To answer the question about goniometric accuracy in adverse conditions, this study has shown that it does yield solid, useful information for reconstructions. Goniometry is not going to be as accurate as digital measuring of a raised, preserved, and conserved vessel, but neither are baseline offsets or GPS recording. The goniometer proved very useful as the conditions would have made more traditional methods difficult for reconstructing the vessel. More advanced methods such as GPS may be more useful, at least in the extremely shallow water, but these alternative methods would have to be tried on this same wreck to properly compare them to the goniometer. There are advantages and disadvantages to every method and which is best depends on the site. The biggest advantage for the goniometer here is that it seems to be accurate even in atrocious visibility (in deep water, placing and using GPS equipment may be more difficult and less reliable with this sort of visibility). This is a real strength of the goniometer and opens the door of opportunity for more reconstructions on sites that have not been properly recorded due to visibility issues. Other factors in the goniometer's favor are that goniometers are relatively cheap, they can be improvised if needed with hardware store items, and goniometry is not dependent on satellite signal reception and dead batteries are not an issue (if using a spirit level and manual protractor rather than digital). There is a strong argument to be made for simple, robust field equipment.

The abandonment theories proved useful, at least in terms of why the vessel is where it is and why it may be there. The shipbuilding theoretical framework was less useful in this particular instance; the site needs further archaeological fieldwork and analysis to improve on the models and in finding clues as to what the vessel's primary purpose was meant to be. What the vessel was meant to be will open the philosophy discussion up more than is possible now. At this stage, the discussion can be had, but it would have to be on the assumption that the TCV was originally conceived to be a coastal cargo vessel (though for what sort of cargo is anyone's guess), and this assumption is based only on this plausible hull form. Without knowing what sort of cargoes it was optimized for or if it was built as a general purpose vessel with no specific optimization, the discussion is best served by waiting for more information.

The most unexpected things (at least to the author) that the models revealed were that the narrow models had higher displacement than the broader beamed models, and the degree of difference in tonnage that the sternpost angle made. The Waterplane and Block Coefficients indicate this is not a calculation anomaly; they are consistently higher for all the narrow-beamed models, drafts, and trims. It would seem that volume in the back half of the vessel counts for increased displacement more than bluffer entry and broader beams, at least for beam measurements within about a meter of each other. This was an extremely surprising result of the ORCA analyses. It could be the use of SB68 INTERPRETED generating a wider aft measurement. If something similar to SB68 INTERPRETED was done in a position in a similarly proportional spot in relation to SB62 maybe this would not be the case. More models would need to be built to test that. A thesis dedicated to an exploration of these and the other aspects of the analyses would be more appropriate than further examination in this study.

Future Research Opportunities

The most important avenue for future research is the need for more reconstructions of North-Carolina vessels in general, but especially the larger coastal vessels. Much of the difficulty with this project was the lack of information available. The author has, in previous studies of North Carolina vessels, faced this issue. In consulting on another project with Curator of Maritime History David Bennett of the North Carolina Maritime Museum at Beaufort, the author learned that as a whole, North Carolina vessels are understudied and relatively poorly understood (2021 pers. comm.). A North Carolina reconstruction database needs to be built up so that vessels can be compared like-to-like. These can then be compared to the county or sound of origin and highlight the influence of local cultural variations on the shipbuilding practices in North Carolina. Then perhaps examining North Carolina vessels in contrast to the Chesapeake and South Carolina coastal vessels could be a viable direction of study.

Another opportunity for future research is building more reconstructions of this vessel. There is a maddening number of "what-ifs" in regards to which frames are pushed out of shape and which are not and which way a given frame is deformed – particularly when looking at frames SB59 and SB60. Many more models could have been made based on frame SB59 as being correct and SB60 having been splayed inward. The question of why the narrower vessels have higher displacements could also be addressed. It is also entirely possible this vessel actually *is* an outlier and there is a bias from the database that misled this project; the database is made up largely of registration records which may have been inaccurate either in the reporting to the authorities or recording by the authorities. It could take a whole career to investigate all the possibilities and there needs to be more known NC wrecks recorded with an eye towards future reconstructions to build an archaeological database to work from and use as comparable vessels. At the time of this study, the TCV is the only North Carolina wreck that has been reconstructed in this way, as far as the author and his adviser are aware. There is nothing against which to compare the TCV like-to like.

Interestingly, the fact that the TCV has a centerboard may suggest a higher likelihood that it was an unfinished, new vessel or was stripped-down for a total refit. In his 2005 thesis, Snyder boldly hypothesized that as late as 1859, larger North Carolina vessels were typically built without a centerboard. This could suggest that centerboards were a relatively new technology in the region, and that most builders of larger coastal trading vessels (not ones meant primarily for canals) were late-adopters of it (Snyder 2005:154-155). If he is correct, and that point alone could take years of examination. The TCV's centerboard trunk suggests that there is the possibility it was either a vessel started without a centerboard and was being refitted (which could explain the centerboard trunk being beside rather than over the keel), or its construction was started after the war. If the latter is correct, then not only the deposition, but construction window for the TCV could fall between 1865 and 1871. Snyder's claim is provocative, but is currently unverified, and to the author's knowledge, unexplored by researchers since Snyder proposed it.

A related avenue for future research is to examine if there was a common relationship between the maximum beam of a vessel and the length of its centerboard trunk and how widespread that relationship might have been. On *Sunny South*, the centerboard trunk's length is equal to about 75% of the vessel's maximum beam. The centerboard trunk on the Tranter's Creek Vessel is just short of 16 feet, 10 inches. When this number is divided by .75, it gives a beam of

22feet, 4 inches, which is very close to the 23-foot beam. A sample size of two does not remotely prove a correlation between beam and centerboard length, but it does suggest that it may be worth further study, as there is probably some proportional correlation for hydrodynamic reasons, even if 75% of beam is not the typical proportion.

The impact that the sternpost angle has on the tonnage for a given draft is worth further investigation. A change of multiple tons of cargo capacity just from an angle change in the sternpost should not be dismissed. While the approximately 100 degree sternpost appears to be much more common than the more raked sternposts, there are examples in the 110-120 degree range. Not all examples were lines drawings of extant or archaeological vessels. Some were drawings exemplifying ideals in various naval and shipbuilding treatises re-recorded in the secondary sources, and most of the examples (though not all) the author found in the literature with the more raked sternposts tended to be earlier vessels with hulls designed for greater speed and deeper drafts (Chappelle 1958:217, 223, 263, 294, 296, 298). Though seemingly rare in flat-bottomed vessels, the fact that the archaeological recording of the TCV listed a 120 degree sternpost demanded that models with that rake be constructed, even if no other examples had been found; the archaeological data of the sternpost as recorded had to be modeled as it is not wholly implausible. It is admittedly a bit of a stretch to use these particular vessels as comparables, but nothing more suitable was found. The greater carrying capacity for a given draft that the more heavily raked sternposts provide could be a significant point. It is beyond this study to look further into the implications of sternpost angle on operational, legal, and Steffy/Hocker-esque philosophical-design issues, but as a database of reconstructed North Carolina vessels is compiled, the opportunity to investigate correlation between sternpost angles and the (late nineteenth-century) growing understanding of hydrodynamics, finances of the operator, primary operational environments/purpose, and how it corelates to what was happening in society at the time (such as increasing use of screw-driven steam and internal combustion engines). Every decision made in a vessel's design gives modern researchers useful information, and reconstructions help visualize and study these design choices.

Dr. Still's database would benefit from updating, particularly a more specific and consistent naming convention, and the addition of new data criteria. One of the struggles with this project was deciding on a draft. The database has depth of hold data but no draft data. This meant educated guesses had to be made about the draft. The draft used is not uncommon for shallow-water coasters, but deeper drafts were known in the Tar-Pamlico. *Cotton Plant*, the first steamer to begin running the Tar after the Civil War had a draft of 4.5 feet or 1.372 meters (Bridgers 2013:79-80). That is not significantly deeper than the daft used for the TCV models, but *Cotton Plant* was no coaster; it was a purpose-built river steamer, and it was slightly deeper than the vessel thought to be intended for use on the open coast. It does not negate the validity of the draft as used in the models, but it does mean substantially deeper draft models could be made with equal viability. Those deeper models could open new lines of inquiry and make connections this project did not – again, a maddening number of feasible "what-ifs."

An analysis of the wood samples taken from the TCV would be useful both for species (to determine if it was local or from outside the region) and dendrochronology. The dendrochronology mentioned in the field school report still needs to be done, but funds have never been allocated for this purpose (Stewart 2024 pers. comm.). If the samples dated to after 1871, it would require a complete rethink of the *terminus post quem*, which would also require a reassessment of the process of narrowing down vessels from the database. It may also give an indication on the lifespan of the vessel; was it repaired repeatedly over a span of years or was it sunk before it was complete? If it was not a local vessel the odds would be very high it was completed and named and so, with more field work done on the site, could give more answers about its intended purpose. After Reconstruction, Washington shipbuilding began to pick up again, but it was primarily for non-local business interests. With a name, the state (or country) of registration might be tracked down. This could also help explain what purpose the TCV was primarily conceived for. The primary purpose might suggest which model was most correct or indicate that all four models in this study are not particularly close to what the vessel was when it was afloat.

There is a particular question about the ceiling planks that is the author's favorite future research opportunity. In the field school report, the difficulty in removing the ceiling planks was mentioned, but not examined. They seem to be heavy for the size of the vessel though it is difficult to say definitively that they are non-typical with so little recorded in North Carolina to compare it to, and *that* is of interest. In *The Merchant Schooners*, Basil Greenhill mentions a Cornish tradition of building vessels with relatively (though not excessively) light hull planking and particularly robust ceiling planking (1988:67). Greenhill does not examine why the tradition exists or if it has any practical effect on a vessel, but it raises not only the question of why it was done, but did similar traditions exist elsewhere? There is no reason to believe that the TCV was of Cornish origin or that the shipwright who built it was. However, given the international connections Washington had by the late eighteenth century, is it possible this tradition (and others) influenced one or more North Carolina shipwrights? Again, there is no reason at this time to believe that is the case, but it would make for a fascinating and useful line of inquiry that could open other lines of inquiry. Alternatively, it could be something as mundane as thick planks being on sale when the inside of the TCV was planked. Yet, that might lead to useful socio-economic studies. These would not be irrelevant considering the post-Civil War exploitation of the coastal forests by business from outside North Carolina.

Closing Remarks

This study was successful in developing four feasible models of what the hull form of the Tranter's Creek Vessel might have looked like when afloat for the chosen draft. Basic analyses including tonnage and primary hull coefficients were performed on the models. They are all reasonable possibilities but are not in any way conclusive. The study was not successful at finding a name for the vessel, but it did discover that there is a good probability the vessel was sank in that location as a river training structure for the Tar-Pamlico. This suggests the vessel may have never been complete enough to name, particularly with the current lack of any evidence of use in a systemic context while afloat. Being able to develop a plethora of viable models which had to be narrowed down to four indicates strongly that not only is goniometry sufficiently accurate in low-to-zero visibility conditions, but that hull reconstructions from partial, unraised archaeological remains are viable as well. It does not match the detail of raised, conserved remains that can be studied at one's leisure, but works adequately well if the artifacts cannot be raised. This would be particularly good for rescue archaeology. A team might only afford one GPS unit but could hand out half a dozen goniometers and use both technologies to compliment each other. The suspected deliberate discard of the vessel for post-abandonment use suggests strongly that more study of the Tar-Pamlico as a post-Civil War highway for commerce could be and should be undertaken. This study concludes that more reconstructions of this and as many other North Carolina "wrecks" as possible should be made to advance the overall study of local vessels, shipping, communities, traditions, growth and maybe even resistance to or acceptance of change. At this point in the study of North Carolina shipbuilding and coastal populations, almost no line of inquiry should be thought of as irrelevant. Whether it be reconstructions, historical investigations, or other types of inquiry, it will all eventually prove useful.

References

Adams, Jonathan
2013 *A Maritime Archaeology of Ships: Innovation and Social Change in Medieval and Early Modern Europe.* Oxbow Books, Oxford, UK.

Alexander, Hoyt, Nicholas Delong; William Flemming; Nathaniel King; Dylan McCusker; Ivor Mollema; Hannah Piner; Mateusz Polakowski; Melissa Price; and James Pruitt
2014 0003TRR Tranter's Creek Documentation Project 2014: Final Report. Program in Maritime Studies, East Carolina University, Greenville, NC.

Alford, Michael B.
1997 A Story of Shoal Waters and a Connecticut Yankee: Sharpies in the Carolinas. *WoodenBoat* 137: 62-71.

Baker, William H.
1966 *Sloops and Shallops*. University of South Carolina Press, Columbia, SC.

Barrett, John Gilchrist
1980 *North Carolina as a Civil War Battleground 1861 – 1865*. 5th printing. North Carolina Department of Cultural Resources, Raleigh, NC.

Bass, George F.
2008 J. Richard Steffy, 1924–2007. *The International Journal of Nautical Archaeology* 37.2: 393–394. < https://doi.org/10.1111/J.1095-9270.2008.00198.X> Accessed 12 February 2026.

Boyd, Doug
2026 Anchors In Time. East Magazine, East Carolina University <https://east.ecu.edu/2026/01/30/anchors-in-time/>

Bridgers, Henry Clark, Jr.
2013 *Steamboats on the Tar*, Ronald Kemp, editor. Privately printed, n.p.

Bryner, Jeanna; Stephanie Pappas; and LiveScience
2013 Confirmed: Bones of King Richard III Found under Parking Lot. ScientificAmerican.com < https://www.scientificamerican.com/article/confirmed-bones-of-king-richard/> Accessed 13 February 2026.

Carver, Martin
2026 *The Experimental Sutton Hoo Ship: Context and Design*. Boydell & Brewer, Woodbridge, UK.

Chappelle, Howard I.
1951 *American Small Sailing Craft: Their Design, Development, and Construction*. W. W. Norton & Company, Inc., New York.

1958 *The Search for Speed Under Sail 1700 – 1855*. W. W. Norton & Company, Inc., New York.

1973 *The American Fishing Schooners 1825 – 1935*. W. W. Norton & Company, Inc., New York.

Cozzi, J.
1998 The Goniometer: an Improved Device for Recording Submerged Ship Wreck Timbers. *The International Journal of Nautical Archaeology* 27.1: 64-80.

Crumlin-Pedersen, Ole
1986 Aspects of Viking-Age Shipbuilding In the Light of the Construction and Trials of the Skuldelev Ship-Replicas *Saga Siglar* and *Roar Ege*. *Journal of Danish Archaeology* 5.1: 209-228. <https://doi.org/10.1080/0108464X.1986.10589968> Accessed 13 February 2026.

1995 Experimental Archaeology and Ships—Bridging the Arts and the Sciences. *The International Journal of Nautical Archaeology* 24.4: 303-306. <https://doi.org/10.1111%2Fj.1095-9270.1995.tb00743.x> Accessed 13 February 2026.

2000 To Be or Not to Be a Cog: the Bremen Cog in Perspective. *The International Journal of Nautical Archaeology*. 29.2: 230-246. <https://doi.org/10.1111%2Fj.1095-9270.2000.tb01454.x> Accessed 13 February 2026.

Damgård-Sørensen, Tinna
2012 Obituary: Ole Crumlin-Pedersen (24 February 1935 – 14 October 2011). *EXARC Journal* 2. <https://exarc.net/ark:/88735/10046> Accessed 13 February 2026.

Dorr, Frederick W. (topographer)
1872 *Washington and its Environs North Carolina*, Register No. 1274. United States Coast Survey, Washington, DC. Washington and its Environs, Coastal Topographic Sheets of North Carolina, Alabama Maps <http://cartweb.geography.ua.edu/lizardtech/iserv/calcrgn?cat=Special%20Topics&item=Coastal%20Topography%20Sheets%20(T-maps)/T-1274.sid&wid=500&hei=400&props=item(Name,Description),cat(Name,Description)&style=default/view.xsl&plugin=true>. Accessed 13 February 2026.

Edwards, Justin Randolph
2015 Tar River Blounts and a Traditional Maritime Cultural Landscape, 1778-1802. Master's Thesis, Department of History, East Carolina University, Greenville, NC.

Google
1999 Google Earth Image of Tranter's Creek-Tar/Pamlico Confluence. <https://earth.google.com/web/@35.5536658,-77.0855427,-0.68088643a,3521.00219998d,30.00047014y,0h,0t,0r/data=ChYqEAgBEgoxOTk5LTAxLTI1GAFCAggBOgMKATBCAggASggImteKpwIQAA> Accessed 13 February 2026.

2005 Google Earth Image of Tranter's Creek-Tar/Pamlico Confluence. <https://earth.google.com/web/@35.5536658,-77.0855427,-0.68088643a,3521.00219998d,30.00047014y,0h,0t,0r/data=ChYqEAgBEgoyMDA1LTEwLTE3GAFCAggBOgMKATBCAggASggImteKpwIQAA> Accessed 13 February 2026.

2009 Google Earth Image of Tranter's Creek-Tar/Pamlico Confluence. <https://earth.google.com/web/@35.5536658,-77.0855427,-0.68088643a,3521.00219998d,30.00047014y,0h,0t,0r/data=ChYqEAgBEgoyMDA5LTEwLTE5GAFCAggBOgMKATBCAggASggImteKpwIQAA> Accessed 13 February 2026.

2017 Google Earth Image of Tranter's Creek-Tar/Pamlico Confluence. <https://earth.google.com/web/@35.5536658,-77.0855427,-0.68088643a,3521.00219998d,30.00047014y,0h,0t,0r/data=ChYqEAgBEgoyMDE3LTAyLTIwGAFCAggBOgMKATBCAggASggImteKpwIQAA> Accessed 13 February 2026.

2023 Google Earth Image of Tranter's Creek-Tar/Pamlico Confluence. <https://www.google.com/maps/@35.5539962,-77.0865037,853m/data=!3m1!1e3?entry=ttu&g_ep=EgoyMDI1MDQwMi4xIKXMDSoASAFQAw%3D%3D>. Accessed 13 February 2026.

Greenhill, Basil
1988 *The Merchant Schooners*, second edition. Naval Institute Press, Annapolis, MD.

Hocker, Frederick M.
2004 *The Philosophy of Shipbuilding: Conceptual Approaches to the Study of Wooden Ships*. Frederick M. Hocker and Cheryl A. Ward, editors., pp. 1-11. Texas A&M University Press, College Station, TX.

Hoffmann, Per
1986 The Bremen Cog Sails a New Course. *The International Journal of Nautical Archaeology* 15.3: 215-219. <https://doi.org/10.1111/j.1095-9270.1986.tb00579.x> Accessed 13 February 2026

Jackson, Christopher W.
2021 *Tradition, Innovation, and Invasion: Logboats, Shadboats, and Sharpies in the North Carolina Sounds, 1870-1900*. Program in Maritime Studies, East Carolina University, Greenville, NC.

Lawrence, Matthew S.
2003 A Fair Specimen of a Southern Rive Steamer: The Oregon and Tar/Pamlico River Steam Navigation. M.A. thesis, Department of History, East Carolina University, Greenville, NC.

MacGregor, David R
1997 *The Schooner: Its Design and Development From 1600 to the Present*. Naval Institute Press, Annapolis, MD.

Marsden, Peter
1994 *Ships of the Port of London: First to Eleventh Centuries AD*. English Heritage, London, UK.

McCabe, Christopher P.
2007 The Development and Decline of Tar-Pamlico River Maritime Commerce and Its Impact Upon Regional Settlement Patterns. M.A. thesis, Department of History, East Carolina University, Greenville, NC.

Marquardt, Karl Heinz
2003 *The Global Schooner: Origins, Development, Design and Construction 1695 – 1845*. Naval Institute Press, Annapolis, MD.

Merriman, Ann M.
1996 North Carolina Schooners, 1815-1901, and the S. R. Fowle and Son Company of Washington, North Carolina. M.A. thesis, Department of History, East Carolina University, Greenville, NC.

Meyers, Lucy Wheelock Warren
1976 By-Gone Days. *Washington and the Pamlico*. Ursula Fogleman Loy and Pauline Marion Worthy, editors, pp. 30-36. Washington-Beaufort Bicentennial Commission, Washington, NC.

Muckleroy, Keith
1978 *Maritime Archaeology*. Cambridge University Press, Cambridge, UK.

1998 Introducing Maritime Archaeology. *Maritime Archaeology : A Reader of Substantive and Theoretical Contributions*. Lawrence Edward Babits and Hans Van Tilburg, editors, pp. 23-37. Springer, Boston, MA.

North Carolina Department of Natural and Cultural Resources
2016 The Siege and Burning of Washington, April 1864. North Carolina Department of Natural and Cultural Resources, State of North Carolina. <https://www.dncr.nc.gov/blog/2016/04/30/siege-and-burning-washington-april-1864>. Accessed 13 February 2026.

Paschal, Herbert
1976 In the Beginning. *Washington and the Pamlico*. Ursula Fogleman Loy and Pauline Marion Worthy, editors, pp.1-5. Washington-Beaufort Bicentennial Commission, Washington, NC.

Phillips, C. W.
1940 Excavation of the Sutton Hoo Ship-burial. *The Antiquaries Journal*. XX.2: 149-202.

Quarstein, John V.
2021 Burnside's Roanoke Island Expedition: The Battle for the North Carolina Sounds. The Mariners' Museum < https://www.marinersmuseum.org/2021/04/burnsides-roanoke-island-expedition-the-battle-for-the-north-carolina-sounds/>. Accessed 13 February 2026.

Reed, C. Wingate
1962 *Beaufort County: Two Centuries of Its History*. (No City) USA.

Richards, Nathan
2022 *Ships' Graveyards: Abandoned Watercraft and the Archaeological Site Formation Process*. Society for Historical Archaeology, Columbia, SC.

Saunders, William L. (editor)
1890 *Colonial Records of North Carolina*. Reprinted 1993, Broadfoot Publishing Company, Wilmington, NC.
Shiffer, Michael B.
1987 *Formation Processes of the Archaeological Record*, University of Utah Press Edition. University of New Mexico Press, Albuquerque, NM.

Schoepf, D. Johan David
1911 *Travels in the Confederation 1783-1784*. Vols. I and II. Reprinted 1968, Burt Franklin, New York.

Snyder, J. Travis
2005 Washington, North Carolina's 19th Century Coasting Trade and Historical and Archaeological Investigation of the Schooner STAR. Master's Thesis, Department of History, East Carolina University, Greenville, NC.

Steffy, J. Richard
1989 The Role of Three-Dimensional Research in the Kyrenia Ship Reconstruction. *Proceedings of the 1st International Symposium on Ship Construction in Antiquity*, H. Tzalas, editor, pp. 249-262. Tropis I, Athens.

1994 *Wooden Ship Building and the Interpretation of Shipwrecks*. Texas A&M University Press, College Station, TX.

Steffy, Loren C.
2012 *The Man Who Thought Like a Ship*. Texas A&M Press, College Station, TX.

Still, William N.
1981 The Shipbuilding Industry in Washington, North Carolina. *Of Tar-Heel Towns, Shipbuilders, Reconstructionists and Alliancemen: Papers in North Carolina History*. Joseph F. Steelman, editor, pp. 26-50. East Carolina University Publications, Department of History, Greenville, NC.

Tarboro Southerner

1866 Steam Communication Between Norfolk and Washington, N.C. 6 Dec. (1): 2
1866 *Cotton Plant.* 6 Dec. (1): 3

United States Army Corps of Engineers
1993 *Opportunities for Small & Disadvantaged Business with the U.S. Amry Corps of Engineers*. United States Army. <https://www.publications.usace.army.mil/Portals/76/Publications/EngineerPamphlets/EP_715-1-1.pdf> Accessed 13 February 2026.

United States Army Corps of Engineers Rock Island District
2006 *Upper Mississippi River System Environmental Management Program Environmental Design Handbook*. United States Army, Environmental Design Handbook, Internet Wayback Machine. <https://web.archive.org/web/20090109092159/http://www.mvr.usace.army.mil/EMP/designhandbook.htm> Accessed 13 February 2026.
United States Army Corps of Engineers St. Louis District
[2024] Dikes. United States Army. < https://www.mvs-wc.usace.army.mil/arec/Basics_Dikes.html> Accessed 13 February 2026.

United States Naval War Records Office
1898 *Official Records of the Union and Confederate Navies in the War of the Rebellion*, Series 1, Vol. 7, *North Atlantic Blockading Squadron, from March 8, 1862, to September 4, 1862.* United States Naval War Records Office, Washington, DC. <https://hdl.handle.net/2027/coo.31924051350860> Accessed 13 February 2026.

1899 *Official Records of the Union and Confederate Navies in the War of the Rebellion*, Series 1, Vol. 8, *North Atlantic Blockading Squadron, from September 5, 1862, to May 4, 1863.* United States Naval War Records Office, Washington, DC. <https://hdl.handle.net/2027/coo.31924051350878> Accessed 13 February 2026.

1899 *Official Records of the Union and Confederate Navies in the War of the Rebellion*, Series 1, Vol. 9, *North Atlantic Blockading Squadron, from May 5, 1862, to May 5, 1864.* United States Naval War Records Office, Washington, DC. <https://hdl.handle.net/2027/coo.31924051350886> Accessed 13 February 2026.

United States War Department
1882 *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies*, Series 1, Vol. 4. United States War Department, Washington, DC. <https://hdl.handle.net/2027/coo.31924079601088> Accessed 13 February 2026.

1883 *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies*, Series 1, Vol. 9. United States War Department, Washington, DC. <https://hdl.handle.net/2027/coo.31924079609552> Accessed 13 February 2026.

1887 *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies*, Series 1, Vol. 18. United States War Department, Washington, DC. <https://hdl.handle.net/2027/coo.31924079571554> Accessed 13 February 2026.

1891 *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies*, Series 1, Vol. 33. United States War Department, Washington, DC. <https://hdl.handle.net/2027/coo.31924077699811> Accessed 13 February 2026.

United States War Department
1866 *Annual Report of the Chief of Engineers, United States Army, to the Secretary of War for the Year 1866*. United States War Department, Washington, DC. <https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll6/id/1692> Accessed 13 February 2026.

1880 *Annual Report of the Chief of Engineers, United States Army, to the Secretary of War for the Year 1880*. United States War Department, Washington, DC. <https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll6/id/1698> Accessed 13 February 2026.

Warren, Charles F.
1976 Washington During the Civil War. *Washington and the Pamlico*. Ursula Fogleman Loy and Pauline Marion Worthy, editors, pp. 37-45. Washington-Beaufort Bicentennial Commission, Washington, NC.Worthy, Pauline M.

1976 They Fought for Freedom. *Washington and the Pamlico*. Ursula Fogleman Loy and Pauline Marion Worthy, editors, pp. 6-7. Washington-Beaufort Bicentennial Commission, Washington, NC.

APPENDIX A

Goniometer Measurements

This appendix contains scans of the table of goniometer measurements used in the reconstructions,

	Frame Set #	Baseline	Keel Width	Keel Angle	Direction Facing	Edge	Space B4 Goniomet	1(8)	2(9)	3(10)	4(11)	5(12)	6(13)	7(14)	
	SB50	12.15		↓0.2	AFT	FWD	Ø	↓16.6	↓6.2	↓9.2	↓10.2	(0.08m)			
	SB51	12.75		↑6.3	AFT	FWD	Ø	↓6.6	↓3.2	↓4.9	↓4.4	(0.11m)			
	SB53	13.20		↑2.0	AFT	FWD	Ø	↓5.9	↓6.7	↓7.1	↓18.2	↓2.5	↓17.3	↓16.9	(0.14m)
	SB54	14.05		↑3.6	FWD	AFT	Ø	↓1.6	↑0.7	↓2.4	↓0.8	↓2.4	↓2.9	↓2.7	(0.12m)
	SB55	14.59		↑0.1	AFT	FWD	Ø	↓3.4	↓4.5	↓2.2	↑3.4	↓1.0	↓2.6	↓2.2	
	SB55							↓7.1	↓3.2	↓3.0	↓6.2	↑2.1	↑4.3	(Ø)	
	SB57	15.20		↑2.1	AFT	FWD	Ø	↓13.4	↑1.1	↑1.6	↑5.5	↑1.0	↑0.9	↑0.5	
	SB57							↑0.2	↑3.8	↑2.7	(0.022m)				
	SB58	15.93		↑5.3	FWD	AFT	Ø	↑6.2	↑0.1	↓9.5	↑0.8	↓5.0	↑2.1	↓2.1	
	SB58							↑4.8	↑1.2	↑1.3	↑7.8	↑0.2	↑4.3	↑6.0	
	SB58							↑6.9	(Ø)						
	SB59	16.53		↓6.6	FWD	AFT	Ø	↑13.6	↓2.2	↓4.2	↑0.6	↓0.7	↑1.3	↓1.5	
	SB59							↓2.3	↓0.3	↓6.2	↓1.5	↑1.2	↑9.1	↑12.8	
	SB59							↑28.2	(0.23m)						
**	SB60	16.94		↓3.9	AFT	FWD	Ø	↑5.8	↑10.3	↓1.2	↓4.2	↑1.4	↓3.1	↓8.6	
**	SB60	futtock	forward	of floor	60			↑7.3	↓3.7	↑3.0	↓3.1	↓3.7	↓6.8	(0.03m)	
	SB61	17.18		↑7.6	FWD	AFT	34cm to CBT	↓6.8	↓2.1	↓2.6	↑3.9	↓1.6	(0.055m)		
*	SB61	aft futtock					1.43m to CBT	↓0.2	↑0.7	↓3.1	↑4.2	↑6.3	↑9.6	↑7.7	
*	SB61	aft futtock						↑26.9	(0.205m)						
	SB62	17.78		↑3.4	FWD	AFT	34cm to CBT	↑1.9	↑2.0	↑3.6	↓3.1	↑2.6	↓3.4	↓2.1	
	SB62							↑4.1	(Ø)						
*	SB62	aft futtock					1.77m to CBT	↓0.7	↑1.4	↑4.5	↑3.0	↑15.0	↑18.8	↑30.4	(0.145m)
	SB63	18.02		↓15.7	FWD	AFT	33cm to CBT	↓6.5	↓3.5	↓2.0	↓3.1	↓2.3	↓1.7	↓2.0	
	SB63							↓0.8	↓0.2	↑6.2	↑15.1	(0.03m)			
				16.5cm between SB63 & SB64											
	SB65	18.85		↑1.8	FWD	AFT	Ø	↑5.7	↓2.7	↓0.9	↓0.1	↓1.6	↑2.8	↓1.5	
	SB65							↓1.8	↓4.1	↑8.8	↑2.6	↓8.9	(Ø)		
	SB66	18.86		↑23.7	AFT	FWD	Ø	↑1.8	↑1.1	↑2.4	↑2.9	↑0.6	↑1.9	↑1.9	
	SB66							↑3.2	↑3.6	↓0.4	↓2.0	↓14.6	↓23.5	(0.11m)	
**	SB67	19.22		~~AF~~ ↑29.0	AFT	FWD	Ø	↑5.5	↑2.2	↑2.8	↑2.7	↓0.8	↓1.5	↑0.9	
**	SB67	futtock	forward	of floor				↑2.3	↓2.6	↓9.0	↓5.8	↓20.4	(Ø)		
	SB68	20.20		↓2.8	FWD	AFT	Ø	↓5.7	↑9.3	↑6.3	↑6.4	↑11.0	↑4.2	↑24.1	
	SB68							↑3.8	↑4.7	↑11.7	↑15.9	↑28.3	↑24.1	(Ø)	
	SB69	20.65		↑33.5	AFT	FWD	Ø	↑1.6	↑4.2	↑3.7	↑2.9	↑3.2	↑1.8	↓0.1	
	SB69							↑1.3	↓2.0	↓11.9	↓20.3	↓32.2	(0.15m)		

* only include the starred for futtock measurements. ** include all of SB## for futtock measurement.

Frame Set #	Baseline	Keel Width	Keel Angle	Direction Facing	Edge	Space B4 Goniomet	1(8)	2(9)	3(10)	4(11)	5(12)	6(13)	7(14)
** SB70	21.10		↑22.3	AFT	FWD	Ø	↑2.4	↑4.4	↓1.1	↓1.7	↑8.5	↓1.5	↑1.6
** SB70	futtock forward of floor			—	—	—	↓3.0	↓14.1	↓13.5	↓25.9	(Ø)		
SB71	21.85		↑14.7	AFT	FWD	Ø	↑0.5	↑1.0	↑1.5	↑0.1	↑0.4	↑0.8	↑0.3
SB71	—	—	—	—	—	—	↓0.5	↓6.0	↓16.9	↓13.9	(0.03m)		
—	—	—	no space between SB 72 & 74				—	—	—	—	—	—	—
SB75	23.69		↑9.5	AFT	FWD	31cm to KS	↑10.1	↑2.8	↓3.5	↑1.9	↓3.8	↓1.8	↑2.2
SB75	—	—	—	—	—	—	↓3.0	(Ø)					
SB76	24.30		↑10.6	AFT	FWD	58cm to KS	↓0.4	↑2.2	↑1.7	↓2.4	↑1.9	↓0.3	↓2.8
SB76	—	—	—	—	—	—	↓14.5	↓15.6	↓28.7	(0.09m)			
SB77	25.19		↓10.8	FWD	AFT	Ø	↓8.2	↑0.1	↑2.6	↑3.5	↑3.4	↓0.4	skipped 22cm : fastener
SB77	—	—	—	—	—	—	↓5.3	↑0.1	↑7.2	↑5.8	(0.05m)		
SB78	25.50		↑10.9	AFT	FWD	Ø	↓8.0	↓1.7	↓1.9	↑1.0	↓2.6	↑8.2	↓4.5
SB78	—	—	—	—	—	—	↓8.7	(0.80m) → too small					
SB79	25.99		↑12.0	AFT	FWD	Ø	↑7.4	↑1.1	↓0.2	↑3.6	↑5.1	↑3.6	↓3.5
SB79	—	—	—	—	—	—	↓5.1	↑5.5	↓1.7	↓12.3	↓6.5	(0.23m)	
SB80	27.04		↓13.4	FWD	AFT	Ø	↓5.4	↓11.0	↓5.0	↑0.6	↓3.6	↑9.7	(0.06m)
—	—	—	no space to take measurements on SB81					—	—	—	—	—	—
SB82	28.20		↓6.8	FWD	AFT	Ø	↑5.6	↑5.0	↑12.3	(0.38m)			
SB83	28.74		no keelson	FWD	AFT	Ø	↑20.7	↑25.4	(0.04m)				

Appendix B

ORCA 3D Analyses Tables

This appendix contains the summary tables generated By ORCA 3D. These tables have all information relevant to this study. On request, the ORCA-generated Excel spreadsheets are available in their entirety.

Narrow Beam, 100-Degree Sternpost Tables 1.25m Draft

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=1.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001	m
Maximum angle	0	Maximum edge length	0	m
Maximum aspect ratio	0	Max distance, edge to surf.	0	m
Minimum initial grid quads	0	Jagged seams	False	
Refine mesh	True	Simple planes	True	

Load Condition Parameters

Model Sinkage	1.250	m
Model Trim	1.000	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000	deg	Sinkage	1.250	m
Trim Angle	1.000	deg			

Overall Dimensions

Length Overall, LOA	24.258	m	Loa / Boa	3.555
Beam Overall, Boa	6.823	m	Boa / D	2.104
Depth Overall, D	3.243	m		

Waterline Dimensions

Waterline Length, Lwl	22.229	m	Lwl / Bwl	3.279
Waterline Beam, Bwl	6.780	m	Bwl / T	4.107
Navigational Draft, T	1.651	m	D / T	1.965

Volumetric Values

Displacement Weight	131516.240	kgf	Displ-Length Ratio			333.699
Volume	128.196	m^3				
LCB	12.210	m	FB/Lwl	0.502	AB/Lwl	0.498
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.826	m				
Wetted Surface Area	145.763	m^2				
Moment To Trim	1387.729	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	111.400	m^2				
LCF	12.224	m	FF/Lwl	0.502	AF/Lwl	0.498
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1142.857	kgf/cm				

Sectional Parameters

Ax	8.725	m^2		
Ax Location	14.353	m	Ax Location / Lwl	0.598

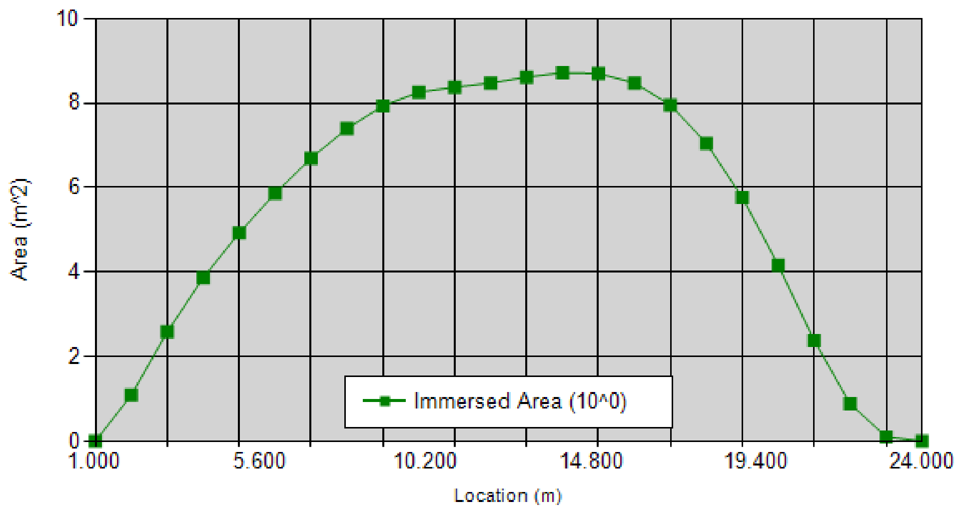
Hull Form Coefficients

Cb	0.515	Cx	0.779
Cp	0.661	Cwp	0.739
Cvp	0.697	Cws	2.731

Static Stability Parameters

I(transverse)	325.883	m^4	I(longitudinal)	3006.893	m^4
BMt	2.542	m	BMl	23.455	m
GMt	None Available	m	GMl	None Available	m
Mt	1.905	m	Ml	22.819	m

Station Data



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.089	3.002
3.000	2.587	4.068
4.000	3.869	5.071
5.000	4.931	5.889
6.000	5.865	6.581
7.000	6.695	7.166
8.000	7.399	7.640
9.000	7.936	7.986
10.000	8.257	8.177
11.000	8.375	8.216
12.000	8.473	8.215
13.000	8.614	8.224
14.000	8.717	8.214
15.000	8.699	8.149
16.000	8.476	7.986
17.000	7.955	7.676
18.000	7.049	7.185
19.000	5.765	6.553
20.000	4.162	5.872
21.000	2.380	5.180
22.000	0.880	3.483
23.000	0.102	3.014
24.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=1.50,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250	m
Model Trim	1.500	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	1.500 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.555
Beam Overall, Boa	6.823 m	Boa / D	2.104
Depth Overall, D	3.243 m		

Waterline Dimensions

Waterline Length, Lwl	22.273 m	Lwl / Bwl	3.277
Waterline Beam, Bwl	6.797 m	Bwl / T	3.671
Navigational Draft, T	1.851 m	D / T	1.752

Volumetric Values

Displacement Weight	143952.713	kgf	Displ-Length Ratio			363.114
Volume	140.318	m^3				
LCB	12.410	m	FB/Lwl	0.509	AB/Lwl	0.491
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.890	m				
Wetted Surface Area	151.970	m^2				
Moment To Trim	1464.787	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	113.956	m^2				
LCF	12.375	m	FF/Lwl	0.508	AF/Lwl	0.492
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1169.074	kgf/cm				

Sectional Parameters

Ax	9.554	m^2		
Ax Location	14.702	m	Ax Location / Lwl	0.612

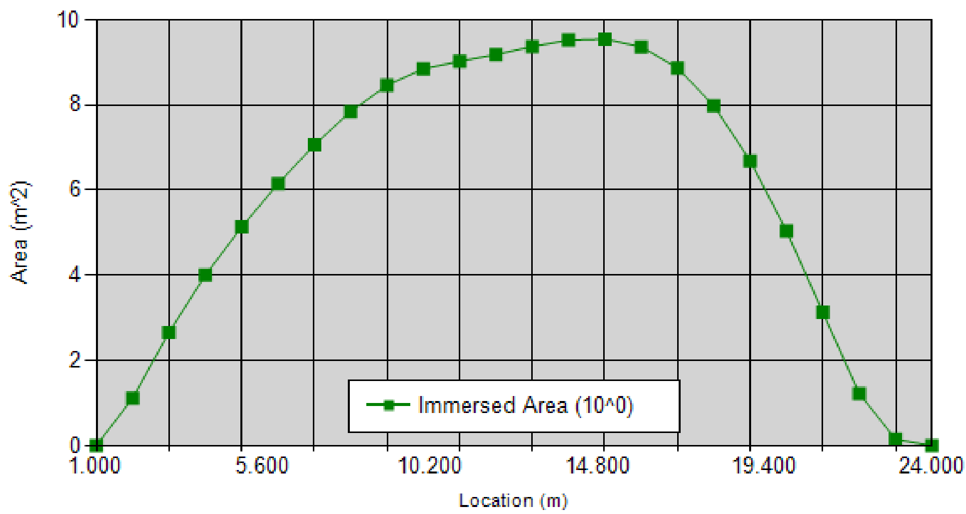
Hull Form Coefficients

Cb	0.501	Cx	0.759
Cp	0.659	Cwp	0.753
Cvp	0.665	Cws	2.718

Static Stability Parameters

I(transverse)	337.495	m^4	I(longitudinal)	3180.085	m^4
BMt	2.405	m	BMl	22.663	m
GMt	None Available	m	GMl	None Available	m
Mt	1.720	m	Ml	21.979	m

Station Data



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.116	3.040
3.000	2.660	4.124
4.000	4.003	5.147
5.000	5.136	5.984
6.000	6.150	6.693
7.000	7.062	7.294
8.000	7.846	7.783
9.000	8.459	8.146
10.000	8.848	8.353
11.000	9.026	8.410
12.000	9.180	8.426
13.000	9.372	8.453
14.000	9.523	8.460
15.000	9.549	8.414
16.000	9.362	8.270
17.000	8.868	7.981
18.000	7.977	7.517
19.000	6.685	6.928
20.000	5.036	6.328
21.000	3.129	5.827
22.000	1.221	5.057
23.000	0.147	3.420
24.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=2.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250 m
Model Trim	2.000 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	2.000 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.555
Beam Overall, Boa	6.823 m	Boa / D	2.104
Depth Overall, D	3.243 m		

Waterline Dimensions

Waterline Length, Lwl	22.318 m	Lwl / Bwl	3.277
Waterline Beam, Bwl	6.810 m	Bwl / T	3.319
Navigational Draft, T	2.052 m	D / T	1.581

Volumetric Values

Displacement Weight	156870.245	kgf	Displ-Length Ratio			393.285
Volume	152.910	m^3				
LCB	12.601	m	FB/Lwl	0.516	AB/Lwl	0.484
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.957	m				
Wetted Surface Area	158.519	m^2				
Moment To Trim	1558.215	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	116.798	m^2				
LCF	12.553	m	FF/Lwl	0.514	AF/Lwl	0.486
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1198.230	kgf/cm				

Sectional Parameters

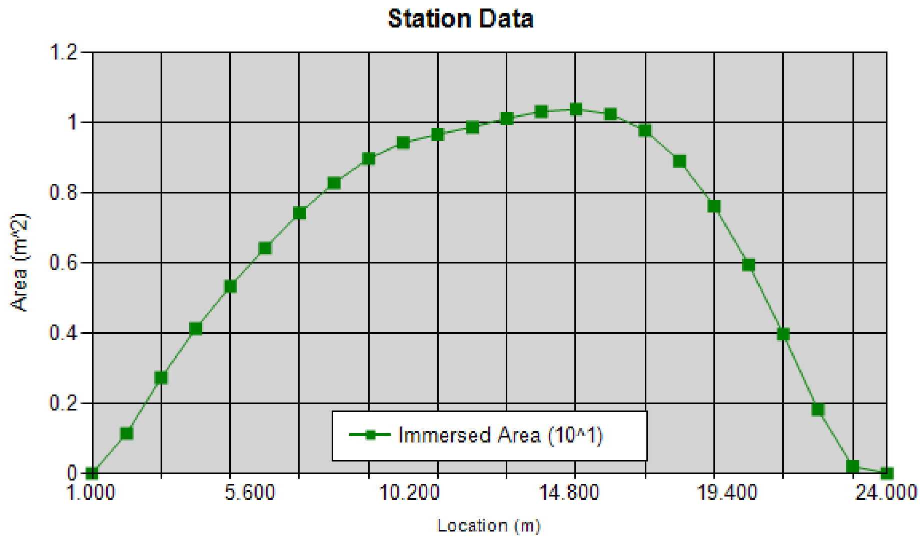
Ax	10.405	m^2		
Ax Location	14.820	m	Ax Location / Lwl	0.616

Hull Form Coefficients

Cb	0.490	Cx	0.745
Cp	0.658	Cwp	0.769
Cvp	0.638	Cws	2.714

Static Stability Parameters

I(transverse)	349.751	m^4	I(longitudinal)	3389.824	m^4
BMt	2.287	m	BMl	22.169	m
GMt	None Available	m	GMl	None Available	m
Mt	1.554	m	Ml	21.436	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.142	3.077
3.000	2.734	4.179
4.000	4.138	5.222
5.000	5.344	6.079
6.000	6.436	6.805
7.000	7.430	7.421
8.000	8.295	7.926
9.000	8.982	8.304
10.000	9.440	8.529
11.000	9.678	8.603
12.000	9.887	8.637
13.000	10.133	8.681
14.000	10.332	8.706
15.000	10.402	8.677
16.000	10.254	8.552
17.000	9.791	8.284
18.000	8.920	7.845
19.000	7.632	7.293
20.000	5.959	6.763
21.000	3.969	6.426
22.000	1.819	6.158
23.000	0.205	3.827
24.000	0.000	0.000

<u>Narrow Beam, 100-Degree Sternpost Tables 1.50m Draft</u>

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=1.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500 m
Model Trim	1.000 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	1.000 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.555
Beam Overall, Boa	6.823 m	Boa / D	2.104
Depth Overall, D	3.243 m		

Waterline Dimensions

Waterline Length, Lwl	22.357 m	Lwl / Bwl	3.280
Waterline Beam, Bwl	6.815 m	Bwl / T	3.585
Navigational Draft, T	1.901 m	D / T	1.706

Volumetric Values

Displacement Weight	160667.496	kgf	Displ-Length Ratio			400.680
Volume	156.611	m^3				
LCB	12.226	m	FB/Lwl	0.503	AB/Lwl	0.497
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.965	m				
Wetted Surface Area	159.387	m^2				
Moment To Trim	1516.686	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	115.902	m^2				
LCF	12.369	m	FF/Lwl	0.509	AF/Lwl	0.491
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1189.041	kgf/cm				

Sectional Parameters

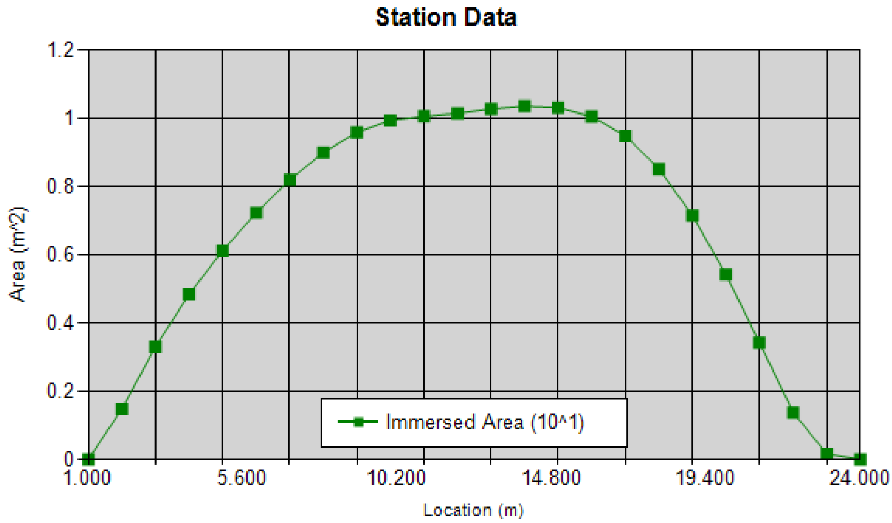
Ax	10.372	m^2		
Ax Location	14.146	m	Ax Location / Lwl	0.589

Hull Form Coefficients

Cb	0.541	Cx	0.801
Cp	0.675	Cwp	0.761
Cvp	0.711	Cws	2.694

Static Stability Parameters

I(transverse)	347.554	m^4	I(longitudinal)	3305.301	m^4
BMt	2.219	m	BMl	21.105	m
GMt	None Available	m	GMl	None Available	m
Mt	1.471	m	Ml	20.357	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.005	0.276
2.000	1.483	3.525
3.000	3.305	4.593
4.000	4.850	5.606
5.000	6.131	6.426
6.000	7.243	7.108
7.000	8.208	7.682
8.000	9.008	8.148
9.000	9.605	8.490
10.000	9.953	8.678
11.000	10.074	8.718
12.000	10.162	8.717
13.000	10.288	8.726
14.000	10.370	8.716
15.000	10.325	8.652
16.000	10.067	8.492
17.000	9.500	8.187
18.000	8.534	7.711
19.000	7.163	7.113
20.000	5.430	6.517
21.000	3.425	6.049
22.000	1.381	5.410
23.000	0.160	3.519
24.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=1.50,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500 m
Model Trim	1.500 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	1.500 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.555
Beam Overall, Boa	6.823 m	Boa / D	2.104
Depth Overall, D	3.243 m		

Waterline Dimensions

Waterline Length, Lwl	22.401 m	Lwl / Bwl	3.284
Waterline Beam, Bwl	6.821 m	Bwl / T	3.246
Navigational Draft, T	2.101 m	D / T	1.543

Volumetric Values

Displacement Weight	173790.029	kgf	Displ-Length Ratio			430.901
Volume	169.403	m^3				
LCB	12.419	m	FB/Lwl	0.510	AB/Lwl	0.490
TCB	0.000	m	TCB / Bwl			0.000
VCB	1.030	m				
Wetted Surface Area	166.008	m^2				
Moment To Trim	1614.599	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	118.736	m^2				
LCF	12.554	m	FF/Lwl	0.516	AF/Lwl	0.484
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1218.116	kgf/cm				

Sectional Parameters

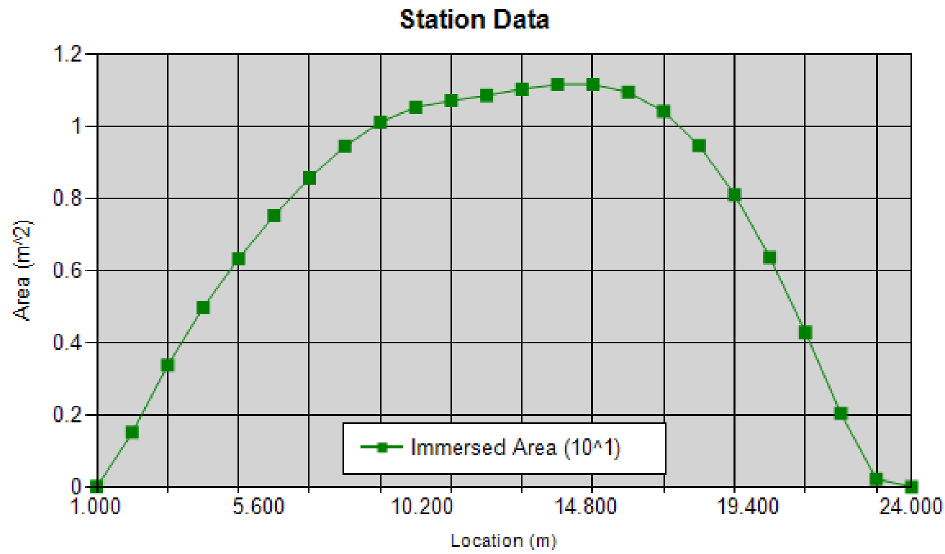
Ax	11.198	m^2		
Ax Location	14.499	m	Ax Location / Lwl	0.603

Hull Form Coefficients

Cb	0.528	Cx	0.781
Cp	0.675	Cwp	0.777
Cvp	0.679	Cws	2.695

Static Stability Parameters

I(transverse)	359.396	m^4	I(longitudinal)	3525.486	m^4
BMt	2.122	m	BMl	20.811	m
GMt	None Available	m	GMl	None Available	m
Mt	1.326	m	Ml	20.016	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.006	0.295
2.000	1.511	3.562
3.000	3.382	4.648
4.000	4.991	5.681
5.000	6.345	6.519
6.000	7.536	7.218
7.000	8.582	7.808
8.000	9.460	8.290
9.000	10.131	8.648
10.000	10.547	8.854
11.000	10.727	8.910
12.000	10.872	8.927
13.000	11.050	8.954
14.000	11.181	8.962
15.000	11.181	8.916
16.000	10.963	8.773
17.000	10.428	8.489
18.000	9.485	8.036
19.000	8.122	7.473
20.000	6.371	6.943
21.000	4.297	6.630
22.000	2.037	6.458
23.000	0.221	3.926
24.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=2.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500 m
Model Trim	2.000 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	2.000 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.555
Beam Overall, Boa	6.823 m	Boa / D	2.104
Depth Overall, D	3.243 m		

Waterline Dimensions

Waterline Length, Lwl	22.446 m	Lwl / Bwl	3.290
Waterline Beam, Bwl	6.823 m	Bwl / T	2.964
Navigational Draft, T	2.302 m	D / T	1.409

Volumetric Values

Displacement Weight	187495.878	kgf	Displ-Length Ratio				462.085
Volume	182.762	m^3					
LCB	12.612	m	FB/Lwl	0.517		AB/Lwl	0.483
TCB	0.000	m	TCB / Bwl				0.000
VCB	1.098	m					
Wetted Surface Area	173.201	m^2					
Moment To Trim	1740.924	kgf-m/cm					

Waterplane Values

Waterplane Area, Awp	122.080	m^2				
LCF	12.782	m	FF/Lwl	0.525	AF/Lwl	0.475
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1252.420	kgf/cm				

Sectional Parameters

Ax	12.049	m^2		
Ax Location	14.704	m	Ax Location / Lwl	0.610

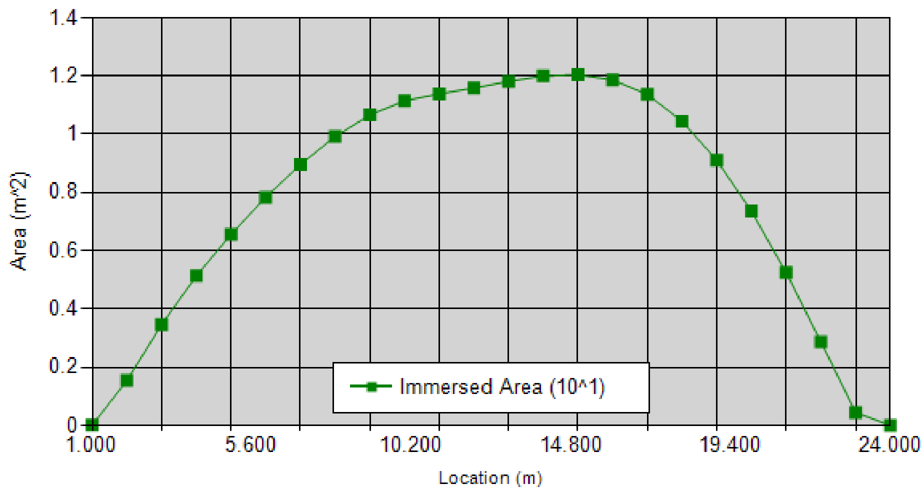
Hull Form Coefficients

Cb	0.518	Cx	0.767
Cp	0.676	Cwp	0.797
Cvp	0.650	Cws	2.704

Static Stability Parameters

I(transverse)	372.638	m^4	I(longitudinal)	3808.977	m^4
BMt	2.039	m	BMl	20.841	m
GMt	None Available	m	GMl	None Available	m
Mt	1.196	m	Ml	19.998	m

Station Data



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.006	0.314
2.000	1.540	3.599
3.000	3.460	4.704
4.000	5.132	5.757
5.000	6.561	6.613
6.000	7.831	7.328
7.000	8.958	7.933
8.000	9.914	8.431
9.000	10.658	8.806
10.000	11.141	9.029
11.000	11.382	9.103
12.000	11.582	9.138
13.000	11.813	9.182
14.000	11.994	9.207
15.000	12.039	9.179
16.000	11.862	9.055
17.000	11.362	8.788
18.000	10.446	8.356
19.000	9.101	7.821
20.000	7.351	7.340
21.000	5.244	7.153
22.000	2.866	7.374
23.000	0.444	6.622
24.000	0.000	0.000

Narrow Beam 120 Degree Sternpost Tables 1.25m Draft

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=1.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250 m
Model Trim	1.000 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	1.000 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.719
Beam Overall, Boa	6.824 m	Boa / D	2.129
Depth Overall, D	3.204 m		

Waterline Dimensions

Waterline Length, Lwl	22.900 m	Lwl / Bwl	3.377
Waterline Beam, Bwl	6.781 m	Bwl / T	4.107
Navigational Draft, T	1.651 m	D / T	1.941

Volumetric Values

Displacement Weight	134620.851	kgf	Displ-Length Ratio			312.425
Volume	131.222	m^3				
LCB	12.424	m	FB/Lwl	0.496	AB/Lwl	0.504
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.832	m				
Wetted Surface Area	148.593	m^2				
Moment To Trim	1485.234	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	114.742	m^2				
LCF	12.504	m	FF/Lwl	0.500	AF/Lwl	0.500
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1177.141	kgf/cm				

Sectional Parameters

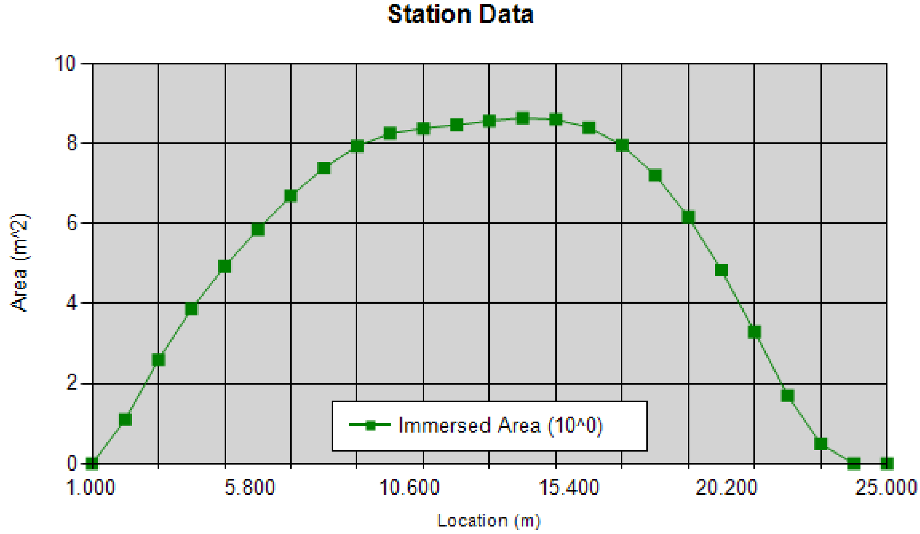
Ax	8.636	m^2		
Ax Location	14.163	m	Ax Location / Lwl	0.572

Hull Form Coefficients

Cb	0.512	Cx	0.771
Cp	0.664	Cwp	0.739
Cvp	0.693	Cws	2.711

Static Stability Parameters

I(transverse)	332.349	m^4	I(longitudinal)	3315.298	m^4
BMt	2.533	m	BMl	25.265	m
GMt	None Available	m	GMl	None Available	m
Mt	1.898	m	Ml	24.630	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.103	3.010
3.000	2.596	4.075
4.000	3.870	5.072
5.000	4.927	5.887
6.000	5.859	6.578
7.000	6.688	7.163
8.000	7.393	7.637
9.000	7.932	7.985
10.000	8.258	8.177
11.000	8.379	8.218
12.000	8.461	8.210
13.000	8.567	8.204
14.000	8.635	8.177
15.000	8.600	8.103
16.000	8.399	7.949
17.000	7.959	7.678
18.000	7.215	7.260
19.000	6.163	6.717
20.000	4.835	6.102
21.000	3.297	5.475
22.000	1.699	4.755
23.000	0.494	3.399
24.000	0.000	0.000
25.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=1.50,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z	
		Fwd Direction = Negative_X	

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001	m
Maximum angle	0	Maximum edge length	0	m
Maximum aspect ratio	0	Max distance, edge to surf.	0	m
Minimum initial grid quads	0	Jagged seams	False	
Refine mesh	True	Simple planes	True	

Load Condition Parameters

Model Sinkage	1.250	m
Model Trim	1.500	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000	deg	Sinkage	1.250	m
Trim Angle	1.500	deg			

Overall Dimensions

Length Overall, LOA	25.378	m	Loa / Boa	3.719
Beam Overall, Boa	6.824	m	Boa / D	2.129
Depth Overall, D	3.204	m		

Waterline Dimensions

Waterline Length, Lwl	23.030	m	Lwl / Bwl	3.388
Waterline Beam, Bwl	6.798	m	Bwl / T	3.672
Navigational Draft, T	1.851	m	D / T	1.731

Volumetric Values

Displacement Weight	147754.869	kgf	Displ-Length Ratio			337.116
Volume	144.025	m^3				
LCB	12.646	m	FB/Lwl	0.503	AB/Lwl	0.497
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.898	m				
Wetted Surface Area	155.238	m^2				
Moment To Trim	1574.659	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	117.705	m^2				
LCF	12.687	m	FF/Lwl	0.504	AF/Lwl	0.496
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1207.540	kgf/cm				

Sectional Parameters

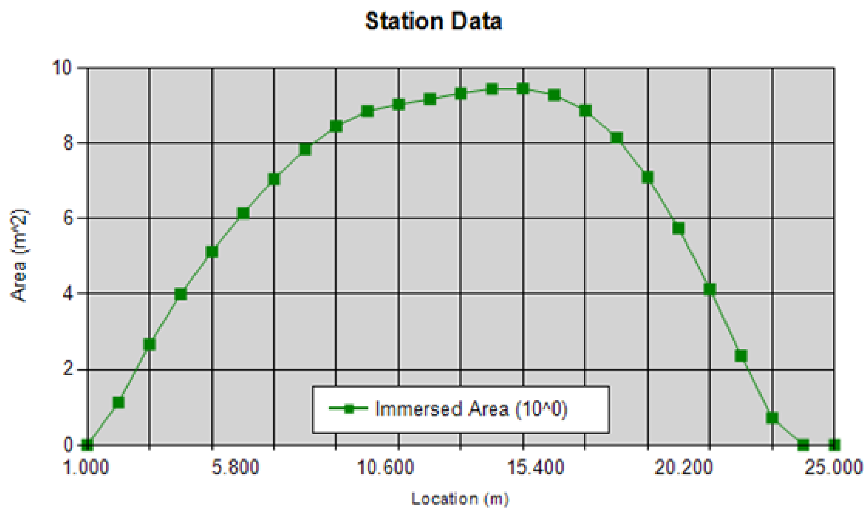
Ax	9.458	m^2		
Ax Location	14.579	m	Ax Location / Lwl	0.587

Hull Form Coefficients

Cb	0.497	Cx	0.752
Cp	0.661	Cwp	0.752
Cvp	0.661	Cws	2.695

Static Stability Parameters

I(transverse)	345.252	m^4	I(longitudinal)	3534.917	m^4
BMt	2.397	m	BMl	24.544	m
GMt	None Available	m	GMl	None Available	m
Mt	1.714	m	Ml	23.861	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.130	3.047
3.000	2.670	4.131
4.000	4.004	5.147
5.000	5.133	5.982
6.000	6.144	6.690
7.000	7.055	7.290
8.000	7.840	7.780
9.000	8.455	8.144
10.000	8.849	8.353
11.000	9.030	8.411
12.000	9.167	8.421
13.000	9.325	8.433
14.000	9.440	8.424
15.000	9.448	8.368
16.000	9.284	8.233
17.000	8.873	7.983
18.000	8.146	7.591
19.000	7.097	7.084
20.000	5.745	6.530
21.000	4.136	6.021
22.000	2.370	5.563
23.000	0.717	4.400
24.000	0.003	0.210
25.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=2.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001	m
Maximum angle	0	Maximum edge length	0	m
Maximum aspect ratio	0	Max distance, edge to surf.	0	m
Minimum initial grid quads	0	Jagged seams	False	
Refine mesh	True	Simple planes	True	

Load Condition Parameters

Model Sinkage	1.250	m
Model Trim	2.000	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000	deg	Sinkage	1.250	m
Trim Angle	2.000	deg			

Overall Dimensions

Length Overall, LOA	25.378	m	Loa / Boa	3.719
Beam Overall, Boa	6.824	m	Boa / D	2.129
Depth Overall, D	3.204	m		

Waterline Dimensions

Waterline Length, Lwl	23.164	m	Lwl / Bwl	3.402
Waterline Beam, Bwl	6.810	m	Bwl / T	3.319
Navigational Draft, T	2.052	m	D / T	1.562

Volumetric Values

Displacement Weight	161474.735	kgf	Displ-Length Ratio			362.084
Volume	157.398	m^3				
LCB	12.862	m	FB/Lwl	0.509	AB/Lwl	0.491
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.968	m				
Wetted Surface Area	162.372	m^2				
Moment To Trim	1686.689	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	121.081	m^2				
LCF	12.906	m	FF/Lwl	0.511	AF/Lwl	0.489
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1242.171	kgf/cm				

Sectional Parameters

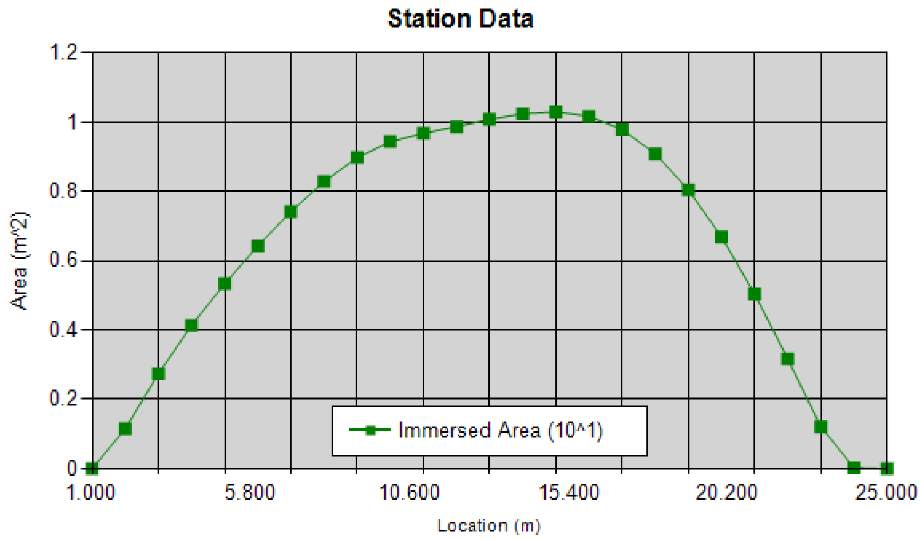
Ax	10.304	m^2		
Ax Location	14.794	m	Ax Location / Lwl	0.592

Hull Form Coefficients

Cb	0.486	Cx	0.737
Cp	0.659	Cwp	0.768
Cvp	0.634	Cws	2.689

Static Stability Parameters

I(transverse)	359.214	m^4	I(longitudinal)	3808.368	m^4
BMt	2.282	m	BMl	24.196	m
GMt	None Available	m	GMl	None Available	m
Mt	1.550	m	Ml	23.464	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.156	3.084
3.000	2.744	4.186
4.000	4.139	5.223
5.000	5.340	6.077
6.000	6.431	6.801
7.000	7.423	7.417
8.000	8.288	7.923
9.000	8.978	8.303
10.000	9.441	8.529
11.000	9.683	8.605
12.000	9.875	8.632
13.000	10.084	8.661
14.000	10.248	8.670
15.000	10.300	8.632
16.000	10.174	8.516
17.000	9.795	8.286
18.000	9.093	7.918
19.000	8.054	7.444
20.000	6.694	6.942
21.000	5.044	6.535
22.000	3.169	6.308
23.000	1.214	5.870
24.000	0.029	0.653
25.000	0.000	0.000

Narrow Beam, 120-Degree Sternpost Tables 1.50m Draft

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=1.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500 m
Model Trim	1.000 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	1.000 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.719
Beam Overall, Boa	6.824 m	Boa / D	2.129
Depth Overall, D	3.204 m		

Waterline Dimensions

Waterline Length, Lwl	23.130 m	Lwl / Bwl	3.394
Waterline Beam, Bwl	6.816 m	Bwl / T	3.586
Navigational Draft, T	1.901 m	D / T	1.686

Volumetric Values

Displacement Weight	164687.280	kgf	Displ-Length Ratio			370.902
Volume	160.530	m^3				
LCB	12.454	m	FB/Lwl	0.496	AB/Lwl	0.504
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.971	m				
Wetted Surface Area	162.716	m^2				
Moment To Trim	1628.905	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	119.711	m^2				
LCF	12.683	m	FF/Lwl	0.506	AF/Lwl	0.494
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1228.119	kgf/cm				

Sectional Parameters

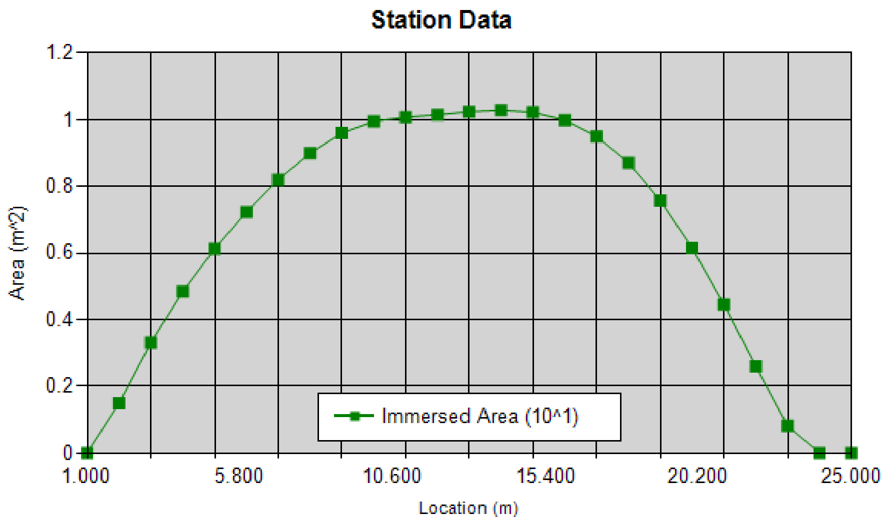
Ax	10.286	m^2		
Ax Location	13.925	m	Ax Location / Lwl	0.560

Hull Form Coefficients

Cb	0.536	Cx	0.794
Cp	0.675	Cwp	0.759
Cvp	0.705	Cws	2.670

Static Stability Parameters

I(transverse)	355.634	m^4	I(longitudinal)	3672.554	m^4
BMt	2.215	m	BMl	22.878	m
GMt	None Available	m	GMl	None Available	m
Mt	1.469	m	Ml	22.132	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.005	0.276
2.000	1.499	3.532
3.000	3.316	4.599
4.000	4.851	5.607
5.000	6.127	6.423
6.000	7.236	7.105
7.000	8.201	7.679
8.000	9.001	8.145
9.000	9.601	8.488
10.000	9.955	8.679
11.000	10.078	8.719
12.000	10.150	8.712
13.000	10.240	8.706
14.000	10.286	8.680
15.000	10.224	8.607
16.000	9.988	8.456
17.000	9.505	8.189
18.000	8.705	7.784
19.000	7.581	7.267
20.000	6.151	6.709
21.000	4.460	6.210
22.000	2.599	5.793
23.000	0.813	4.819
24.000	0.005	0.294
25.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=1.50,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500	m
Model Trim	1.500	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	1.500 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.719
Beam Overall, Boa	6.824 m	Boa / D	2.129
Depth Overall, D	3.204 m		

Waterline Dimensions

Waterline Length, Lwl	23.261 m	Lwl / Bwl	3.410
Waterline Beam, Bwl	6.821 m	Bwl / T	3.246
Navigational Draft, T	2.101 m	D / T	1.525

Volumetric Values

Displacement Weight	178627.788	kgf	Displ-Length Ratio			395.552
Volume	174.118	m^3				
LCB	12.672	m	FB/Lwl	0.502	AB/Lwl	0.498
TCB	0.000	m	TCB / Bwl			0.000
VCB	1.039	m				
Wetted Surface Area	169.938	m^2				
Moment To Trim	1746.106	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	123.087	m^2				
LCF	12.910	m	FF/Lwl	0.512	AF/Lwl	0.488
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1262.751	kgf/cm				

Sectional Parameters

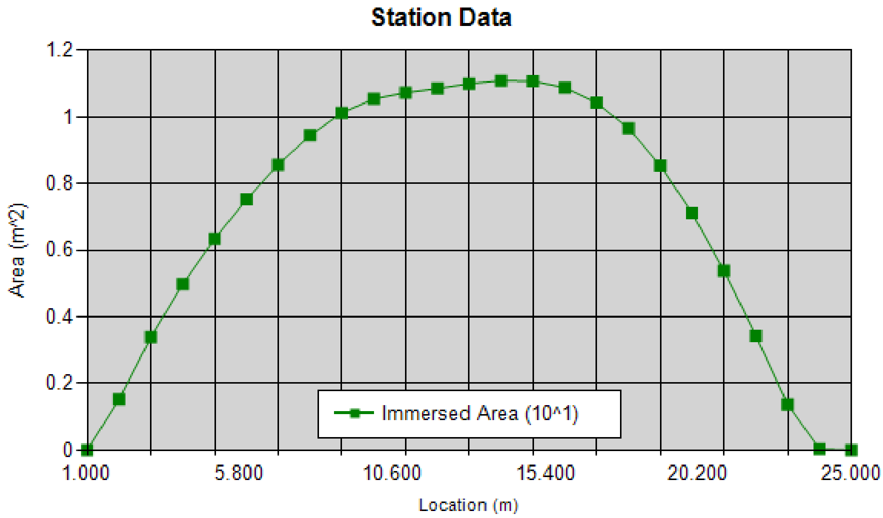
Ax	11.103	m^2		
Ax Location	14.344	m	Ax Location / Lwl	0.574

Hull Form Coefficients

Cb	0.522	Cx	0.775
Cp	0.674	Cwp	0.776
Cvp	0.673	Cws	2.670

Static Stability Parameters

I(transverse)	369.242	m^4	I(longitudinal)	3959.052	m^4
BMt	2.121	m	BMl	22.738	m
GMt	None Available	m	GMl	None Available	m
Mt	1.327	m	Ml	21.944	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.006	0.295
2.000	1.528	3.569
3.000	3.394	4.655
4.000	4.992	5.682
5.000	6.342	6.517
6.000	7.530	7.215
7.000	8.575	7.804
8.000	9.454	8.287
9.000	10.127	8.646
10.000	10.548	8.854
11.000	10.732	8.912
12.000	10.859	8.922
13.000	11.001	8.934
14.000	11.096	8.925
15.000	11.079	8.870
16.000	10.882	8.737
17.000	10.433	8.491
18.000	9.659	8.108
19.000	8.549	7.622
20.000	7.116	7.114
21.000	5.392	6.713
22.000	3.435	6.517
23.000	1.376	6.176
24.000	0.037	0.739
25.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=2.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001	m
Maximum angle	0	Maximum edge length	0	m
Maximum aspect ratio	0	Max distance, edge to surf.	0	m
Minimum initial grid quads	0	Jagged seams	False	
Refine mesh	True	Simple planes	True	

Load Condition Parameters

Model Sinkage	1.500	m
Model Trim	2.000	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000	deg	Sinkage	1.500	m
Trim Angle	2.000	deg			

Overall Dimensions

Length Overall, LOA	25.378	m	Loa / Boa	3.719
Beam Overall, Boa	6.824	m	Boa / D	2.129
Depth Overall, D	3.204	m		

Waterline Dimensions

Waterline Length, Lwl	23.395	m	Lwl / Bwl	3.429
Waterline Beam, Bwl	6.824	m	Bwl / T	2.964
Navigational Draft, T	2.302	m	D / T	1.392

Volumetric Values

Displacement Weight	193302.161	kgf	Displ-Length Ratio				420.733
Volume	188.422	m^3					
LCB	12.892	m	FB/Lwl	0.508		AB/Lwl	0.492
TCB	0.000	m	TCB / Bwl				0.000
VCB	1.110	m					
Wetted Surface Area	178.014	m^2					
Moment To Trim	1905.147	kgf-m/cm					

Waterplane Values

Waterplane Area, Awp	127.227	m^2				
LCF	13.199	m	FF/Lwl	0.521	AF/Lwl	0.479
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1305.223	kgf/cm				

Sectional Parameters

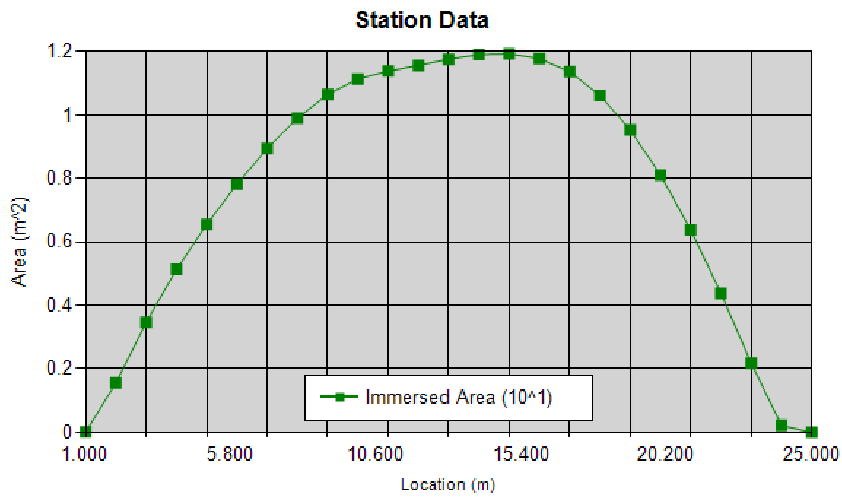
Ax	11.946	m^2		
Ax Location	14.652	m	Ax Location / Lwl	0.583

Hull Form Coefficients

Cb	0.513	Cx	0.761
Cp	0.674	Cwp	0.797
Cvp	0.643	Cws	2.681

Static Stability Parameters

I(transverse)	385.223	m^4	I(longitudinal)	4344.542	m^4
BMt	2.044	m	BMl	23.058	m
GMt	None Available	m	GMl	None Available	m
Mt	1.204	m	Ml	22.217	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.006	0.314
2.000	1.558	3.607
3.000	3.472	4.711
4.000	5.134	5.758
5.000	6.557	6.610
6.000	7.825	7.325
7.000	8.950	7.930
8.000	9.907	8.428
9.000	10.654	8.805
10.000	11.142	9.030
11.000	11.386	9.105
12.000	11.569	9.133
13.000	11.764	9.162
14.000	11.908	9.171
15.000	11.935	9.134
16.000	11.780	9.019
17.000	11.367	8.790
18.000	10.623	8.428
19.000	9.536	7.968
20.000	8.114	7.500
21.000	6.382	7.177
22.000	4.380	7.166
23.000	2.178	7.347
24.000	0.213	3.239
25.000	0.000	0.000

Broad Beam 100 Degree Sternpost Tables 1.25m Draft

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=1.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250 m
Model Trim	1.000 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	1.000 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.201
Beam Overall, Boa	7.578 m	Boa / D	2.317
Depth Overall, D	3.270 m		

Waterline Dimensions

Waterline Length, Lwl	22.229 m	Lwl / Bwl	3.195
Waterline Beam, Bwl	6.958 m	Bwl / T	4.215
Navigational Draft, T	1.651 m	D / T	1.981

Volumetric Values

Displacement Weight	127365.326	kgf	Displ-Length Ratio				323.161
Volume	124.150	m^3					
LCB	11.563	m	FB/Lwl	0.472		AB/Lwl	0.528
TCB	0.000	m	TCB / Bwl				0.000
VCB	0.824	m					
Wetted Surface Area	144.854	m^2					
Moment To Trim	1401.462	kgf-m/cm					

Waterplane Values

Waterplane Area, Awp	113.869	m^2				
LCF	11.516	m	FF/Lwl	0.470	AF/Lwl	0.530
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1168.186	kgf/cm				

Sectional Parameters

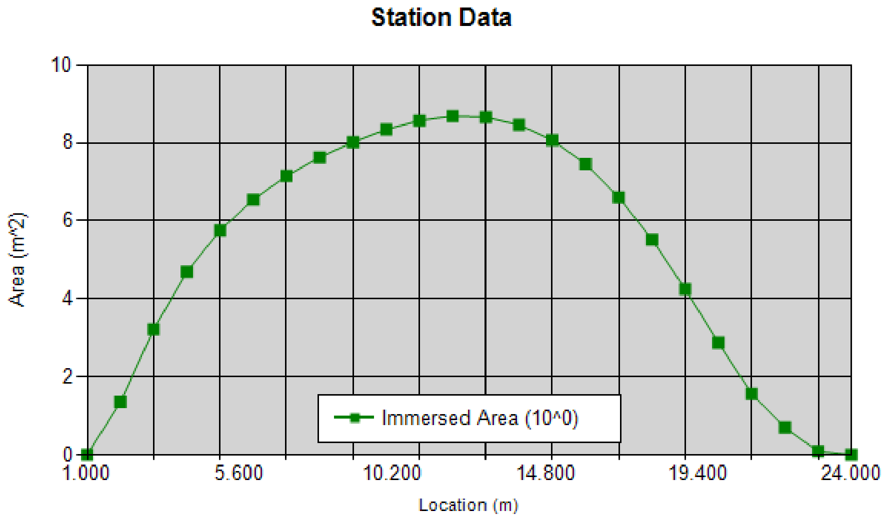
Ax	8.696	m^2		
Ax Location	12.298	m	Ax Location / Lwl	0.505

Hull Form Coefficients

Cb	0.486	Cx	0.757
Cp	0.642	Cwp	0.736
Cvp	0.660	Cws	2.757

Static Stability Parameters

I(transverse)	353.101	m^4	I(longitudinal)	3036.670	m^4
BMt	2.844	m	BMl	24.460	m
GMt	None Available	m	GMl	None Available	m
Mt	2.216	m	Ml	23.832	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.354	3.277
3.000	3.213	4.760
4.000	4.695	5.953
5.000	5.760	6.749
6.000	6.549	7.288
7.000	7.155	7.662
8.000	7.632	7.924
9.000	8.021	8.108
10.000	8.344	8.234
11.000	8.575	8.297
12.000	8.690	8.291
13.000	8.661	8.209
14.000	8.463	8.043
15.000	8.070	7.785
16.000	7.458	7.428
17.000	6.606	6.972
18.000	5.522	6.434
19.000	4.249	5.842
20.000	2.870	5.189
21.000	1.566	4.200
22.000	0.695	3.394
23.000	0.085	3.011
24.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=1.50,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250	m
Model Trim	1.500	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	1.500 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.201
Beam Overall, Boa	7.578 m	Boa / D	2.317
Depth Overall, D	3.270 m		

Waterline Dimensions

Waterline Length, Lwl	22.273 m	Lwl / Bwl	3.166
Waterline Beam, Bwl	7.034 m	Bwl / T	3.799
Navigational Draft, T	1.851 m	D / T	1.766

Volumetric Values

Displacement Weight	139417.475	kgf	Displ-Length Ratio			351.670
Volume	135.898	m^3				
LCB	11.768	m	FB/Lwl	0.480	AB/Lwl	0.520
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.887	m				
Wetted Surface Area	151.476	m^2				
Moment To Trim	1497.588	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	117.579	m^2				
LCF	11.693	m	FF/Lwl	0.477	AF/Lwl	0.523
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1206.242	kgf/cm				

Sectional Parameters

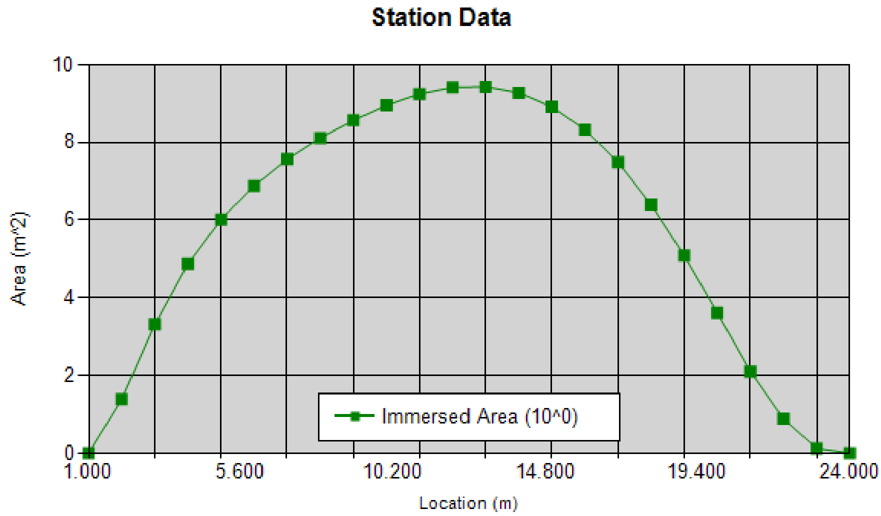
Ax	9.446	m^2		
Ax Location	12.606	m	Ax Location / Lwl	0.518

Hull Form Coefficients

Cb	0.469	Cx	0.725
Cp	0.646	Cwp	0.750
Cvp	0.624	Cws	2.753

Static Stability Parameters

I(transverse)	374.561	m^4	I(longitudinal)	3251.310	m^4
BMt	2.756	m	BMl	23.925	m
GMt	None Available	m	GMl	None Available	m
Mt	2.085	m	Ml	23.254	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.389	3.320
3.000	3.314	4.826
4.000	4.873	6.041
5.000	6.017	6.856
6.000	6.884	7.413
7.000	7.564	7.804
8.000	8.111	8.082
9.000	8.568	8.283
10.000	8.954	8.425
11.000	9.245	8.505
12.000	9.413	8.516
13.000	9.432	8.452
14.000	9.275	8.305
15.000	8.914	8.069
16.000	8.326	7.738
17.000	7.485	7.315
18.000	6.393	6.826
19.000	5.083	6.315
20.000	3.613	5.816
21.000	2.099	5.220
22.000	0.881	3.795
23.000	0.122	3.415
24.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=2.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250 m
Model Trim	2.000 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	2.000 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.201
Beam Overall, Boa	7.578 m	Boa / D	2.317
Depth Overall, D	3.270 m		

Waterline Dimensions

Waterline Length, Lwl	22.318 m	Lwl / Bwl	3.141
Waterline Beam, Bwl	7.105 m	Bwl / T	3.463
Navigational Draft, T	2.052 m	D / T	1.594

Volumetric Values

Displacement Weight	152102.485	kgf	Displ-Length Ratio			381.329
Volume	148.262	m^3				
LCB	11.969	m	FB/Lwl	0.488	AB/Lwl	0.512
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.954	m				
Wetted Surface Area	158.546	m^2				
Moment To Trim	1618.204	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	121.743	m^2				
LCF	11.906	m	FF/Lwl	0.485	AF/Lwl	0.515
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1248.963	kgf/cm				

Sectional Parameters

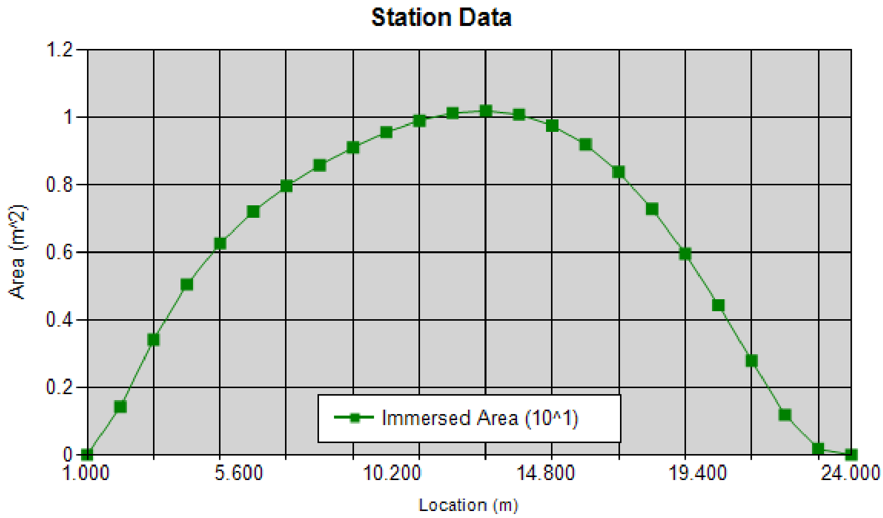
Ax	10.214	m^2		
Ax Location	12.871	m	Ax Location / Lwl	0.528

Hull Form Coefficients

Cb	0.456	Cx	0.701
Cp	0.650	Cwp	0.768
Cvp	0.594	Cws	2.756

Static Stability Parameters

I(transverse)	397.682	m^4	I(longitudinal)	3520.337	m^4
BMt	2.682	m	BMl	23.744	m
GMt	None Available	m	GMl	None Available	m
Mt	1.968	m	Ml	23.029	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.425	3.363
3.000	3.416	4.892
4.000	5.053	6.127
5.000	6.277	6.962
6.000	7.222	7.537
7.000	7.977	7.945
8.000	8.596	8.239
9.000	9.121	8.456
10.000	9.571	8.614
11.000	9.922	8.710
12.000	10.145	8.739
13.000	10.212	8.692
14.000	10.097	8.565
15.000	9.772	8.349
16.000	9.211	8.042
17.000	8.387	7.651
18.000	7.298	7.206
19.000	5.969	6.767
20.000	4.442	6.402
21.000	2.790	6.095
22.000	1.185	5.362
23.000	0.168	3.821
24.000	0.000	0.000

Broad Beam 100 Degree Sternpost Tables 1.50m Draft

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=1.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001	m
Maximum angle	0	Maximum edge length	0	m
Maximum aspect ratio	0	Max distance, edge to surf.	0	m
Minimum initial grid quads	0	Jagged seams	False	
Refine mesh	True	Simple planes	True	

Load Condition Parameters

Model Sinkage	1.500	m
Model Trim	1.000	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000	deg	Sinkage	1.500	m
Trim Angle	1.000	deg			

Overall Dimensions

Length Overall, LOA	24.258	m	Loa / Boa	3.201
Beam Overall, Boa	7.578	m	Boa / D	2.317
Depth Overall, D	3.270	m		

Waterline Dimensions

Waterline Length, Lwl	22.357	m	Lwl / Bwl	3.121
Waterline Beam, Bwl	7.163	m	Bwl / T	3.768
Navigational Draft, T	1.901	m	D / T	1.720

Volumetric Values

Displacement Weight	157545.760	kgf	Displ-Length Ratio			392.896
Volume	153.568	m^3				
LCB	11.567	m	FB/Lwl	0.473	AB/Lwl	0.527
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.969	m				
Wetted Surface Area	159.724	m^2				
Moment To Trim	1581.609	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	121.467	m^2				
LCF	11.662	m	FF/Lwl	0.478	AF/Lwl	0.522
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1246.127	kgf/cm				

Sectional Parameters

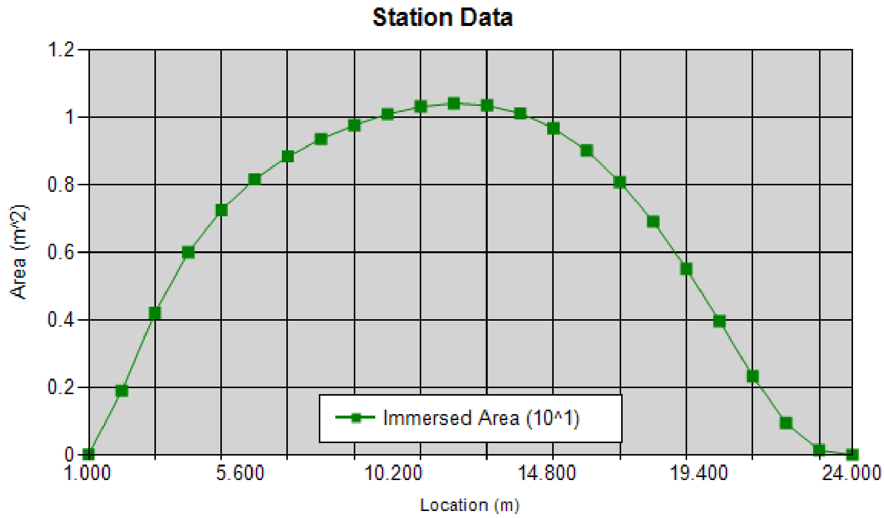
Ax	10.432	m^2		
Ax Location	12.125	m	Ax Location / Lwl	0.498

Hull Form Coefficients

Cb	0.504	Cx	0.766
Cp	0.658	Cwp	0.758
Cvp	0.665	Cws	2.726

Static Stability Parameters

I(transverse)	402.943	m^4	I(longitudinal)	3446.787	m^4
BMt	2.624	m	BMl	22.445	m
GMt	None Available	m	GMl	None Available	m
Mt	1.890	m	Ml	21.711	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.006	0.283
2.000	1.900	3.881
3.000	4.217	5.374
4.000	6.009	6.560
5.000	7.268	7.346
6.000	8.177	7.871
7.000	8.856	8.232
8.000	9.373	8.481
9.000	9.782	8.656
10.000	10.110	8.774
11.000	10.334	8.832
12.000	10.430	8.822
13.000	10.373	8.739
14.000	10.136	8.575
15.000	9.695	8.322
16.000	9.024	7.978
17.000	8.101	7.545
18.000	6.924	7.051
19.000	5.527	6.546
20.000	3.962	6.072
21.000	2.334	5.548
22.000	0.941	3.915
23.000	0.132	3.514
24.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=1.50,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500	m
Model Trim	1.500	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	1.500 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.201
Beam Overall, Boa	7.578 m	Boa / D	2.317
Depth Overall, D	3.270 m		

Waterline Dimensions

Waterline Length, Lwl	22.401 m	Lwl / Bwl	3.101
Waterline Beam, Bwl	7.224 m	Bwl / T	3.438
Navigational Draft, T	2.101 m	D / T	1.556

Volumetric Values

Displacement Weight	170604.695	kgf	Displ-Length Ratio			423.004
Volume	166.298	m^3				
LCB	11.771	m	FB/Lwl	0.481	AB/Lwl	0.519
TCB	0.000	m	TCB / Bwl			0.000
VCB	1.033	m				
Wetted Surface Area	166.887	m^2				
Moment To Trim	1710.870	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	125.659	m^2				
LCF	11.886	m	FF/Lwl	0.486	AF/Lwl	0.514
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1289.140	kgf/cm				

Sectional Parameters

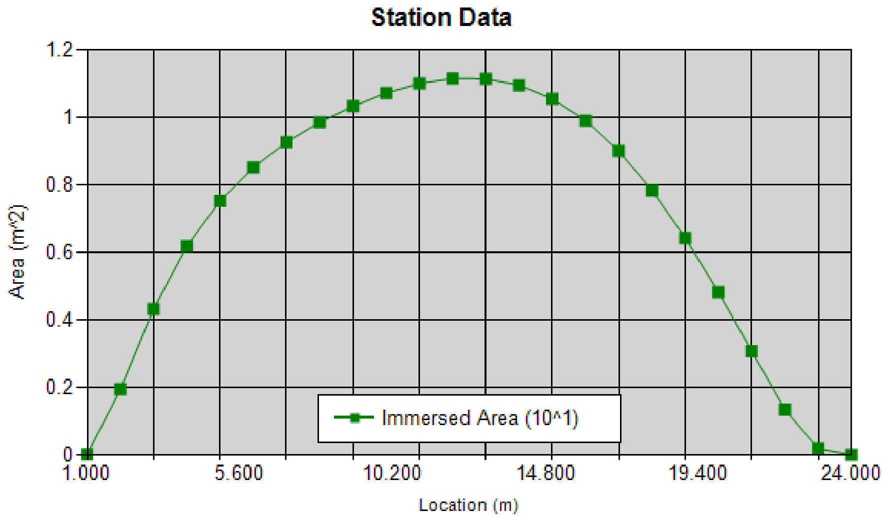
Ax	11.188	m^2		
Ax Location	12.446	m	Ax Location / Lwl	0.511

Hull Form Coefficients

Cb	0.489	Cx	0.737
Cp	0.664	Cwp	0.777
Cvp	0.630	Cws	2.734

Static Stability Parameters

I(transverse)	426.104	m^4	I(longitudinal)	3735.694	m^4
BMt	2.562	m	BMl	22.464	m
GMt	None Available	m	GMl	None Available	m
Mt	1.787	m	Ml	21.689	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.007	0.302
2.000	1.941	3.924
3.000	4.327	5.438
4.000	6.199	6.643
5.000	7.540	7.448
6.000	8.527	7.991
7.000	9.281	8.369
8.000	9.870	8.634
9.000	10.346	8.825
10.000	10.737	8.959
11.000	11.021	9.034
12.000	11.172	9.042
13.000	11.163	8.977
14.000	10.969	8.832
15.000	10.564	8.600
16.000	9.922	8.279
17.000	9.018	7.876
18.000	7.849	7.424
19.000	6.439	6.987
20.000	4.826	6.641
21.000	3.077	6.391
22.000	1.341	5.827
23.000	0.181	3.919
24.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=2.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500	m
Model Trim	2.000	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	2.000 deg		

Overall Dimensions

Length Overall, LOA	24.258 m	Loa / Boa	3.201
Beam Overall, Boa	7.578 m	Boa / D	2.317
Depth Overall, D	3.270 m		

Waterline Dimensions

Waterline Length, Lwl	22.446 m	Lwl / Bwl	3.083
Waterline Beam, Bwl	7.281 m	Bwl / T	3.163
Navigational Draft, T	2.302 m	D / T	1.421

Volumetric Values

Displacement Weight	184455.882	kgf	Displ-Length Ratio			454.594
Volume	179.799	m^3				
LCB	11.980	m	FB/Lwl	0.489	AB/Lwl	0.511
TCB	0.000	m	TCB / Bwl			0.000
VCB	1.102	m				
Wetted Surface Area	174.846	m^2				
Moment To Trim	1884.339	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	130.662	m^2				
LCF	12.170	m	FF/Lwl	0.497	AF/Lwl	0.503
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1340.462	kgf/cm				

Sectional Parameters

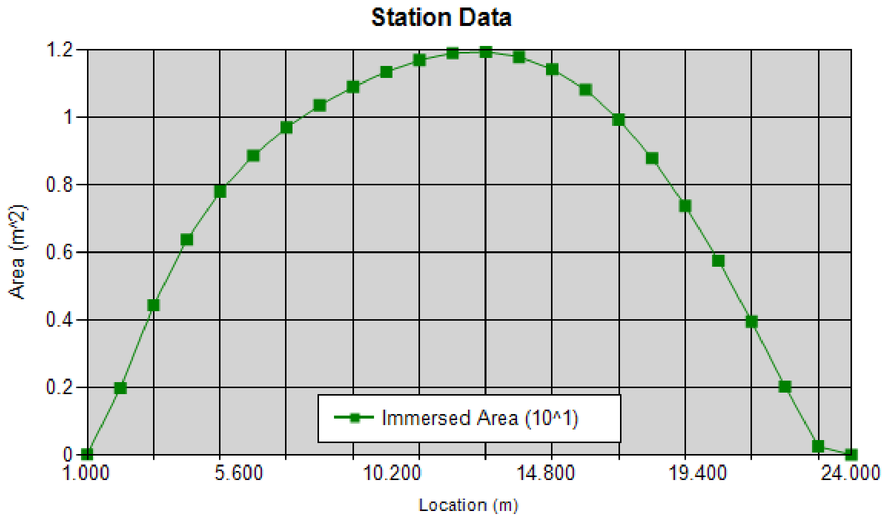
Ax	11.968	m^2		
Ax Location	12.717	m	Ax Location / Lwl	0.522

Hull Form Coefficients

Cb	0.478	Cx	0.714
Cp	0.669	Cwp	0.800
Cvp	0.598	Cws	2.752

Static Stability Parameters

I(transverse)	452.382	m^4	I(longitudinal)	4122.754	m^4
BMt	2.516	m	BMl	22.930	m
GMt	None Available	m	GMl	None Available	m
Mt	1.699	m	Ml	22.113	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.008	0.322
2.000	1.983	3.967
3.000	4.438	5.501
4.000	6.390	6.726
5.000	7.813	7.549
6.000	8.880	8.110
7.000	9.710	8.504
8.000	10.370	8.786
9.000	10.914	8.993
10.000	11.370	9.144
11.000	11.714	9.235
12.000	11.919	9.261
13.000	11.961	9.215
14.000	11.812	9.089
15.000	11.445	8.877
16.000	10.835	8.577
17.000	9.956	8.199
18.000	8.802	7.782
19.000	7.395	7.400
20.000	5.763	7.163
21.000	3.950	7.150
22.000	2.027	7.211
23.000	0.251	5.133
24.000	0.000	0.000

<u>Broad Beam 120 Degree Sternpost Tables 1.25m Draft</u>

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=1.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z	
		Fwd Direction = Negative_X	

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250	m
Model Trim	1.000	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	1.000 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.349
Beam Overall, Boa	7.578 m	Boa / D	2.361
Depth Overall, D	3.210 m		

Waterline Dimensions

Waterline Length, Lwl	22.900 m	Lwl / Bwl	3.294
Waterline Beam, Bwl	6.953 m	Bwl / T	4.211
Navigational Draft, T	1.651 m	D / T	1.944

Volumetric Values

Displacement Weight	129499.893	kgf	Displ-Length Ratio			300.528
Volume	126.231	m^3				
LCB	11.745	m	FB/Lwl	0.467	AB/Lwl	0.533
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.831	m				
Wetted Surface Area	147.165	m^2				
Moment To Trim	1487.793	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	116.724	m^2				
LCF	11.764	m	FF/Lwl	0.467	AF/Lwl	0.533
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1197.467	kgf/cm				

Sectional Parameters

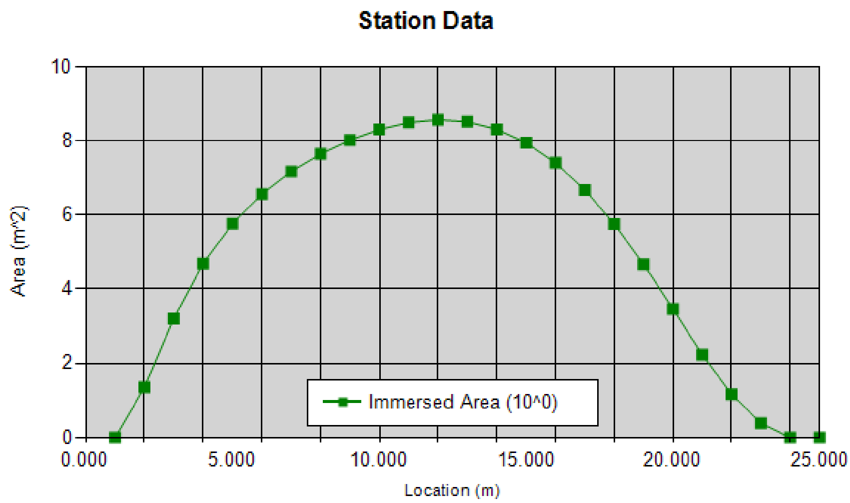
Ax	8.567	m^2		
Ax Location	12.071	m	Ax Location / Lwl	0.481

Hull Form Coefficients

Cb	0.480	Cx	0.746
Cp	0.643	Cwp	0.733
Cvp	0.655	Cws	2.737

Static Stability Parameters

I(transverse)	357.406	m^4	I(longitudinal)	3321.053	m^4
BMt	2.831	m	BMl	26.309	m
GMt	None Available	m	GMl	None Available	m
Mt	2.207	m	Ml	25.685	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.355	3.278
3.000	3.210	4.759
4.000	4.694	5.953
5.000	5.768	6.753
6.000	6.565	7.295
7.000	7.174	7.670
8.000	7.645	7.929
9.000	8.015	8.106
10.000	8.302	8.217
11.000	8.492	8.261
12.000	8.567	8.237
13.000	8.511	8.142
14.000	8.308	7.972
15.000	7.945	7.727
16.000	7.406	7.404
17.000	6.676	7.004
18.000	5.757	6.533
19.000	4.673	6.008
20.000	3.468	5.436
21.000	2.231	4.746
22.000	1.164	3.656
23.000	0.385	3.314
24.000	0.000	0.000
25.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=1.50,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250	m
Model Trim	1.500	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	1.500 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.349
Beam Overall, Boa	7.578 m	Boa / D	2.361
Depth Overall, D	3.210 m		

Waterline Dimensions

Waterline Length, Lwl	23.031 m	Lwl / Bwl	3.276
Waterline Beam, Bwl	7.029 m	Bwl / T	3.797
Navigational Draft, T	1.851 m	D / T	1.734

Volumetric Values

Displacement Weight	142149.983	kgf	Displ-Length Ratio			324.315
Volume	138.561	m^3				
LCB	11.973	m	FB/Lwl	0.473	AB/Lwl	0.527
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.896	m				
Wetted Surface Area	154.253	m^2				
Moment To Trim	1596.778	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	120.872	m^2				
LCF	11.971	m	FF/Lwl	0.473	AF/Lwl	0.527
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1240.027	kgf/cm				

Sectional Parameters

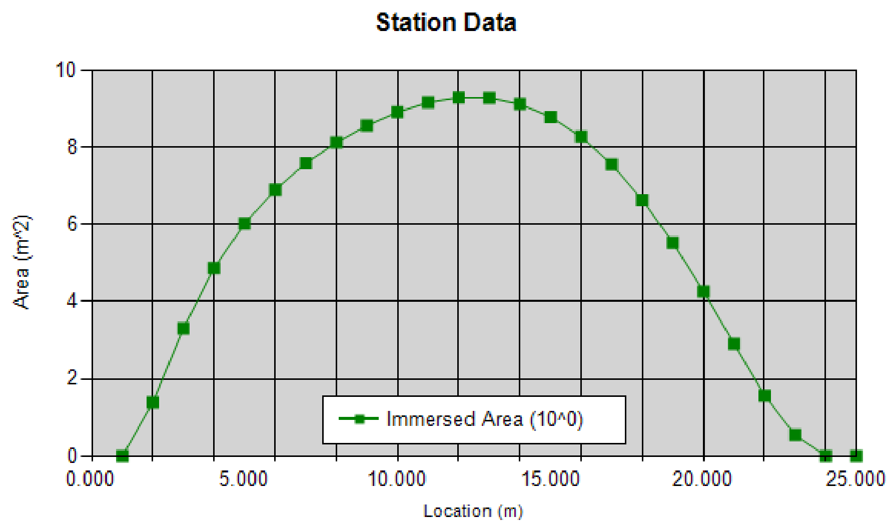
Ax	9.301	m^2		
Ax Location	12.434	m	Ax Location / Lwl	0.493

Hull Form Coefficients

Cb	0.462	Cx	0.715
Cp	0.647	Cwp	0.747
Cvp	0.619	Cws	2.731

Static Stability Parameters

I(transverse)	380.304	m^4	I(longitudinal)	3584.621	m^4
BMt	2.745	m	BMl	25.870	m
GMt	None Available	m	GMl	None Available	m
Mt	2.077	m	Ml	25.203	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.390	3.321
3.000	3.311	4.825
4.000	4.872	6.040
5.000	6.025	6.860
6.000	6.900	7.420
7.000	7.584	7.812
8.000	8.125	8.088
9.000	8.562	8.280
10.000	8.912	8.408
11.000	9.161	8.469
12.000	9.288	8.462
13.000	9.280	8.385
14.000	9.118	8.236
15.000	8.788	8.012
16.000	8.273	7.714
17.000	7.556	7.345
18.000	6.637	6.919
19.000	5.530	6.461
20.000	4.267	6.001
21.000	2.906	5.530
22.000	1.566	4.829
23.000	0.544	3.748
24.000	0.002	0.207
25.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.25,Model Trim=2.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.250 m
Model Trim	2.000 deg
Model Heel	0.000 deg
VCG	None available m
Fluid Type	Seawater
Fluid Density	1025.900 kg/m^3
Mirror Geometry	True

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.250 m
Trim Angle	2.000 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.349
Beam Overall, Boa	7.578 m	Boa / D	2.361
Depth Overall, D	3.210 m		

Waterline Dimensions

Waterline Length, Lwl	23.164 m	Lwl / Bwl	3.262
Waterline Beam, Bwl	7.101 m	Bwl / T	3.461
Navigational Draft, T	2.052 m	D / T	1.565

Volumetric Values

Displacement Weight	155542.079	kgf	Displ-Length Ratio			348.768
Volume	151.615	m^3				
LCB	12.199	m	FB/Lwl	0.480	AB/Lwl	0.520
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.965	m				
Wetted Surface Area	161.965	m^2				
Moment To Trim	1738.452	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	125.641	m^2				
LCF	12.227	m	FF/Lwl	0.481	AF/Lwl	0.519
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1288.947	kgf/cm				

Sectional Parameters

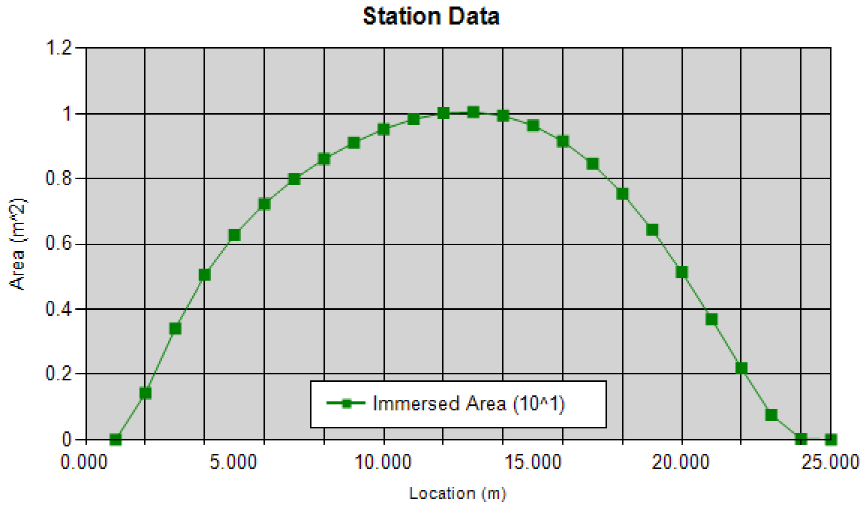
Ax	10.063	m^2		
Ax Location	12.748	m	Ax Location / Lwl	0.504

Hull Form Coefficients

Cb	0.449	Cx	0.691
Cp	0.650	Cwp	0.764
Cvp	0.588	Cws	2.733

Static Stability Parameters

I(transverse)	405.431	m^4	I(longitudinal)	3925.289	m^4
BMt	2.674	m	BMl	25.890	m
GMt	None Available	m	GMl	None Available	m
Mt	1.963	m	Ml	25.179	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.000	0.000
2.000	1.426	3.364
3.000	3.413	4.891
4.000	5.052	6.127
5.000	6.285	6.966
6.000	7.238	7.544
7.000	7.997	7.953
8.000	8.610	8.245
9.000	9.114	8.453
10.000	9.529	8.597
11.000	9.836	8.675
12.000	10.018	8.685
13.000	10.058	8.626
14.000	9.938	8.496
15.000	9.643	8.293
16.000	9.157	8.019
17.000	8.460	7.680
18.000	7.549	7.294
19.000	6.435	6.896
20.000	5.140	6.535
21.000	3.701	6.246
22.000	2.185	5.940
23.000	0.763	4.897
24.000	0.022	0.640
25.000	0.000	0.000

Broad Beam 120 Degree Sternpost Tables 1.50m Draft

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=1.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500	m
Model Trim	1.000	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	1.000 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.349
Beam Overall, Boa	7.578 m	Boa / D	2.361
Depth Overall, D	3.210 m		

Waterline Dimensions

Waterline Length, Lwl	23.130 m	Lwl / Bwl	3.231
Waterline Beam, Bwl	7.160 m	Bwl / T	3.766
Navigational Draft, T	1.901 m	D / T	1.689

Volumetric Values

Displacement Weight	160476.810	kgf	Displ-Length Ratio			361.422
Volume	156.425	m^3				
LCB	11.765	m	FB/Lwl	0.466	AB/Lwl	0.534
TCB	0.000	m	TCB / Bwl			0.000
VCB	0.976	m				
Wetted Surface Area	162.585	m^2				
Moment To Trim	1684.434	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	124.852	m^2				
LCF	11.942	m	FF/Lwl	0.474	AF/Lwl	0.526
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1280.859	kgf/cm				

Sectional Parameters

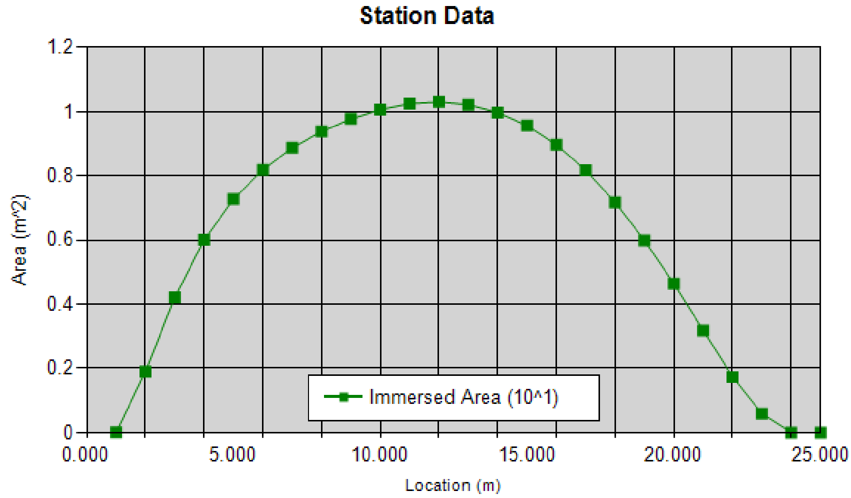
Ax	10.304	m^2		
Ax Location	11.892	m	Ax Location / Lwl	0.472

Hull Form Coefficients

Cb	0.497	Cx	0.757
Cp	0.656	Cwp	0.754
Cvp	0.659	Cws	2.703

Static Stability Parameters

I(transverse)	409.195	m^4	I(longitudinal)	3797.741	m^4
BMt	2.616	m	BMl	24.278	m
GMt	None Available	m	GMl	None Available	m
Mt	1.887	m	Ml	23.549	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.006	0.283
2.000	1.901	3.882
3.000	4.214	5.373
4.000	6.008	6.560
5.000	7.276	7.349
6.000	8.194	7.878
7.000	8.876	8.240
8.000	9.387	8.487
9.000	9.776	8.653
10.000	10.067	8.757
11.000	10.248	8.796
12.000	10.303	8.769
13.000	10.218	8.673
14.000	9.977	8.506
15.000	9.566	8.267
16.000	8.971	7.955
17.000	8.174	7.574
18.000	7.173	7.141
19.000	5.984	6.682
20.000	4.636	6.234
21.000	3.183	5.795
22.000	1.732	5.181
23.000	0.588	3.854
24.000	0.004	0.290
25.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=1.50,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500	m
Model Trim	1.500	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	1.500 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.349
Beam Overall, Boa	7.578 m	Boa / D	2.361
Depth Overall, D	3.210 m		

Waterline Dimensions

Waterline Length, Lwl	23.261 m	Lwl / Bwl	3.221
Waterline Beam, Bwl	7.221 m	Bwl / T	3.436
Navigational Draft, T	2.101 m	D / T	1.528

Volumetric Values

Displacement Weight	174266.568	kgf	Displ-Length Ratio			385.897
Volume	169.867	m^3				
LCB	11.994	m	FB/Lwl	0.473	AB/Lwl	0.527
TCB	0.000	m	TCB / Bwl			0.000
VCB	1.043	m				
Wetted Surface Area	170.407	m^2				
Moment To Trim	1835.894	kgf-m/cm				

Waterplane Values

Waterplane Area, Awp	129.657	m^2				
LCF	12.209	m	FF/Lwl	0.482	AF/Lwl	0.518
TCF	0.000	m	TCF / Lwl			0.000
Weight To Immerse	1330.154	kgf/cm				

Sectional Parameters

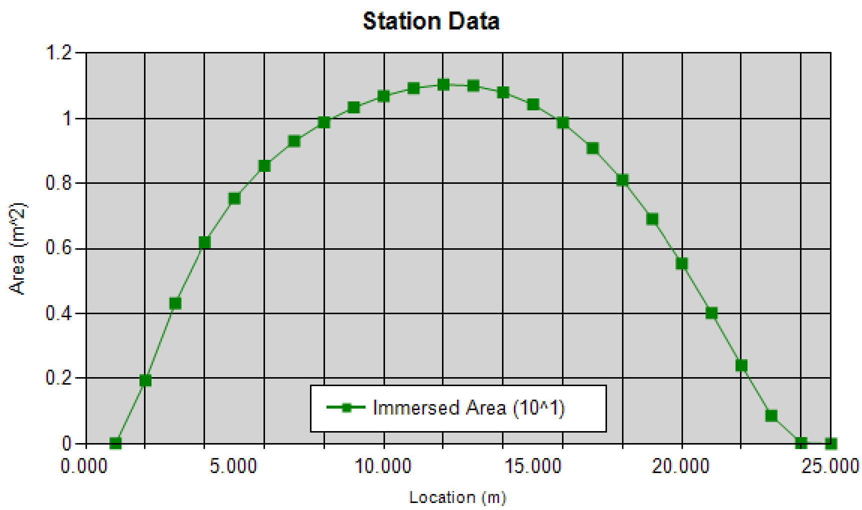
Ax	11.048	m^2		
Ax Location	12.246	m	Ax Location / Lwl	0.484

Hull Form Coefficients

Cb	0.481	Cx	0.728
Cp	0.661	Cwp	0.772
Cvp	0.623	Cws	2.711

Static Stability Parameters

I(transverse)	434.408	m^4	I(longitudinal)	4162.622	m^4
BMt	2.557	m	BMl	24.505	m
GMt	None Available	m	GMl	None Available	m
Mt	1.786	m	Ml	23.734	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.007	0.302
2.000	1.942	3.925
3.000	4.324	5.437
4.000	6.198	6.643
5.000	7.547	7.451
6.000	8.544	7.997
7.000	9.302	8.376
8.000	9.884	8.640
9.000	10.339	8.822
10.000	10.694	8.942
11.000	10.934	8.999
12.000	11.043	8.989
13.000	11.006	8.911
14.000	10.808	8.763
15.000	10.434	8.545
16.000	9.868	8.256
17.000	9.093	7.904
18.000	8.104	7.509
19.000	6.912	7.109
20.000	5.539	6.755
21.000	4.018	6.492
22.000	2.410	6.245
23.000	0.865	5.387
24.000	0.029	0.724
25.000	0.000	0.000

Condition Name=Condition 1,Model Sinkage=1.50,Model Trim=2.00,Model Heel=0.00

General Info

Analysis Type	FixedFlotationPlane	Up Direction = Positive_Z
		Fwd Direction = Negative_X

Surface Meshing Parameters

Density	1	Minimum edge length	0.0001 m
Maximum angle	0	Maximum edge length	0 m
Maximum aspect ratio	0	Max distance, edge to surf.	0 m
Minimum initial grid quads	0	Jagged seams	False
Refine mesh	True	Simple planes	True

Load Condition Parameters

Model Sinkage	1.500	m
Model Trim	2.000	deg
Model Heel	0.000	deg
VCG	None available	m
Fluid Type	Seawater	
Fluid Density	1025.900	kg/m^3
Mirror Geometry	True	

Resultant Model Attitude

Heel Angle	0.000 deg	Sinkage	1.500 m
Trim Angle	2.000 deg		

Overall Dimensions

Length Overall, LOA	25.378 m	Loa / Boa	3.349
Beam Overall, Boa	7.578 m	Boa / D	2.361
Depth Overall, D	3.210 m		

Waterline Dimensions

Waterline Length, Lwl	23.395 m	Lwl / Bwl	3.215
Waterline Beam, Bwl	7.277 m	Bwl / T	3.162
Navigational Draft, T	2.302 m	D / T	1.395

Volumetric Values

Displacement Weight	189020.118	kgf	Displ-Length Ratio				411.416
Volume	184.248	m^3					
LCB	12.232	m	FB/Lwl	0.480		AB/Lwl	0.520
TCB	0.000	m	TCB / Bwl				0.000
VCB	1.115	m					
Wetted Surface Area	179.394	m^2					
Moment To Trim	2051.243	kgf-m/cm					

Waterplane Values

Waterplane Area, Awp	135.629	m^2					
LCF	12.564	m	FF/Lwl	0.494		AF/Lwl	0.506
TCF	0.000	m	TCF / Lwl				0.000
Weight To Immerse	1391.419	kgf/cm					

Sectional Parameters

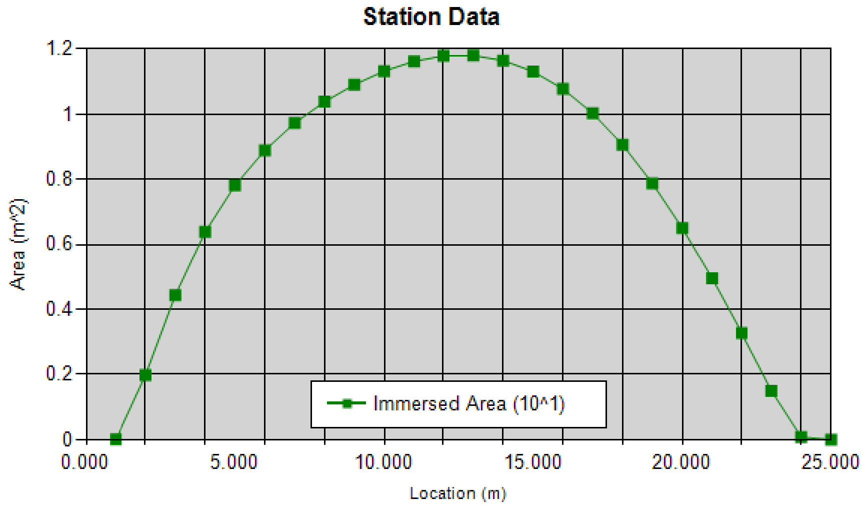
Ax	11.817	m^2		
Ax Location	12.574	m	Ax Location / Lwl	0.495

Hull Form Coefficients

Cb	0.470	Cx	0.705
Cp	0.666	Cwp	0.797
Cvp	0.590	Cws	2.732

Static Stability Parameters

I(transverse)	464.078	m^4	I(longitudinal)	4677.688	m^4
BMt	2.519	m	BMl	25.388	m
GMt	None Available	m	GMl	None Available	m
Mt	1.706	m	Ml	24.575	m



Location (m)	Immersed Area (m^2)	Immersed Girth (m)
1.000	0.008	0.322
2.000	1.984	3.968
3.000	4.435	5.500
4.000	6.389	6.726
5.000	7.821	7.552
6.000	8.897	8.116
7.000	9.731	8.512
8.000	10.384	8.791
9.000	10.908	8.990
10.000	11.326	9.127
11.000	11.626	9.200
12.000	11.790	9.208
13.000	11.802	9.149
14.000	11.648	9.020
15.000	11.312	8.821
16.000	10.779	8.554
17.000	10.031	8.228
18.000	9.063	7.866
19.000	7.882	7.513
20.000	6.505	7.241
21.000	4.954	7.130
22.000	3.266	7.198
23.000	1.501	7.138
24.000	0.082	1.721
25.000	0.000	0.000