Oxford Tree-Ring Laboratory
Report 2019/04

The Tree-Ring Dating of the Archeological Evaluation and Mitigation of Site 44AX0235, Robinson Landing, City of Alexandria, Virginia WSSI #22335.04

Michael J. Worthington and Jane I. Seiter

Vince Gallacci of Thunderbird Archeology sampling Ship 3, Feature 159

Oxford Tree-Ring Laboratory
25 East Montgomery Street, Baltimore, MD 21230
michael@dendrochronology.com
www.dendrochronology.com
410-929-1520

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Summary:

Robinson Landing, Alexandria, Virginia **(38.801219, -77.039935)**

Feature 155-2 Bulkhead Associated with Ship 2	*Felling dates:* **Summer 1765, Winter 1771/2, Winter 1784/5**
Feature 155-4 Bulkhead Associated with Ship 2	*Felling Date:* **Winter 1772/3**
Feature 155-6 Bulkhead Associated with Ship 2	*Felling Date:* **Spring 1772**
Feature 160-6 Bulkhead Between Ship 1 and Ship 2	*Felling Date:* **Winter 1771/2**
Feature 161-1 Bulkhead System Along Wolfe Street	*Felling Date:* **Winter 1767/8 Summer 1770**
Feature 162 Grillage and Disarticulated Logs Possibly Associated with Feature 165	*Felling Date:* **Winter 1735/6 Winter 1770/1**
Feature 164 Addition to Feature 161	*Felling Date:* **Summer 1771 Summer 1773 Winter 1773/4 Spring 1785**
Feature 165 Large Coffer East of Ship 2	*Felling Date:* **After 1792**
Feature 168 Partial Bulkhead on North End near Duke Street	*Felling Date:* **After 1842**
Feature 200 Ship 1	*Felling Date:* **Undated**
Feature 159 Ship 3	*Felling Date:* **Undated**

Site Master 1657-1784 (oak) RTVAx1 (*t* = 8.76 MDZ7; 8.46 POPMASTE; 8.32 ESHORE1).
Site Master 1771-1784 (oak) f155-2 (*t* = 5.53 hs wews3; 5.51 WILDx1; 5.20 WCMDx1).
Site Master 1648-1762 (oak) f155-2-D1 (*t* = 5.70 RHMDx1; 5.22 SOTx12; 5.18 haas1).
Site Master 1727-1784 (oak) rtva1 (*t* = 5.39 GLOx1; 5.14 CBHMx1; 5.01 SGHx1).
Site Master 1703-1785 (oak) f161-a1y (*t* = 7.29 yardAB; 6.84 DCAREA2; 6.55 MDZ8).
Site Master 1686-1767 (tulip poplar) f161-1 (*t* = 5.69 CDMDx6; 5.66 OMBx1; 5.63 PIEDMO).
Site Master 1618-1769 (oak) f161-1-b18 (*t* = 7.29 BPR; 6.74 MATHISTO; 6.71 FTLOUD).
Site Master 1600-1770 (tulip poplar) f162 (*t* = 7.23 DRNx6; 7.13 HESSx; 6.89 flpa).
Site Master 1674-1770 (oak) f162-4-a2 (*t* = 8.13 MTVx4; 6.76 SBK6; 6.36 FDMDx1).
Site Master 1671-1784 (oak) f164-4 (*t* = 6.03 CHVAx1; 5.92 MDOAK; 5.81 SBS2).
Site Master 1632-1816 (oak) f168-2-a1 (*t* = 5.96 CDMDx6; 5.33 WCM; 5.31 eapenn).

Dendrochronological analysis was undertaken at the Robinson Landing site in Alexandria, Virginia, to help understand the development of the site. The analysis targeted several wooden features uncovered during the excavations, primarily bulkhead wharves, square crib wharf structures, and the remnants of three ships that were used as a framework for shore infilling and wharf construction. Dendrochronological samples were taken from eleven features in total, using a mix of sectioning and coring techniques. Nine of the features were successfully dated, providing a series of precise felling dates that ranged from the winter of 1735/6 through to the winter of 1784/5.

Date sampled:	April 6, 9, 16, and 18; May 6; and October 22, 2018
Commissioner:	John P. Mullen, Principal Archeologist/Assistant Manager, Thunderbird Archeology
Client:	Eakin Youngentob and Associates
Street address:	2 Duke Street, Alexandria, VA 22314
Summary published:	**www.dendrochronology.com**

How Dendrochronology Works

Dendrochronology has over the past few decades become one of the leading and most accurate scientific dating methods. While not always successful, when it does work, it is precise, often to the season of the year. Tree-ring dating to this degree of precision is well known for its use in dating historic buildings and archaeological timbers. However, more ancillary objects such as doors, furniture, panel paintings, and wooden boards in medieval book-bindings can sometimes be successfully dated.

The science of dendrochronology is based on a combination of biology and statistics. In temperate zones, a tree puts on a new layer of growth underneath the bark every year, with the effect being that the tree grows wider and taller as it ages. Each annual ring is composed of the growth which takes place during the spring and summer and continues until about November, when the leaves are shed and the tree becomes dormant for the winter period. For the two principal American oaks, the white and red (*Quercus alba* and *Q. rubra*), as well as for the black ash (*Fraxinus nigra*) and many other species, the annual ring is composed of two distinct parts: the spring growth or early wood, and the summer growth, or late wood. Early wood is composed of large vessels formed during the period of shoot growth which takes place between March and May, before the establishment of any significant leaf growth. This is produced by using most of the energy and raw materials laid down the previous year. Then, there is an abrupt change at the time of leaf expansion around May or June when hormonal activity dictates a change in the quality of the xylem, and the summer growth, or late wood, is formed. Here the wood becomes increasingly fibrous and contains much smaller vessels. Trees with this type of growth pattern are known as ring-porous, and are distinguished by the contrast between the open, light-colored early wood vessels and the dense, darker-colored late wood.

Other species of tree, such as tulip poplar (*Liriodendron tulipifera L.*), are known as diffuse-porous. Unlike the ring-porous trees, the spring vessels consist of very small spring vessels that become even smaller as the tree advances into the summer growth. The annual growth rings are often very difficult to distinguish under even a powerful microscope, and one often needs to study the medullary rays, which thicken at the ring boundaries.

Dendrochronology utilizes the variation in the width of the annual rings as influenced by climatic conditions common to a large area, as opposed to other more local factors such as woodland competition and insect attack. It is these climate-induced variations in ring widths that allow calendar dates to be ascribed to an undated timber when compared to a firmly-dated sequence. If a tree section is complete to the bark edge, then when dated a precise date of felling can be determined. The felling date will be precise to the season of the year, depending on the degree of formation of the outermost ring. Therefore, a tree with bark that has the spring vessels formed but no summer growth can be said to be felled in the spring, although it is not possible to say in which particular month the tree was felled.

Another important dimension to dendrochronological studies is the presence of sapwood and bark. This is the band of growth rings immediately beneath the bark and comprises the living growth rings which transport the sap from the roots to the leaves. This sapwood band is distinguished from the heartwood by the prominent features of color change and the blocking of the spring vessels with tyloses, the waste products of the tree's growth. The heartwood is generally darker in color, and the spring vessels are usually blocked with tyloses. The heartwood is dead tissue, whereas the sapwood is living, although the only really living, growing, cells are in the cambium, immediately beneath the bark. In the American white oak (*Quercus* alba), the difference in color is not generally matched by the change in the spring vessels, which are often filled by tyloses to within a year or two of the terminal ring. Conversely, the spring vessels in the American red oak (*Q* rubra) are almost all free of tyloses, right to the pith. Generally the sapwood retains stored food and is therefore attractive to insect and fungal attack once the tree is felled and therefore is often removed during conversion.

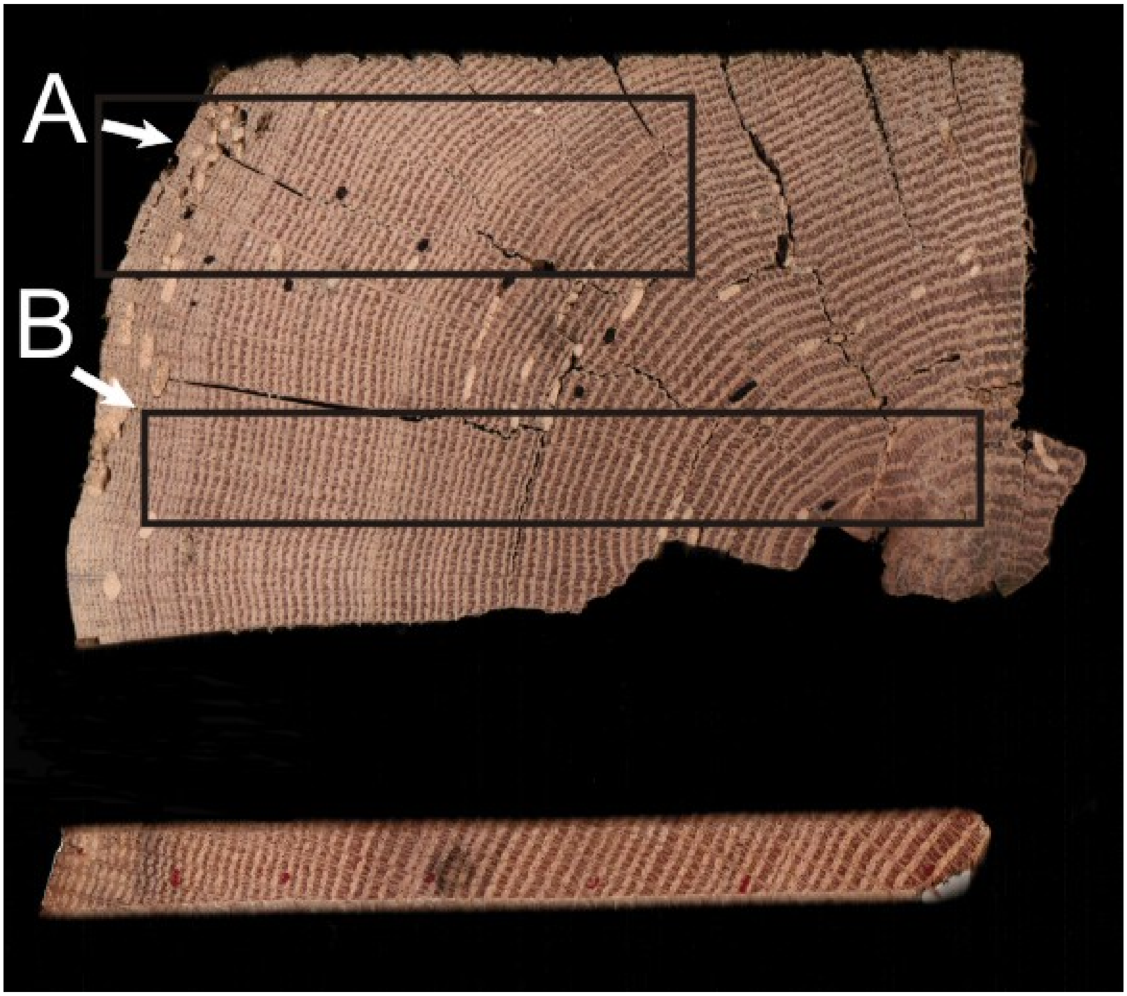

Figure 1. A cross-section of an oak timber with sapwood rings on the left-hand side (above). The boxes illustrate conversion methods resulting in **A)** a precise felling date and **B)** a *terminus post quem* or felled after date. Also pictured is a core showing complete sapwood (below).

Methodology: The Dating Process

All samples were taken from what appeared to be primary first-use timbers. Timbers that looked most suitable for dendrochronological purposes—those with complete sapwood or reasonably long ring sequences—were selected. *In-situ* timbers were sampled through coring, using a 5 mm hollow auger or sections were cut with a chainsaw.

The dry samples were sanded on a linisher, or bench-mounted belt sander, using 60 to 1200 grit abrasive paper, and were cleaned with compressed air to allow the ring boundaries to be clearly distinguished. They were then measured under a x10/x30 microscope using a travelling stage electronically displaying displacement to a precision of 0.01mm. Thus each ring or year is represented by its measurement which is arranged as a series of ring-width indices within a data set, with the earliest ring being placed at the beginning of the series, and the latest or outermost ring concluding the data set.

As indicated above, the principle behind tree-ring dating is a simple one: the seasonal variations in climate-induced growth as reflected in the varying width of a series of measured annual rings is compared with other, previously dated ring sequences to allow precise dates to be ascribed to each ring. When an undated sample or site sequence is compared against a dated sequence, known as a reference chronology, an indication of how good the match is must be determined. Although it is almost impossible to define a visual match, computer comparisons can be accurately quantified. While it may not be the best statistical indicator, Student's (a pseudonym for W S Gosset) *t*-value has been widely used among dendrochronologists. The cross-correlation algorithms most commonly used and published are derived from Baillie and Pilcher's CROS program (Baillie and Pilcher 1973).

Generally, *t*-values over 3.5 should be considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, or higher, and for these to be well replicated from different, independent chronologies with local and regional chronologies well represented. Users of dates also need to assess their validity critically. They should not have great faith in a date supported by a handful of *t*-values of 3s with one or two 4s, nor should they be entirely satisfied with a single high match of 5 or 6. Examples of spurious *t*-values in excess of 7 have been noted, so it is essential that matches with reference chronologies be well replicated, and that this is confirmed with visual matches between the two graphs. Matches with *t*-values of 10 or more between individual sequences usually signify having originated from the same parent tree.

In reality, the probability of a particular date being valid is itself a statistical measure depending on the *t*-values. Consideration must also be given to the length of the sequence being dated as well as those of the reference chronologies. A sample with 30 or 40 years growth is likely to match with high *t*-values at varying positions, whereas a sample with 100 consecutive rings is much more likely to match significantly at only one unique position. Samples with ring counts as low as 50 may occasionally be dated, but only if the matches are very strong, clear, and well replicated, with no other significant matching positions. This is essential for intra-site matching when dealing with such short sequences. Consideration should also be given to evaluating the reference chronology against which the samples have been matched: those with well-replicated components that are geographically near to the sampling site are given more weight than an individual site or sample from far away.

It is general practice to cross-match samples from within the same phase to each other first, combining them into a site master, before comparing with the reference chronologies. This has the advantage of averaging out the "noise" of individual trees and is much more likely to obtain higher *t*-values and stronger visual matches. After measurement, the ring-width series for each sample is plotted as a graph of width against year on log-linear graph paper. The graphs of each of the samples in the phase under study are then compared visually at the positions indicated by the computer matching and, if found satisfactory and consistent, are averaged to form a mean curve for the site or phase. This mean curve and any unmatched individual sequences are compared against dated reference chronologies to obtain an absolute calendar date for each sequence. Sometimes, especially in urban situations, timbers may have come from different sources and fail to match each other, thus making the compilation of a site master difficult. In this situation samples must then be compared individually with the reference chronologies.

Therefore, when cross-matching samples with each other, or against reference chronologies, a combination of both visual matching and a process of qualified statistical comparison by computer is used. For this study, the ring-width series were compared on an IBM compatible computer for statistical cross-matching using a variant of the Belfast CROS program (Baillie and Pilcher 1973).

Ascribing and Interpreting Felling Dates

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. For samples that have sapwood complete to the underside of, or including, bark, this process is relatively straight forward. Depending on the completeness of the final ring, i.e. if it has only the early wood formed, or the latewood, a *precise felling date and season* can be given. Where the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then the question of when the tree was felled becomes considerably more complicated. In the European oaks, sapwood tends to be of a relatively constant width and/or number of rings, and it is possible to estimate the approximate number of sapwood rings that are missing from any given timber.

Unfortunately, it has not been possible to apply an accurate sapwood estimate to either the white or red oaks at this time. Primarily, it would appear that there is a complete absence of literature on sapwood estimates for oak anywhere in the country (Grissino-Mayer, *pers comm*). The matter is further complicated in that the sapwood in white oak (*Quercus alba*) occurs in two bands, with only the outer ring or two being free of tyloses in the spring vessels (Gerry 1914; Kato and Kishima 1965). Out of some 50 or so samples, only a handful had more than 3 rings of sapwood without tyloses. The actual sapwood band is differentiated sometimes by a lighter color, although this is often indiscernible (Desch 1948). In archaeological timbers, the lighter colored sapwood does not collapse as it does in the European oak (*Q rober*), but only the last ring or two without tyloses shrink tangentially. In these circumstances the only way of being able to identify the heartwood/sapwood boundary is by recording how far into the timber wood boring beetle larvae penetrate, as the heartwood is not usually susceptible to attack unless the timber is in poor or damp conditions. Despite all of these drawbacks, some effort has been made in recording sapwood ring counts on white oak, although the effort is acknowledged to be somewhat subjective.

As for red oaks (*Quercus rubra*) it will probably not be possible to determine a sapwood estimate as these are what are known as "sapwood trees" (Chattaway 1952). Whereas the white oak suffers from an excess of tyloses, these are virtually non-existent in the red oak, even to the pith. Furthermore, there is no obvious color change throughout the section of the tree, and wood-boring insects will often penetrate right through to the center of the timber. Therefore, in sampling red oaks, it is vital to retain the final ring beneath the bark, or to make a careful note of the approximate number of rings lost in sampling, if any meaningful interpretation of felling dates is to be made. Similarly, no study has been made in estimating the number of sapwood rings in tulip-poplar, black ash, or any of the pines.

Therefore, if the bark edge does not survive on any of the timbers sampled, only a *terminus post quem* or *felled after* date can be given. The earliest possible felling date would be the year after the last measured ring date, adjusted for any unmeasured rings or rings lost during the process of coring.

Some caution must be used in interpreting solitary precise felling dates. Many instances have been noted where timbers used in the same structural phase have been felled one, two, or more years apart. Whenever possible, a group of precise felling dates should be used as a more reliable indication of the construction period. It must be emphasized that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure under study. However, it is common practice to build timber-framed structures with green or unseasoned timber and therefore construction usually took place within twelve to eighteen months of felling (Miles 1997).

Details of Dendrochronological Analysis

The results of the dendrochronological analysis for the buildings under study are presented in a number of detailed tables. The most useful of these is the summary **Table 1**. This gives most of the salient results of the dendrochronological process, and includes details for each sample, such as its species, location, and felling date, if successfully tree-ring dated. This last column is of particular interest to the end user, as it gives the actual year and season when the tree was felled, if bark or bark edge is present. If bark edge is not present, it gives a *terminus post quem* or date after which the timber was felled. Often these *terminus post quem* dates begin far earlier than any associated precise felling dates. This is simply because far more rings have been lost in the initial conversion of the timber. If the sapwood was complete on the timber but some was lost during coring, an estimated date range can sometimes be given.

It will also be noticed that often the precise felling dates will vary within several years of each other. Unless there is supporting archaeological evidence suggesting different phases, all this would indicate is either stockpiling of timber, or of trees that had been felled or died at varying times but were not cut up until the commencement of the particular building operations in question. When presented with varying precise felling dates, one should always take the latest date for the structure under study, and it is likely that construction will have been completed for ordinary vernacular buildings within twelve or eighteen months from this latest felling date (Miles 1997).

Table 2 gives an indication of the statistical reliability of the match between one sequence and another. This shows the *t*-value over the number of years overlap for each combination of samples in a matrix table. It should be born in mind that *t*-values with less than 80 rings overlap may not truly reflect the same degree of matching and that spurious matches may produce similar values.

First, multiple radii have been cross-matched with each other and combined to form same-timber means. These are then compared with other samples from the site and any which are found to have originated from the same parent tree are again similarly combined. Finally, all samples, including all same timber and same tree means, are combined to form one or more site masters. Again, the cross-matching is shown as a matrix table of *t*-values over the number of years overlaps. Reference should always be made to **Table 1** to clearly identify which components have been combined.

Table 3 shows the degree of cross-matching between the site master(s) and a selection of reference chronologies. This shows the state or region from which the reference chronology originated, the common chronology name, the publication reference, and the years covered by the reference chronology. The number of overlapping years between the reference chronology and the site master is also shown together with the resulting *t*-value. It should be noted that well replicated regional reference chronologies, which are shown in **bold**, will often produce better matches than individual site masters or indeed individual sample sequences.

Figures include a bar diagram that shows the chronological relationship between two or more dated samples from a phase of building and any plans showing sample locations, if available.

Publication of all dated sites for English buildings occurs annually in *Vernacular Architecture*, but regrettably there is at the present time no vehicle available for the publication of dated American buildings. However, a similar entry is shown on the summary page of the report, which could be used in any future publication of American dates. This does not give as much technical data for the samples dated, but does give the *t*-value matches against the relevant chronologies, provides a short descriptive paragraph for each building or phase dated, and gives a useful short summary of samples dated. These summaries are also listed on the web-site maintained by the Laboratory, which can be accessed at www.dendrochronology.com. The Oxford Tree-Ring Laboratory retains copyright of this report, but the commissioner of the report has the right to use the report for his or her own use so long as the authorship is quoted. Primary data and the resulting site master(s) used in the analysis are available from the Laboratory on request by the commissioner and bona fide researchers. The samples form part of the Laboratory archives, unless an alternative archive, such as the Colonial Williamsburg Foundation in association with the Oxford Tree-Ring Laboratory, has been specified in advance.

Overview of Robinson Landing Site, provided by John P. Mullen, Principal Archeologist/Assistant Manager, Thunderbird Archeology

Thunderbird Archeology, a division of Wetland Studies and Solutions, Inc. (WSSI), of Gainesville, Virginia, conducted an *Archaeological Evaluation* and *Archaeological Excavation* (mitigation) study on behalf of Eakin Youngentob and Associates at the site of Robinson Landing in 2017 and 2018. Robinson Landing is located along the historic waterfront in Alexandria, Virginia, and is bounded by Duke Street, South Union Street, Wolfe Street, and the Potomac River.

The remains of a late 18th- to early 19th-century city block were exposed during the archeological excavations beneath the 20th-century Robinson Terminal Warehouse Corporation warehouses that once enclosed the entire city block. Thunderbird Archeology recorded the block as *Site 44AX0235*, which encompassed the stone and brick foundations of residential and commercial buildings facing Wolfe, Union and Duke Streets.

Most of these dwellings had crawl spaces or cellars with intact deposits dating to the occupation of the houses. Numerous privies were found in the backyards, which contained even more clues (in the well preserved "night soil") about the occupants and uses of these buildings. A few structures were located within the interior of the property, delineating the location of previously unknown alleyways that ran across the interior. The entire property was divided in half in 1780 by a well-known “alley” named The Strand; Thunderbird located a flagstone and cobblestone portion of the Strand that likely dates to 1820 based on the artifacts found beneath the cobblestones. The east side of the Strand facing the Potomac River was lined with the foundations of commercial warehouses, situated on wharves. A brick sidewalk with stone curbs fronted the warehouses. Finally, the northeastern end of the site was home to the Hooe’s Warehouse (circa 1783), Hartshorn’s Store, and was later the location of the circa 1851 Pioneer Mill, which was the largest building in Alexandria at that time and a well-known landmark.

However, prior to 1851, the northeastern end of the site (along Duke Street) was the location of Alexandria’s small 18th- and early 19th-century shipbuilding industry. The town of Alexandria was established in 1749 between two points of land on either side of a crescent shaped bay on the Potomac River. The waterfront originally consisted of 15-20 feet high bluffs overlooking the river and the tidal flats. The southernmost point of land on this bay, which the Robinson site and the Hotel Indigo site shared, was named Point Lumley. The rest of the Robinson site consisted of tidal mud flats that were completely infilled between 1750 and 1790, by cutting down the high bluffs and spreading the soil out into the shallow water in a process known as “banking out.”

Thunderbird Archeology also found evidence of how the owners and residents of this city block reclaimed the tidal flats and created new land, so that they could access the deep-water channel of the Potomac River and the benefits of merchant trade opportunities. Several bulkhead wharf remnants, consisting of stacked and interlocked long timbers, were located around the eastern edge of the property, and in other areas were found what appears to be crib wharf construction: a square framework of timbers that sank to the bottom of the river when filled with stone or soil. Given the proximity to the river and an early shipyard, three ship remnants were located at the site that were used as the framework for the wharf construction and for creating new land on this city block.

Dendrochronological Sampling

A dendrochronological study of Robinson Landing was undertaken to help understand the development of the site by providing dates for the wooden archaeological features and the three ships that were found during excavation.

Sixty-eight timbers in total were sampled from the site, comprising a mix of oak, tulip polar, pine, and bald cypress. Samples from the site were given individual codes by the archaeologists; these codes have been used throughout this report to enable cross-comparison between the different site reports. The position of each sample was noted at the time of sampling (see figures 3, 4, and 5).

Summary of Dating

Of the sixty-eight timbers sampled, thirteen were found to be unsuitable for analysis due to insufficient rings or the timber were found to be too rotten and were discarded. Bark edge survived on twenty-nine timber deemed suitable for analysis.

All of the timber sequences were compared with each other. Eleven timbers (**F155-2-D2, F155-2-E1, F155-4, F155-6, F160-6-F1, F161-1-A1, F164-1-A1, F164-1-A2, F164-1-B1, F164-5, and F164-6**) were found to match each other allowing them to be combined into the 126-year site masters **RTVAx1**.

Five timbers **(F159-1, F159-11, F159-2, F159-4, and F159-7)** were found to match each other allowing them to be combined into the 178-year site masters **RTVAx2**.

The site masters and the remaining unmatched samples were compared with more than one thousand master chronologies from the East Coast of the United States. **RTVAx1** was found to date spanning the years 1659 to 1784 (Table 2a). Ten of the individual samples were also found to date (see Table 1).

Interpretation

The dendrochronology study has successfully dated nine of the eleven archeological features sampled. The bulkhead associated with ship2 – f155-2 were found to date to the summer of 1765, winter of 1771/2, and the winter of 1784/5. The bulkhead associated with ship2 – f155-4 was found to date to the winter of 1772/3. The bulkhead associated with ship2 – f155-6 dated to the spring of 1772. The bulkhead between ship1 and ship2 – f160-6 dated to winter 1771/2, the bulkhead system along Wolfe Street – f161-1 dated to the winter of 1767/8 and the summer 1770. The grillage and disarticulated logs associated with 165 dated to winter of 1735/6 and winter of 1770/1. The addition to 161 – f164 dated to summer of 1771, summer 1773, the winter of 1773/4 and the spring of 1785. The large coffer east of Ship 2 dated to after 1792 and the partial bulkhead on north end near Duke Street to after 1842.

Two of the three ships found at Robinson Landing—ship 1 and ship 3 f159—were found to be suitable for sampling; the third was extremely decayed and the remaining timbers lacked a sufficient number of rings to be sampled. Both of the sampled ships were found not to date.

Acknowledgements

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Table 1: Summary of tree-ring dating

ROBINSON TERMINAL, ALEXANDRIA, VIRGINIA

Sample number & type		Species	Timber and position	Dates AD spanning	Last Ring	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges
Feature 155 Bulkhead Associated with Ship2										
f155-2	s	QUAL		1711-1784	C	74	1.37	0.62	0.186	Winter 1784/5
f155-2-b2	s	QUAL		-	h/w only	97	2.02	1.07	0.177	
f155-2-c2	s	QUAL		-	h/w only	62	3.03	1.35	0.359	
f155-2-c3	s	QUAL		-	13nm	129	1.59	0.55	0.177	
f155-2-d1	s	QUAL		-	C	115	1.89	0.66	0.133	
* **f155-2-d2**	s	QUAL		1680-1771	C	92	1.70	0.61	0.184	Winter 1771/2
* **f155-2-e1**	s	QUAL		1680-1764	½C	85	2.09	0.67	0.169	Summer 1765
* **f155-4**	s	PISP		1674-1772	C	99	1.66	0.57	0.187	Winter 1772/3
* **f155-6**	s	QUAL		1712-1771	¼C	60	2.46	0.83	0.203	Spring 1772
f155-a3	s	TADI		-	h/w only	130	1.70	0.92	0.212	
rtva1	s	QUAL		1727-1784	¼C	58	2.02	1.16	0.262	Spring 1784/5

Key: *, †, § = sample included in site-master; c = core; mc = micro-core; s = slice/section; g = graticule; p = photograph; ¼C, ½C, C = bark edge present, partial or complete ring: ¼C = spring (last partial ring not measured), ½C = summer/autumn (last partial ring not measured), or C = winter felling (ring measured); h/w only = heartwood only; nm = number of unmeasured rings; std devn = standard deviation; mean sens = mean sensitivity; QUAL = *Quercus Alba* (White oak) LITU = *Liriodendron tulipifera L.* (tulip poplar); PISP = *Pinus L.* (Southern yellow pine) QUPR = *Quercus prinus* (chestnut oak) TADI= *Taxodium distichum (L.) Rich.* (Boldcypress)

Table 1: Summary of tree-ring dating

ROBINSON TERMINAL, ALEXANDRIA, VIRGINIA

Sample number & type	Species	Timber and position	Dates AD spanning	Last Ring	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges
Feature 159 Ship 3									
† **f159-2** mc	QUAL	F13	-	h/w only	91	1.48	0.48	0.196	
f159-3 mc	QUAL	F12-FF4N	-	3nm	80	1.07	0.39	0.147	
† **f159-4** mc	QUAL	F11-F3N	-	h/w only	107	1.04	0.38	0.191	
f159-5 mc	QUAL	F9-FØ	-	6nm	59	0.66	0.22	0.151	
f159-6 mc	QUAL	F10	-	6nm	48	0.94	0.39	0.202	
† **f159-7** mc	QUAL	F11	-	5nm	82	0.84	0.42	0.124	
† **f159-11** mc	QUAL	F31-F3N	-	h/w only	38	1.37	0.61	0.235	
f159-a2 mc	QUAL	F8-F25 a2	-	h/w only	76	0.92	0.54	0.151	
f159-f13 mc	QUAL	F13-FØ	-	h/w only	77	1.84	0.56	0.169	
f159-5-4 mc	QUAL	F5-F4	-	h/w only	67	0.59	0.19	0.115	
† **f159-1-f36** mc	QUAL	F36-F2n	-	h/w only	64	1.58	0.60	0.111	
f159-1-f37 mc	QUAL	F37-FØ	-	h/w only	72	1.88	1.04	0.135	
f159-1-f7 mc	QUAL	f7-fØ	-	11nm	84	1.33	0.47	0.190	
† = RTVAx2 Site Master			-		178	1.17	0.40	0.164	
Feature 160-6 Bulkhead between ship1 and ship2									
f160-4a s	LITU	Insufficient annual rings							
f160-7-02 s	LITU	Insufficient annual rings							
f160-7-f2 s	LITU	To rotten to measure							
f160-1-b1 s	Hemlock		-	h/w only	76	2.06	1.07	0.164	
* **f160-6-f1** s	PISP		1663-1771	C	109	2.65	0.73	0.175	Winter 1771/2
f160-7-g1 s	PISP		-	3nm	117	1.21	0.50	0.213	

Key: *, †, § = sample included in site-master; c = core; mc = micro-core; s = slice/section; g = graticule; p = photograph; ¼C, ½C, C = bark edge present, partial or complete ring: ¼C = spring (last partial ring not measured), ½C = summer/autumn (last partial ring not measured), or C = winter felling (ring measured); h/w only = heartwood only; nm = number of unmeasured rings; std devn = standard deviation; mean sens = mean sensitivity; QUAL = *Quercus Alba* (White oak) LITU = *Liriodendron tulipifera L.* (tulip poplar); PISP = *Pinus L.* (Southern yellow pine) QUPR = *Quercus prinus* (chestnut oak) CADN= *Castanea dentata (Marsh.) Borkh.* (chestnut)

Table 1: Summary of tree-ring dating
ROBINSON TERMINAL, ALEXANDRIA, VIRGINIA

Sample number & type	Species	Timber and position	Dates AD spanning	Last Ring	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges
Feature 161-1 Bulkhead system along Wolfe Street									
f161-a1y s	QUAL		1703-1785	h/w only	83	1.37	0.30	0.158	After 1785
f161-1 s	LITU		1686-1767	C	82	1.91	0.98	0.132	Winter 1767/8
* **f161-1-a1** s	QUAL		1659-1747	4nm	89	1.88	0.74	0.158	After 1751
f161-1-a2 s	QUAL		-	½C	68	2.68	1.13	0.170	
f161-1-a3 s	LITU		-	h/w only	68	2.62	1.53	0.227	
f161-1-b1 s	QUAL		-	C	85	1.68	0.61	0.158	
f161-1-b17	QUAL		-	C	83	1.83	0.91	0.137	
f161-1-b18	QUAL		1618-1769	½C	152	0.94	0.50	0.197	Summer 1770
f161-1-b2 s	LITU		-	½C	69	2.19	0.58	0.183	
f161-1-c2 s	QUAL		-	C	71	2.49	0.60	0.179	
f161-20-b2	QUAL		-	½C	53	3.07	0.92	0.152	
f161-20-c2	QUAL		-	C	44	2.89	0.66	0.211	
f161-24 s	CADN		-	C	96	1.41	0.63	0.185	
f161-100a mc	LITU		-	h/w only	148	0.79	0.35	0.202	
f161-100b mc	LITU		-	5NM	143	0.87	0.42	0.212	
f161-123 s	CADN		-	½C	142	1.42	0.42	0.194	
f161-1919 s	QUAL		-	3NM	68	2.12	1.10	0.279	

Key: *, †, § = sample included in site-master; c = core; mc = micro-core; s = slice/section; g = graticule; p = photograph; ¼C, ½C, C = bark edge present, partial or complete ring: ¼C = spring (last partial ring not measured), ½C = summer/autumn (last partial ring not measured), or C = winter felling (ring measured); h/w only = heartwood only; nm = number of unmeasured rings; std devn = standard deviation; mean sens = mean sensitivity; QUAL = *Quercus Alba* (White oak) LITU = *Liriodendron tulipifera L.* (tulip poplar); PISP = *Pinus L.* (Southern yellow pine) QUPR = *Quercus prinus* (chestnut oak) CADN = *Castanea dentata (Marsh.) Borkh.* (chestnut)

Table 1: Summary of tree-ring dating

ROBINSON TERMINAL, ALEXANDRIA, VIRGINIA

Sample number & type		Species	Timber and position	Dates AD spanning	Last Ring	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges
Feature 162 - Grillage and disarticulated logs associated with 165										
f162-a1	s	LITU		-	h/w only	56	2.02	0.91	0.226	
f162-a2	s	LITU		1600-1735	C	136	1.77	0.67	0.171	Winter 1735/6
f162-a3	s	LITU		-	h/w only	141	1.55	0.78	0.199	
f162-a4	s	LITU		1630-1770	C	141	1.40	0.46	0.139	Winter 1770/1
f162-a6	s	LITU		-	5nm	63	2.31	0.92	0.247	
f162	m		Mean of **f162-a2** + **f162-a4**	1600-1770		171	1.70	0.64	0.141	
Feature 164 - Addition to Feature 161										
* **f164-1-a1**	s	QUAL		1678-1773	C	96	2.03	0.93	0.168	Winter 1773/4
f164-1-a2	s	QUAL		1674-1770	½C	97	2.15	0.90	0.168	Summer 1771
* **f164-1-b1**	s	QUAL		1691-1773	C	83	1.92	0.80	0.166	Winter 1773/4
f164-3	s	QUAL	Insufficient annual rings							
f164-4	s	QUAL		1671-1784	¼C	114	2.22	0.89	0.200	Spring 1785
* **f164-5**	s	QUAL		1711-1784	¼C	74	1.91	0.97	0.258	Spring 1785
* **f164-6**	s	QUAL		1672-1772	½C	101	1.93	0.60	0.189	Summer 1773
Feature 165 – Large Coffer east of Ship 2										
f165-3-b1	s	PISP	Insufficient annual rings							
f165-3-d1	s	QUAL		-	C	126	2.17	1.33	0.192	
f165-3-e1	s	LITU	To rotten to measure							
f165-5-c1	s	PISP		-	h/w only	107	2.21	0.68	0.214	After 1792

Key: *, †, § = sample included in site-master; c = core; mc = micro-core; s = slice/section; g = graticule; p = photograph; ¼C, ½C, C = bark edge present, partial or complete ring: ¼C = spring (last partial ring not measured), ½C = summer/autumn (last partial ring not measured), or C = winter felling (ring measured); h/w only = heartwood only; nm = number of unmeasured rings; std devn = standard deviation; mean sens = mean sensitivity; QUAL = *Quercus Alba* (White oak) LITU = *Liriodendron tulipifera L.* (tulip poplar); PISP = *Pinus L.* (Southern yellow pine) QUPR = *Quercus prinus* (chestnut oak) CADN= *Castanea dentata (Marsh.) Borkh.* (chestnut)

Table 1: Summary of tree-ring dating

ROBINSON TERMINAL, ALEXANDRIA, VIRGINIA

Sample number & type		Species	Timber and position	Dates AD spanning	Last Ring	No of rings	Mean width	Std devn	Mean sens	Felling seasons and dates/date ranges
Feature 168 – Partial Bulkhead on North End near Duke Street										
f168-1-a1	s	Unkn	To rotten to measure							
f168-1-b1	s	Unkn	Insufficient annual rings							
f168-1-b2	s	Unkn	Insufficient annual rings							
f168-1-c1	s	Unkn	Insufficient annual rings							
f168-2a1	s	QUAL		1632-1816	26NM	185	0.87	0.23	0.178	After 1842
f168-2-b1	s	QUAL	Insufficient annual rings							
f168-2-d1	s	LITU	Insufficient annual rings							
f168-7	s	PISP	Insufficient annual rings							
Feature F200 – Ship 1										
RT1	s	QUAL		-		85	1.32	0.37	0.178	
*** = RTVAx1 Site Master**				**1659-1784**		**126**	**2.13**	**0.59**	**0.154**	

Key: *, †, § = sample included in site-master; c = core; mc = micro-core; s = slice/section; g = graticule; p = photograph; ¼C, ½C, C = bark edge present, partial or complete ring: ¼C = spring (last partial ring not measured), ½C = summer/autumn (last partial ring not measured), or C = winter felling (ring measured); h/w only = heartwood only; nm = number of unmeasured rings; std devn = standard deviation; mean sens = mean sensitivity; QUAL = *Quercus Alba* (White oak) LITU = *Liriodendron tulipifera L.* (tulip poplar); PISP = *Pinus L.* (Southern yellow pine) QUPR = *Quercus prinus* (chestnut oak) CADN= *Castanea dentata (Marsh.) Borkh.* (chestnut)

Explanation of terms used in Table 1

The summary table gives most of the salient results of the dendrochronological process. For ease in quickly referring to various types of information, these have all been presented in Table 1. The information includes the following categories:

Sample number: Generally, each site is given a two or three letter identifying prefix code, after which each timber is given an individual number. If a timber is sampled twice, or if two timbers were noted at time of sampling as having clearly originated from the same tree, then they are given suffixes '**a**', '**b**', etc. Where a core sample has broken, with no clear overlap between segments, these are differentiated by a further suffix '**1**', '**2**', etc.

Type shows whether the sample was from a core 'c', or a section or slice from a timber's'. Sometimes photographs are used 'p', or timbers measured *in situ* with a graticule 'g'.

Species gives the four-letter species code used by the International Tree-Ring Data Bank, at NOAA. These are identified in the key at the bottom of the table.

Timber and position column details each timber sampled along with a location reference. This will usually refer to a bay or truss number, or relate to compass points or to a reference drawing.

Dates AD spanning gives the first and last measured ring dates of the sequence (if dated),

H/S bdry is the date of the heartwood/sapwood transition or boundary (if identifiable).

Sapwood complement gives the number of sapwood rings, if identifiable. The tree starts growing in the spring during which time the earlywood is produced, also known also as spring growth. This consists of between one and three decreasing spring vessels and is noted as *Spring* felling and is indicated by a ¼ C after the number of sapwood ring count. Sometimes this can be more accurately pin-pointed to very early spring when just a few spring vessels are visible. After the spring growing season, the latewood or summer growth commences, and is differentiated from the proceeding spring growth by the dense band of tissue. This summer growth continues until just before the leaves drop, in about October. Trees felled during this period are noted as *summer* felled (½ C), but it is difficult to be too precise, as the width of the latewood can be variable, and it can be difficult to distinguish whether a tree stopped growing in autumn or *winter*. When the summer growth band is clearly complete, then the tree would have been felled during the dormant winter period, as shown by a single C. Sometimes a sample will clearly have complete sapwood, but due either to slight abrasion at the point of coring, or extremely narrow growth rings, it is impossible to determine the season of felling.

Number of rings: The total number of measured rings included in the samples analysed.

Mean ring width: This, simply put, is the sum total of all the individual ring widths, divided by the number of rings, giving an average ring width for the series.

Mean sensitivity: A statistic measuring the mean percentage, or relative, change from each measured yearly ring value to the next; that is, the average relative difference from one ring width to the next, calculated by dividing the absolute value of the differences between each pair of measurements by the average of the paired measurements, then averaging the quotients for all pairs in the tree-ring series (Fritts 1976). Sensitivity is a dendrochronological term referring to the presence of ring-width variability in the radial direction within a tree which indicates the growth response of a particular tree is "sensitive" to variations in climate, as opposed to complacency.

Standard deviation: The mean scatter of a population of numbers from the population mean. The square root of the variance, which is itself the square of the mean scatter of a statistical population of numbers from the population mean. (Fritts 1976).

Felling seasons and dates/date ranges is probably the most important column of the summary table. Here the actual felling dates and seasons are given for each dated sample (if complete sapwood is present). Sometimes it will be noticed that often the precise felling dates will vary within several years of each other. Unless there is supporting archaeological evidence suggesting different phases, all this would indicate is either stockpiling of timber, or of trees which have been felled or died at varying times but not cut up until the commencement of the particular building operations in question. When presented with varying precise felling dates, one should always take the *latest* date for the structure under study, and it is likely that construction will have been completed for ordinary vernacular buildings within twelve or eighteen months from this latest felling date (Miles 1997).

Table 2a: Matrix of *t*-values and overlaps for the individual samples

Components of master **F162a2+4**

Sample: *Last ring date AD:*	**f162-a4** 1630-1770
f162-a2 1600-1735	4.48 106

Components of site master **RTVAx1**

	155-2-E1	155-4	155-6	160-6-F1	161-1-A1	164-1-A1	164-1-A2	164-1-B1	164-5	164-6
	1680-1764	1674-1772	1712-1771	1663-1771	1659-1747	1678-1773	1674-1770	1691-1773	1711-1784	1672-1772
155-2-D2R	3.91	4.44	3.73	6.02	5.73	5.84	5.5	6.11	3.63	6.19
1680-1771	85	92	60	92	68	92	91	81	61	92
155-2-E1		4.59	3.8	3.13	5.62	4.77	4.83	4.35	3.38	6
1680-1764		85	53	85	68	85	85	74	54	85
155-4			4.29	5.21	3.86	7.9	9.22	3.26	4.47	10.65
1674-1772			60	98	74	95	97	82	62	99
155-6				4.4	No Test	3.97	3.35	3.38	4.35	6.25
1712-1771				60		60	59	60	60	60
160-6-F1					6.33	5.95	4.79	4.72	1.94	5.99
1663-1771					85	94	97	81	61	100
161-1-A1						4.28	4.53	3.84	No Test	4.03
1659-1747						70	74	57		76
164-1-A1							8.04	6.13	3.61	9.42
1678-1773							93	83	63	95
164-1-A2								6.42	4.88	10.52
1674-1770								80	60	97
164-1-B1									3.92	5.82
1691-1773									63	82
164-5										5.19
1711-1784										62

Components of site master **RTVAx2**

Sample: Last ring Date AD:	F159-11	F159-2	F159-4	F159-7
F159-1	5.8 38	4.37 60	4.3 40	4.03 35
F159-11		3.33 36	3.61 38	No Test
F159-2			4.41 36	1.97 66
F159-4				No Test

Table 3: Dating of site master **RTVAx1** (1659-1784) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
	Maryland	Maryland Oak Master Chronology	Heikkenen Archive	**MDZ7**	1603-1988	126	8.76
¥	Maryland	Poplar Neck House, Caroline County	Worthington 2010	**POPMASTE**	1653-1830	126	8.46
	Maryland	Eastern Shore Master Chronology	Worthington 2011	**ESHORE1**	1592-1836	126	8.32
¥	Maryland	Linchester Mill, Preston	Worthington & Miles 2009/14	LMP	1592-1823	126	8.18
	Maryland	Main House Concord Plantation	Worthington & Seiter 2014/06	CDMDx1	1675-1788	110	7.80
®	Virginia	Rickneck Corn Crib	Heikkenen Archive	RCBC3	1687-1830	98	7.55
	Virginia	Piedmont Master Oak + Historical QUSP	Columbia unpublished	PIEDMO	1488-2001	126	7.41
®	Virginia	Rickneck Barn, Riverdale	Heikkenen Archive	rickcbar	1685-1830	100	7.40
	Virginia	Mt Vernon	Miles & Worthington 2006/20	MTVx6	1678-1758	81	7.29

Chronologies in **bold** denote regional masters

¥ = Component of **ESHORE1**
® = Possible component of **MDZ7**

Table 3: Dating of site master **f155-2** (1711-1784) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
®	Unknown	Unknown	Heikkenen Archive	hs wews3	1678-1806	74	5.53
	Maryland	The Wilderness, Trappe	Worthington and Seiter 2013/1	WILDx1	1693-1807	74	5.51
	Maryland	Wrights Chance Centreville	Worthington Forthcoming	WCMDx1	1696-1794	74	5.20
®	Virginia	Rick's Corn Crib	Heikkenen Archive	RCBC3	1687-1830	74	5.02
	Maryland	Barn at Best Farm, Monocacy National Battlefield	Worthington and Seiter 2011/4	MCYx5	1726-1892	59	5.05
	Maryland	Maryland Oak Master Chronology	Heikkenen Archive	**MDZ7**	1603-1988	74	4.92
	Maryland	Linchester Mill, Preston	Worthington & Miles 2009/14	LMP	1592-1823	74	4.80
®	Virginia	Rickneck Barn, Riverdale	Heikkenen	rickcbar	1685-1830	74	4.80
®	Maryland	Manor House St Francis Xavier	Heikkenen Archive	MHC5	1670-1824	74	4.73

Chronologies in **bold** denote regional masters

® = Possible component of **MDZ7**

Table 3: Dating of site master **f155-2-D1** (1648-1762) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
∞	Maryland	Rich Hill, Bel Alton	Worthington & Seiter 2015/19	RHMDx1	1578-1728	81	5.70
	Maryland	Sotterley Mansion, Hollywood	Miles and Worthington 2006/6	SOTx12	1601-1723	76	5.22
	Unknown State	Unknown Site	Heikkenen Archive	haas1	1654-1746	93	5.18
	Maryland	Charles Carrol House	Heikkenen Archive	WCCHHS3	1565-1748	101	4.90
	New Jersey	Holland Township Master Chronology	Worthington & Seiter 2016/13	**HOLL2016**	1550-1824	115	4.82
	Virginia	William Byrd III House, Williamsburg	Worthington & Seiter 2015/15	WBTVAx1	1637-1749	102	4.77
	Maryland	Cloverfields, Wye Mills _ Oak	Worthington & Seiter 2018/09	CFMDx1	1526-1728	81	4.77

Chronologies in **bold** denote regional masters

∞ = Possible component of **HOLL2016**

Table 3: Dating of site master **rtva1** (1727-1784) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
	Virginia	Gloucester Courthouse oak master	Miles & Worthington 2006/55	GLOx1	1702-1823	58	5.39
	Maryland	Compton Bassett Chapel, Upper Marlboro	Worthington & Seiter 2013/04	CBHMx1	1684-1787	58	5.14
	Virginia	South Garden House Mount Vernon	Worthington & Seiter 2017/10	SGHx1	1666-1784	58	5.01
	Virginia	Galt Cottage, Williamsburg	Worthington & Seiter 2017/09	GCVAx1	1653-1809	58	4.90
	Virginia	Historic Huntley, Alexandria	Worthington & Seiter 2017/04	HUVAx1	1723-1822	58	4.89
	New Jersey	Britton-Rapp Barn, Milford	Worthington & Seiter 2017/18	BRNJx1	1663-1831	58	4.74
	Maryland	Eyre Hall, Cheriton, VA	Miles & Worthington 2003/08	EYREHALL	1514-1806	58	4.77
	Pennsylvania	Rickett's Glen State Park	Cook E.R World Data Bank	PA010	1637-1981	58	4.60
	Pennsylvania	Davis Chambers House Mercersburg	Worthington & Seiter 2014/20	DCHPAx1	1721-1811	58	4.33

Table 3: Dating of site master **f161-a1y** (1703-1785) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
	Washington DC	Parcel L Wharf/Barry's Wharf	Worthington & Seiter 2017/04	yardAB	1703-1796	83	7.29
	Washington DC, Maryland and Virginia	DC Area Oak Master Chronology made from sites within a 100-mile radius of Washington DC	Worthington 2013	**DCAREA2**	1536-1892	83	6.84
	Maryland	Area Master Chronology	Heikkenen Archive	**MDZ8**	1603-1988	83	6.55
¥	Virginia	Old Town House, Newtown	Heikkenen Archive	OTHS3	1711-1806	75	6.32
	Pennsylvania	Stone House, Lancaster	Worthington Forthcoming	SHPAx2	1712-1807	74	6.11
§	Virginia	Rose Hill, Winchester	Worthington & Seiter 2012/2	RHVx1	1671-1828	83	5.91
¥	Delaware	Cubbage Mill	Heikkenen Archive	cum2s1	1677-1824	83	5.82
§	Maryland	Doughoregan Manor Maryland composite master	Worthington & Seiter 2011/06	DRNx	1536-1859	83	5.86

Chronologies in **bold** denote regional masters

§ = Component of **DCAREA2**
¥ = Possible component of **MDZ8**

Table 3: Dating of site master **f161-1** (1686-1767) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
β	Maryland	Tobacco Barn Concord Plantation	Worthington & Seiter 2014/06	CDMDx6	1699-1857	69	5.69
	Maryland	Old Mansion, Bowling Green	Miles & Worthington 2006/52	OMBx1	1570-1790	82	5.66
	Virginia	Piedmont Master Oak + Historical	Columbia unpublished	PIEDMO	1488-2001	82	5.63
#	Maryland	Concord Plantation	Worthington & Seiter 2014/06	**CONCORD1**	1699-1857	69	5.53
	Washington DC, Maryland, and Virginia	DC Area Oak Master Chronology made from sites within a 100-mile radius of Washington DC	Worthington 2010	**DCAREA**	1570-1883	82	5.45
	Maryland	Brome Barn Granary Shingles	Heikkenen Archive	BFS3	1627-1785	82	5.44
	Virginia	Riversdale / Long I	Heikkenen Archive	lghs5	1690-1801	78	5.24
	Maryland or Virginia	Riverdale Sharps VA - Period 2	Heikkenen Archive	rlhs3	1690-1832	78	5.22
	Maryland	Cloverfields Mansion	Worthington & Seiter 2018/09	WCMDx1	1696-1794	72	5.14

Chronologies in **bold** denote regional masters

β = Component of **CONCORD1**

Table 3: Dating of site master **f161-1-b18** (1618-1769) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
	Virginia	Brockenbrough-Peyton House, Port Royal	Miles & Worthington 2006/51	BPR	1481-1777	152	7.29
	Maryland	Maryland Master Chronology (Columbia University)	Columbia unpublished	MATHISTO	1540-1786	152	6.74
	Pennsylvania	Fort Loudon Pennsylvania	Cook and Callahan 1987	FTLOUD	1624-1786	146	6.71
	New York	Abraham Hasbrouck House, New Paltz	Cook, Krusic & Callahan 2002	npzny	1449-1806	152	6.24
	Virginia	Clifton House, Warrington	Worthington & Seiter 2017/08	CHVAx1	1623-1816	147	6.04
	New York	Mid-Hudson Valley Region Historical	Pederson *et al*	NY041	1449-1799	152	5.88
	Virginia	South West Virginia Master Chronology	Heikkenen Archive	swvz7	1652-1990	118	5.74
	Virginia	Old Mansion, Bowling Green	Miles & Worthington 2006/52	OMBx1	1570-1790	152	5.79
	Virginia	Hanover Tavern VA Oak	Columbia unpublished	WATCH	1595-1981	152	5.67

Table 3: Dating of site master **f162** (1600-1770) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	t-*value:*
Ω	Maryland	Doughoregan Manor Overseers House	Worthington & Seiter 2011/06	DRNx6	1626-1807	145	7.23
Ω	Maryland	Hess House, Keedysville, Washington County	Worthington & Seiter 2014/02	HESSx	1662-1776	109	7.13
	Pennsylvania	Fort Loudon	Cook and Callaham 1987	flpa	1629-1786	142	6.89
	New Jersey	Apgar Barn, Milford	Worthington & Seiter 2014/19	APGNJx1	1619-1808	152	6.72
Ω	Maryland	Joseph Fiery Home Place, Clear Springs	Worthington & Seiter 2014/01	FYMDx2	1591-1768	169	6.65
	Virginia	South West Virginia Master Chronology	Heikkenen Archive	swvz7	1652-1990	119	6.51
Ω	New Jersey	Joseph Fiery Home Place, Clear Springs	Worthington & Seiter 2014/01	FYMDx1	1591-1768	169	6.59
	Maryland	Central Maryland Master Chronology	Worthington 2014	**MARYLAND**	1536-1892	171	6.24
	Unknown	Unknown	Heikkenen Archive	haas1	1654-1746	93	6.07

Chronologies in **bold** denote regional masters

Ω = Component of **Maryland**

Table 3: Dating of site master **f164-1-a2** (1674-1770) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
	Virginia	Mt Vernon	Miles & Worthington 2006/20	MTVx4	1567-1777	97	8.13
®	Virginia	Stratford Hall	Heikkenen Archive	SBK6	1625-1795	97	6.76
	Maryland	Friendship House La Plata	Worthington & Seiter 2015/01	FDMDx1	1669-1831	97	6.39
®	Virginia	Rick's Corn Crib	Heikkenen Archive	RCBC3	1687-1830	84	6.21
®	Virginia	Rickneck Barn, Riverdale	Heikkenen Archive	rickcbar	1685-1830	86	5.71
	Maryland	Area Master Chronology	Heikkenen Archive	**MDZ7**	1603-1988	97	5.62
	Washington DC, Maryland, and Virginia	DC Area Oak Master Chronology made from sites within a 100-mile radius of Washington DC	Worthington 2010	**DCAREA**	1570-1883	97	5.52
	Virginia	Mt Vernon	Miles & Worthington 2006/20	MTXx6	1678-1758	81	5.53
ʕ	Maryland	Poplar Neck House, Caroline County Maryland	Worthington 2010	POPMASTE	1653-1830	97	5.50

Chronologies in **bold** denote regional masters
® = Possible component of **MDZ7**
ʕ = Component of **DCAREA**

Table 3: Dating of site master **f164-4** (1671-1784) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
	Virginia	Clifton House, Warrington	Worthington & Seiter 2017/08	CHVAx1	1623-1816	114	6.03
	Maryland	Area Master Chronology	Heikkenen Archive	**MDOAK**	1570-1981	114	5.92
µ	Virginia	Stratford Hall Stable II	Heikkenen Archive	SBS2	1625-1795	114	5.81
	Maryland	Mullberry Field	Heikkenen Archive	MULLx1	1590-1755	85	5.48
	Virginia	Bushy Park Gainesville	Worthington & Seiter 2016/01	BUSHx1	1590-1798	114	5.29
	Virginia	Old Mansion, Bowling Green	Miles & Worthington 2006/52	OMBx1	1570-1790	114	5.21
µ	Unknown	Unknown	Heikkenen Archive	gmcas1	1651-1787	114	5.02
µ	Unknown	Unknown	Heikkenen Archive	cbc2	1603-1805	114	5.02

Chronologies in **bold** denote regional masters
µ = Possible component of **MDOAK**

Table 3: Dating of site master **f168-2-a1** (1632-1816) against reference chronologies

	State or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	t-*value:*
	Maryland	Tobacco Barn Concord Plantation	Worthington & Seiter 2014/06	CDMDx6	1699-1857	118	5.96
	Maryland	Prescott Road Log Cabin	Miles & Worthington 2009/15	WCM	1731-1844	86	5.33
	Pennsylvania	Eastern Pennsylvania Master Chronology	Columbia unpublished	eapenn	1471-2003	185	5.31
	Maryland	Area Master Chronology	Heikkenen Archive	**MDOAK**	1570-1981	185	5.23
	Virginia	Mt Vernon	Miles & Worthington 2006/20	mtvx6	1678-1758	81	5.21
µ	Maryland	Coe Barn, Anne Arundel	Heikkenen Archive	coebarn	1603-1805	174	5.16
µ	Virginia	Long Hook, Riverdale	Heikkenen Archive	LGS7	1734-1835	83	5.08
µ	Virginia	Long Hook, Riverdale Phase 2	Heikkenen Archive	LK1S4	1680-1758	79	5.07

Chronologies in **bold** denote regional masters

µ = Possible component of **MDOAK**

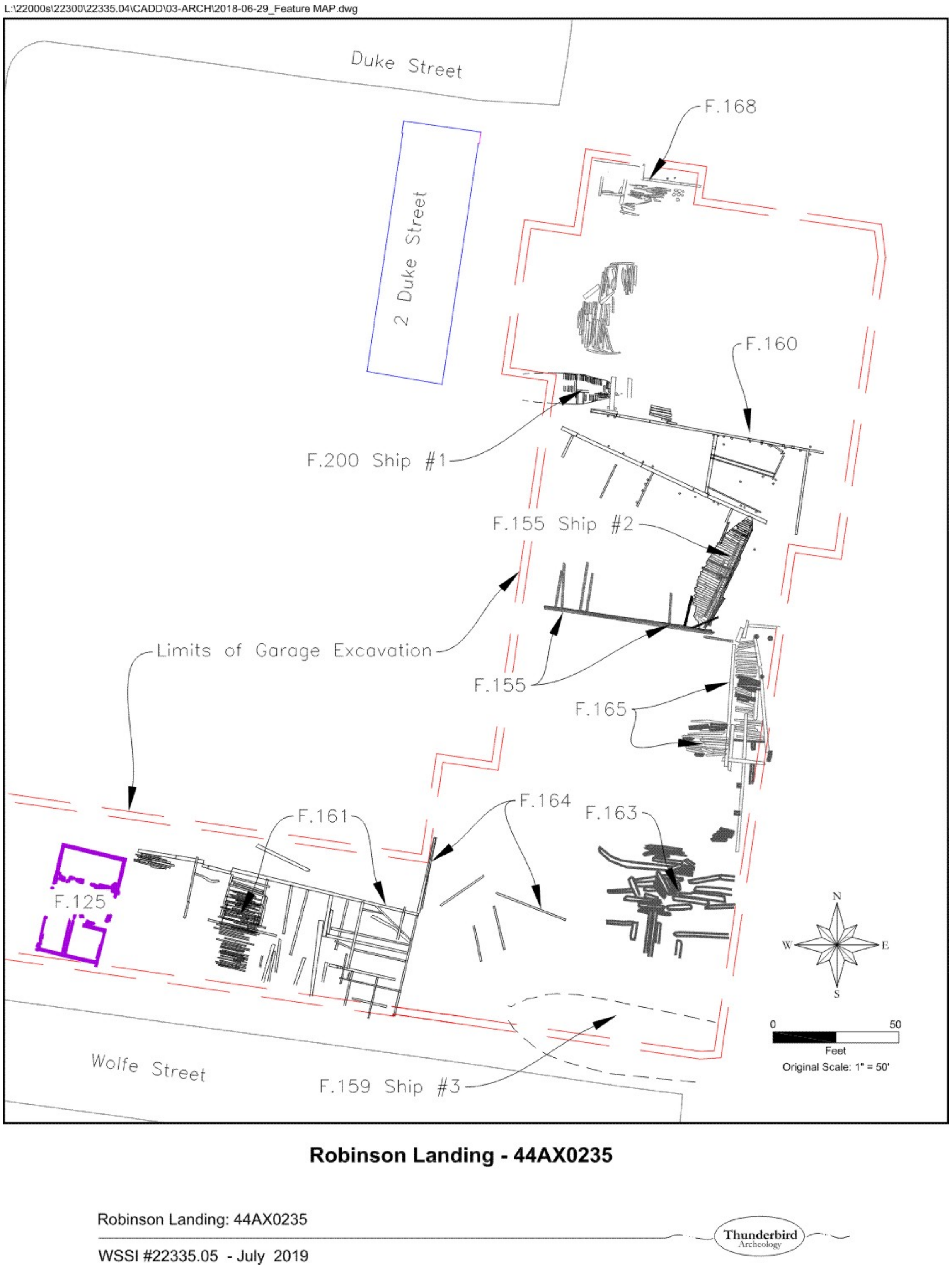

Figure 2. Overview of Robinson Landing John Mullen Thunderbird Archeology.

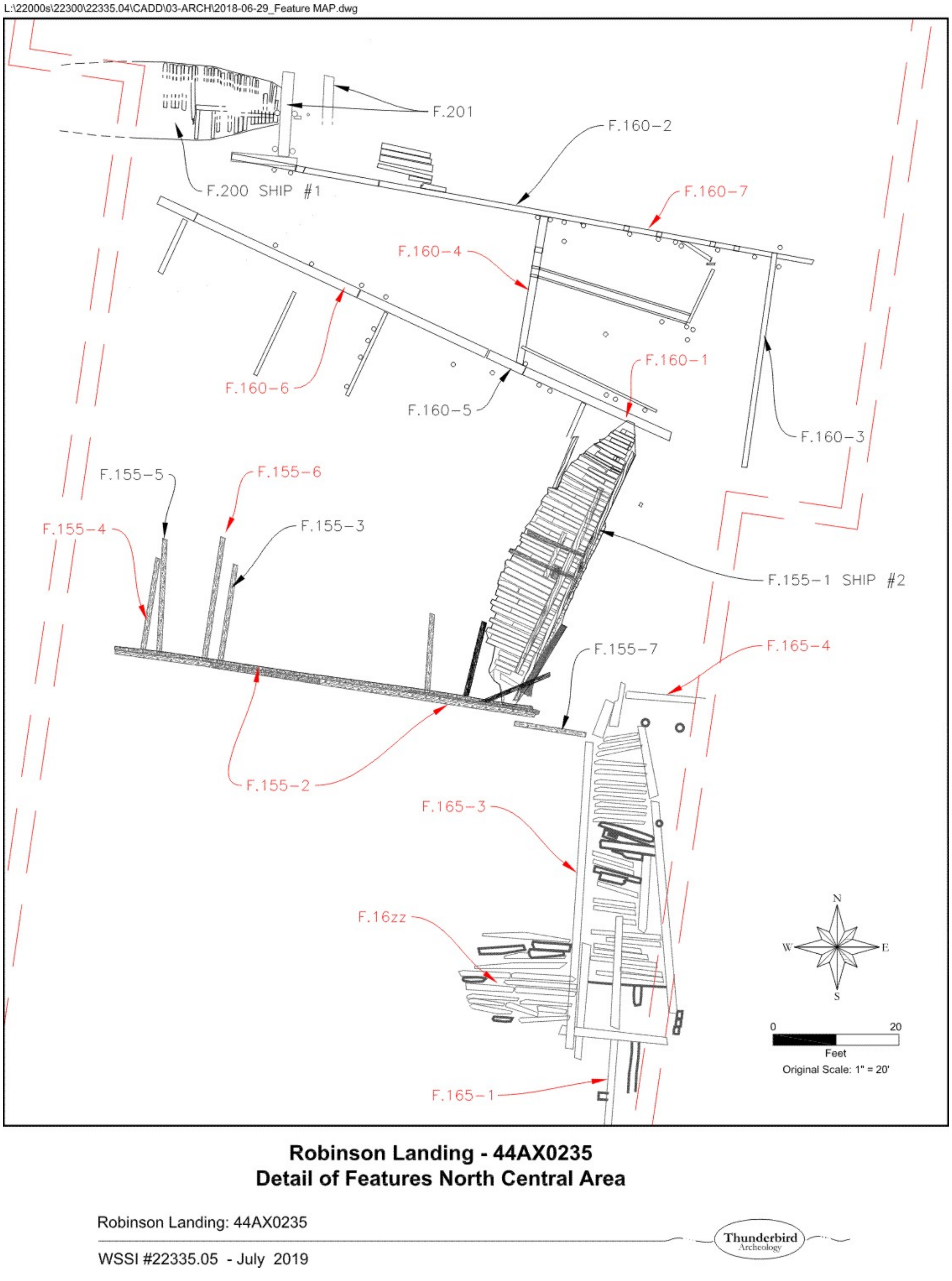

Figure 3. Features in north central area of Robinson Landing John Mullen Thunderbird Archeology.

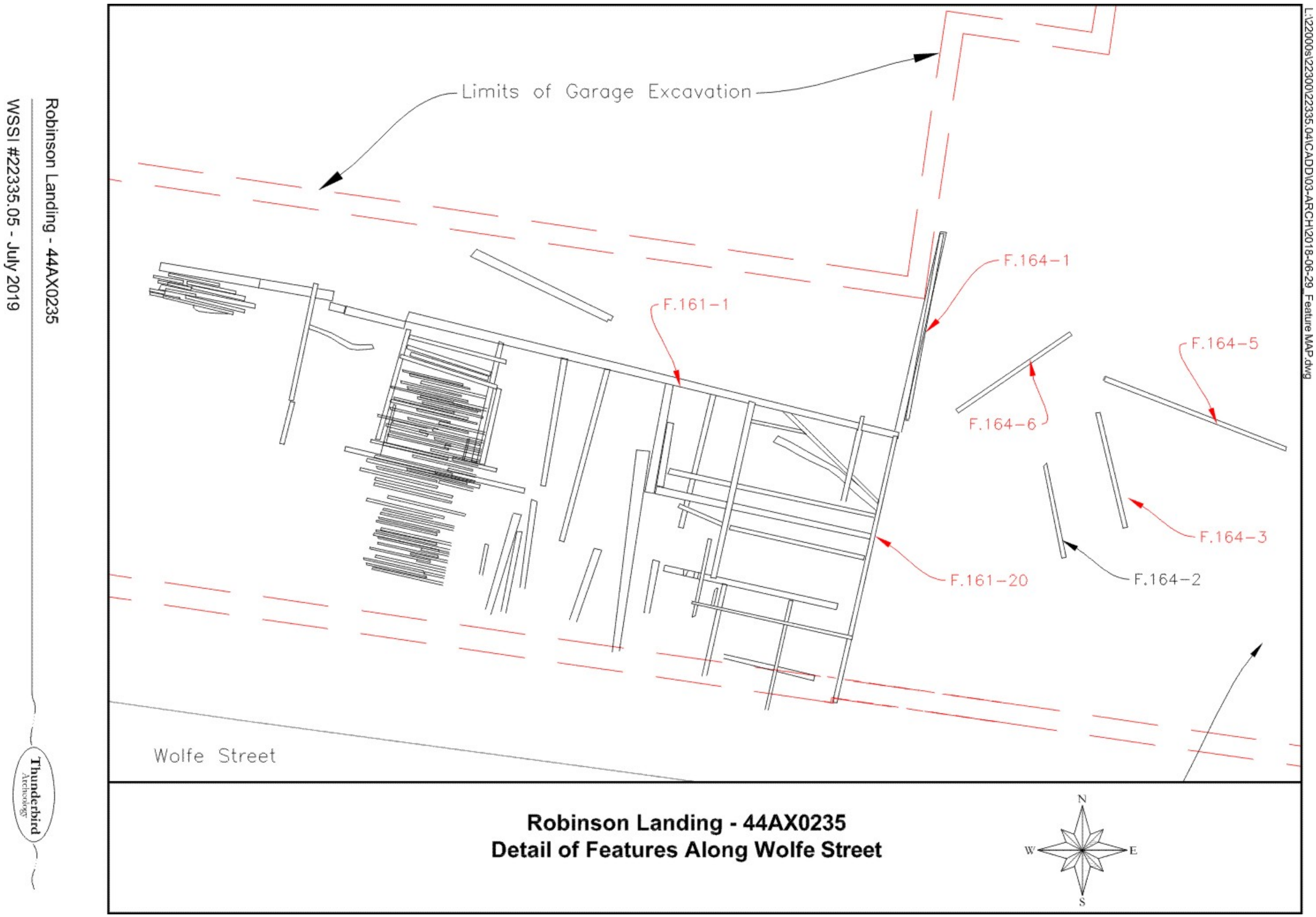

Figure 4. Features in north central area of Robinson Landing by John Mullen of Thunderbird Archeology.

Figure 5. Photograph showing location of samples from ship 3 Feature 159 John Mullen Thunderbird Archeology.

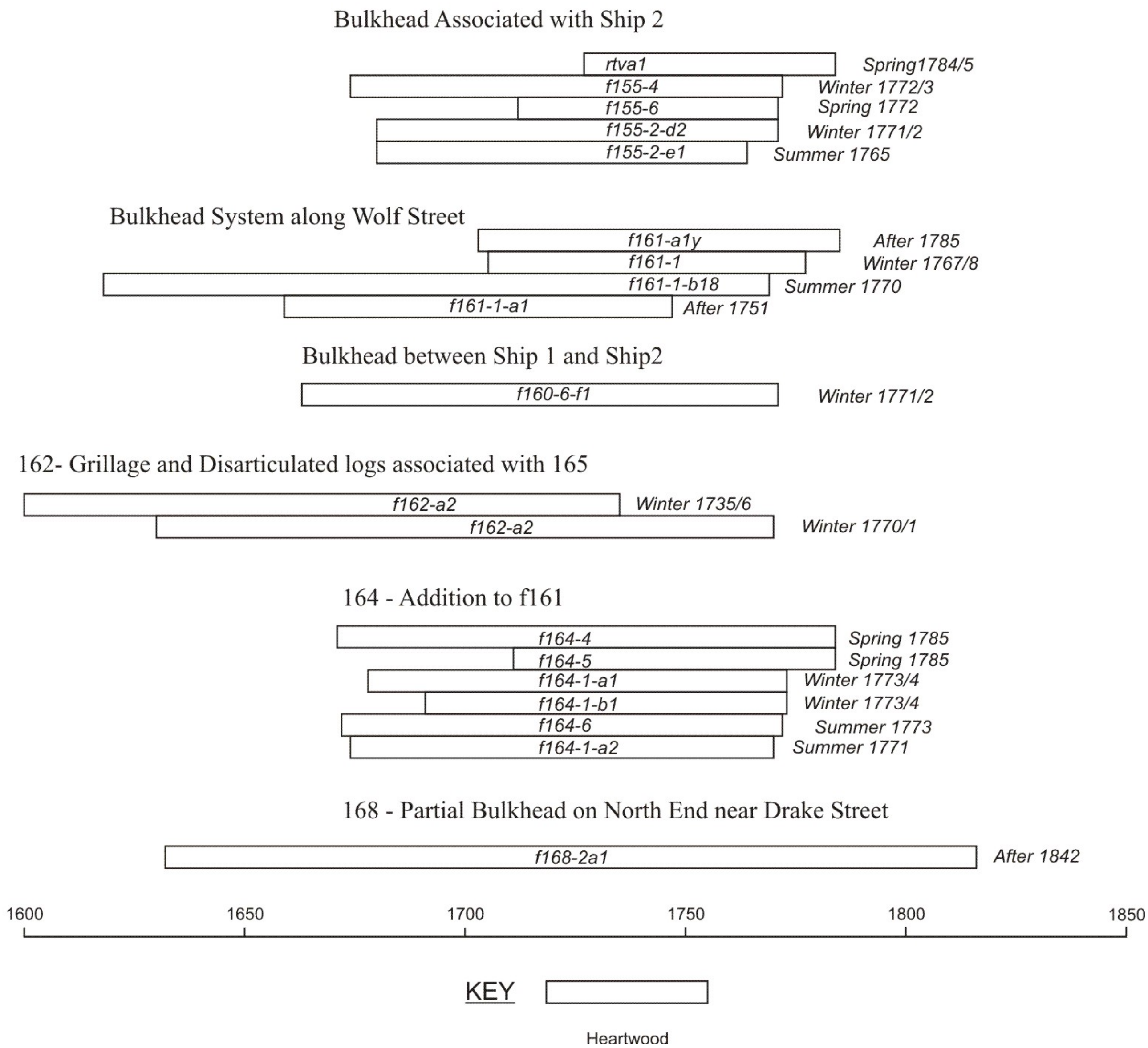

Figure 6. Bar diagram showing dated timbers in chronological order.