KIRSTEN MOFFITT

PAINT ANALYSIS REPORT

‘DUDLEY DIGGES HOUSE’
524 PRINCE GEORGE STREET
WILLIAMSBURG, VIRGINIA

November 19, 2017

Requested by:

Susan Kern
Executive Director, Historic Campus
College of William and Mary
P.O. Box 8795
Williamsburg, VA 23187
757.221.1540
sakern@wm.edu

Prepared by:

Kirsten Moffitt
Conservator and Paint Analyst
[redacted]
kirstenetravers@gmail.com

TABLE OF CONTENTS

'Dudley Digges House' 524 Prince George St, Williamsburg, VA 23187
[photo: Moffitt, October 2017]

Purpose:

The goal of this project was to use cross-section microscopy techniques to explore the structural and decorative history of original elements in the Dudley Digges House to complement the evidence collected for the Historic Structures Report (HSR) prepared in 2005.

Historical Background[1]:

The building on Prince George street known as the Dudley Digges house was originally located on the southeast corner of Prince George and North Boundary streets. Although the exact date of construction is unknown, physical and documentary evidence suggest it may date to the third quarter of the 18th century. Originally, the house was three bays wide with a center passage, having a gable roof with chimneys at each end, and two additional rooms in the attic story. In the early 19th century it was remodeled with mantels and in the north and south rooms, window sash replaced. Major renovations were carried out in the early 20th century, and much of the current woodwork dates to this period. In 1930, it was purchased by the College of William and Mary and moved to its present site.

The HSR lists the following inventory of early materials (p: 29):

Period I Woodwork (mid-late 18th c.)

- much of the staircase, including its substructure, several newels, three shorter handrails...the stringers and fascia

[1] Ackerman, D. 2005. "Historic Structure Report for the Prince George Street House, also known as Brown Hall and the Dudley Digges House, The College of William and Mary, Virginia". Unpublished report prepared for the College of William and Mary.

- upper sash in north [west*] window in the first-floor north room
- a small four-panel door with H-L hinges in the first-floor west passage
- some portions of baseboards in the center passage and possibly the south room

Period II Woodwork (c. 1805-1815)

- mantels in first-floor north and south rooms
- window framing in first-floor north and south rooms (not sills)
- nine-by-nine upper sash windows in the first-floor north and south rooms, south [east*] wall

*Ackerman's orientations differ from the 2017 orientations [in brackets], because the house is not clearly aligned on a northern axis

Analytical Procedures:

Sample Collection:
Twenty-one samples were collected on-site by Kirsten Moffitt accompanied by Ed Chappell, the retired Shirley and Richard Roberts Director of the Department of Architectural and Archaeological Research at the Colonial Williamsburg Foundation. Chappell previously investigated the house in 2004 and 2005 and this work contributed to the HSR. Also on-site was Susan Kern, Executive Director of the Historic Campus at the College of William and Mary, and Ashley Losco, Chappell's relation and a preservation student at the University of Pennsylvania.

Before sampling, potential sample locations were reviewed on-site with Moffitt, Chappell, and Kern. Areas with significant paint accumulations were examined closely with a hand-held illuminated loupe, and small micro-excavations were made in inconspicuous areas throughout the room to to determine which areas had the best-preserved paint evidence. Samples were removed with a microscalpel and stored in individual ziploc baggies labeled with sample location information. Sample locations were photographed for future reference. Detailed sample information was recorded by Chappell. The sample memorandum is attached as Appendix A. Sample location photographs are found throughout this report.

Sample Preparation:
In the laboratory, the fragments were examined at 10x-50x magnification to obtain a general idea of the finish history. Smaller fragments with the best evidence were cast in mini-cubes of Extec Polyester Clear Resin (methyl methacrylate monomer), and polymerized with the recommended amount of methyl ethyl ketone peroxide catalyst. The resin was allowed to cure for 24 hours under ambient light. After cure, the individual cubes were removed from the casting tray and sanded down using a rotary sander with grits ranging from 200 – 600 to expose the cross-section surface. The samples were then dry polished with silica-embedded Micro-mesh Inc. cloths with grits ranging from 1500 to 12,000, lending the final cross-section surface a glassy-smooth finish.

Microscopy and Documentation:
The cross-section samples were examined using a Nikon Eclipse 80i microscope equipped with an Nikon High Intensity light source (Hg100W). Samples were examined and photographed under visible and ultraviolet light conditions (excitation (EX) 330-380 nm, barrier (BA)filter 420nm), at 100- 400x magnifications. Digital images were captured using a Spotflex digital camera with Spot software. The following illustrated report was prepared with Adobe InDesign CS5.

Pigment Identification with Polarized Light Microscopy (PLM):
To collect a pigment sample for polarized light microscopy (PLM), a surgical scalpel was used to collect a small scraping from a clean, representative area of paint in an unmounted sample. The tip of the blade (on which the pigment grains were collected) was then pressed and pulled across a clean glass microscope slide, dispersing the pigment particles across the surface. The pigments were then permanently embedded under a cover slip using Cargille Meltmount (refractive index (RI) 1.66). The embedded pigments were then examined in cross and plane-polarized transmitted light with a Nikon Eclipse 80i microscope from 200-400x magnification. The observed morphologies (size, shape, agglomeration, cleavage patterns), and optical properties (including color, refractive index, extinction), were compared to reference standards as well as literature sources before making final determinations. Digital images were captured using a Spot-flex digital camera with Spot software.

Scanning Electron Microscopy - Energy Dispersive Spectroscopy (SEM-EDS):
Special permission was obtained to analyze samples with SEM-EDS at the Materials Analysis Laboratory at the Colonial Williamsburg Foundation's Conservation Department. Analysis was conducted by Kirsten Moffitt, Conservator and Materials Analyst. Mounted paint cross-sections (samples DD1 and DD17) were analyzed with a Nanoscience Phenom Pro-X desktop scanning electron microscope (SEM) equipped with a backscatter detector (BSE) for characterization of materials based on their atomic number (higher atomic number elements, like lead, being white and lower atomic number elements like iron or calcium, and organic coatings like varnishes and oils, being gray), and an energy dispersive spectrometer (EDS) for elemental identification in point mode at 15kV accelerating voltage and 30 second scan.

Presentation of Results:

The samples contained excellent evidence to better understand early interior finishes at the Digges House. In this report, the results are presented in sections according to the rooms which contained early woodwork, starting with the passage, and followed by the re-used door leaf, the north first-floor room, the south first-floor room, and the attic.

Each section includes a written description of the results, in particular the original finish, if it could be identified. All relevant samples from each section are included. Photomicrographs of paint stratigraphies have been annotated according to finish generation. For instance, a primer, paint layer, and varnish may represent one finish generation and are all given the same number, but differentiated with lowercase letters (1a, 1b, 1c, etc...).

Please note that the colors observed in the photomicrographs are not accurate to the actual colors. Due to the intensity of illumination at these high magnifications, they can appear much lighter and more intensely pigmented than in reality.

Summary of Results:

Comparison of the paint cross-sections demonstrates that there is a clear chronology of woodwork throughout the house reflecting periods of change over time. In some cases, this conforms to what was suggested by the HSR, but other findings tell a different story that does not align with the previously designated periods. In addition, the presence of particular pigments provided certain benchmark dates for paints that proved to be much later than what was previously suggested.

The earliest finishes may not survive. One of the earliest elements in the house - the tall newel post in the

stair passage - contains what appear to be remnants of resinous or oil-based coatings deeply embedded in the wood cells (p. 14). In this sample, the surface of the wood is soiled and grimy - this before the earliest paint layer was applied. However, these resinous or oil-based coatings followed by grime were not found in all samples, and, where present, they are fragmentary at best. Yet, since the woodwork is believed to be 18th century, but the first finish layer contains 19th century pigments (discussion below), one explanation for this condition is that earlier clear coatings that were originally used to treat the wood surfaces have worn away. The author has noted through experience that some clear woodwork coatings, such as waxes, are extremely thin and almost impossible to identify under the microscope.

Generation 1

The paint cross-sections suggest that the earliest elements in the house are:

- **the tall stair newel (DD 17)**
- **the small four-paneled door re-used as wainscot in the first-floor lobby (DD 1 & 2)**
- **north first-floor room: the east and west window architraves (DD 8, DD 4), and the top sash of the east window (DD 7)**
- **south first-floor room: the east window architrave (DD 15) and top sash (DD 16)**

The results suggest that the woodwork in the house was not all painted the same color throughout. In the first generation, a gray primer (1a) and green paint (1b) was found on the stair newel, the re-used door leaf, and the east and west window architraves in the north room (see comparison, next page). This paint contains large, coarsely ground pigment particles which suggests it was hand-ground, and therefore, early. However, PLM and SEM-EDS analysis determined that this green paint contains chrome yellow pigment, which was not introduced until the early 19th century (c.1814 is the earliest known advertisement for this pigment). Perhaps more importantly, small amounts of zinc were also detected in this paint. While some cross-contamination between layers can sometimes occur from the polishing process, this element was identfied in two separate samples (pp. 47, 48). The presence of a zinc-based pigment pushes the date of this layer to c.1845, when zinc white was introduced to housepaint formulations.

In the south first-floor room, the east window architrave was primed white (1a) and painted with a blue paint (1b). This blue paint was not found elsewhere in the house. In this same period, the top sash of the east windows in the two early rooms were both painted white or off-white. These paints also appear hand-ground and early. They were not instrumentally analyzed, but their pale orange autofluorescence in UV suggests they are lead-based paints. Since lead white pigment has been in use since antiquity, this does not provide any useful dating information.

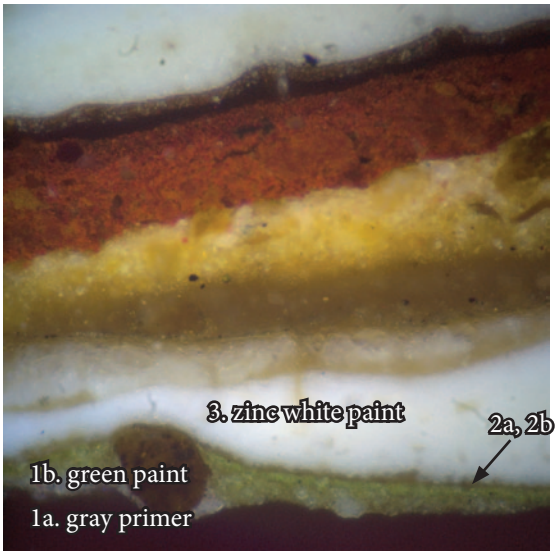
Generation 2

In generation two, most of the surfaces that were painted green were re-painted with another, thinner layer of green paint (2a) and a thin oil-based varnish (2b). This appears to have been a similar or the same color as the previous green, and was found in most, but not all, samples with the first generation green paint. This could represent a 'touch up' period, perhaps even using the same paint.

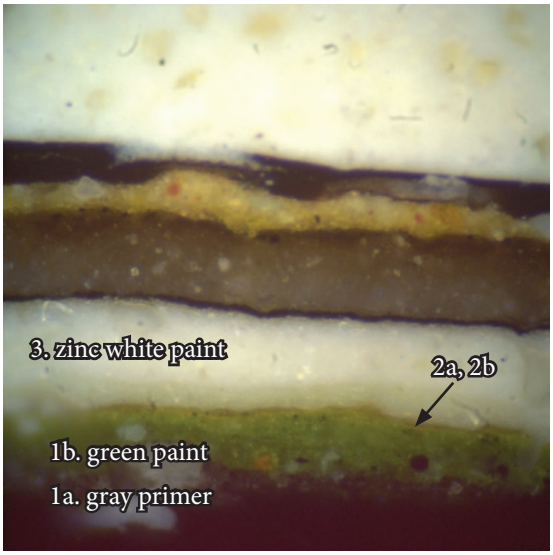
In the south room, the east window architrave and top sash was painted white/cream. In the north room, the east window top sash was also painted white/cream. These appear to be lead white, oil-based paints.

Comparison of select early woodwork:

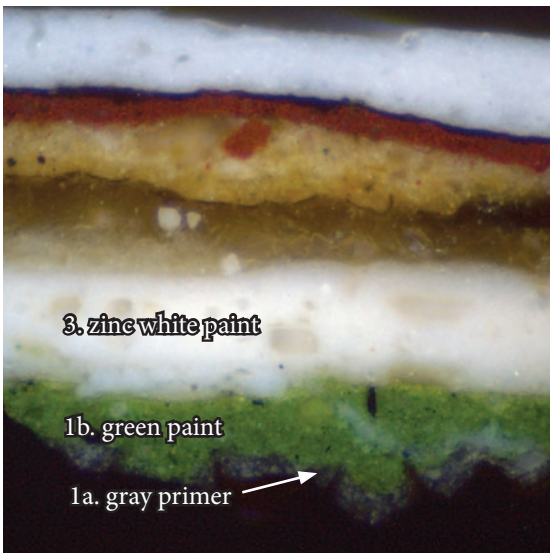
Stair Newel (DD 17), 200x



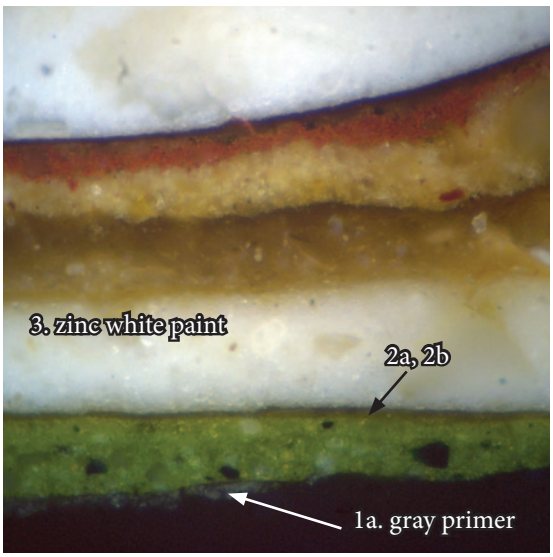
Door leaf (DD 1), 200x



North room, East window architrave (DD 8), 200x



North room, West window architrave (DD 8), 200x



Generation 3

The paint cross-sections suggest that the following elements were installed in this period:

- **Stair balusters (DD 19)**
- **Stair stringer (DD 18)**

In this period, a white paint was used throughout the house. This paint contains zinc, which dates this paint to c.1845 or later. Further analysis with SEM-EDS suggests the presence of a zinc-based pigment

called lithopone, which was patented in 1874. The presence of lithopone pushes the date of this layer up to almost the last quarter of the 19th century. This white paint was the earliest coating on the stair balusters and stringer.

Generation 4

The fourth paint generation is a translucent grayish layer that was used throughout the house.

Generation 5

The paint cross-sections suggest that the following elements were installed in this period:

- **The top and bottom sash of the west window in the north room (DD 5 and 6)**

Generation five appears to be a wood-graining finish with a peach-colored base coat (5a) and a deep red-brown figuring layer (5b). The thickness of the graining layer suggests this was a 'painterly' style of graining made through an additive process, thickly painting the graining on, rather than the more traditional subtractive process where a thin glaze layer is applied to a brightly-colored base coat and the figuring is created by running a tool such as a comb or brush through the glaze to reveal the base coat underneath.

Generations 6 - present

The rest of the paint history in the house, where applicable, is discussed throughout this report and described in tables in each section.

Mantels

The mantels were more difficult to align with the rest of the house, as they appear to have been finished differently from the rest of the woodwork in their rooms, complicating the comparison.

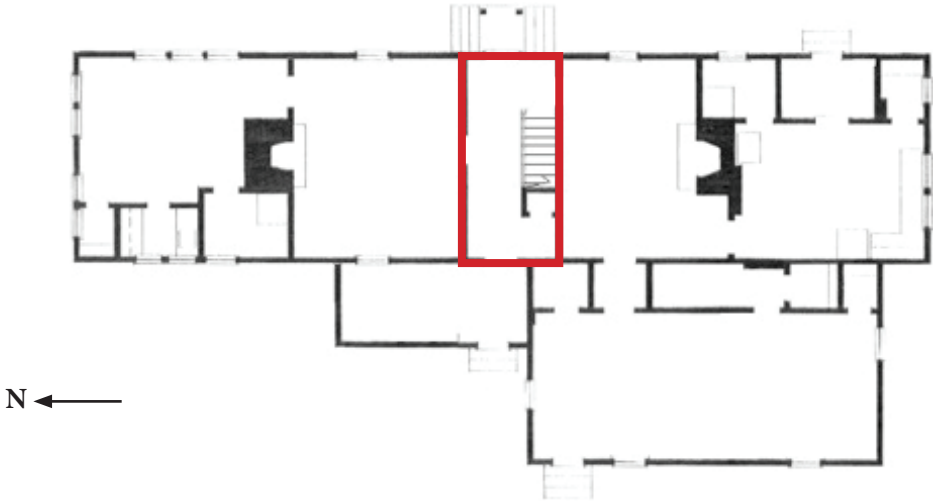
In the north-first floor room, the mantel had far fewer paint layers when compared to the rest of the woodwork in the room. The earliest paint on this mantel was a tannish paint that was coarsely ground, but the alignment strongly suggests that this paint dates to generation eight. However, this paint could have been applied earlier and left unpainted for some time (although this seems unlikely, since there is no dirt or grime on its surface). The analysis could not clearly assign a generation to this particular paint layer.

In the south first-floor room, the mantel did contain a number of early paint layers (which were very different from those found on the mantel in the north room), but unfortunately none of these aligned with the rest of the room until generation five - when the mantel was grained to imitate wood.

Attic

The coating on the attic boards does not appear to be limewash. However, this coating appears to contain lime and a great deal of coarse aggregate, possibly a masonry material. The reason for the presence of this coating on the attic boards is unclear. Chappell suggests that they could be pieces of recycled scaffolding from a work site.

Passage



Digges House, first floor plan (2005)
The passage is in red.

Sample	Description	Results
DD 17	Tall second post, east (front) face at the outer corner, 3'6" above the lower floor	pp. 13-14
DD 18	Stringer cap, long first run, north face 4'2" above the floor	p. 16
DD 19	Nineteenth baluster, south face, immediately below the handrail	p. 15
DD 20	Third section of handrail, north fascia just below torus, where it meets the 4th post	p. 17

History/Observations:

The HSR reports that much of the closeed-string staircase is Period I, including the lowest four newels, three shorter handrails, and portions of the stringer and fascia. *In-situ* examination found these elements retained very thick accumulations of paint on their surfaces. The square balusters appeared to be 19th-century, but samples were taken for comparison to the rest of the stair. The handrail does not retain multiple layers of paint and appears to have been stripped. Regardless, samples were taken from the handrail in the hopes of finding early evidence trapped in the wood cells.

Discussion of Results:

Four samples were collected from the stair passage. The tall second post (DD 17) contains the most intact paint history, dating back to what is believed to be generation 1. This sample contained important information: beneath the extant paints, the surface of the wood in this sample is grimy, and there appears to be some resinous (varnish) material deeply embedded in the wood cells (visible in reflected UV light). These conditions were not observed in any other samples, but it suggests that the stair might have originally been finished with a clear coating (possibly a wax, varnish, and/or oil), which was exposed for a certain period of time before being painted.

On the tall post, the first paint finish is a thin gray primer (1a) and a coarsely ground green paint. This

finish was found on several early elements throughout the house (re-used door leaf, north room east and west window architraves). PLM and SEM-EDS determined that this green paint contains chrome yellow pigment, dating this paint to the early 19th century. In generation two, this green paint was re-applied (2a), and followed by what appears to be a thin layer of varnish (2b). This varnish is dim in UV, suggesting it is an oil-based varnish. This layer is not always visible in all samples.

In generation three, the entire stair was painted white with a zinc-based paint, dating this layer to c.1845 or later. Further analysis with SEM-EDS suggests that this paint could contain the zinc-based pigment lithophone, which was introduced in 1874. This is the earliest finish on the balusters and the stringer cap. It should be noted that multiple micr-excavations were made on the stringer before sampling. No evidence of the early greens on the post were found. Each area excavated appeared to contain the same paint history.

The handrail has been stripped of its earliest finishes and contains modern paints only.

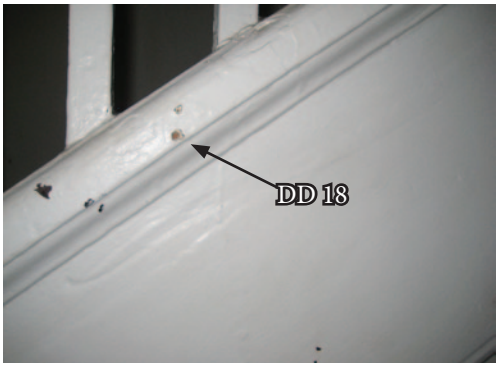
The complete paint history of the stair passage is summarized in Table 1 (next page).

Table 1. Stair Passage Comparative Paint History

Generations	Tall newel post (DD 17)	Stringer cap (18)	Baluster (DD 19)	Handrail (20)
25	*although not pictured in this report, the rest of the paint history of this post aligns with the rest of the house (modern whites, creams, pale yellows, some dark browns)*	current white paint	current white paint	current white paint
24		white paint	white paint	*unpainted*
23		white paint	white paint	*unpainted*
22		dark brown paint	dark brown paint	dark brown paint
21		dark brown paint	dark brown paint	dark brown paint
20		white paint	white paint	x
19		*these layers are not shown in the report, because they cleaved from the sample, but they align with the rest of the house (whites, creams, pale yellows)*	yellow paint	x
18			*these layers are not shown in the report, because they cleaved from the sample, but they align with the rest of the house (whites, creams, pale yellows)*	x
17				x
15				x
15				x
14				x
13				x
12				x
11				x
10				x
9	white paint (appears late 19th or 20th c.)	white paint (appears late 19th or 20th c.)	white paint (appears late 19th or 20th c.)	x
8	two layers dark oil varnish	two layers dark oil varnish	two layers dark oil varnish	x
7	brick red paint	brick red paint	brick red paint	x
6	*unpainted*	brown paint (6a), brick red paint (6b)	brown paint (6a), brick red paint (6b)	x
5	wood graining finish with deep yellow base coat and red graining layer	wood graining finish with deep yellow base coat and red graining layer	wood graining finish with deep yellow base coat and red graining layer	x
4	translucent, gray paint	translucent, gray paint	translucent, gray paint	x
3	white paint (contains zinc - post c.1845)	white paint (contains zinc - post c.1845)	white paint (contains zinc - post c.1845)	x
2	green paint (2a), thin oil varnish (2b)	x	x	x
1	gray primer (1a), green paint (!b)	x	x	x
wood	soiling on wood surface and remnants of resins/oils suggests earlier, worn coating	x	x	x

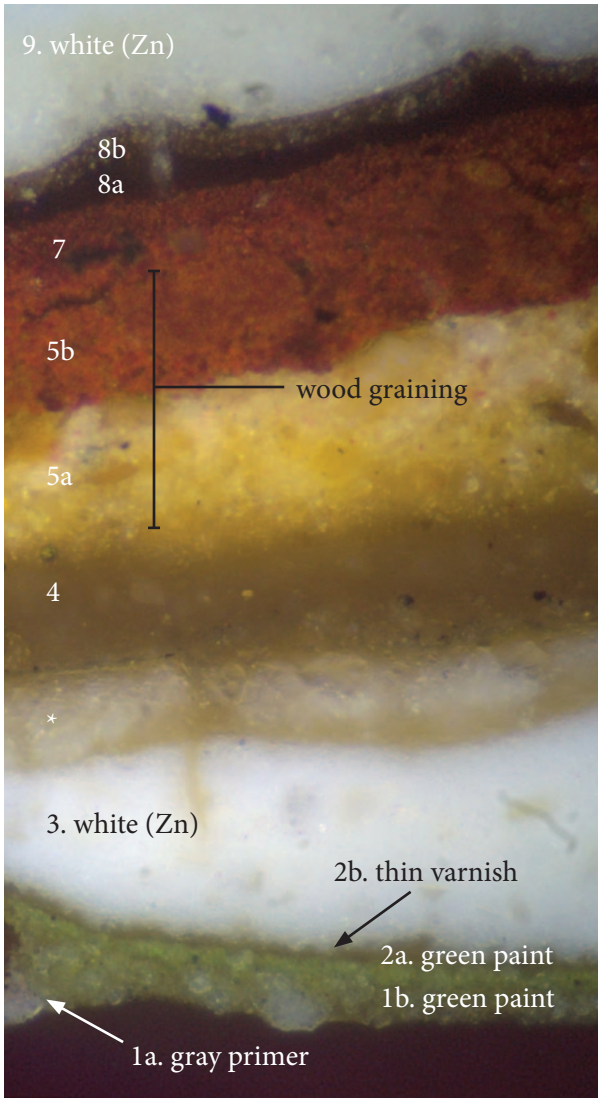
Passage - Sample Location images

stair passage

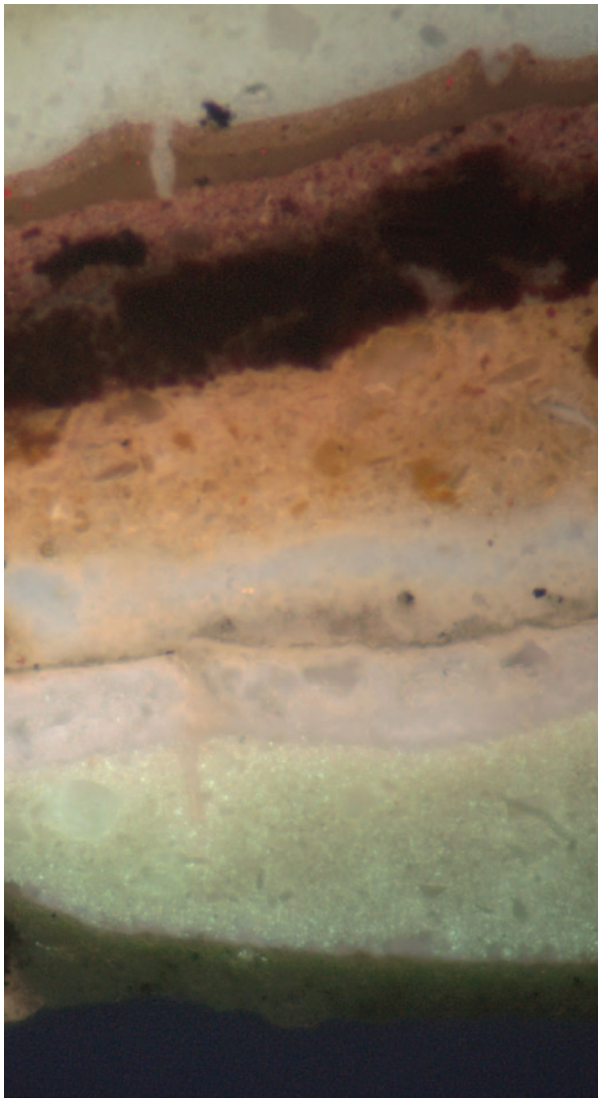


Cross-section Microscopy Results

Sample DD 17: tall second post, east (front) face at the outer corner, 3'6" above the lower floor



DD 17 (2), visible light, 400x



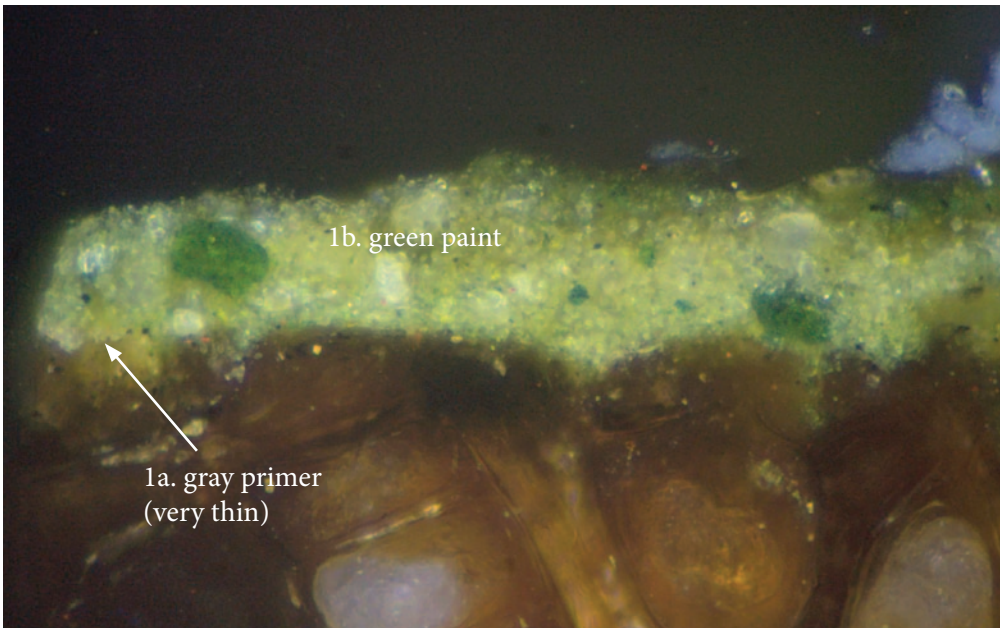
DD 17 (2), UV light, 400x

This sample from the stair newel post aligns with the earliest paint layers in the house. The earliest layers are shown in detail here, including the first generation gray primer (1a) and green paint (1b). The second generation green paint (2a) and varnish (2b) follow, although they are not as obvious here as they are in other samples. Generation three is a zinc-based paint, which SEM-EDS found to contain lithopone, which could date this layer to the late 19th c. The following tannish, translucent layer (*) was present only in this sample and not elsewhere, so it was not annotated. Generations 5-8 are imitation wood graining and/or dark brownish layers.

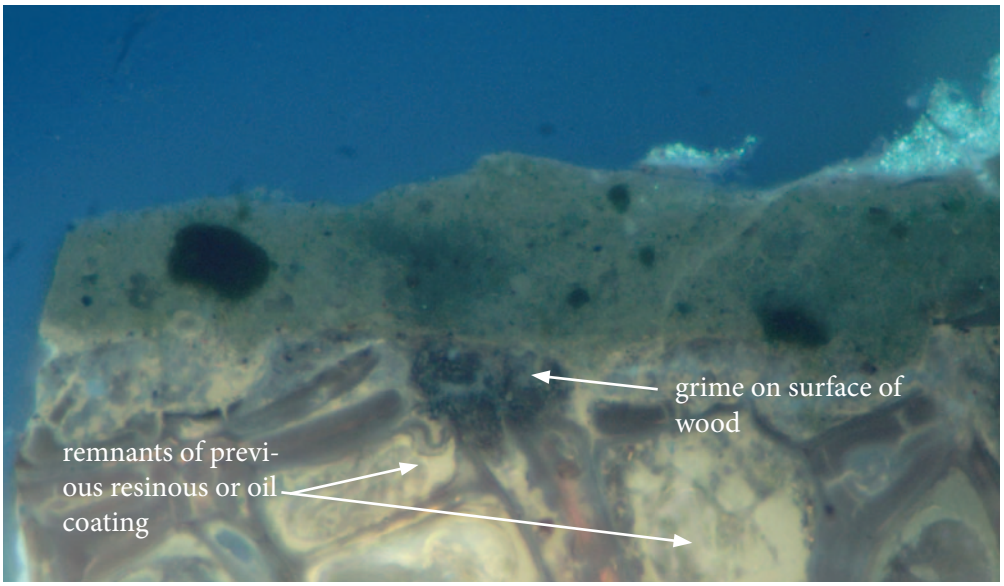
See next page for additional discussion.

Cross-section Microscopy Results

Sample DD 17: Continued from previous page



DD 17 (3), visible light, 400x

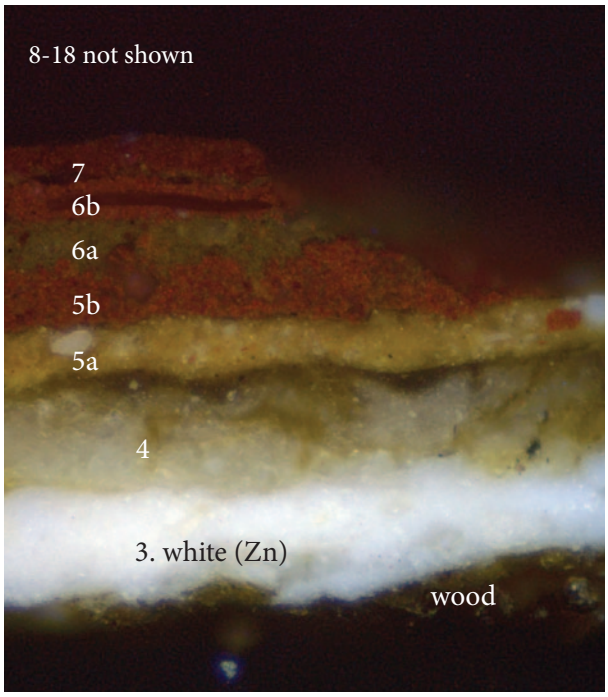


DD 17 (3), UV light, 400x

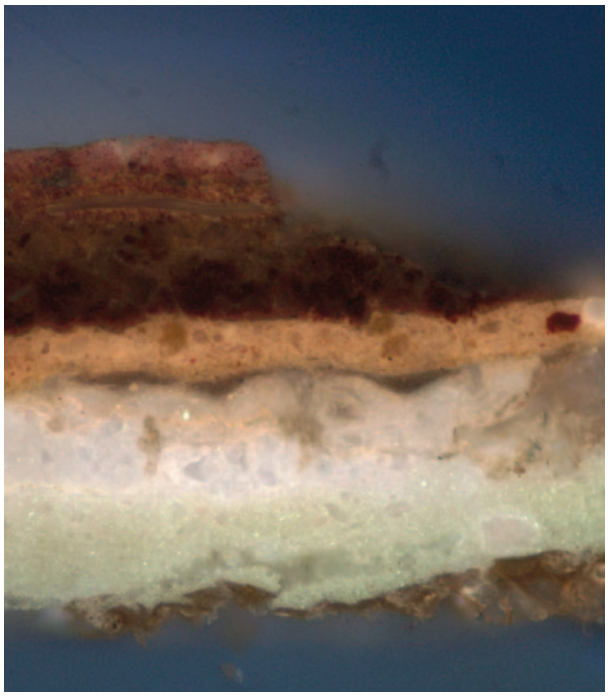
This fragment from sample DD17 is significant in that it shows what appears to be remnants of an earlier reinsous or oil-based finish embedded into the wood cells, covered with a layer of grime. This suggests than an earlier clear coating (which could include an oil, resin (varnish), or wax (which is notoriuously difficult to identify in a thin layer on wood in cross-section)), was applied to the wood and allowed to wear and become soiled before being painted over with the first generation green paint.

Cross-section Microscopy Results

Sample DD 19: Nineteenth baluster, south face, immediately below the handrail



DD 19a (bottom, 200x), 19c (top, 200x), visible light

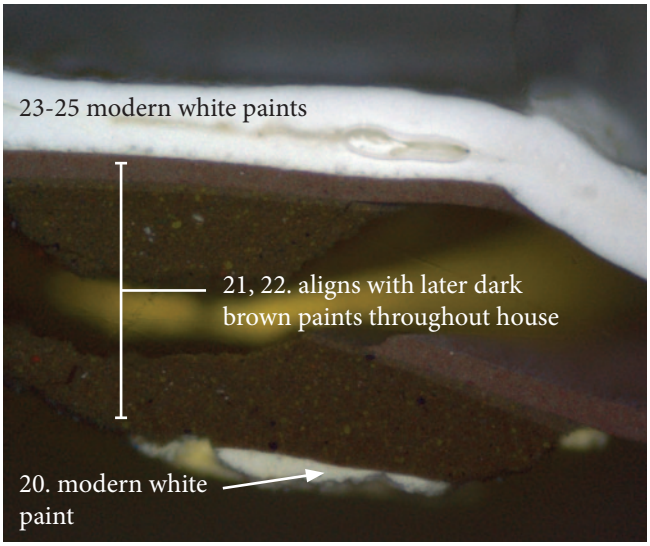


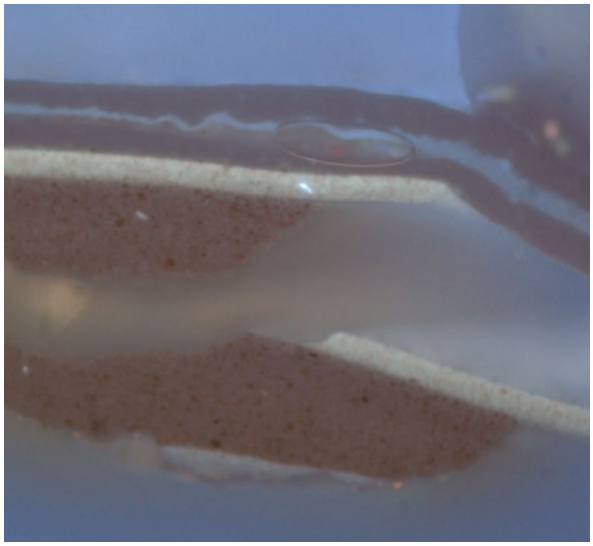
DD 19a (bottom, 200x), 19c (top, 200x), visible light

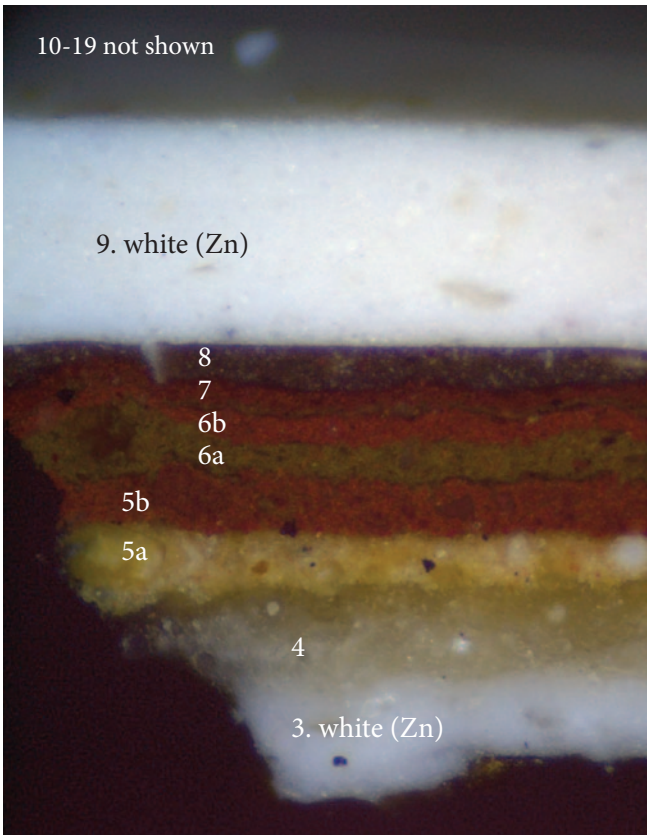
Only the earliest paints from the baluster are shown here. The earliest paint on the wood is the white paint that aligns with the third generation throughout the house. This confirms that the balusters are later than the first period woodwork. The presence of a zinc-based pigment in the earliest paint dates the balusters to c.1845 or later. In addition, SEM-EDS suggests that this paint could contain the zinc-based pigment lithophone, which was introduced in 1874.

Cross-section Microscopy Results

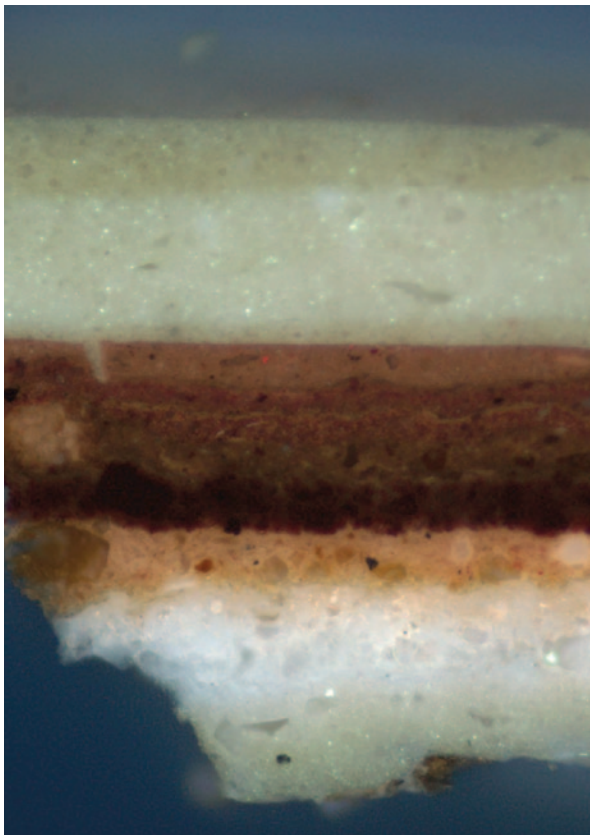
Sample DD 18: Stringer cap, long first run, north face 4'2" above the floor







DD 18a (bottom, 200x), 18b (top, 100x), visible light

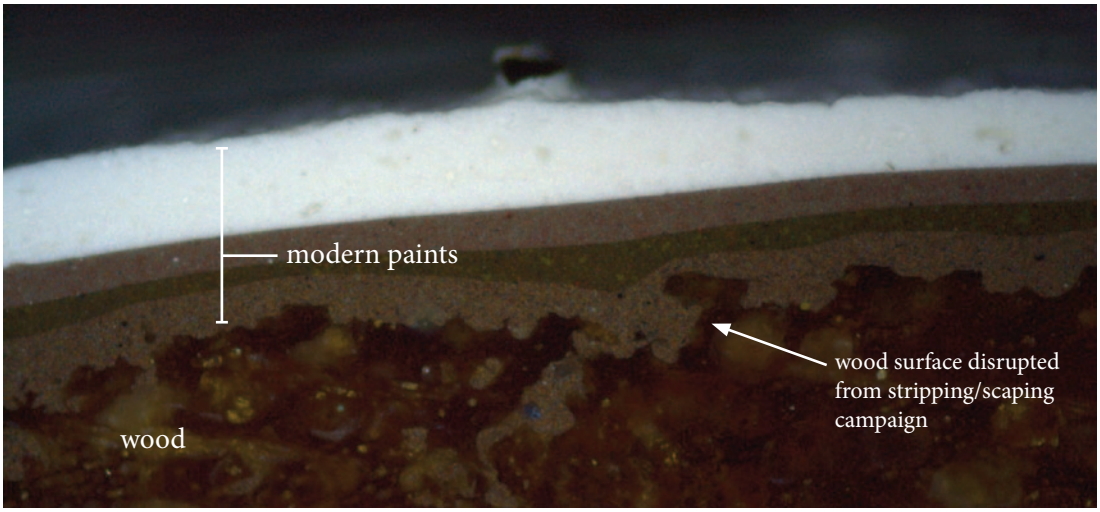


DD 18a (bottom, 200x), 18b (top, 100x), UV light

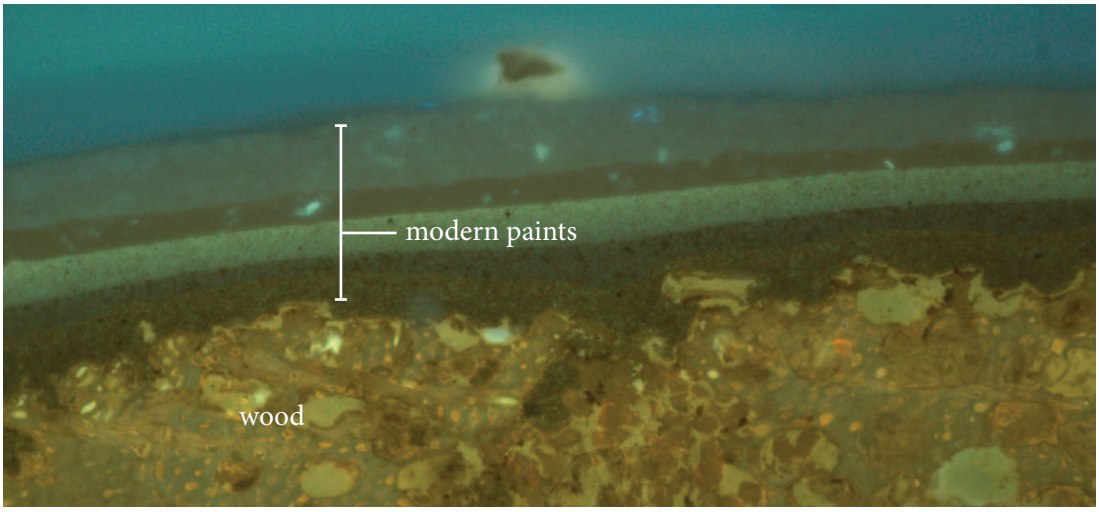
The paint history of the stringer aligns with that of the balusters. The earliest generation is the white paint that aligns with generation three in the rest of the house.

Cross-section Microscopy Results

Sample DD 20: Third section of handrail, north fascia just below torus, where it meets the 4th post



DD 20, visible light



DD 20, UV light

The extant coatings on the handrail are all finely ground, dimly autofluorescent modern (20th c.) paints that align with generations 21-15 in the rest of the house. Any earlier finishes appear to have been stripped or scraped from the handrail, evidenced by the rough, disrupted surface of the wood substrate underneath.

Re-used door leaf in west first-floor lobby

Digges House, first floor plan (2005)
The door in the west lobby is in red.

Sample	Description	Results
DD 1	Face of re-used panel door, top ovolo of lower-left panel, 1" from the upper-left corner	p. 21
DD 2	Same face of door, bottom of left stile 1/2"' from the bottom rail, 2" above floor.	p. 22
DD 3	Ghost of an upper HL hinge at the joint between the horizontal and vertical arm.	p. 23

History:

The HSR reports that this small, four panel door which has been re-used as wainscoting, is probably the only early door remaining in the house (p. 22). One can see the outlines of earlier H-L hinges that have been removed. E. Chappell notes in his memo that "Such doors were used in Virginia as late as c.1810, but this door seems most likely to be c.1760-75 in light of the other woodwork" (HSR, Appendix C).

Discussion of Results:

The first paint generation on the door leaf is a thin gray primer (1a) and a coarsely ground green paint. This finish was found on several early elements throughout the house (stair tall post, north room east and west window architraves). PLM and SEM-EDS determined that this green paint contains chrome yellow pigment, dating this paint to the early 19th century. In generation two, this green paint was re-applied (2a), and followed by what appears to be a thin layer of varnish (2b). This varnish is dim in UV, suggesting it is an oil-based varnish. This layer is not always visible in all samples.

In generation three, the entire door was painted white with a zinc-based paint, dating this layer to c.1845 or later. Further analysis with SEM-EDS suggests that this paint could contain the zinc-based pigment lithophone, which was introduced in 1874.

The handrail has been stripped of its earliest finishes and contains modern paints only.

The sample from the paint ghost at the original H-L hinge contained ten layers of modern paints. This suggests that the original hinge was removed in the 20th century.

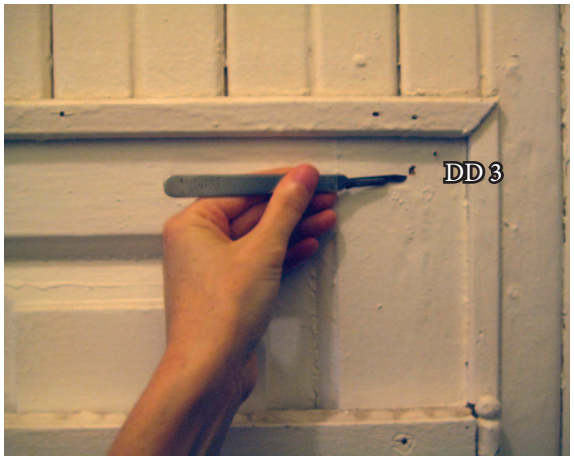
The complete history of the door leaf is summarized in the table below.

Table 2. Small Four-Panel Door Paint History

Generations	Panel Ovolo (DD 1)	Stile (DD 2)	Hinge Ghost (DD 3)
23	*rest of stratigraphy made up of modern paints (20th c.), that do not always align clearly with rest of house, therefore no generations assigned*	*only the earliest layers were examined. Rest of history assumed to be same as panel ovolo*	*only ten layers of modern (20th c.) paints present. Hinge must have been removed and door painted over mid-late 20th c.*
22			
21			
20			
19			
18			
17			
15			
15			
14			
13			
12			
11			x
10			x
9	white paint (appears late 19th or 20th c.)		x
8	thin, dark, oil-based varnish over graining		x
7	*in these periods the stair woodwork was painted, but the rest of the house was unpainted*		
6			
5	wood graining finish with deep yellow base coat (red graining not seen here)	wood graining finish with deep yellow base coat (red graining not seen here)	x
4	translucent, gray paint	translucent, gray paint	x
3 c.1845	white paint (contains zinc - post c.1845) as on entire door, then ovolo painted black (3b)	white paint (contains zinc - post c.1845)	x
2	green paint (2a), thin oil varnish (2b)	green paint (2a), thin oil varnish (2b)	x
1	gray primer (1a), green paint (!b)	gray primer (1a), green paint (!b)	x

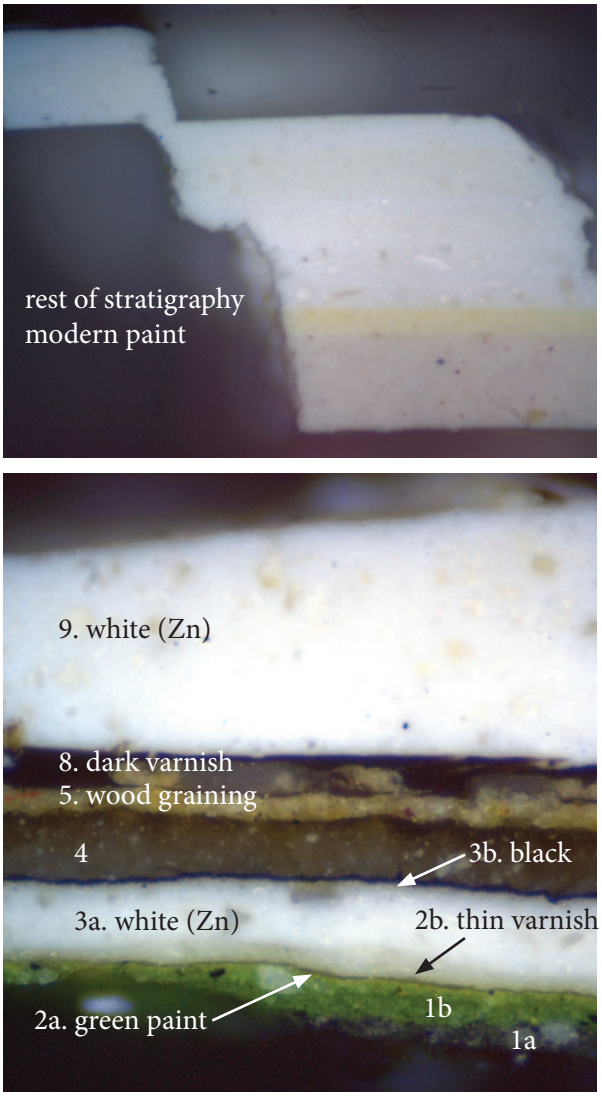
Re-used door leaf in west first-floor lobby - Sample Location Images

Re-used 4-panel door leaf in west lobby, overall

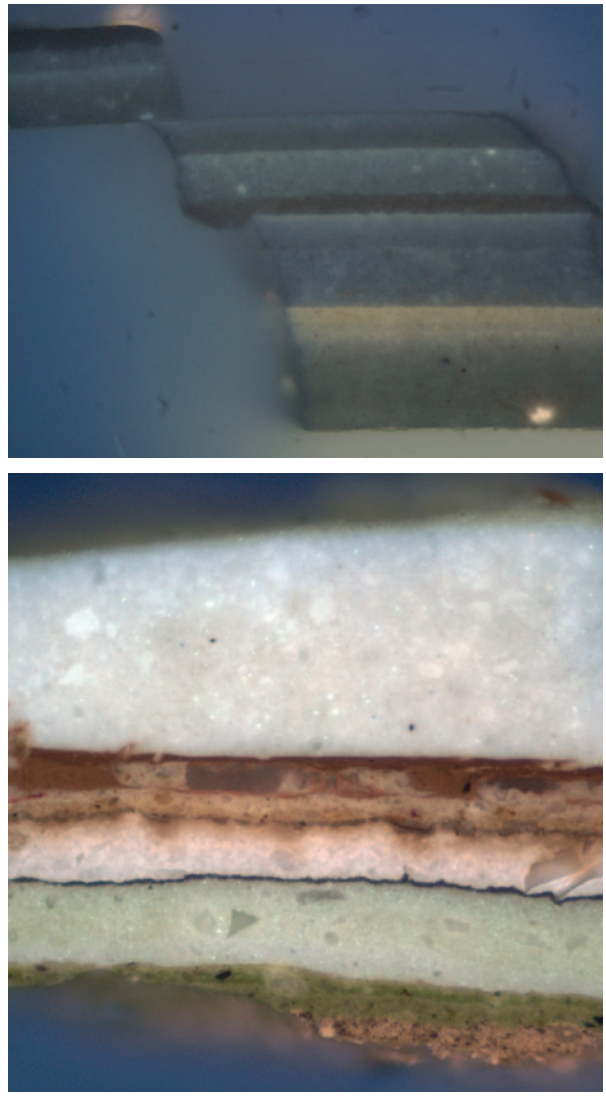


Cross-section Microscopy Results

Sample DD 1: Face of re-used panel door, top ovolo of lower-left panel, 1" from the upper-left corner (Period I)



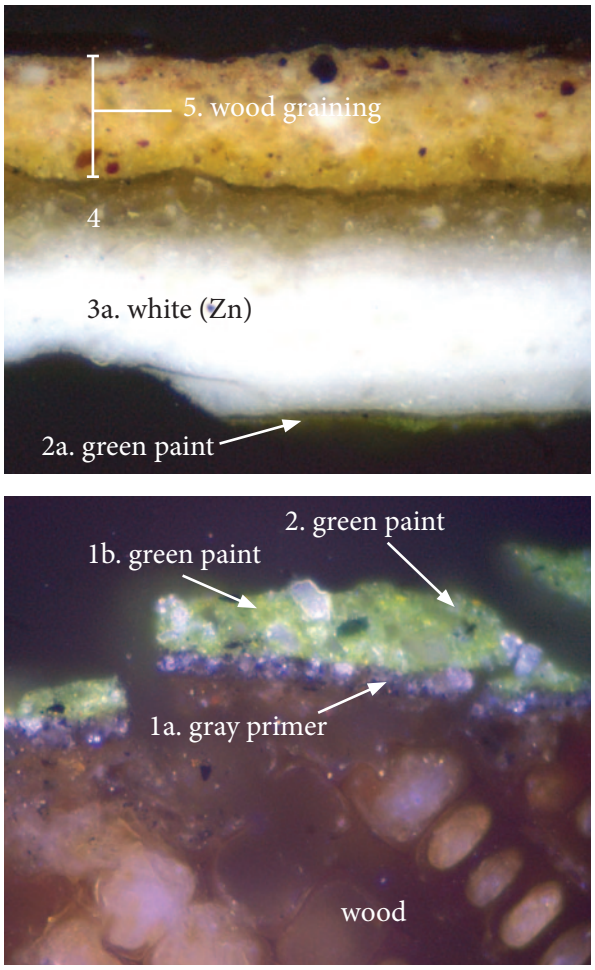
DD 1a (bottom, 400x), 1b (center, 200x), 1c (top, 200x), visible light



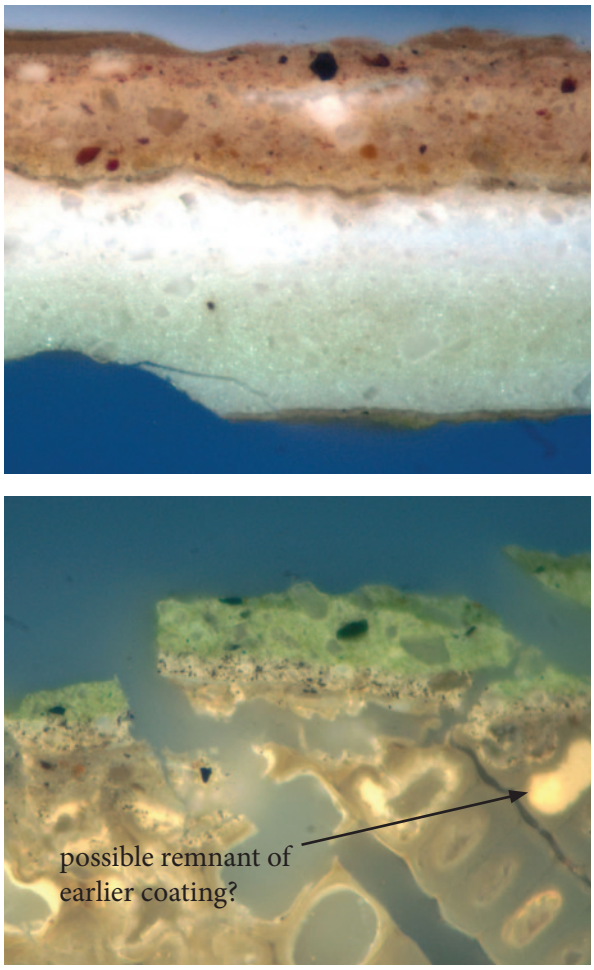
DD 1a (bottom, 400x), 1b (center, 200x), 1c (top, 200x), UV light

Cross-section Microscopy Results

Sample DD 2: Same face of door, bottom of left stile 1/2"' from the bottom rail, 2" above floor (Period I)



DD 2a (bottom, 400x), 2b (top, 200x), visible light



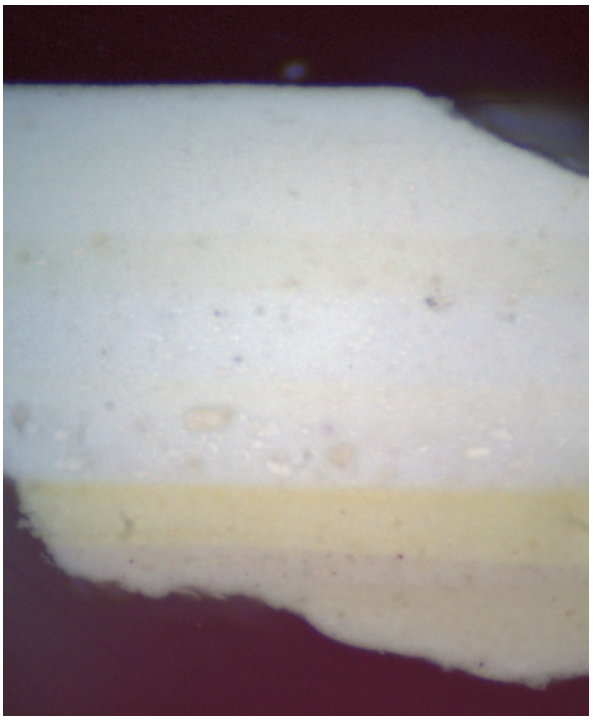
DD 2a (bottom, 400x), 2b (top, 200x), UV light

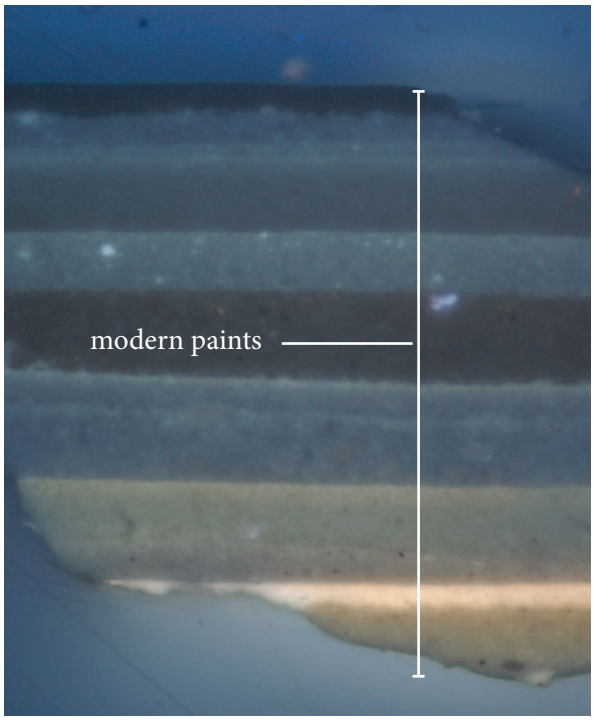
The earliest paint on the door leaf (previous page, and above) is the gray primer (1a) and coarsely ground green paint (1b) found on all of the period 1 elements in the house. There is some pale orange autofluorescent material in the wood cells which could be the remnant of an earlier coating (compare to stair newel, p. x), but this is could also be some oil from the first generation paint flowing into the wood cells (a condition commonly observed by the author and confirmed through instrumental analyses).

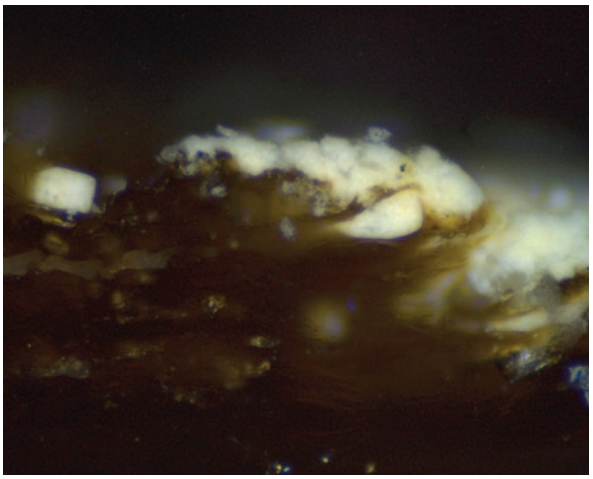
The second generation coarsely ground green paint (2a) has a darker autofluorescence than generation 1, but otherwise this paint is very similar in color and composition. Generation three is the white paint used throughout the house. This paint contains zinc and dates to c.1845 or could be as late as 1874.

Cross-section Microscopy Results

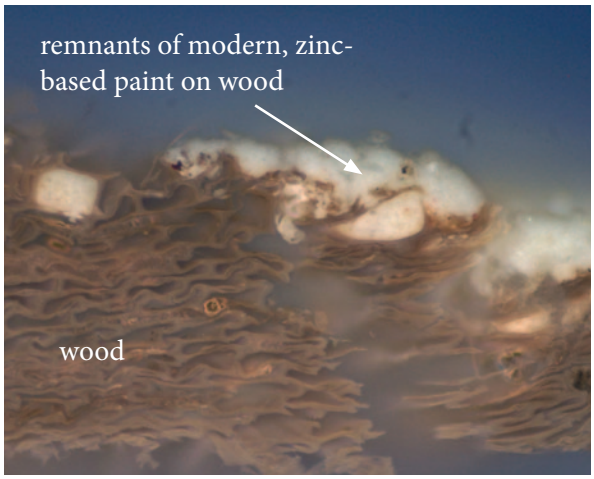
Sample DD 3: Ghost of an upper HL hinge at the joint between the horizontal and vertical arm.







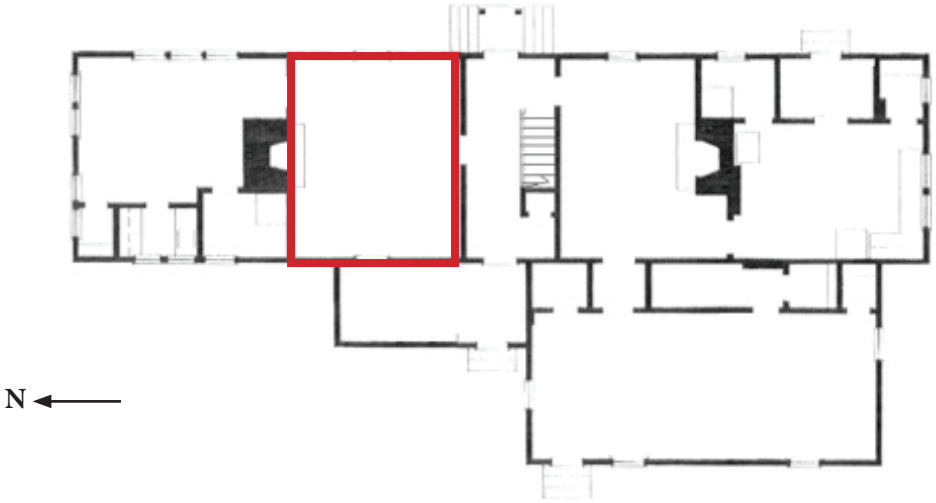
DD 3a (bottom, 200x), 3b (top, 200x), visible light



DD 3a (bottom, 200x), 3b (top, 200x), UV light

Following removal of the hinge, the door was painted with ten layers of finely ground, dimly autofluorescent modern paints (20th c.). This suggests the hinge was removed in the mid-late 20th c.

North First Floor Room



Digges House, first floor plan (2005)
The north first floor room is in red.

Sample	Description	Results
DD 4	West window, convex surface of north (right) cyma backband, 2' below the upper corner	p. 31
DD 5	West window, lower 2nd period sash, south (left) stile, face, 1' below top rail	p. 33
DD 6	West window, upper sash, south (left) stile, face next to ovolo 1'6" below top rail.	p. 34
DD 7	East window, upper sash, north (left) stile, 1'4" below rail	p. 32
DD 8	East window, north (left) architrave, on bead 2'2" above sill	p. 30
DD 9	Mantel, convex part of cyma above the left pilaster, above dentils, west (left) end	redundant, not cast
DD 10	Mantel, face of westernmost dentil above west pilaster.	same as 12, not shown
DD 11	Mantel, west pilaster, face of reeding, at center, 2' above floor.	incomplete, not cast
DD 12	Mantel, upper left corner of fascia board above hearth	p. 35

History:

Acording to the HSR, the earliest woodwork in this room is believed to be the window architraves, the upper sash on both windows, and the mantel (although again, the mantel is clearly post 1800). The upper sash in both windows have wide muntins, suggesting an earlier date, possibly pre-Revolutionary. The lower sash in both windows and the mantel on the north wall are believed to date to period II (1805-15).

Discussion of Results:

The findings suggest that the earliest elements are the east and west window architraves and the upper sash in the east window only. On the architraves, the first paint generation is the thin gray primer (1a) and coarsely ground green paint that was found on several early elements throughout the house (stair tall post,

re-used door leaf). However, PLM and SEM-EDS determined that this green paint contains chrome yellow pigment, dating this paint to the early 19th century. In generation two, this green paint was re-applied (2a), and followed by what appears to be a thin layer of varnish (2b). This varnish is dim in UV, suggesting it is an oil-based varnish. This layer is not always visible in all samples.

The upper sash in the east window had the same number of early paint layers as the architrave, but the first two paint generations are white/off-white (1) and cream-colored (2) paints. Both of these generations have the pale peach-colored autofluroescence typical of oil-based paints that contain lead white pigment.

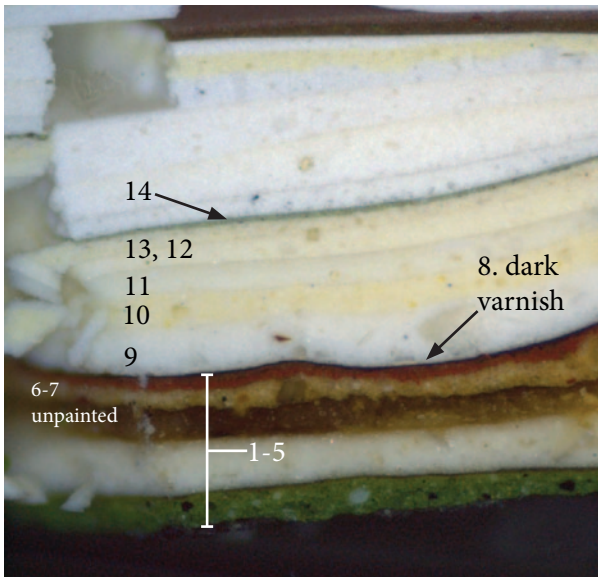
In generation three, the window architraves and east window upper sash were painted white with a zinc-based paint, dating this layer to c.1845 or later. Further analysis with SEM-EDS suggests that this paint could contain the zinc-based pigment lithophone, which was introduced in 1874.

Generation four is a translucent, grayish-colored paint.

Generation five is the earlist paint on both the upper and lower sash of the west window. In this generation, all extant woodwork was faux-grained to imitate wood.

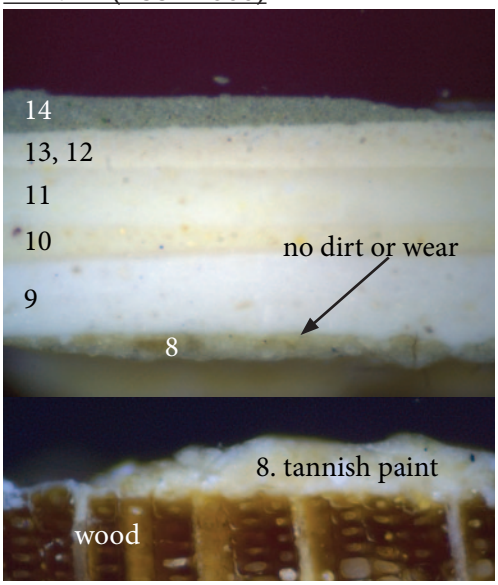
The sample from the mantel contained mostly modern (late 19th - 20th c.) paints that align with generations 9-22 on the rest of the woodwork (see comparison below). However, the earliest generation on the mantel appears to be a hand-ground tan-colored paint not seen elsewhere. This is not unusual, since mantels were often painted differently from the rest of the woodwork. The alignment suggests it could date to generation eight, although it could be even earlier. However, the lack of dirt or wear on its surface suggests the tan paint was not exposed for a significant amount of time. While the paint stratigraphy confirms the mantel is later (which was expected), there is not enough evidence to confidently place its installation within the context of the house.

East Window Architrave



DD 8, visible light, 100x. Wood missing from bottom of sample.

Mantel(post-1800)



DD 12a, visible light, (bottom, 200x), 12b (top, 200x).
Composite image. Most recent paints not shown here.

Table 3. North First Floor Room Comparative Paint History

Generations	East and west window architraves (DD 8, DD 4)	East window, top sash (DD 7)	West window, top and bottom sash (DD 5, 6)	Mantel (DD 12)
23	current white paint	current white paint	current white paint	current white paint
22	dark brown paint	dark brown paint	dark brown paint	dark brown paint
21	dark brown paint	dark brown paint	dark brown paint	dark brown paint
20	white paint	white paint	white paint	white paint
19	yellow paint	yellow paint	yellow paint	yellow paint
18	light blue paint	light blue paint	light blue paint	light blue paint
17	white paint	white paint	white paint	white paint
15	white paint	white paint	white paint	white paint
15	white paint	white paint	white paint	white paint
14	dark green paint (modern 20th c.)	dark green paint (modern 20th c.)	dark green paint (modern 20th c.)	dark green paint (modern 20th c.)
13	light yellow/cream	light yellow/cream	cream-colored paint	light yellow/cream
12	light yellow/cream	light yellow/cream	cream-colored paint	light yellow/cream
11	white paint	white paint	cream-colored paint	white paint
10	yellow paint	yellow paint	cream-colored paint	yellow paint
9	white paint (appears late 19th or 20th c.)	white paint (appears late 19th or 20th c.)	white paint (appears late 19th or 20th c.)	white paint (appears late 19th or 20th c.)
8	thin, dark, oil-based varnish over graining	dark gray paint	dark gray paint	tannish paint, coarsely ground
7	*in these periods the stair woodwork was painted, but the rest of the house was unpainted*			
6				
5	wood graining finish with deep yellow base coat (5a) and red graining (5b)	wood graining finish with deep yellow base coat (5a) and red graining (5b)	same graining as windows, but includes white primer. Red graining layer not seen here.	x
4	translucent, gray-tan paint	translucent, gray-tan paint	x	x
3 c.1845	white paint (contains zinc - post c.1845)	white paint (contains zinc - post c.1845)	x	x
2	green paint (2a), thin oil varnish (2b)	cream-colored paint	x	x
1	gray primer (1a), green paint (!b)	white paint	x	x

North First Floor Room - Sample Location Images

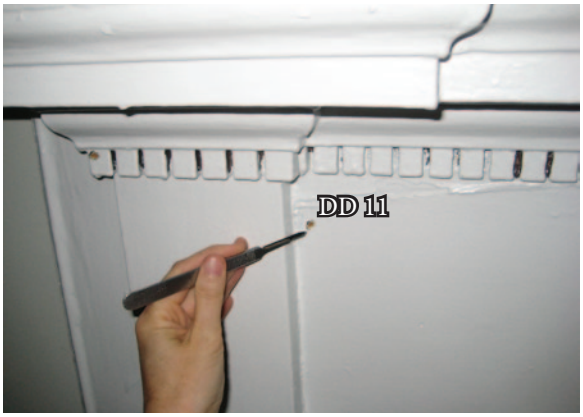
west window

North First Floor Room - Sample Location Images

east window

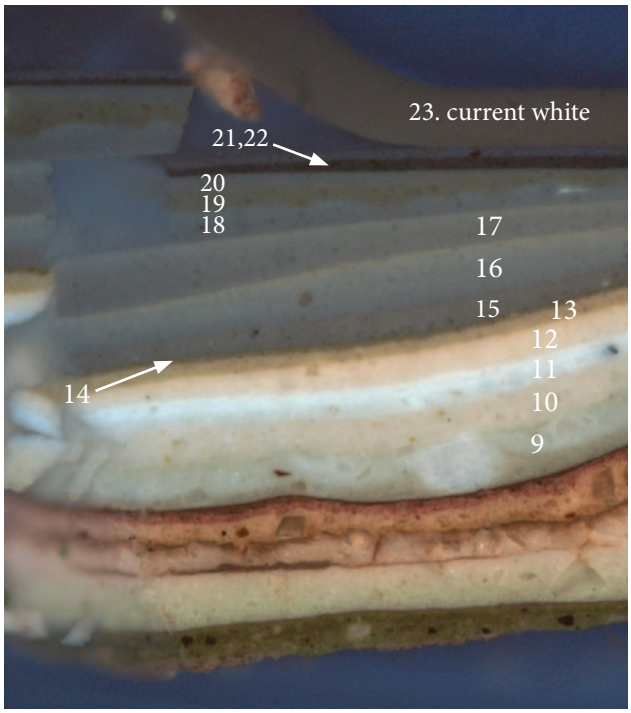
mantel

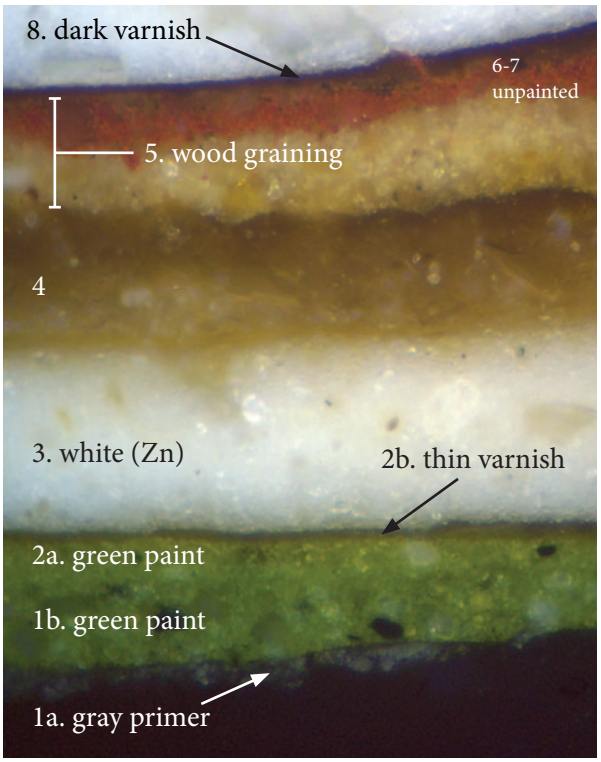
North First Floor Room - Sample Location Images



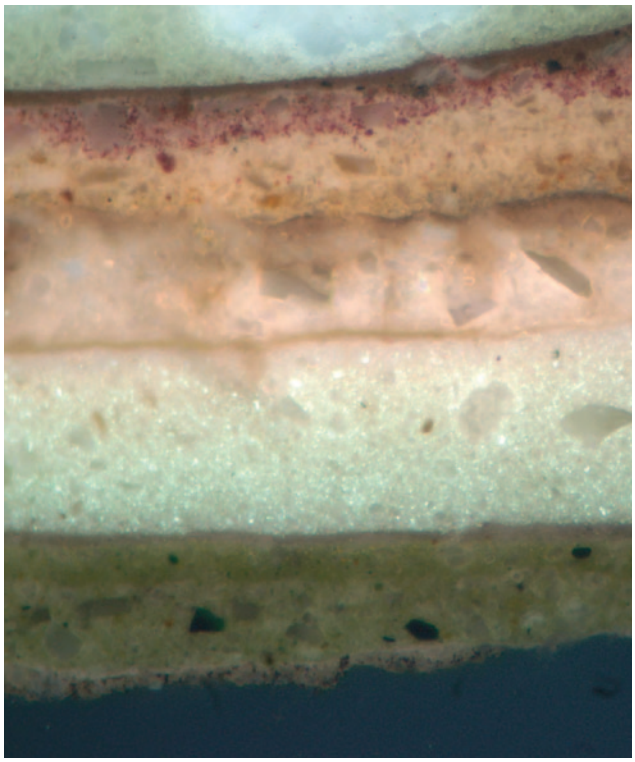
Cross-section Microscopy Results

Sample DD 8: East window, north (left) architrave, on bead 2'2" above sill (Period II)





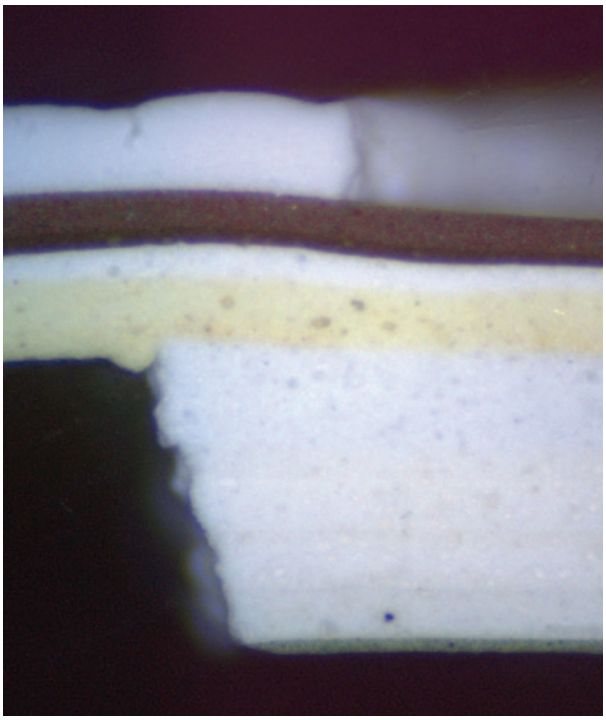
DD 8 (bottom, 400x), top (100x), visible light

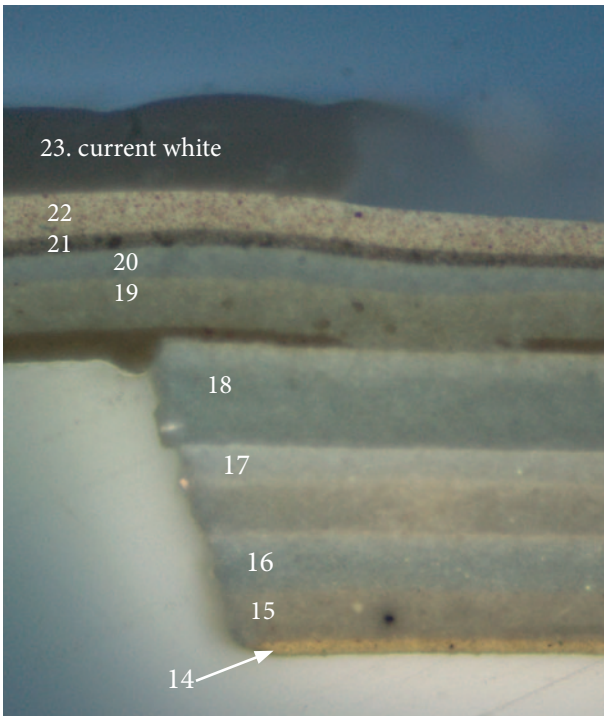


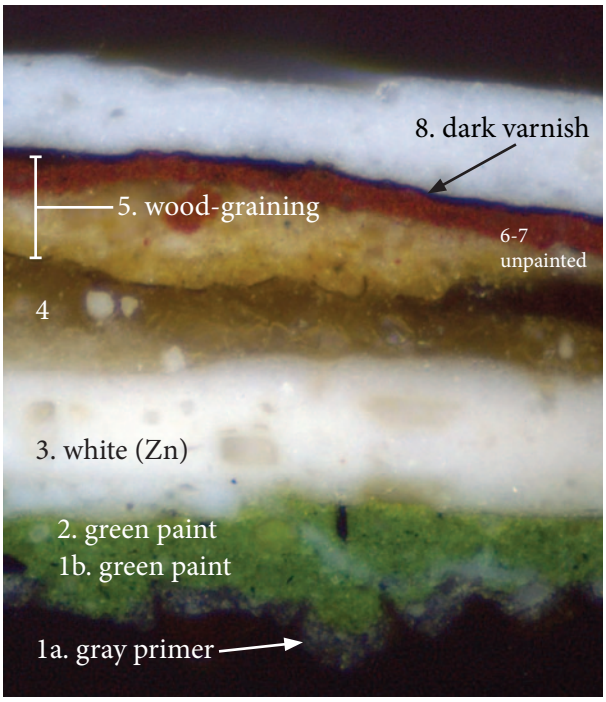
DD 8 (bottom, 400x), top (100x), UV light

Cross-section Microscopy Results

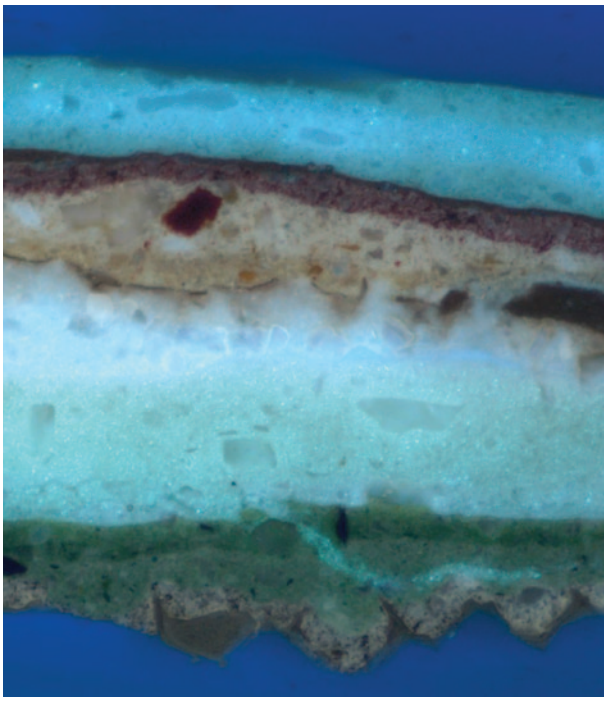
Sample DD 4: West window, convex surface of north (right) cyma backband, 2' below the upper corner (Period II)







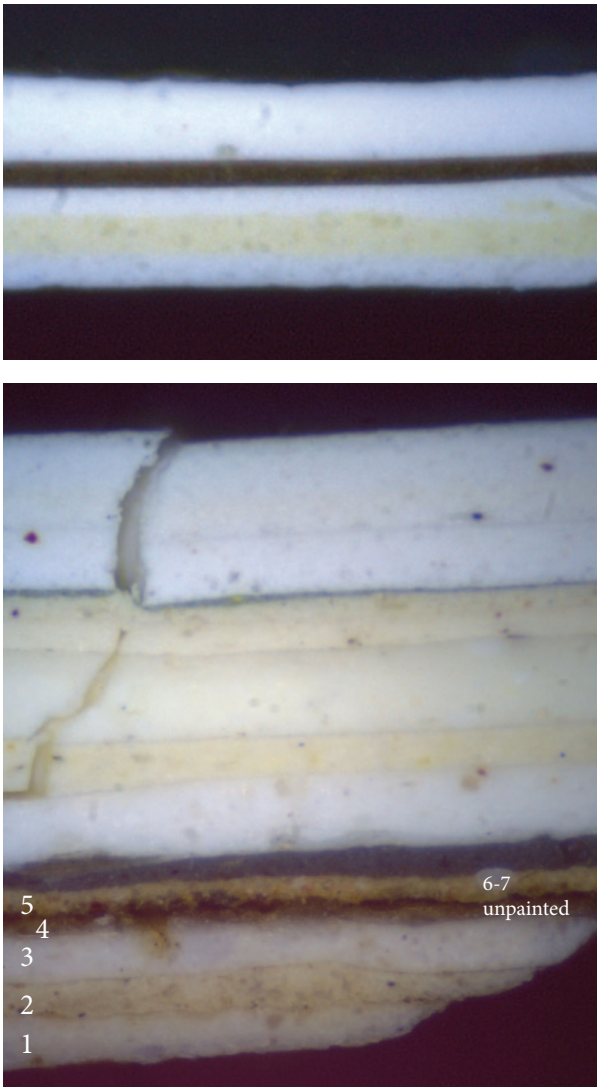
DD 4a (bottom, 400x), 4b (top, 200x), visible light



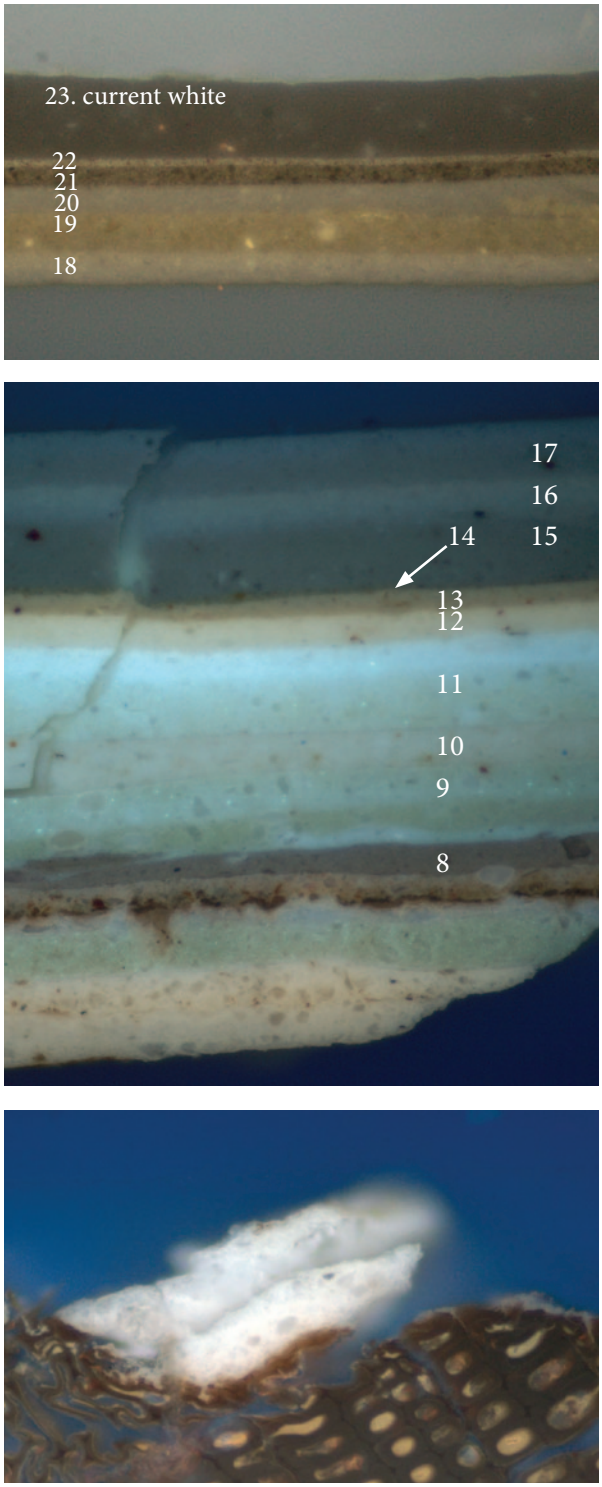
DD 4a (bottom, 400x), 4b (top, 200x), UV light

Cross-section Microscopy Results

Sample DD 7: East window, upper sash, north (left) stile, 1'4" below rail



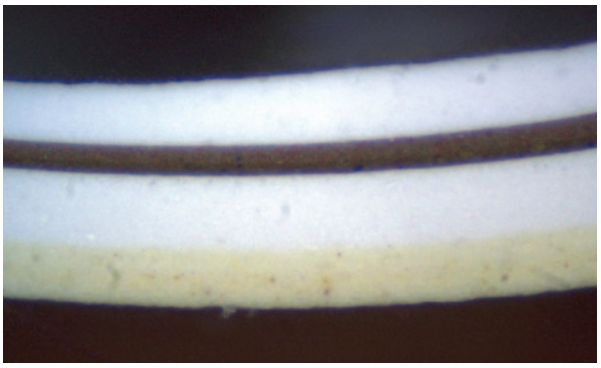
DD 7a (bottom, 200x), 7b (center 200x), 7c (top, 200x, visible light

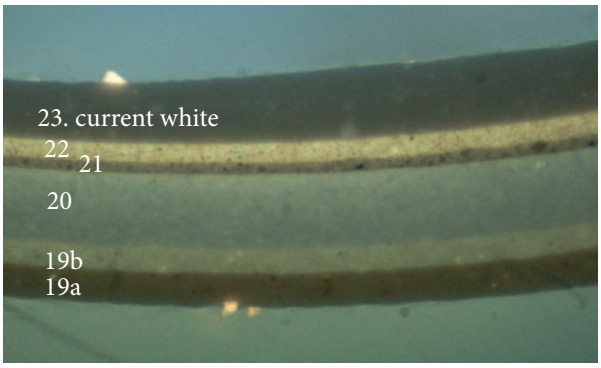


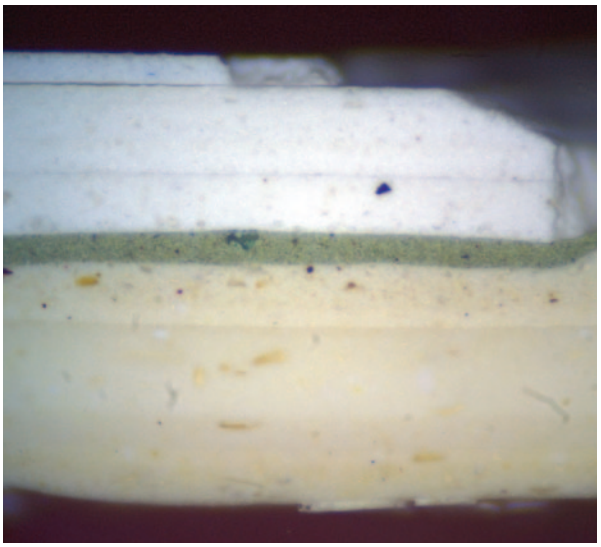
DD 7a (bottom, 200x), 7b (center 200x), 7c (top, 200x), UV light

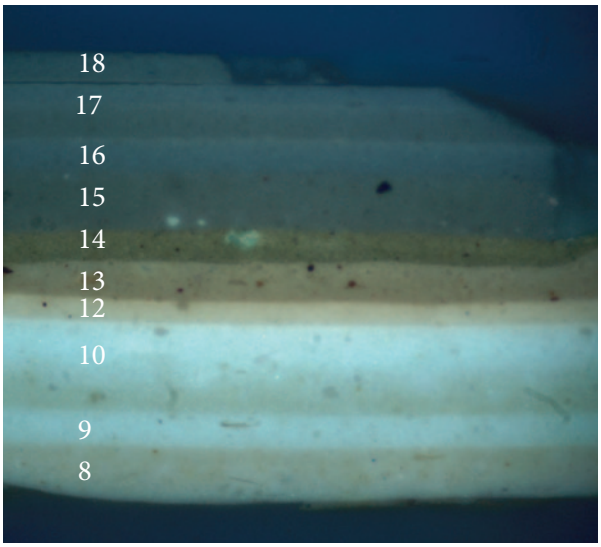
Cross-section Microscopy Results

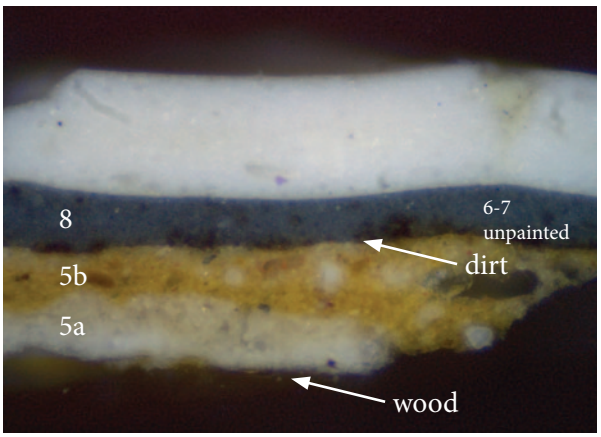
Sample DD 5: West window, lower 2nd period sash, south (left) stile, face, 1' below top rail



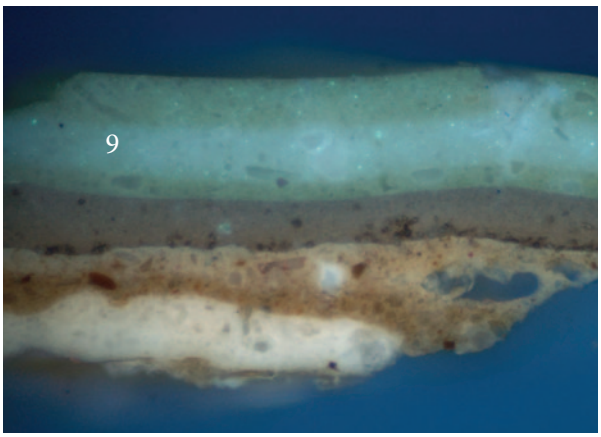








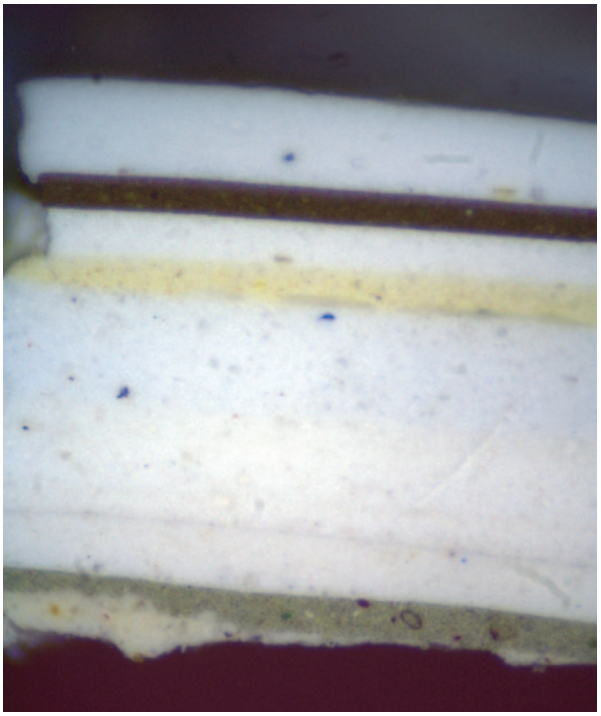
DD 5a (bottom, 200x), 5b (center 200x), 5c (top, 200x, visible light

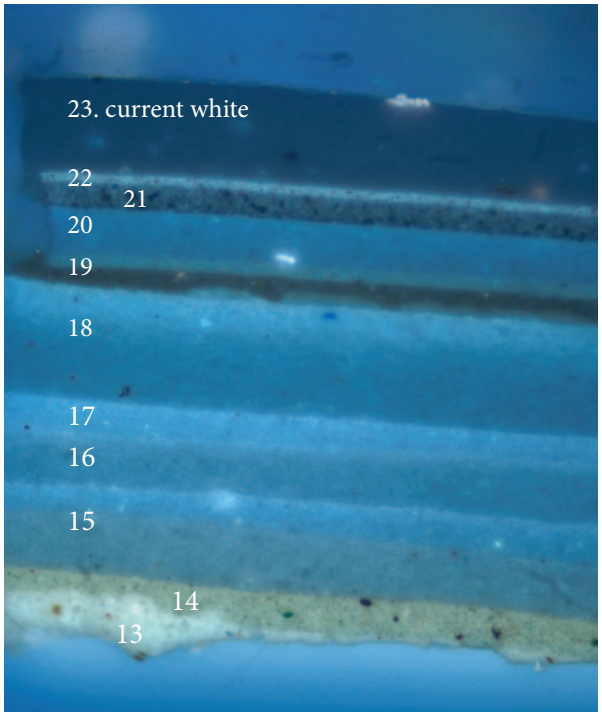


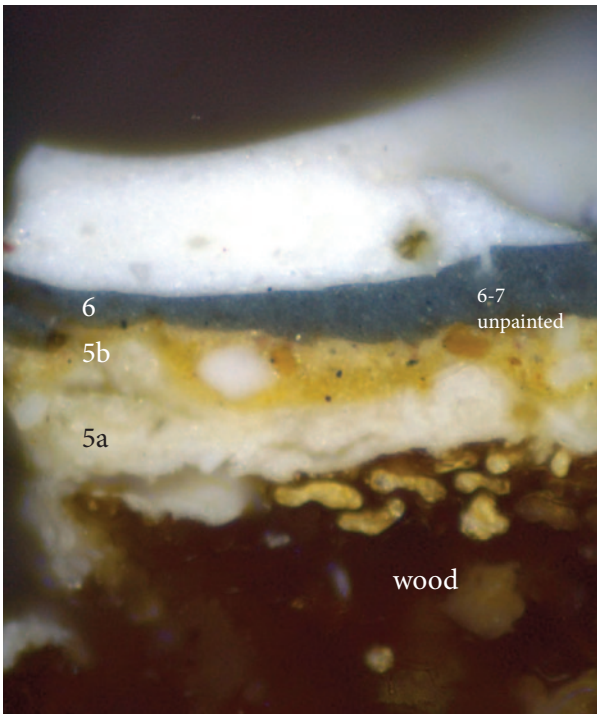
DD 5a (bottom, 200x), 5b (center 200x), 5c (top, 200x), UV light

Cross-section Microscopy Results

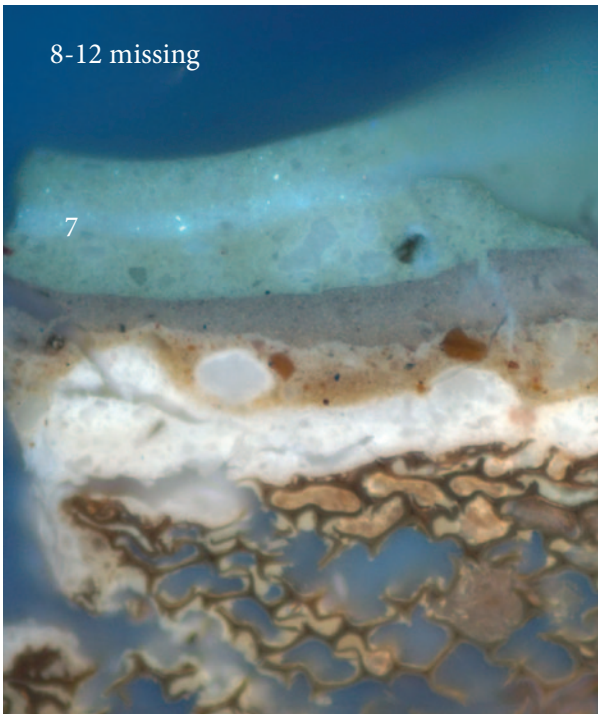
Sample DD 6: West Window, upper sash, south (left) stile, face next to ovolo 1'6" below top rail







DD 6a (bottom, 200x), 6b (top 200x), visible light



DD 6a (bottom, 200x), 6b (top 200x), visible light

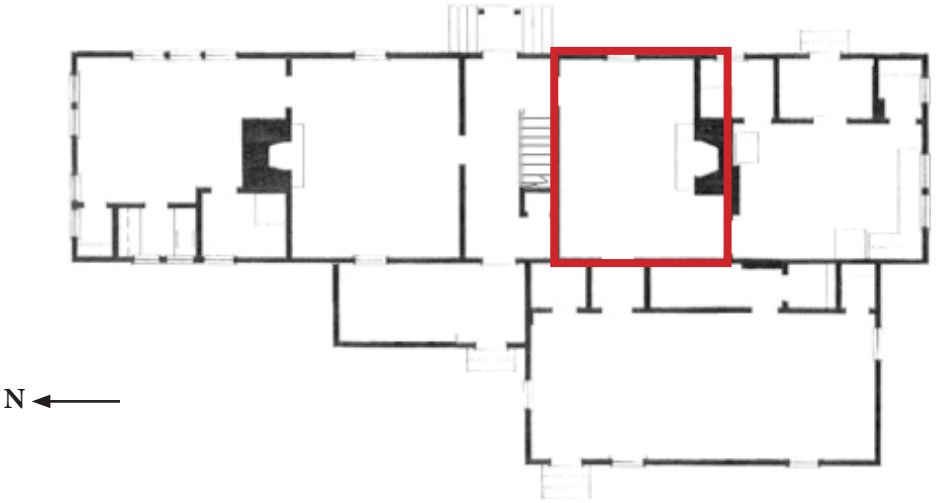
Cross-section Microscopy Results

Sample DD 12: Mantel, upper left corner of fascia board above hearth

DD 12a (bottom, 200x), 12b (center, 200x), 12c (top, 200x), visible light

DD 12a (bottom, 200x), 12b (center, 200x), 12c (top, 200x), UV light

South First Floor Room



Digges House, first floor plan (2005)
The south first floor room is in red.

Sample	Description	Results
DD 13	Mantel, west (right) convex pilaster cap, east (inner side)	incomplete, not cast
DD 14	Mantel, recessed face of east (left) pilaster at upper-left corner	p. 42
DD 15	East window, face of architrave against backband, 1'1" below head	p. 40
DD 16	East window, upper sash, north (left) stile, 1'2" below top rail	p. 41

History:

Acording to the HSR, the earliest woodwork in this room is believed to be the window architrave and upper sash on the east wall. The mantel is believed to date to period II (1805-15).

Discussion of Results:

Interestingly, none of the first generation gray primers (1a) and green paints (1b) were found in this space. By contast, the earliest finish on the east window architrave is a white primer (1a) and a coarsely-ground-blue paint (1b), not seen elsewhere in the house. Further analysis was not carried out, but these appear to be traditional lead-based, oil-bound paints. There is little evidence of dirt or grime on the surface of this blue paint. The alignment suggests that this blue paint was contemporary with the green paint elsewhere (tall stair post, re-used door leaf, north room east and west window architraves). During this period, the upper sash of the east window was painted white.

In generation two, both the window architrave and upper sash were painted white/cream.

Generation three on the architrave and upper sash is the same white, zinc-based paint found throughout the house. The rest of the paint history on both elements is very similar to that found in the rest of the house.

The earliest finishes on the mantel do not align with anything else in the house. The first generation is a

multi-layered finish consisting of a white base coat (1a), a tannish, translucent layer (1b), a dark brownish layer (1c), and a varnish (1d). This varnish is very disrupted suggesting a long period of exposure. Generation two is an oil-based varnish. This is followed by at least four layers of black paint and varnishes. The paint history then aligns with generation five, the wood-graining finish found throughout the house.

This early paint history indicates that the mantel is indeed old, but since it was painted differently from other woodwork in the house (and possibly more often), it is not possible to assign a particular time period of installation.

The complete paint history of samples taken from the south first-floor room is found in the table on the next page.

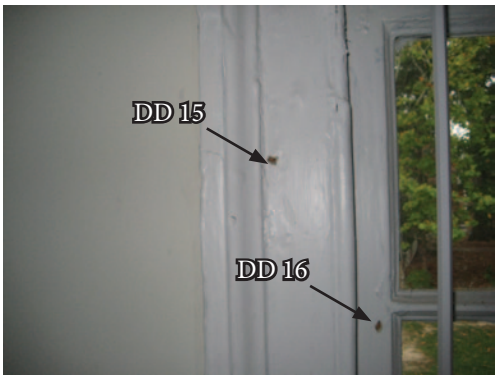
Table 4. South First Floor Room Comparative Paint History

Generations	East window architrave (DD 15)	East window, top sash (DD 16)	Mantel (DD 14)
24	current white paint	current white paint	*complete paint history not shown in report but made up of modern paints that align with rest of woodwork*
23	medium yellow paint	medium yellow paint	
22	dark brown paint	dark brown paint	
21	dark brown paint	dark brown paint	
20	medium yellow paint	medium yellow paint	
19	bright yellow paint	bright yellow paint	
18	light blue paint	light blue paint	
17	white paint	white paint	
16	white paint	white paint	
15	yellow paint	yellow paint	
14	off-white paint	off-white paint	
13	rose-beige paint	rose-beige paint	
12	white paint	white paint	
11	white paint	white paint	
10	white paint	white paint	
9	white paint (modern)	white paint (modern)	
8	thin, dark, oil-based varnish	thin, dark, oil-based varnish	brick red paint (8a) with varnish (8b)
7	*in this period the stair woodwork was painted, but the rest of the house was unpainted*		grayish, translucent paint
6	x	x	brick red paint, appears to align with same brick red in stair passage
5	wood graining finish with deep yellow base coat only	wood graining finish with deep yellow base coat only	wood graining finish with deep yellow base coat and red-brown graining
4	translucent, gray-tan paint	translucent, gray-tan paint	*multiple layers of black paints and varnishes that are unique to this mantel*
3	white (Zn - post c.1845)	white (Zn - post c.1845)	
2	cream-colored paint	cream-colored paint	
1	white primer (1a), blue paint (1b)	white/cream-colored paint	possible decorative finish, white base coat (1a), translucent tannish layer (1b), dark brownish-black layer (1c), varnish (1d, very disrupted)

South First Floor Room - Sample Location Images

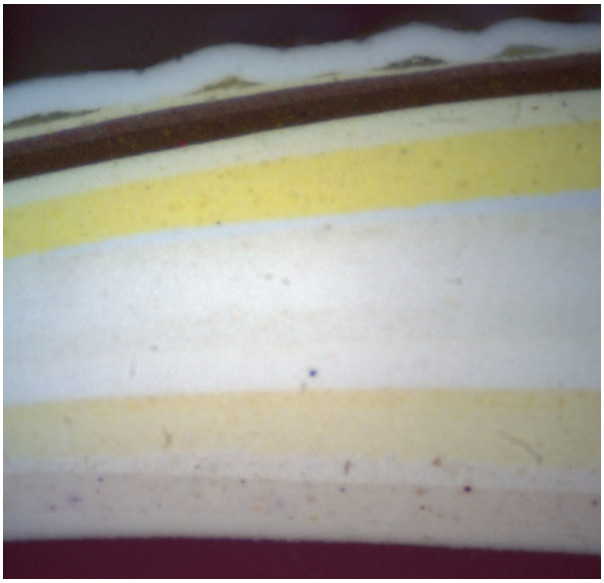
mantel

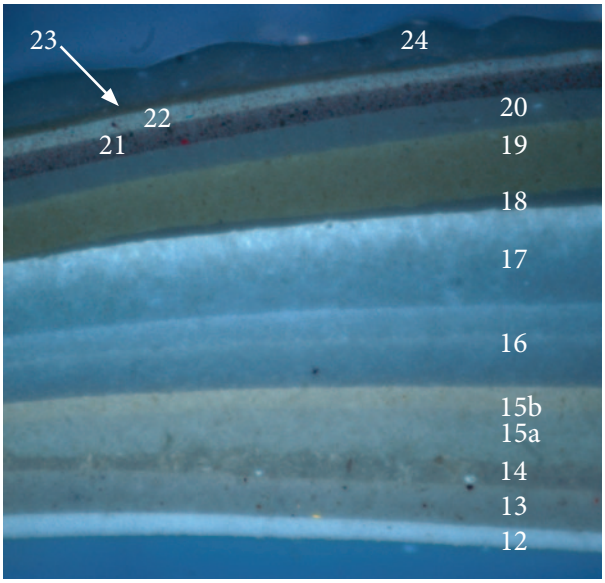
east window

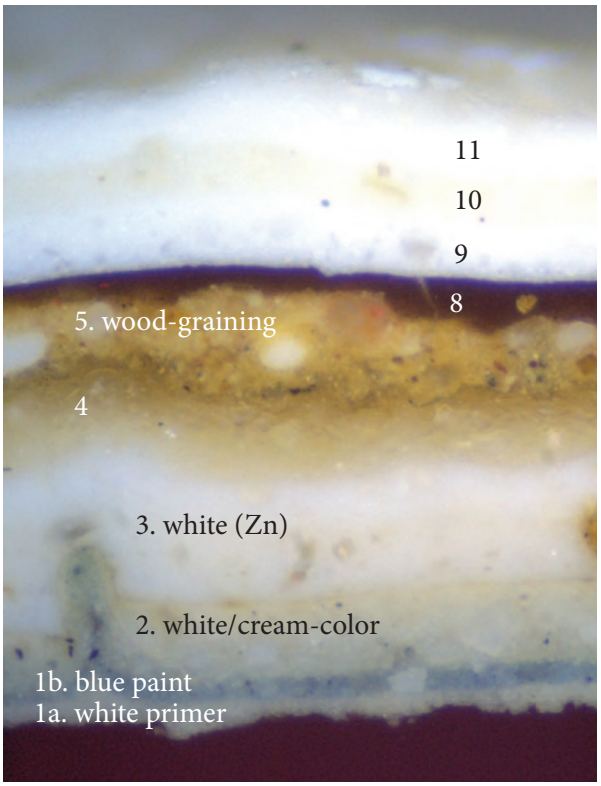


Cross-section Microscopy Results

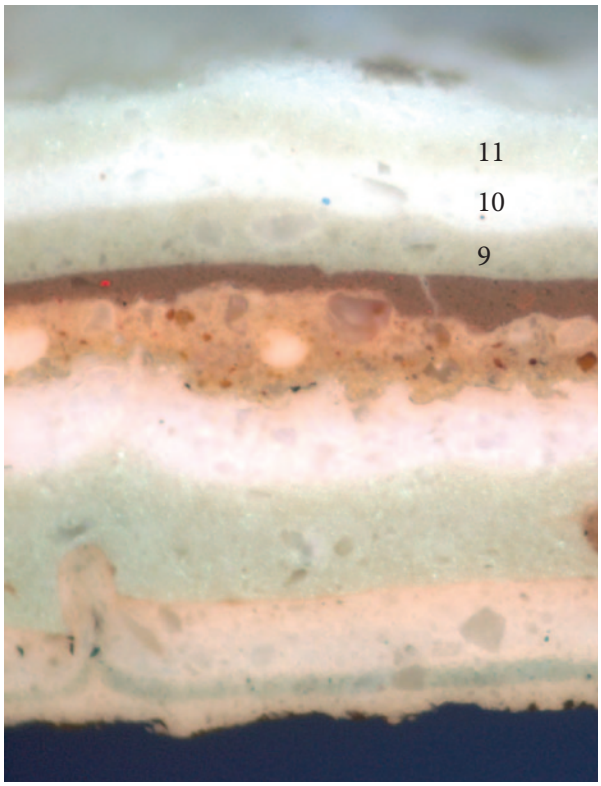
Sample DD 15: East window, face of architrave against backband, 1'1" below head







DD 15c (bottom, 200x), 15a (center, 200x), 15d (top, 200x), visible light

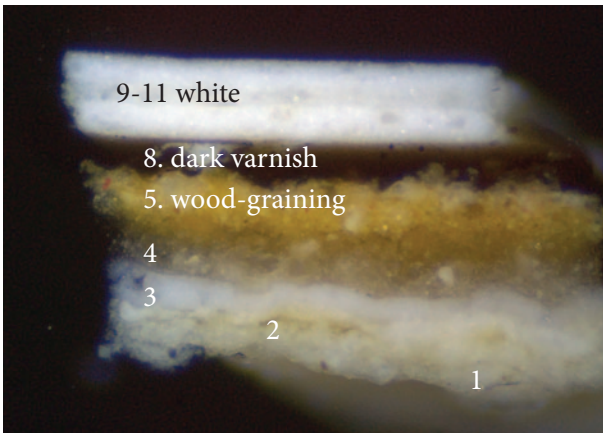


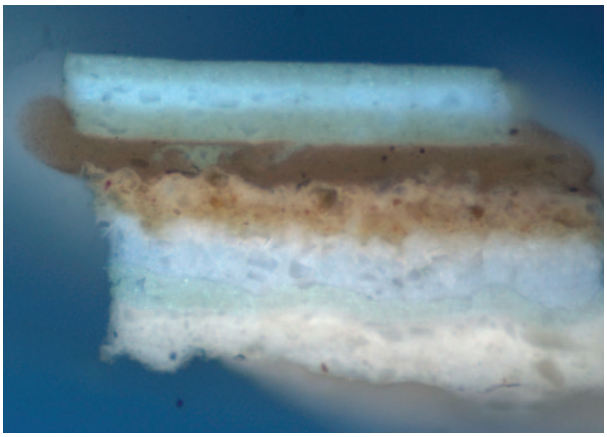
DD 15c (bottom, 200x), 15a (center, 200x), 15d (top, 200x), UV light

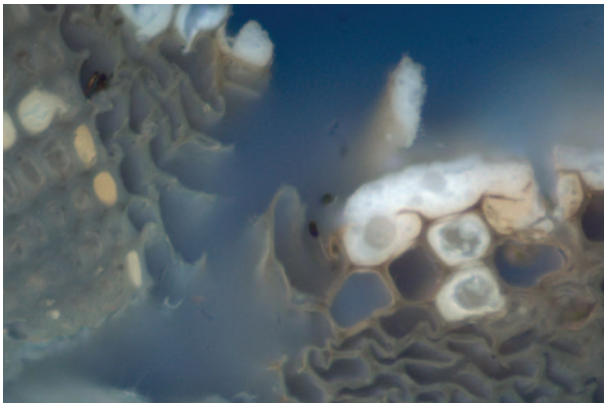
This sample from the east window architrave contains a first generation white primer (1a) and blue paint (1b), not seen elsewhere in the house. This could be contemporary with the first generation green paint found elsewhere. Generation two is a white/ cream-colored paint. Generation three is the same white zinc-based paint used on the rest of the woodwork.

Cross-section Microscopy Results

Sample DD 16: East window, upper sash, north (left) stile, 1'2" below top rail







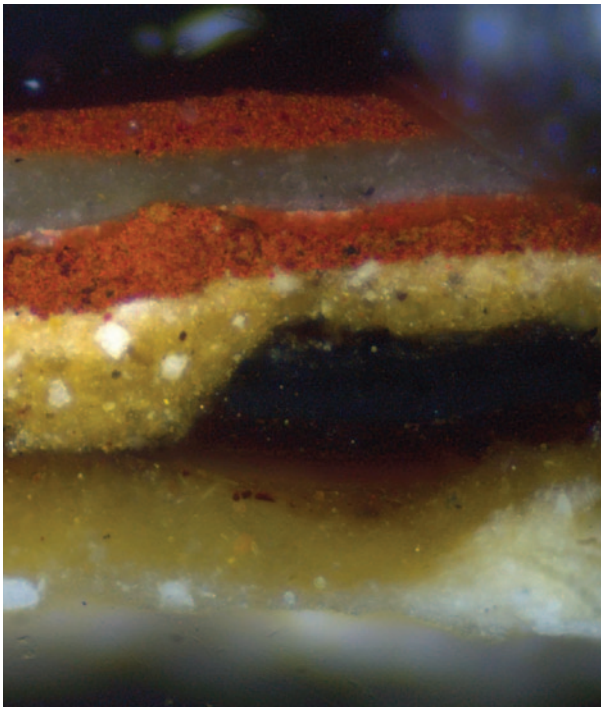
DD 16a (bottom, 200x), 16b (center, 200x), 16c (top, 200x), visible light

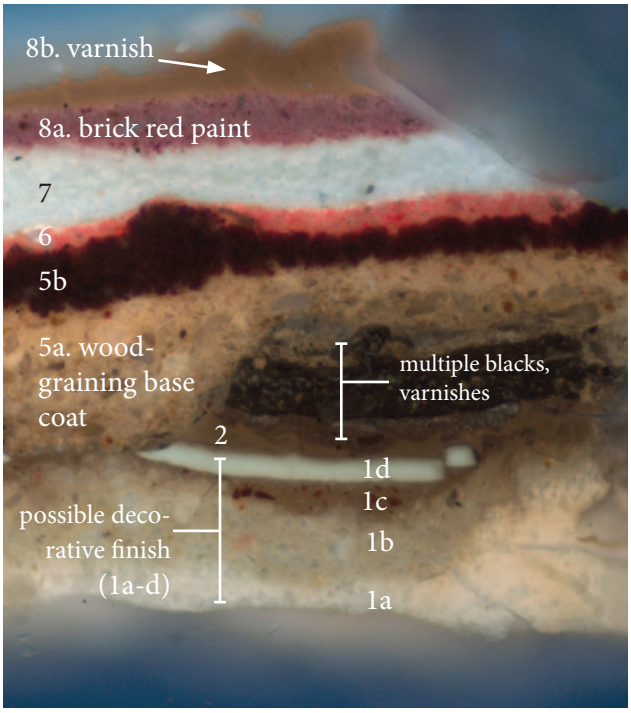
DD 16a (bottom, 200x), 16b (center, 200x), 16c (top, 200x), UV light

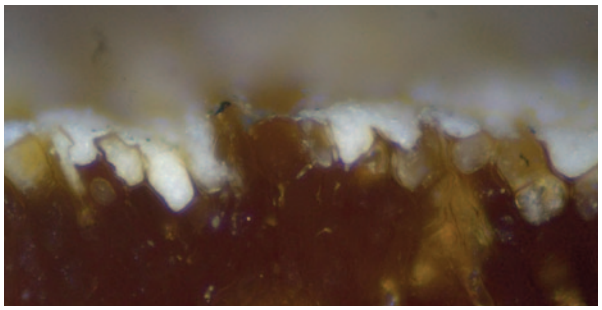
Only the early layers are shown from the upper window sash, for comparison to the architrave (previous page). Although it is difficult to distinguish in the above photomicrograph, there are two early white/cream-colored paint layers. Both contain large pigment particles suggesting they were ground by hand. Their pale orange-white autofluorescence suggests they are oil-based paints with lead white pigment. Comparison of this sample with the window architrave suggests this sash is contemporary with the architrave. In the first generation, the sash was painted white while the architrave was primed white (1a) and painted blue (1b). In the second generation, both the sash and the architrave were painted white/cream-color. Generation three is the same zinc-based white paint found throughout the house. The complete stratigraphy is not shown here, but it aligns with that found on the architrave.

Cross-section Microscopy Results

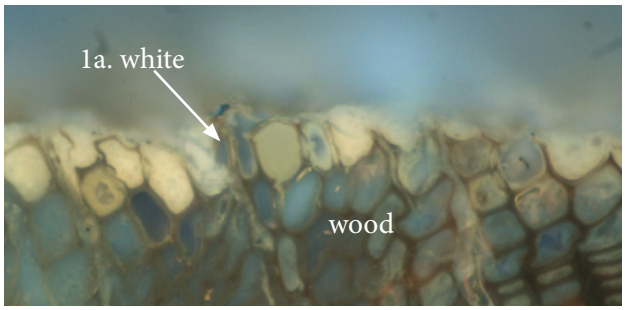
Sample DD 14: Mantel, recessed face of east (left) pilaster at upper-left corner







DD 14a (bottom, 200x), 14b (center, 200x), 14d (top, 100x), visible light



DD 14a (bottom, 200x), 14b (center, 200x), 14d (top, 100x), UV light

This mantel contains a number of early paints that are unique to this element. The first generation could be a multi-layered decorative finish, consisting of a white, opaque base coat (1a), a tannish, translucent layer (1b), a dark brown ish-red layer with some deep red pigments (1c), and a resinous varnish (1d). This varnish is deeply cracked and disrupted suggesting a long period of exposure.
Generation two is a layer of oil-based varnish.
Following this finish, there appear to be multiple layers of black paints and varnishes (these are more easily resolved in UV). These were not assigned numbers as they do not align with any of the layers in the house. There appear to be at least four black paints and varnishes.
Generation five is the same wood-graining finish found on many elements in the house.

The complete stratigraphy is not shown above, but the rest of the paints are modern and align with the rest of the house.

Attic

Digges House, attic

Sample	Description	Results
DD 21	Sample from underside of board between 10th and 11th rafters, counting from the north end, top board on west slope, taken from the edges	p. 44

History:

The HSR report mentions "evidence of whitewashing" (p. 21) on some of the early attic rafters, and suggests that this could indicate that the attic was an occupied space. During the *in-situ* examination, the white material on the boards was noted to look more like mortar than limewash (Chappell sample memo, Oct. 2017). Chappell believes these boards could have been re-used from a construction site.

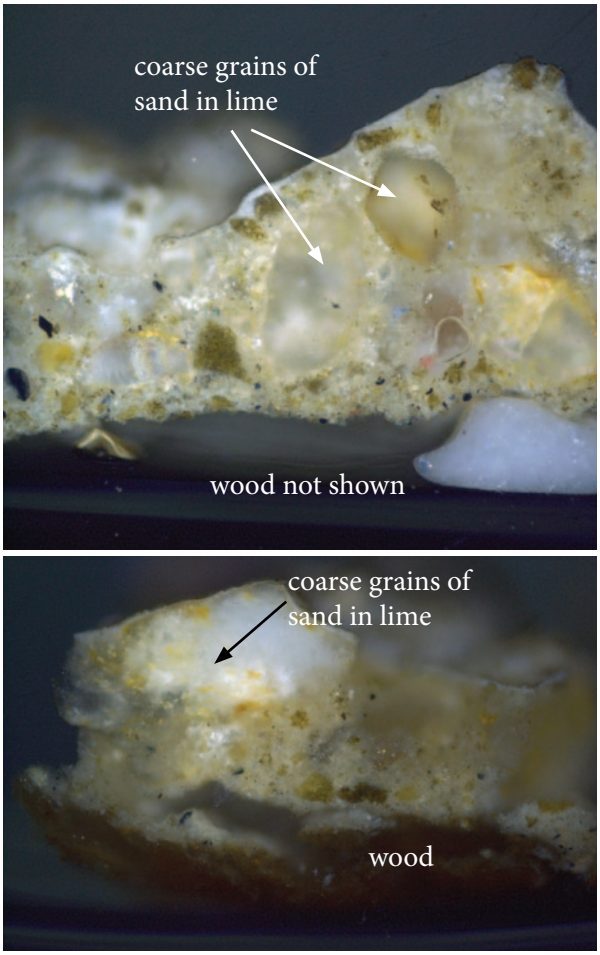
Discussion of results:

The results found that the material on the attic boards does appear to be a mortar, rather than a limewash. There is a thick, single layer of what appears to be a lime-based coating that coatins a good deal of sandy aggregate. This is very unlike a limewash, which is typically very thin and contains no aggregate. The purpose of this mortar-like material on the surface seems to confirm that these boards were re-used from a construction site, possibly as a scaffolding platform.

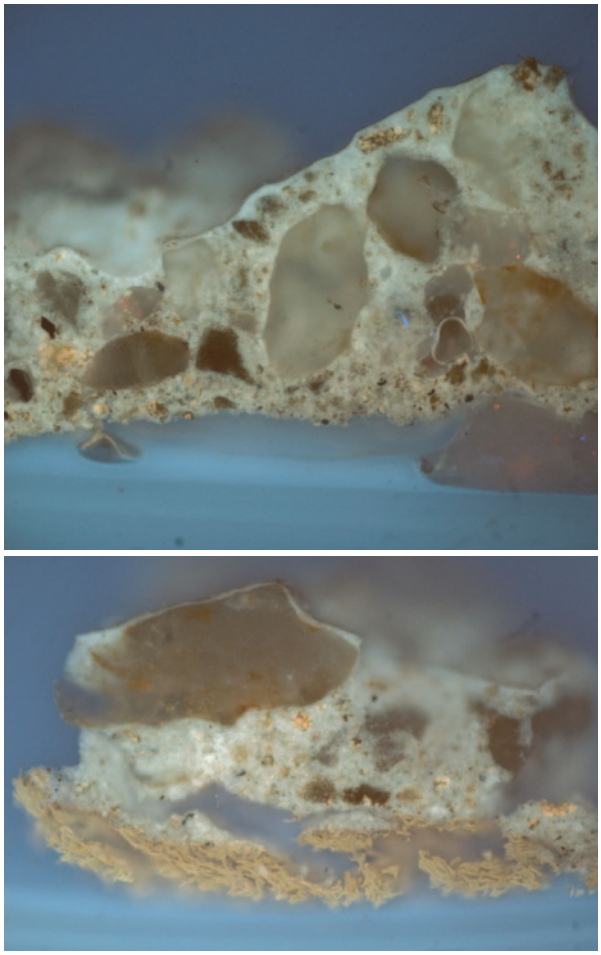
Attic - Sample Location Images

Cross-section Microscopy Results

Sample DD 21: Sample from underside of board between 10th and 11th rafters, counting from the north end, top board on west slope, taken from the edges



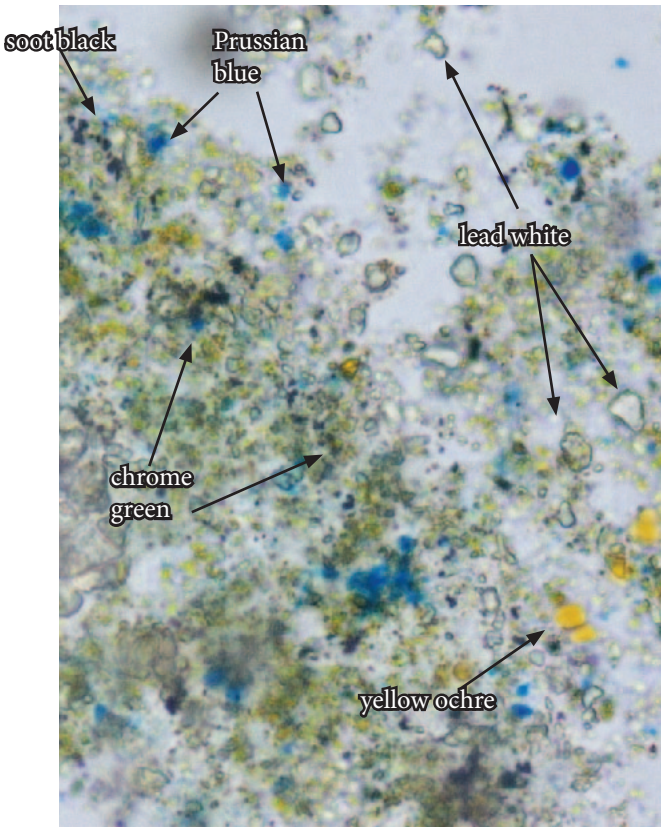
DD 21a (bottom, 100x), 21b (top, 100x), visible light



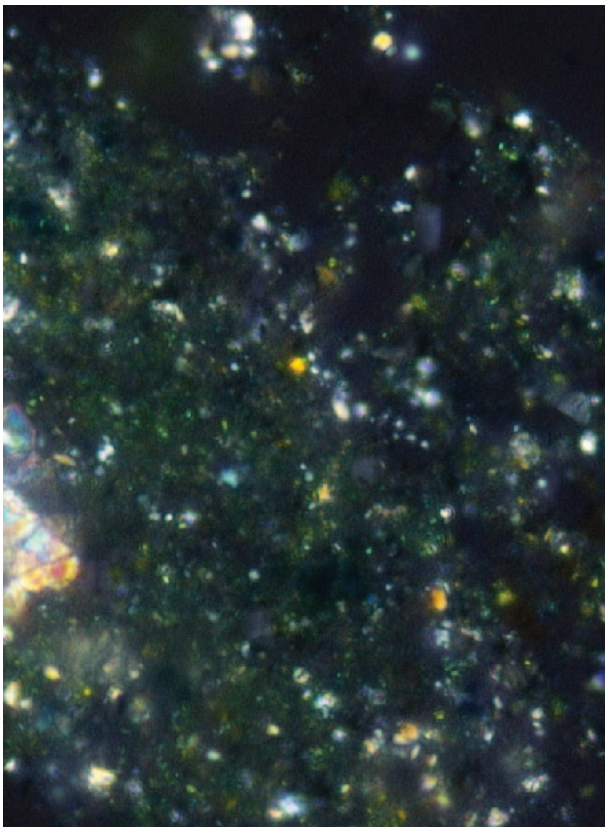
DD 21a (bottom, 100x), 21b (top, 100x), UV light

Pigment Identification Results

Sample DD 1: Generation 1 Green Paint (may also contain some pigments from gray primer).



DD 1, green paint pigments, PPL, 1000x



DD 1, green paint pigments, XPL, 1000x

Pigment particles from the first generation green paint were collected with a clean scalpel blade, dispersed on a glass slide, and mounted in Cargille meltmount (RI=1.662). Examination under plane and cross-polarized light identified the presence of lead white ($2PbCO_3 \cdot Pb(OH)_2$), Prussian blue ($Fe_4[Fe(CN)_6]_3$), chrome green (mixture of Prussian blue and chrome yellow ($PbCrO_4$), yellow ochre ($Fe_2O_3 \cdot nH_2O$), and soot black (C) pigment particles.

Lead white particles were observed to be rounded, colorless grains, ranging in size from 1-3um, with high relief and RI > 1.662. Birefringence was strong with second and third order jewel tones observed. Extinction was complete.

Chrome green is a mixture of Prussian blue and chrome yellow pigment. Prussian blue particles were observed to have a deep blue color, an amorphous shape with low relief (no strong boundaries), and RI < 1.662. This pigment is isotropic (dark) in crossed polars. The chrome yellow pigment appears mostly green in color, suggesting an intimate mixture of the two pigments. Particle size was very small, ~1um, with high relief and RI > 1.662. Birefringence was strong with greenish polarization colors.

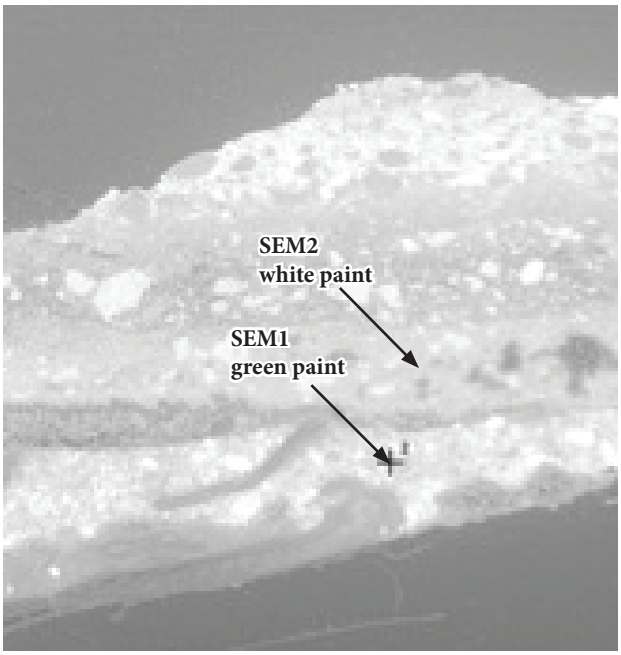
Some yellow iron oxides (yellow ochres) also appear to be present. These particles were yellow to brownish-yellow in color, with a range of particle sizes, low relief, RI > 1.662. Some phases were birefringent

(yellow mineral goethite) while others were isotropic, which is typical of ochres.

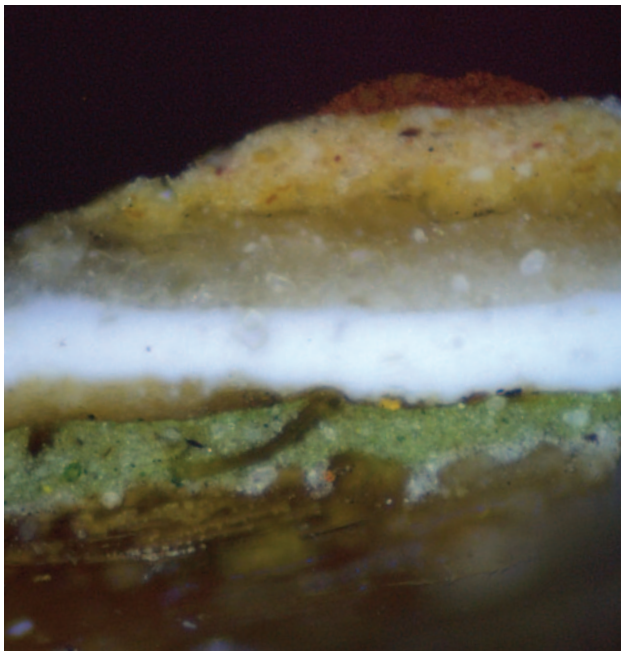
Soot black was identified as small (1um), rounded, opaque black grains that was isotropic (dark) in crossed polars. This is consitent for a carbon-based black. The identification of soot black was made based on the small and narrow particle size distribution (charcoal and other carbon-based blacks typically exhibit a range of sizes with shard-like shapes).

SEM-EDS Results

Sample DD 17: Generation 1 Green Paint



DD 17, SEM-BSE image, 420x



DD 17, visible light, 400x (enlarged)

SEM 1 - gen. 1 green paint	
Element	**Wt. Conc.**
Carbon (C)	26.06
Oxygen (O)	15.65
Lead (Pb)	54.96
Zinc (Zn)	**1.23**
Calcium (Ca)	1.56
Chromium (Cr)	**0.55**

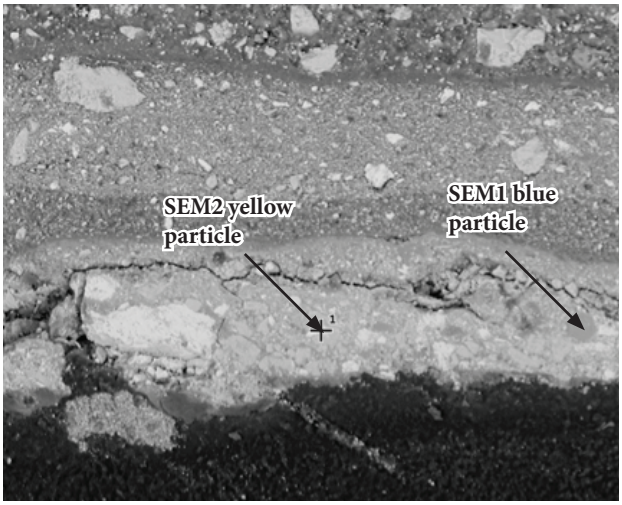
SEM 2 - gen. 3 white paint	
Element	**Wt. Conc.**
Carbon (C)	36.29
Oxygen (O)	22.28
Zinc (Zn)	**25.78**
Barium (Ba)	**12.74**
Sulfur (S)	**2.26**
Calcium (Ca)	0.31
Silicon (Si)	0.33

SEM-EDS analysis of a spot in the center of the green paint layer detected mostly carbon and oxygen, ubiquitous elements which originate from the combination of binding medium (most likely oil), and pigments. The element calcium probably originates from chalk ($CaCO_3$), a common inert filler in housepaints. The presence of lead, chromium, and zinc are significant. Lead and chromium confirm the presence of chrome yellow, also identified with PLM (p. x). This pigment was introduced in the second decade of the 19th c. The presence of zinc, although small, suggests the presence of zinc oxude, also known as zinc white (ZnO), which was not introduced to housepaints until c.1845. This suggests that the first green paint generation is 1845 or later.

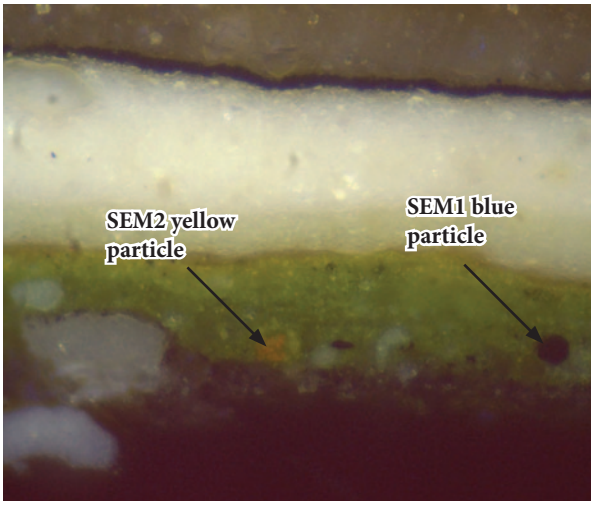
The third generation white paint used throughout the house contains zinc, barium, and sulfur. This combination suggests the presence of a mixture of zinc white (ZnO), and barium sulfate ($BaSO_4$), or the pigment lithopone ($ZnS + BaSO_4$). Also known as "Orr's zinc white", lithopone was patented in 1874.

SEM-EDS Results

Sample DD 1: Generation 1 Green Paint



DD 1, SEM-BSE image, 1000x



DD 1, visible light, 400x (enlarged)

SEM 1 - dark blue pigment particle	
Element	**Wt. Conc.**
Carbon (C)	26.68
Oxygen (O)	12.57
Nitrogen (N)	**8.71**
Lead (Pb)	38.50
Iron (Fe)	**8.65**
Aluminum (Al)	1.01
Potassium (K)	0.72
Zinc (Zn)	**0.97**
Barium (Ba)	1.99
Silicon (Si)	0.21

SEM 2 - yellow pigment particle	
Element	**Wt. Conc.**
Carbon (C)	11.62
Oxygen (O)	11.24
Lead (Pb)	**72.23**
Potassium (K)	1.81
Chromium (Cr)	**2.17**
Zinc (Zn)	**0.93**

The elemental analysis of the green paint in sample DD 1 gave similar results as sample DD 17 (previous page). The complete analysis is found in the attached appendix. The dark blue particle was confirmed as Prussian blue ($Fe_4[Fe(CN)_6]_3$) based on the presence of iron and nitrogen. This confirms the PLM findings. A small amount of zinc was again detected in this layer.

Elemental analysis of a large yellow particle in the first generation green paint detected lead and chromium, again confirming the presence of chrome yellow pigment ($PbCrO_4$). A small amount of zinc was detected in this layer, as well.

Conclusions

The samples collected from the Digges House contained excellent evidence that both confirmed and challenged the theories put forward in previous investigations.

Approximately twenty-five total paint generations were identified throughout the house. The first five paint generations were the most helpful comparisons, and are summarized in the table below.

Table 5. Digges House Early Paint History

Paint Generations 1-5	Rooms			
	Stair Passage	**Re-used Door Leaf**	**North Room (mantel not incl.)**	**South Room (mantel not incl.)**
5	wood-graining finish	wood-graining finish	W window top and bottom sash installed in this period. All woodwork painted with wood-graining finish	wood graining finish
4	tannish, translucent layer	tannish, translucent layer	tannish, translucent layer	tannish, translucent layer
3	Stringer and balusters installed in this period. All painted with white paint, contains zinc, c.1845 at earliest.	door painted with white paint, contains zinc, c.1845 at earliest.	both architraves and E top sash painted with white paint, contains zinc, c.1845 at earliest.	E window arch. and top sash painted with white paint, contains zinc, c.1845 at earliest.
2	tall newel repainted green	door leaf repainted green	both architraves repainted green. E window top sash painted cream	E window architrave and top sash painted cream
1	gray primer and green paint on tall newel post. This paint contains chrome yellow and dates to the early 19th c.	gray primer and green paint on door leaf (not incl. area under removed hinge) This paint contains chrome yellow and dates to the early 19th c.	gray primer and green paint on E & W window architraves. E window top sash also orig., painted white	white primer (1a) blue paint (1b) on E. window architrave. E window top sash painted white

The most surprising finding was that most of the earliest elements shared a first generation green paint that contains chromium and a small amount of zinc. The presence of chromium indicates a chrome yellow pigment, introduced in the early 19th century (c.1814), while the presence of zinc indicates that a zinc-based pigment is present, which pushes the date of this layer back even farther, to c.1845. This is a much later date than was theorized for this woodwork.

However, the presence of a layer of grime on the wood in the sample taken from the stair newel post suggests that this green paint might have been preceeded by some clear coatings such as resins, oils, or waxes applied to the wood. This evidence was not found in any of the other samples but it does provide a plau-

sible explanation for the absence of 18th century paint.

The mantels in the north and south rooms did not contain the same early paints seen in the rest of the house. This is not uncommon, and is consistent with the practice of painting mantels differently from other woodwork in the same room. However, since these finishes are unique they could not be aligned to anything else in the house in any useful manner for dating purposes. It should also be mentioned that another interpretation is that these mantels were re-used from another building. Interestingly, the mantel in the north room contained far fewer finishes than the mantel in the south room.

The white material on the attic rafters was determined to be mortar, not limewash.

The HSR suggested that some of the baseboards were original, but these were examined on-site and there did not appear to be any traces of historic paint to sample.

A draft of the analysis findings was provided to E. Chappell on November 10, 2017. Please see Appendix B (p. 53) for his interpretation.

Appendix A. Sample Memorandum

October 7, 2017

To: Kirsten Moffitt and Susan Kern

From: Ed Chappell

Subject: Interior Paint Samples from "The Dudley Digges House", 524 Prince George Street, Williamsburg, Virginia

The following describes where we took samples today. I have noted your highly preliminary field observations.

20th century lobby west of south room

1. Georgian 4-panel door re-used in a west lobby. Face of re-used panel door, top ovolo of lower-left panel, 1" from the upper-left corner. This is probably a first-period door previously under the stairs, but we see no absolute evidence. You see what may be a brown paint below a green that seems to contain chrome yellow.
2. Same face of door, bottom of left stile 1/2"' from the bottom rail, 2" above floor. You see no indication of a dark base stripe.
3. The ghost of an upper HL hinge at the joint between the horizontal and vertical arm. This misses early layers. We think the door was rehung with butt hinges and the H: may have survived until c. 1930.

North first-floor room

The two windows in the north room both have what we think are original single architraves. The upper sash in both windows have wide muntins. The mantel is clearly neoclassical (19th c.)

4. West window, convex surface of north (right) cyma backband, 2' below the upper corner. Earliest layers look cream and blue.
5. Same window, lower 2nd period sash, south (left) stile, face, 1' below top rail
6. Upper sash, west window, south (left) stile, face next to ovolo 1'6" below top rail. You think you see blue rather than green over a cream.
7. East window, upper sash, north (left) stile, 1'4" below rail.
8. East window, north (left) architrave, on bead 2'2" above sill
9. Mantel, convex part of cyma above the left pilaster, above dentils, west (left) end. First layer looks white, before industrial paints.
10. Face of westernmost dentil above west pilaster.
11. Same mantel, west pilaster, face of reeding, at center, 2' above floor.
12. Same mantel, upper left corner of fascia board above hearth.

South first-floor room

Like the mantel in the north room, the mantel in this room is clearly neoclassical.

13. Mantel, west (right) convex pilaster cap, east (inner side). Earliest layer looks black, followed by graining.
14. Same mantel, recessed face of east (left) pilaster at upper-left corner. Same.
15. East window, face of architrave against backband, 1'1" below head. Looks like blue over white.
16. East window, upper sash, north (left) stile, 1'2" below top rail. White or off-white followed by graining. In form, this resembles the second-period sash in the north room.

Passage

We carefully looked at the stair and found it confusing. The first four posts look battered and ancient. The tall, full-height second post has multiple paint layers and it looks superficially like walnut. But the equally early-looking third post may be poplar. The second, third, and fifth sections of handrail appear early, battered, and bug-eaten, but their wood resembles poplar and they have few layers of paint. The rectangular balusters appear much later. However, the stringer cap with its flaking ovolos looks old, caked with paint, and probably made of pine.

17. Tall second post, east (front) face at the outer corner, 3'6" above the lower floor. First layer appears green.
18. Stringer cap, long first run, north face 4'2" above the floor.
19. Nineteenth baluster, south face, immediately below the handrail.
20. Third section of handrail, north fascia just below torus, where it meets the 4th post.

Attic

The white boards used as roof sheathing c.1930 are hard to understand. Neither the white side nor the unblemished side show the outline of joists, studs, or other framing. The white material looks more like mortar than whitewash.

21. Sample from underside of board between 10th and 11th rafters, counting from the north end, top board on west slope, taken from the edges.

Future Work

It would be worth trying to learn the early exterior paint on the two original sash and beaded exterior frame in the north room, although they are heavily weathered. That on the east is easily accessible from the outside. That in room 102 west of the original north room was inaccessible today and may be blocked. The rear face of the early door leaf is now also inaccessible.

Appendix B. Post-Analysis Memorandum

November 14, 2017

To: Susan Kern and Kirsten Moffitt

From: Edward Chappell

Subject: Review of Kirsten Moffitt's "Finishes Analysis Report: 'Dudley Digges House', 524 Prince George Street, Williamsburg, Virginia", 2107, and the Question of Construction Date

Kirsten and Susan,

Kirsten's report on her findings at the Prince George Street house is excellent. She carefully selected the locations for microscopy samples based on thorough Dermlite-aided examination of all the early woodwork we can recognize in the house, and her analysis and presentation are up to her high standard.

Analysis of Earliest Finishes and Evidence for Construction Date

She found that the earliest finish paint in the north first-floor room and stair passage was a hand-ground green over a gray primer, and that in the south room was hand-ground blue over a white primer.[1] These include the elements that look most convincingly first-period: the stair, a small Georgian paneled door that probably cane from the passage, and Roman window architraves. The interior surfaces of the earliest sash in both rooms were first painted white or off-white. The sash could be first-period or early additions. I am less certain about the provenance of the two Neoclassical mantels, and I have not read her findings on them closely enough to understand when their layers begin to align with paint on other old elements.

Her findings concerning the early green is consequential for a date. She clearly found chrome yellow pigment in the earliest green, indicating that it probably postdates c. 1814. More surprising is her finding of zinc in two of the green samples. Zinc white was first used c 1845.

We sought to do dendrochronology with Mick Worthington, but he found that the accessible elements of framing were pine, too rapidly-grown for him to date. This is unusual among pre-Revolutionary Williamsburg buildings, and it may imply a post-Rev date.

Hardware helps a bit. The only surviving early door was hung on HL hinges. These were used throughout the 18th century. They began to be replaced with butt hinges c 1790s but continued in use for refined doors into c 1820s. It is very unlikely they were installed on a door like this as late as the 1830s.

Given these findings, what do we now think about the date of construction? Just based on the character of the woodwork, I have suggested that it could be as early as the 3rd quarter of the 18th century. This would require the mantels to have been added and perhaps the sash updated. My sense of the sash is that the muntins have Georgian profiles (relatively wide ovolos and fillets relative to their depth), but they are thin for the 1760s or '70s. They could be 1790-1820 but certainly not 1845 and later.

The window architraves, stair rails and moldings, and the door leaf could be as early as c 1750 or as late as the first two decades of the 19th century, when Neoclassical shapes were fashionable but many Chesapeake

[1] Our directions refer to the rooms as they now stand, with the right-hand room located on the north, toward Prince George Street, rather than as the house originally stood.

builders continued producing the old forms. Looking for locations to sample, we increasingly recognized that parts of the stair were replaced, matching the old sections.

Closely read, Kirsten's report offers an indication that the green paint is somewhat later than the woodwork to which it was applied. The tallest newel post, near the back of the passage, revealed grime over evidence for a clear coating such as varnish or oil under the green. She found this only on the one post, but if the green on this post is later than construction, the same green elsewhere is also later. A pre-Revolutionary construction date nevertheless seems increasingly unlikely.

Second-period Paint

Assuming the earliest sash and their earliest paint are original, it is interesting that their interior color contrasts with that on other first-period woodwork. The variation appears to have developed further when the window architrave too in the south room was repainted white.

Linking Woodwork to Spaces

The analysis is useful in identifying paint on the recycled early door as matching that on first-period woodwork elsewhere in the house. This assures us that it is from this house, apparently from the passage. Early layers on the two Neoclassical mantels are more ambiguous. They may indicate the mantels were brought in from elsewhere, but I have not tried to understand this in detail. In form, the mantels look later than the door, windows, and stair.

Construction Debris

Occasionally we encounter unexpected glimpses into early construction methods. Both Kirsten and Susan Buck read the gritty white material on roof sheathing boards in the Prince George Street attic as thicker than paint and more like mortar than limewash. At first glance they resemble whitewashed floorboards or sheathing, but they show no marks from joists, studs, or rafters. This combined with the coarse aggregate suggests to me that they come from a construction site where masonry was underway, probably from a scaffold or muddy ground. The only masonry above foundations at the Prince George street house were the two chimneys. One might be able to judge whether the mortar predates the mid-nineteenth century.

Future Work

More analysis is not essential at this time, but it could be useful to pursue the study now to another stage, best done while we are focused on the house.

I have suggested that it would be useful to look at the exterior of the window sash and the beaded northwest window frame. While such sash and frames are often heavily weathered, we have had some luck studying sash, and learning the exterior finish of another early Williamsburg house would be worthwhile. At the same time, looking a little further at the green-painted interior woodwork could help clarify the degree to which grime and/or a clear finish is present on the surface on the substrate.

Frankly, I would be pleased for Kirsten to explore whether or not there actually is zinc in the green paint or if the layer was contaminated.

A brief comparison of the mortar-like material on the roof boards with early Williamsburg mortars would also be worthwhile.

Conclusion

In summary, the analysis suggests a somewhat later construction date, possibly c 1810s or '20s. But we can feel that the nature of the house is now better understood. It remains an important survivor from early Williamsburg, even if it turns out to be too late for the Bray School. As you have said, we have fewer c 1820 Williamsburg buildings than pre-Revolutionary ones, and the attention that Terry Myers has drawn to the building helps us ensure that it survives into the future. It deserves gentle handling.

E.A.C.

Appendix C. Information Provided by Visible and Ultraviolet Light Microscopy

When examining paint cross-sections under reflected visible and ultraviolet light conditions, a number of physical characteristics can be observed to assist with the interpretation of a paint stratigraphy. These include the number and color of layers applied to a substrate, the thickness or surface texture of layers, and pigment particle size and distribution within the paint film. Relative time periods for coatings can sometimes be assigned at this stage: for instance, pre-industrial-era paints were hand ground, lending them a coarse, uneven surface texture with large pigment particles that vary in size and shape. By contrast, more "modern", industrially-prepared paints have smoother, even surfaces and machine-ground pigment particles of a consistent size and shape. Furthermore, the presence of cracks, dirt layers, or biological growth between layers can indicate presentation surfaces and/or coatings that were left exposed for an extended period of time.

Under UV light conditions, the presence and type of autofluorescence colors can distinguish sealants, clear coatings, and binding media, from darker dirt or paint layers within the stratigraphy. For instance, shellacs exhibit a distinct orange-colored autofluorescence, while natural resins (such as dammar and mastic), typically fluoresce a bright bluish-white color. Oil media tends to quench autofluorescence, while most modern, synthetic paint formulations (such as latex) exhibit little to no fluorescence at all. Some pigments, such as verdigris, madder, and zinc white, have distinct fluorescence characteristics, as well. UV light microscopy is critical to help distinguish otherwise identical layers often found in architectural samples- such as successive varnishes, or multiple layers of unpigmented (white) limewash.