

## **Cross-section Paint Microscopy Report Exterior Paints**

### **Cupola House The Cupola House Association Edenton, North Carolina**

---

For: Tom Newbern  
Chair, Cupola House Preservation Committee  
408 Broad Street  
Edenton, SC 27932

Conservator: Susan L. Buck, Ph.D.  
303 Griffin Avenue  
Williamsburg, VA 23185

Date: October 6, 2018

HABS, Thomas T. Waterman, Photographer, 1939



#### **Purpose:**

The goal of this project is to investigate the evidence for early exterior and interior paints at the 1758 Cupola House using optical microscopy analysis techniques. This investigation will contribute to a better understanding of the surviving paint evidence, and may provide insights into the earliest paints on the woodwork in the first-floor rooms which are now installed in the Brooklyn Museum. Where the original paints can be identified they will be color-matched for replication and documentation using a tristimulus colorimeter/microscope.

## **Procedures:**

The samples were removed during one trip to the site on August 28 and 29, 2018. The history of the building and the potential sample sites were reviewed with Cupola House Preservation Committee members Denny O'Neill, Tom Newbern, and Don Jordan, and Board Chairman Key Stage. Reid Thomas, Restoration Specialist in the North Carolina State Historic Preservation Office, later joined the discussions and participated in the research. Forty small samples (about 300 microns in size) composed of wood fibers or plaster and attached paint layers were removed with a microscalpel after examining the painted surfaces with a 30X monocular microscope. Most of the exterior samples were taken from protected areas not directly exposed to weathering or light damage.

At the lab the samples were first examined at 45X magnification with a binocular microscope and the best samples were selected for analysis. The samples were sorted to determine the most relevant and complete samples which might answer many of the questions posed by the Preservation Committee, within the constraints of the proposed budget of 18 cross-section samples. This group of samples was cast into polyester resin cubes for permanent mounting. The cubes were ground and polished for cross-section microscopy analysis and photography. The sample preparation methods and analytical procedures are described in the reference section of this report.

The cast samples were analyzed with a Nikon Eclipse 80i epi-fluorescence microscope equipped with an EXFO X-Cite 120 Fluorescence Illumination System fiberoptic halogen light source and a polarizing light base using SPOT Advanced software (v. 5.1) for digital image capture and Adobe Photoshop CS for digital image management. Digital images of the best representative cross-sections are included in this report. Please note that the colors in the digital images are affected by the variability of color capture and printing and do not accurately represent the actual colors.

## **Background:**

The house was built in 1758 and has undergone substantial changes since that time, the most dramatic of which was the 1918 sale of the first-floor woodwork (including the front door) by the last member of the Dickenson/Bond family who owned the house, to the Brooklyn Museum. This sale galvanized the Edenton community which raised funds to purchase the house and it was eventually established as a protected property under the auspices of The Cupola House Association. In the 1960s this enterprising group funded the replication and installation of woodwork in the first-floor passage and the two south rooms, after which the house was reopened as a museum. The source of the current replicated first-floor woodwork paint colors is not documented. Lisa Bruno, Carol Lee Shen Chief Conservator at the Brooklyn Museum, believes that no paint analysis has ever been done on their Cupola House rooms, based on the absence of any records in their files.<sup>1</sup>

---

<sup>1</sup> Lisa Bruno, email communication, September 4, 2018

A photograph dated approximately 1918 shows the house had not been painted in many years as the paints have almost completely weathered away in the most exposed areas. There seem to be traces of light-colored paints on the brackets for the overhang on the south elevation, on the pediment of the porch, and on the weatherboards protected by the porch. This porch was added to the house in 1819.<sup>2</sup> The shutters are quite dark in this image, and they are in obvious disrepair. The finial at the top of the roof pediment on the south elevation appears relatively intact.

Cupola House, ca. 1918



[CupolaHouse.org/history/php](http://CupolaHouse.org/history/php)

The original rusticated siding on the house was likely replaced with the current weatherboards around the first quarter of the nineteenth century or up to the 1830s.<sup>3</sup> Some of the original siding was reused in the roof structure of the porch. These boards are not easily accessible. There is ongoing research into the structure and configuration of what is believed to have been the original walkway around the cupola.<sup>4</sup> This research was pursued during the August site visit with NCSHPO restoration specialist Reid Thomas, architectural historian Edward Chappell and Don Jordan.

Research was done by Colonial Williamsburg staff, perhaps in the 1970s into paint colors for the second-floor chambers and passage. Edward Chappell thinks that this work was conducted by Colonial Williamsburg architectural historian Paul Buchanan, as he recognized the handwriting on the notes accompanying the samples. Buchanan retired

---

<sup>2</sup> Reid Thomas, "Recent Discoveries", CupolaHouse.org, February 11, 2013.

<sup>3</sup> Reid Thomas, email communication, October 15, 2018.

<sup>4</sup> Reid Thomas, "Recent Discoveries", CupolaHouse.org, February 11, 2013.

from Colonial Williamsburg early in 1980. The samples consist of woodwork fragments and paint scraping attached with the earliest paint side down to small pieces of glass with duct tape. The notes suggest that the earliest paints in the rooms were identified based on colors in the Colonial Williamsburg commercial palette at that time. For example, the second-floor southeast room woodwork paint color is labeled Williamsburg Raleigh Tavern Green and Wigmakers Shop Green.<sup>5</sup> Photographs of the hand-written notes, reference drawings and the samples are included in Appendix A of this report. These samples were taken back to the lab for review and comparison with the cast cross-sections analyzed for this project.

The building was photographed for the Historic American Buildings Survey (HABS) in 1939 by preservation architect Thomas T. Waterman. Elevations and floor plans were completed by a HABS team in 1940. Some of those photographs and drawings are included in this report as references.

HABS, Thomas T. Waterman, South and East Elevations, 1939



---

<sup>5</sup> Denny O'Neill, memo, February 2017.

## **Exterior Paint Analysis Results:**

This investigation of the paints remaining on selected areas of the interior and exterior of the 1758 Cupola House in Edenton, North Carolina was initiated in August 2018. When the fragile paints clinging to some of the detached architectural elements in the collection of the Cupola House were examined at 10X with an illuminated loupe (Dermlite DL100), it appeared that there were early paints remaining which might help to place these elements into better context and provide insights into alterations to the building.

The paints on some of the fragments did not initially look promising, and many of the surfaces of the weatherboards and trim *in situ* are deeply fissured and cracked, suggesting the early paints had completely weathered away in exposed areas. The wood substrates of a section of rusticated siding and a bolection molding are fissured and grimy from weathering, but the initial examination suggested there were thick accumulations of aged coatings on the edges and in the crevices. Small samples were removed with a scalpel for cross-section microscopy paint analysis with the hope of gleaning more information about the paints remaining on the detached exterior fragments and their original appearance, and how they might relate to the paint evidence remaining in context on the building.

The presentation of the exterior paint analysis results begins with the exterior of the building, followed by the evidence found on a selected group of fragments. Samples were also taken from the interior and exterior of the cupola itself. These cupola samples are less promising, so they were set aside and may be analyzed at a later date.

### Cupola House Exterior

Nine samples were removed from the exterior of the building to search for the earliest paints on the original wood trim like the brackets, and in the accumulations of material which seem to be overlaps of paint from the original rusticated siding onto adjacent window architraves. The current weatherboards were also sampled to establish the paints that post-date their installation. Samples S-2, S-4, S-5 and S-8 were selected for cross-section analysis after screening of this group of nine exterior samples at 45X magnification with a binocular microscope.

The samples taken from the thick paint overlaps from the rusticated siding onto the sides of the window architraves were not analyzed in cross-section as examination at low magnification indicated that these accumulations are primarily degraded putty fill material, not early paints. Photographs of all nine sample locations are included for reference.

South Elevation Sampling Overlap of Siding Paints onto Window Architrave  
Reid Thomas Photograph



Cupola House Exterior Sample Locations

S-1. South elevation, west side, soffit of overhang.

S-2. South elevation, west side, bottom molding of cornice of overhang above west window.

S-3. South elevation, west side, west window, top right corner of architrave.

S-4. South elevation, weatherboard just right of west window.

S-5. South elevation, west side, side of bracket

S-6. South elevation, west side, collection of paints overlapped onto window architrave, possibly from original rusticated siding.

S-7. South elevation, on pediment of porch cornice, top left corner.

Shutter-8. Detached shutter, right side of panel, at join with right stile.

N-9. No sample.

N-10. North elevation, side of window architrave for window just west of door, filler along edges with overlap from rusticated siding.



South Elevation West Side



Sample S-5



Samples 1 through 4



Sample S-6



Sample S-7



Sample Shutter-8



N-10



Exterior Trim and Siding Paints. Most of the paints on the exterior trim, pediment and weatherboards are varying shades of off-whites and cream colors which are difficult to confidently distinguish in reflected visible light. However, many of these paints have distinctive autofluorescence colors in the reflected ultraviolet light cross-section images. The earliest white lead and linseed oil-based paints have a characteristic pinkish-yellow autofluorescence which is readily discernible in this group of samples. Paints with zinc white, a pigment commercially available for architectural paints after about 1845, have a characteristic sparkly bluish appearance in reflected ultraviolet light. Paints containing titanium white, a tiny bluish-white pigment commercially available after about 1920, typically have a pale bluish or grayish autofluorescence.

These differences in autofluorescence make it possible to locate where the earliest white lead-based, cream-colored and off-white paints survive, and to reconstruct an early paint chronology for the exterior of the building.



The most complete cross-section is S-5 from one of the brackets on the south. This element is original to the building and 21 generations of paint can be identified in the cross-section. But, only the first two white lead-based, cream-colored paints might date to the eighteenth century. These two paints are fragmentary, consisting of only two discrete lumps, and are surrounded by later paints which flowed into cracks. The third generation of paint is an off-white paint with a sparkly blue autofluorescence that marks the presence of zinc white, dating this paint to not before about 1845 when zinc white became commercially available. Most of the paint colors on this bracket are creams and off-whites, with the exception of more recent tan paints in generations 16 and 17, as shown in the photomicrographs below.

S-5. South elevation, west side, side of bracket.

Visible Light 100X



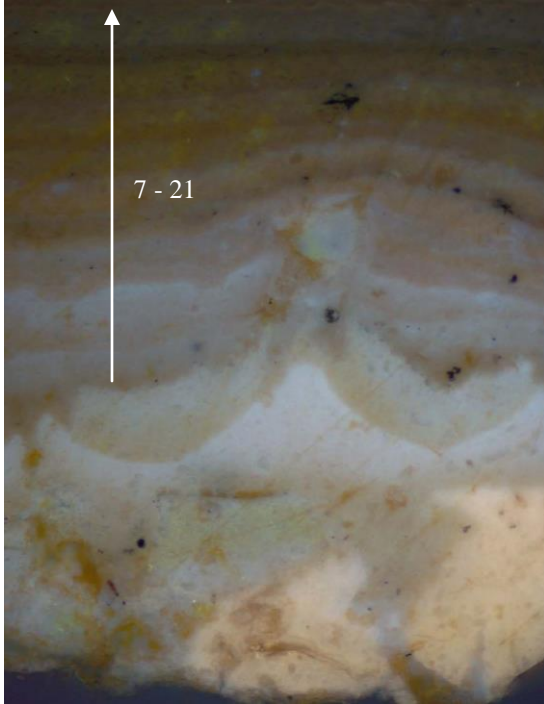
Ultraviolet Light 100X



Binding media analysis of sample S-5 shows that all the paints contain oil components. There are carbohydrate components in generations 7 through 21 which could be organic additives to thicken or toughen the paint (such as natural gums and casein) or cellulosic fillers. The paints in generations 15 through 21 contain protein components, likely surfactants (with amine groups) added to these modern paints to improve their wetting properties. Polarized light microscopy pigment identification of the components in the first cream-colored paint could not be done with confidence because this paint layer is so fragmentary and compromised by penetration of later paints into the cracks in the earliest layer (at the bottom of the cross-section).

S-5. South elevation, west side, side of bracket.

UV Light & TTC for carbohydrates 100X  
+ reactions in generations 7 – 21

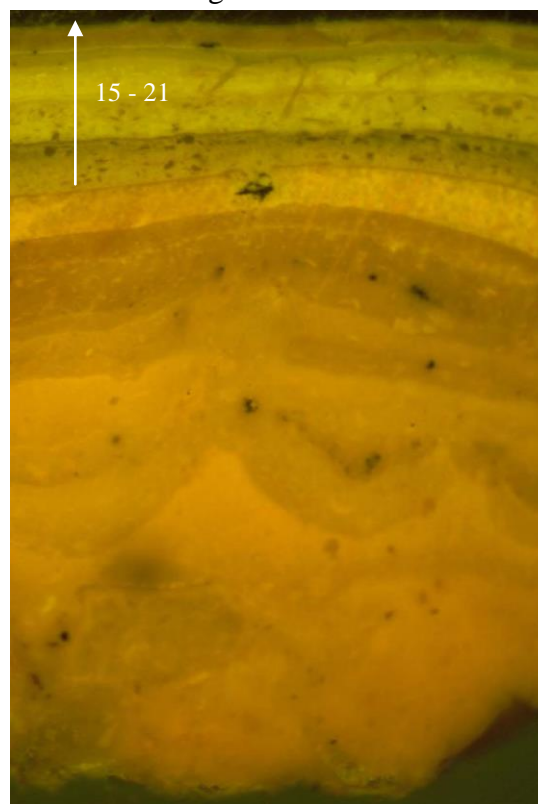
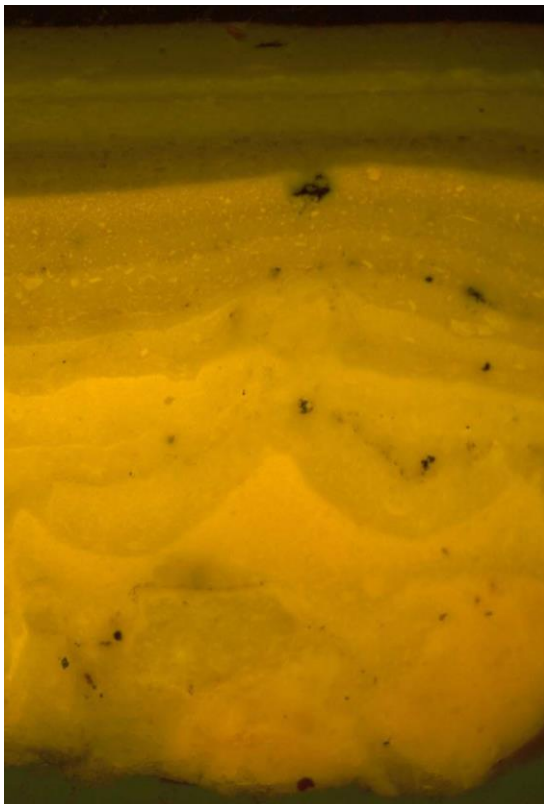


B-2A filter 100X

UV Light & DCF for lipids (oils)  
+ reactions in all paints



B-2A filter & FITC for proteins 100X  
+ reactions in generations 15 - 21



The paint histories are less complete in sample S-1 from the soffit of the overhang on the south elevation and in S-4 from the 1810-20 weatherboard. But, the paint histories can be aligned for comparison in the chart below. This comparative table suggests that most of the earliest paint evidence was lost from weathering, and then perhaps from later paint stripping. The first generation on the early nineteenth-century weatherboard seems to align with the second generation of cream-colored paint found on the bracket. This suggests that almost no eighteenth-century paint remains on the bracket or the soffit. Further research into the exterior paints on other protected original elements, like the roof soffit and the soffit of the cupola, might help to clarify and expand the layering sequence for the eighteenth-century exterior coatings.

Comparative Paint Stratigraphies on the Exterior Trim and Weatherboards

Generation/Layer	S-1. Soffit of overhang	S-4. Weatherboard	S-5. Side of bracket	Observations
21. Cream color	x	Light tan	x	
20. Cream color	x	x	x	
19. Cream color	x	x	x	
18. Cream color	x	x	x	
17. Tan			x	
16. Tan			x	
15. Cream color			x	
14. Off-white			x	
15. Cream color			x	
14. Off-white			x	
13. Off-white			x	
12. Off-white			x	
11. Off-white			x	
10. Off-white			x	
9. Off-white	x	x	x	
8. Cream color	Off-white	x	x	
7. Off-white		Dark cream color	x	
6. Off-white		x	x	
5. Dark cream color			x	
4. Off-white			x	
3. Off-white	x	x	x	Contains zinc white, post 1845
2. Cream color		x	x	Around first quarter of the nineteenth century
1. Cream color	x		x	Many of the eighteenth century exterior paints may be missing due to extreme weathering and/or removal prior to repainting

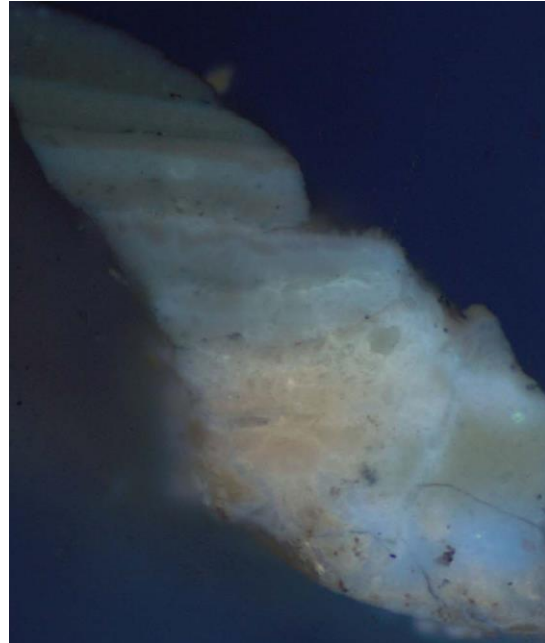
x = Layer is present

S-1. South elevation, west side, soffit of overhang.

Visible Light 100X

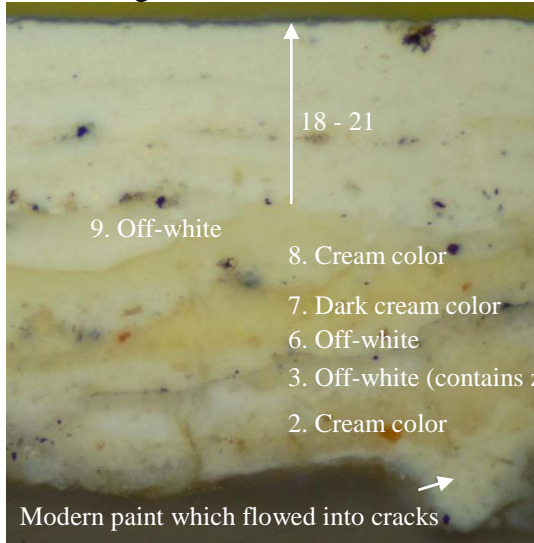


Ultraviolet Light 100X

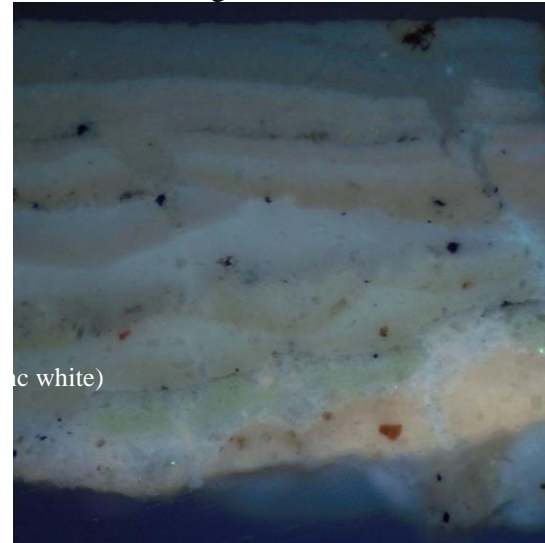


S-4. South elevation, weatherboard just right of west window.

Visible Light 100X



Ultraviolet Light 100X

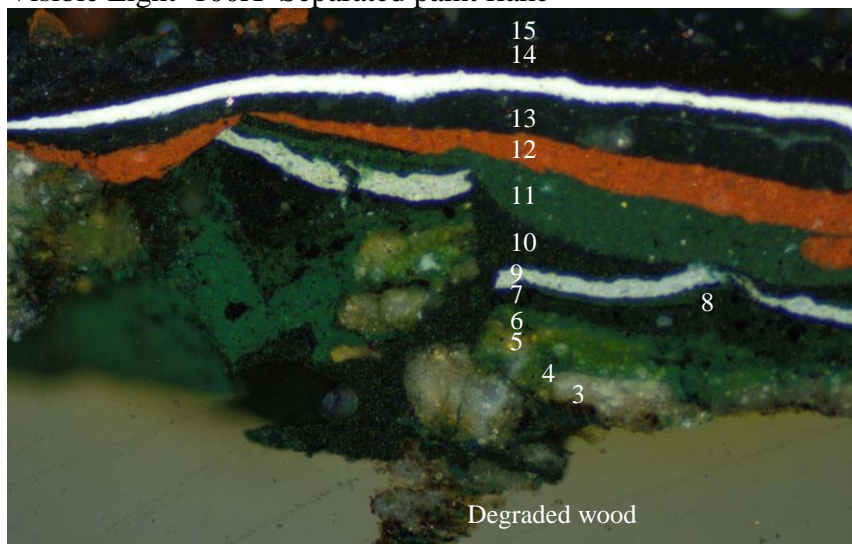




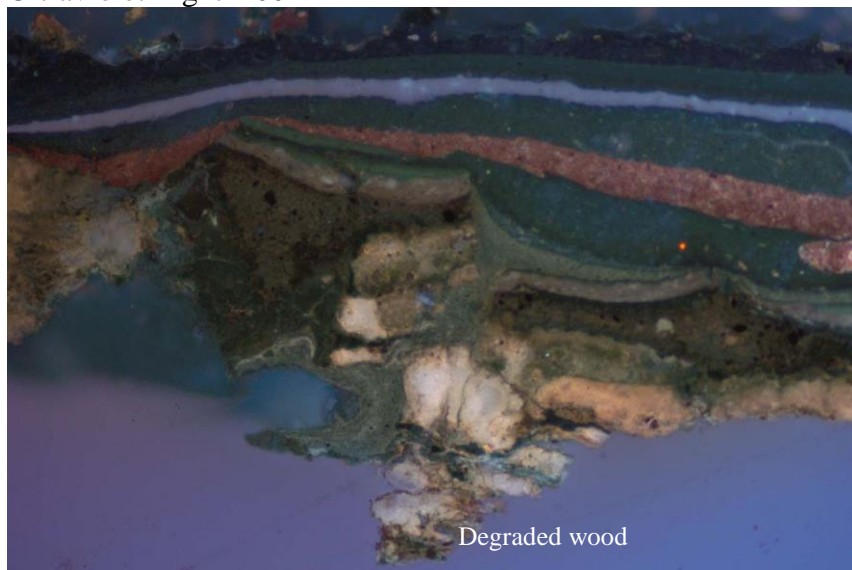
Shutter 8. Exterior shutter. There are at least fifteen generations of paint remaining on the shutter, but the wood substrate in this cross-section, and in the other uncast portions of the shutter samples, is extremely degraded. This suggests that virtually all the earliest paints completely weathered away before later repainting efforts. In sample “Shutter-8” there is clearly a long history of green paints which range from early bright greens to the most recent blackish green. The shutter was painted gray in generations 3 and 9, and deep red in generation 12. The earliest bright green paint in this cross-section can be aligned with the fourth generation of paint in sample 2 from the iron bar, so it has been labeled as generation 4 in this shutter sample. It is likely that the original paint on this shutter was green, but the earliest paints are too degraded and weathered to be confident about interpreting the original shutter color.

Shutter-8. Detached shutter, right side of panel, at join with right stile.

Visible Light 100X Separated paint flake

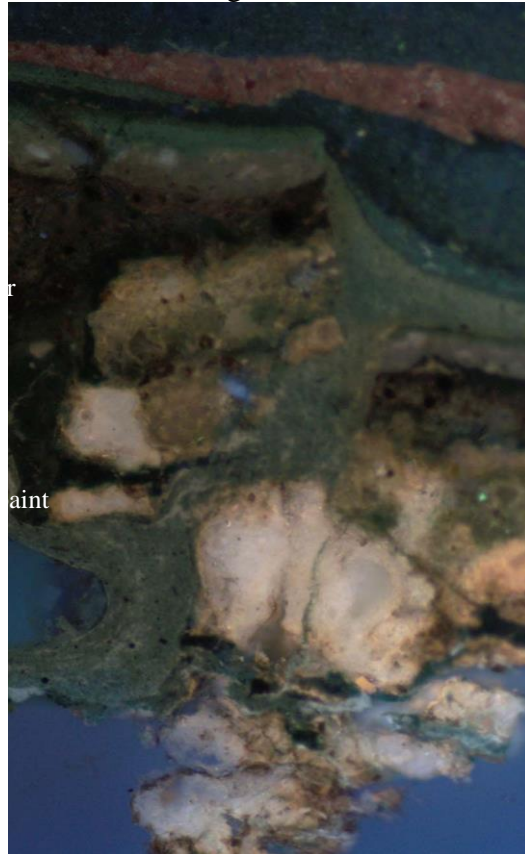


Ultraviolet Light 100X





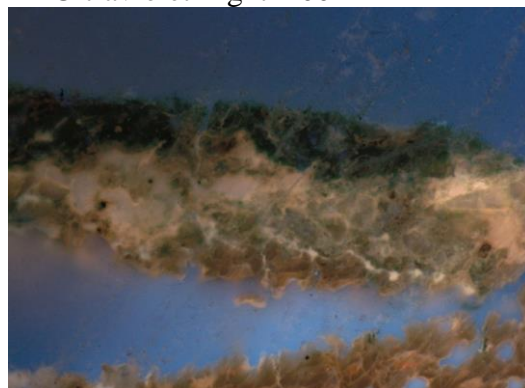
Shutter-8. Detached shutter, right side of panel, at join with right stile.  
Visible Light 200X Separated paint flake      Ultraviolet Light 200X



Visible Light 200X Substrate



Ultraviolet Light 200X



Cupola House Detached Exterior Fragments.

A group of architectural fragments was set aside for examination and sampling with the hope that these elements might retain intact early coatings. The original location of some of these elements is unknown, but ideally their paint histories might provide more context. Cross-section samples from five of the six elements are illustrated and described in this section of the report. Fragment sample 6 from the blue-green painted board was set aside for analysis at a later date.

Exterior Fragments Sample Locations

1. Shingle found trapped in second-floor kneehole attic, at edge of blackened coatings.
2. Iron bracing bar, possibly from cupola, greenish and whitish paints.
3. Cornice bolection molding fragment, along edges.
4. Exterior finial from pediment of cornice, south elevation, on side of carving.
5. Rusticated siding board from cupola, at edges.
6. Blue-green painted board with cut-out for molding.

Sample 1. Shingle.



Sample 2. Iron bracing bar detail



Sample 2. Iron bracing bar



Sample 4. Exterior finial; Sample 5. Rusticated siding; Sample 3. Bolection molding



Sample 6. Blue-green painted board from unknown location



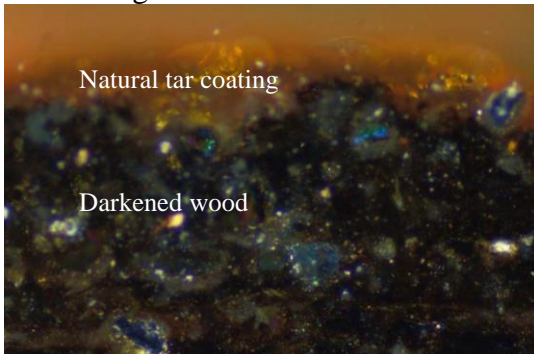


**Sample 1. Shingle.** The exposed end of this blackened shingle is fissured, charred and weathered, but there is an accumulation of slightly glossy, dark brownish material where two shingles overlapped at the top of the exposed end. This area was sampled for analysis and in cross-section the wood substrate is blackened and compressed, most likely from extreme heat exposure. There is an amorphous, translucent brownish coating on top of the wood surface which softened on exposure to the mineral spirits applied to the sample before cover slipping. Binding media analysis shows that there is oil in this brownish coating and in the wood. The appearance of the brownish coating in cross-section, and the presence of oils, is typical of an unpigmented, natural pine tar coatings which were traditionally heated with linseed oil or fish oil during preparation. So, optical microscopy analysis indicates that there is a natural tar coating on the shingle, but further organic materials analysis would be needed to confirm the presence of pine tar and other organic components.

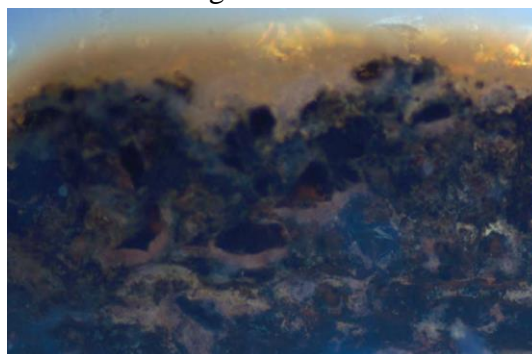


Sample 1. Shingle found trapped in second-floor kneehole attic, at edge of blackened coatings.

Visible Light 100X

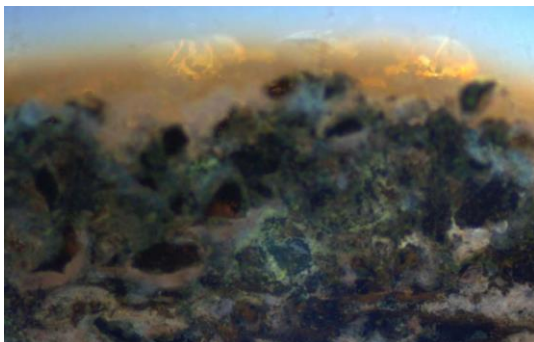


Ultraviolet Light 100X



UV Light & DCF for lipids (oils) 100X

Weak + reactions for oils in tar and in wood



**Sample 2. Iron bracing bar.** The paints on an iron bar that might have been part of the original cupola balcony structure are fragmentary and degraded by rust, but there are still islands of paint clinging to the iron substrate. Cross-section microscopy analysis shows there are four generations of paint remaining on the iron bar, each with films of corrosion and dirt on their surfaces. The earliest surviving paint is a coarsely ground cream color (at the bottom of the cross-section), followed by an off-white paint in the second generation, and then a coarse gray paint in the third generation. There are films of grit and rust between each of these paints. The most recent paint in this cross-section is a thick, coarsely ground, green paint. The bright green paint in this cross-section can be aligned with an early green paint on the shutter, which has been labeled generation 4 in shutter sample 8. The original cream-colored paint is white lead-based, and may relate to the earliest cream-colored paint found on the exterior bracket (sample S-5), but the cream-colored and off-white paints in this sample are too degraded to make a confident connection.

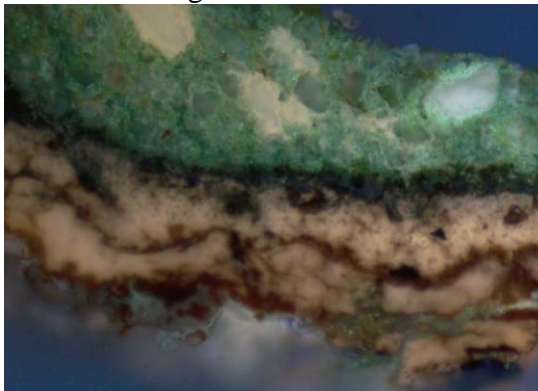
Binding media analysis with biological fluorochrome stains shows that all the paints on the bracing bar are oil-bound, and the fourth generation bright green paint contains protein components as well. The shape, size and morphology of the green pigments in the bright green paint suggest the presence of chrome yellow and chrome green, which dates this green paint to after about 1825 when chrome green became readily available. There is a thick layer of soot and dirt on the top of the third-generation gray paint, which indicates it was exposed for decades before being repainted bright green.

Sample 2. Iron bracing bar, possibly from cupola, greenish and whitish paints.

Visible Light 200X



Ultraviolet Light 200X

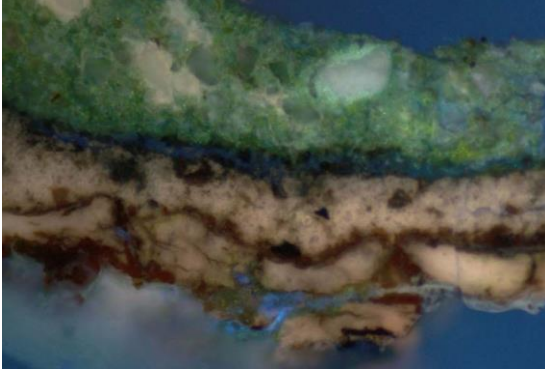




Sample 2. Iron bracing bar, possibly from cupola, greenish and whitish paints.

UV Light & TTC for carbohydrates 200X

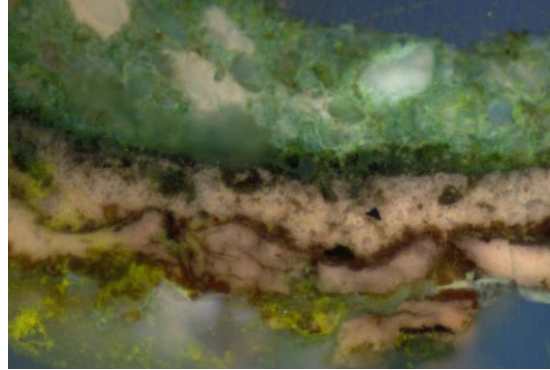
No reactions



B-2A filter 200X

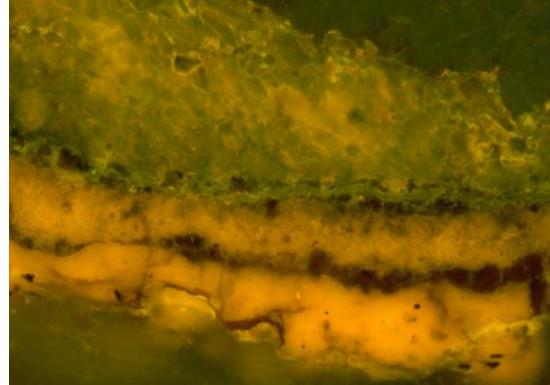
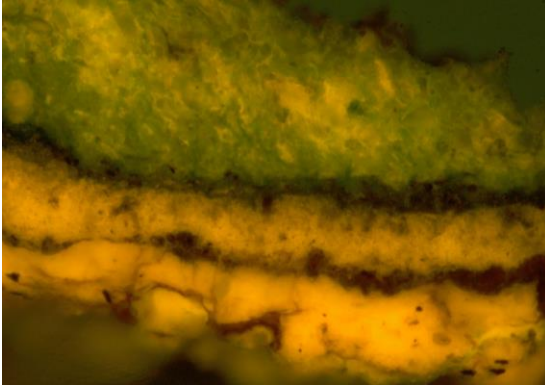
UV Light & DCF for lipids (oils) 200X

+ reactions in all paints



B-2A filter & FITC for proteins 200X

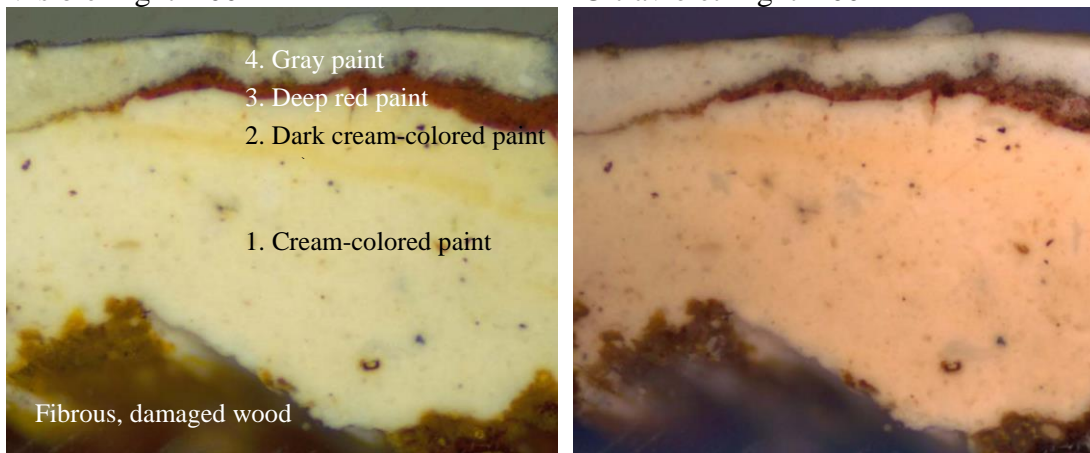
+ reactions in generation 4



Finial. The front of the original wooden finial for the roof pediment on the south elevation is eroded and stained, but there are small patches of aged paints on the sides of the carved decoration of the finial base. The paint chronology in the sample from one side is promising as there are four paint generations on top of the wood. However, in cross-section sample 4 the wood surface is eroded and fibrous, suggesting that the earliest paints completely weathered away before the first cream-colored paint was applied. This decorative element was repainted cream color in the second generation, and then it was repainted deep red in the third generation. The most recent surviving paint is light gray.

This paint chronology does not directly relate to the paints found on the exterior trim, although the two cream-colored paints are white lead-based, like the earliest exterior paints in sample S-5 from the bracket. A search of early photographs of the house may also provide clues about when the finial was painted a dark color, which could provide a date range for the deep red paint in generation 3.

Sample 4. Exterior finial from pediment of cornice, south elevation, on side of carving.  
Visible Light 200X                      Ultraviolet Light 200X



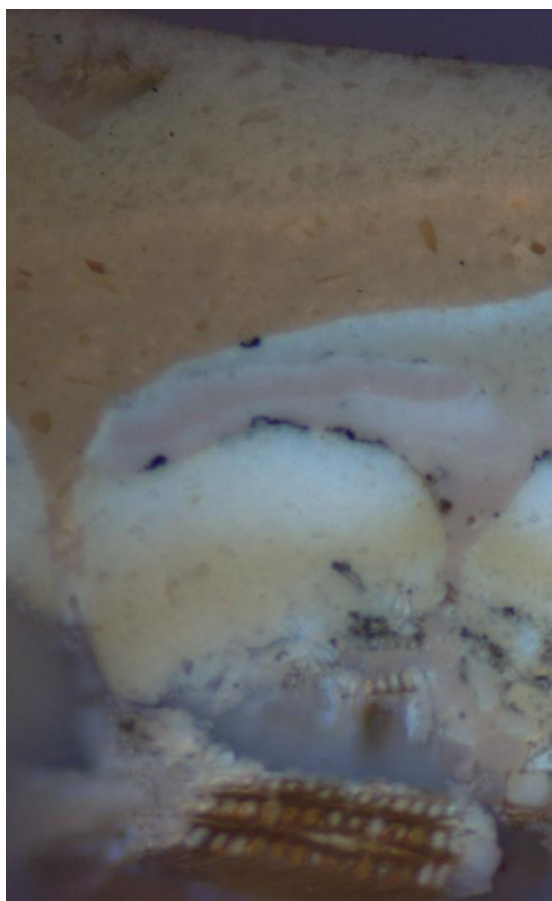
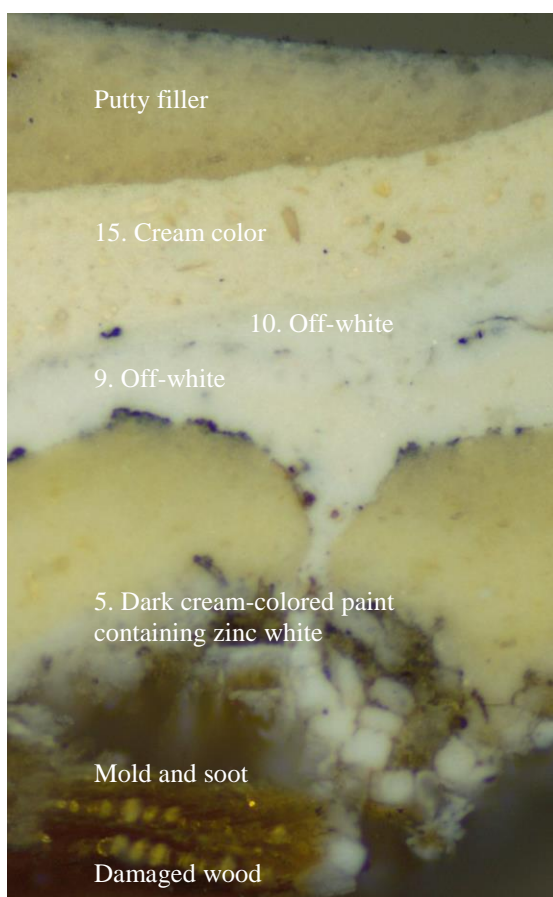
**Sample 5. Rusticated siding.** There are thick accumulations of weathered, discolored paints on the edges of the rusticated siding and bolelection molding which were sampled for cross-section microscopy analysis. At the bottom of the cross-section for sample 5 the wood substrate is disturbed and has blackish mold on its surface. These are clues that the original paint was allowed to weather away completely before the siding was painted dark cream color.

In the reflected ultraviolet light image the first dark cream color has a slightly sparkly bluish appearance, which is characteristic of paints containing the pigment zinc white. This particular pigment was not incorporated into architectural paints until after about 1845, which means that this cross-section does not retain the earliest paints applied to the siding. This dark cream-colored paint may line up with generation 5 in exterior sample S-5 from the bracket, and the later layers can be aligned with generations 9, 10 and 15.

Sample 5. Rusticated siding board from cupola, at edges.

Visible Light 200X

Ultraviolet Light 200X



Cupola Paints.

Four samples were taken from interior woodwork and flooring of the cupola, and three samples were taken from the trim and rusticated siding of the cupola. These samples were examined and screened at 45X magnification. None of them appeared to retain early coatings or complete paint stratigraphies, so they were set aside for possible future analysis.

Cupola Interior and Exterior Sample Locations

- C-1. Interior, window architrave, north window, left corner.
- C-2. Interior, cornice above east window, at bottom edge.
- C-3. Interior, chair rail, corner below east window.
- C-4. Interior, original flooring, blackened stripe where baseboard paint might have overlapped onto edge of flooring.
- C-5. Exterior surface, east wall window, upper sash, upper left corner at edge of dowel.
- C-6. Exterior, rusticated siding below sill for east window (weathered wood).
- C-7. Exterior, cupola bracket on east elevation at base of carved leaf.

C-1 and C-2



C-3 and C-4





Cupola House Interior and Exterior Paint Analysis – Susan L. Buck, October 18, 2018

C-5



C-6



C-7

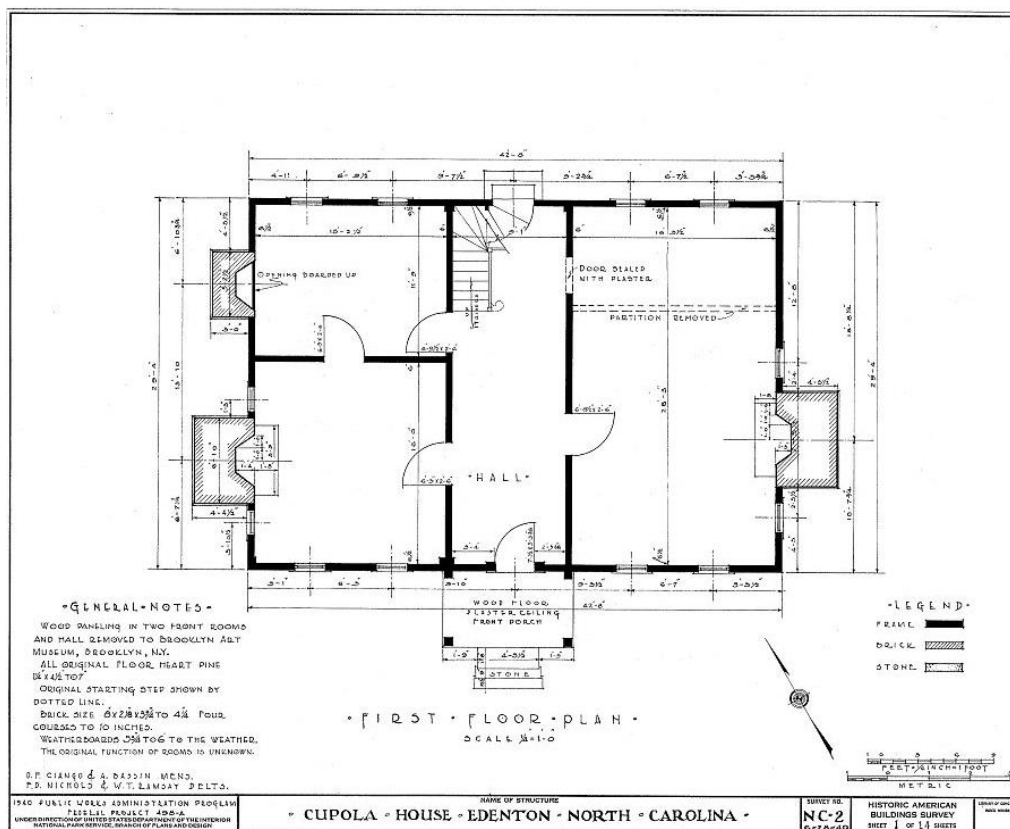




## Interior Paint Analysis Results:

The investigation of the surviving interior paints focused on the second-floor woodwork as those spaces appear to be relatively untouched. However, there are remnants of material in the raised outlines on the flooring adjacent to the baseboards in several first-floor rooms where the earliest paints applied to the baseboards may have accidentally overlapped onto the flooring. These coating accumulations were sampled with the hope that the paint evidence could provide important clues about the eighteenth-century paints on the paneling in the most important, ornate rooms in the Cupola House. It is not known whether early paints still remain on the first-floor woodwork components that were purchased in 1918 and reinstalled as period rooms in the Brooklyn Museum. This section of the report will begin with illustrations and discussions of the coating evidence found on the flooring in three first-floor spaces.

## First Floor HABS Drawing



First-floor Central Passage

Two samples were taken from raised accumulations of material on the floorboards and one sample was taken from the early plaster on the north wall of the closet under the stairs. When the samples were screened at 45X prior to casting it was apparent that the plaster was never painted or limewashed, so it was set aside for possible later analysis. Sample CP-1 seemed to be the more promising of the two samples from the flooring so it was analyzed in cross-section to identify the whitish layer on top of the wood.

Central Passage Sample Locations

CP-1. Raised edge of paint on flooring, west side, southwest corner, possible overlap from baseboard.

CP-2. North wall plaster under stairs.

CP-3. Raised edge of paint on flooring, east side, near electrical outlet.

CP-1



CP-2



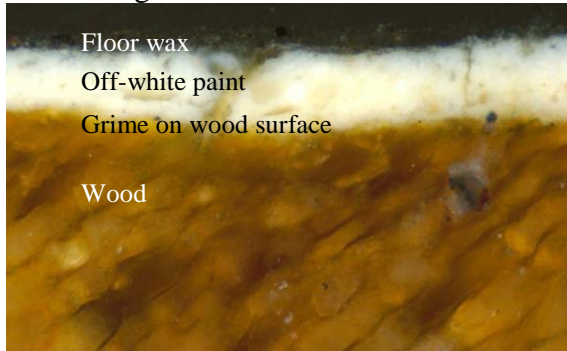
CP-3



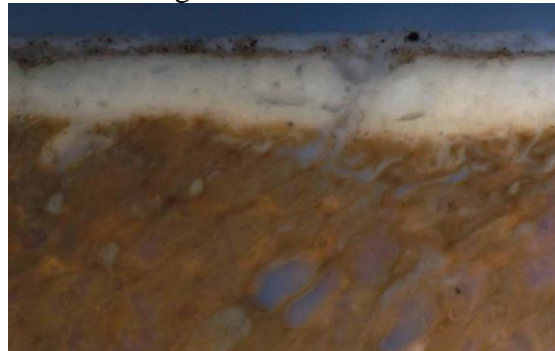
Sample CP-1 Paint Overlap Onto Flooring. In cross-section it is apparent that the accumulated materials on the flooring consist of only one off-white paint layer which is cracked and grimy. There is a translucent layer of modern floor wax on the surface of the paint. This paint is likely not related to the earliest paint on the woodwork because the surface of the wood is oxidized and slightly grimy, indicating that the wood flooring was left unpainted for long enough for it to become degraded before the off-white paint was accidentally brushed or dripped onto the flooring.

CP-1. Raised edge of paint on flooring, west side, southwest corner, possible overlap from baseboard.

Visible Light 200X



Ultraviolet Light 200X



First-floor Southeast Room.

There is a raised ridge of paint and other accumulated material adjacent to the baseboard to the north of the mantel on the east wall. Several samples were taken from this ridge to see if any early paint remains that might conceivably relate to the original woodwork.

Southeast Room Paint on Flooring Sample Location

SE1-1. East wall, north of fireplace, raised edge of paint on flooring that might be overlap from baseboard.

Northeast Corner of Southeast Room



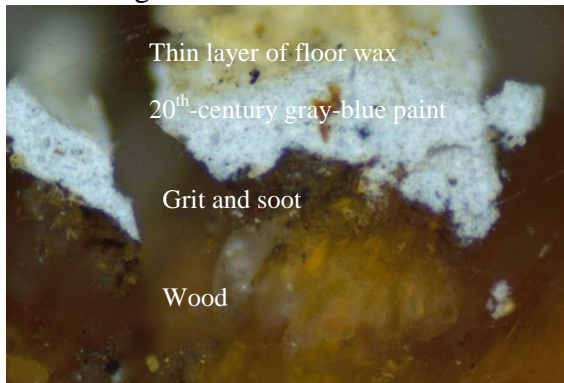
SE-1



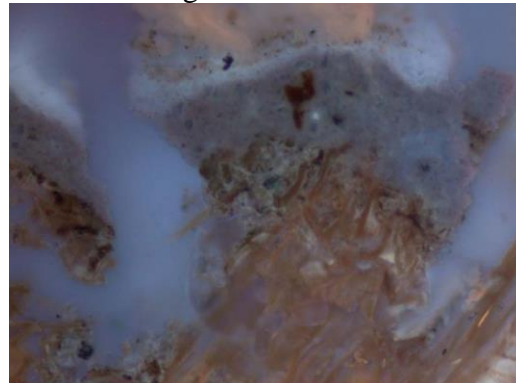
In sample SE1-1 from the flooring there is a thick, uneven layer of blackish grit and soot on top of the wood. This is followed by a layer of finely ground gray-blue paint that seems to relate to the current paint on the replicated woodwork. This evidence suggests there is no eighteenth-century paint remaining on the raised ridges on the flooring in this room.

SE1-1. East wall, north of fireplace, raised edge of paint on flooring that might be overlap from baseboard.

Visible Light 200X



Ultraviolet Light 200X





First-floor Southwest Room.

The most promising accumulation of material on the flooring is a raised ridge along the north wall, near the northeast corner of the room. Several samples were taken from this area to see if any coatings remain that might relate to the original woodwork.

Southwest Room Sample Location

SW1-1. North wall, raised edge of paint along north wall, just right of middle.

West Wall of Southwest Room



SW1-1



The evidence in SW1-1 consists of a coarsely ground tannish-orange paint that might date to the eighteenth or nineteenth century. But this paint is on top of a thick layer of grit and soot which means it cannot be the original woodwork paint.

SW1-1. North wall, raised edge of paint along north wall, just right of middle.

Visible Light 100X



Visible Light 200X

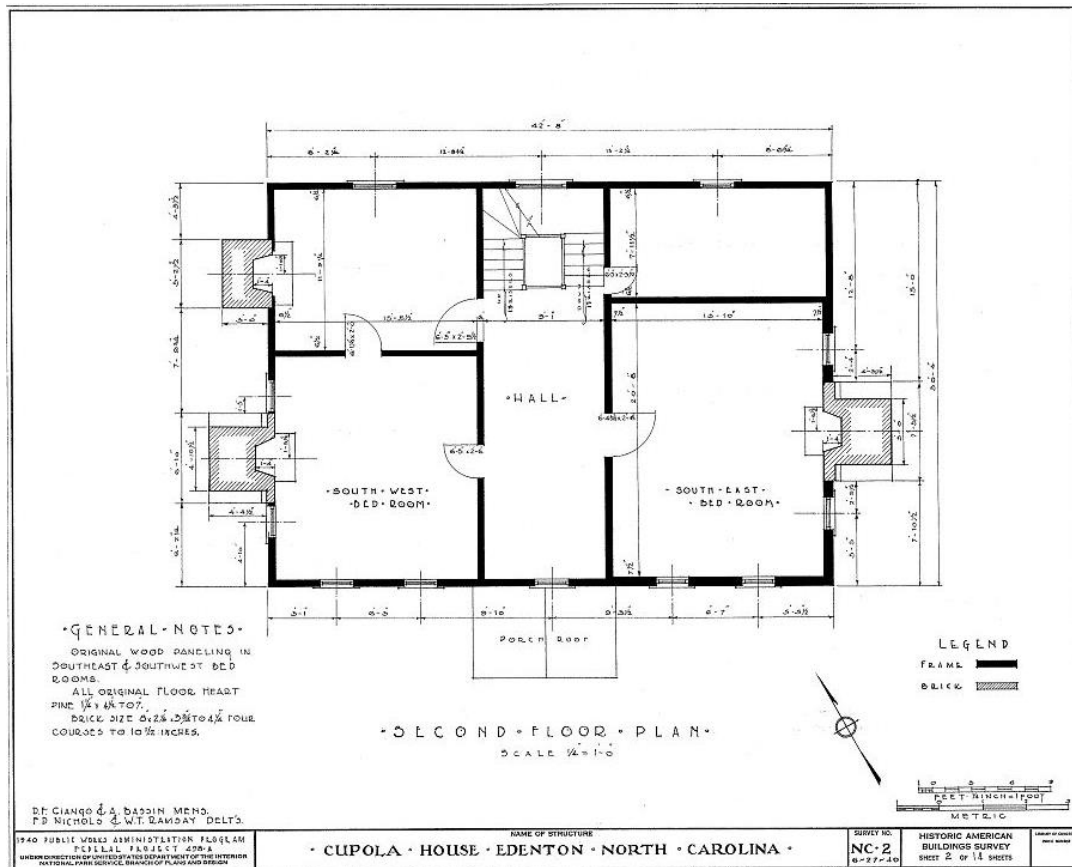


Ultraviolet Light 200X





## Second-floor HABS Drawing



## Second-floor Southeast Bedchamber.

This is the most elaborately decorated bedchamber so there was great interest in learning about the earliest paints on the mantel, woodwork and baseboards. The initial exploration of the mantel, wainscoting and architraves revealed an early, thickly applied, coarsely ground, bright green paint. At that time it was not possible to be sure that this green paint is the original finish coat as there is a cream-colored paint below the green paint. The baseboard in this room was also examined to see if early paints survive there as well. The mantel, wainscoting and window architrave, and one section of baseboard were sampled for optical microscopy analysis.

East Wall of the Southeast Bedchamber



Southeast Bedchamber Sample Locations

- SE-1. East wall, left side of overmantel panel, about 5-feet up.
- SE-2. East wall, south window, edge of left backband molding.
- SE-3. East wall, top left corner of wainscot panel just right of fireplace opening.
- SE-4. West wall, baseboard cap left of door.

SE-1



SE-2



SE-3



SE-4



The evidence in samples SE-2 and SE-3 shows that the first layer above the wood is a cream-colored paint, followed by the distinctive, coarsely ground, bright emerald green-colored paint. There is no boundary or definite edge between the cream-colored paint and the bright green paint, indicating that the cream-colored paint was the original primer. This is a traditional craft approach because the copper-based green pigment verdigris is slightly translucent and does not have good covering power. In the cross-section the surface of the green paint is discolored and darkened, which is typical as verdigris is an unstable pigment which tends to darken over time when combined with linseed oil or varnish. However, when freshly applied this grainy green paint must have been brilliant and glossy, likely making this room the most stylish chamber in Edenton, North Carolina at the time.

The second generation of paint is tannish-gray, and it also became dirty and degraded before being painted over with a finely ground off-white paint in the third generation. This off-white paint is smooth and relatively clean, and is more typical of commercially prepared twentieth-century paints. Generation 4 is a medium blue paint, followed by a light blue-green paint that was identified as generation 7 in sample SW-1 from the southwest chamber. Generation 8 is a green paint, also found in the same context in sample SW-1, and in sample CH-2 from the second-floor hall. The full chronology of paints in the southeast chamber is listed in the comparative table on page 32.

Binding media analysis with biological fluorochrome stains shows that all the paints contain oil components, and generations 9 through 11 contain carbohydrate components. Generations 7 through 11 contain protein components which are likely modern surfactants added to increase the wetting properties of the paints. Polarized light microscopy analysis confirms that the pigments in the green paint consist of very large verdigris pigments, with yellow ochre, white lead and calcium carbonate (sample SE-3).

The evidence in sample SE-4 from the baseboard shows that the baseboard was originally dark brown on top of a cream-colored primer, followed by a pigmented natural resin varnish in the second generation, which would have enhanced and protected the original dark brown paint. The third generation on the baseboard is red-brown, followed by dark brown and dark red in the fourth and fifth generations. The comparative evidence confirms that the baseboards were dark colors until generation 7 when they were painted light blue-green to match the rest of the woodwork. Polarized light microscopy analysis shows that the original dark brown paint is composed of red ochre, charcoal black and calcium carbonate.

The comparative table below aligns the paints in each generation. Some of the early paints in this room may be missing because of deliberate paint removal before repainting, because only the first two generations of paint on the woodwork are consistent with eighteenth and nineteenth century paint composition, autofluorescence, and pigment distribution.

Comparative Paint Stratigraphies on the Southeast Bedchamber Woodwork\*

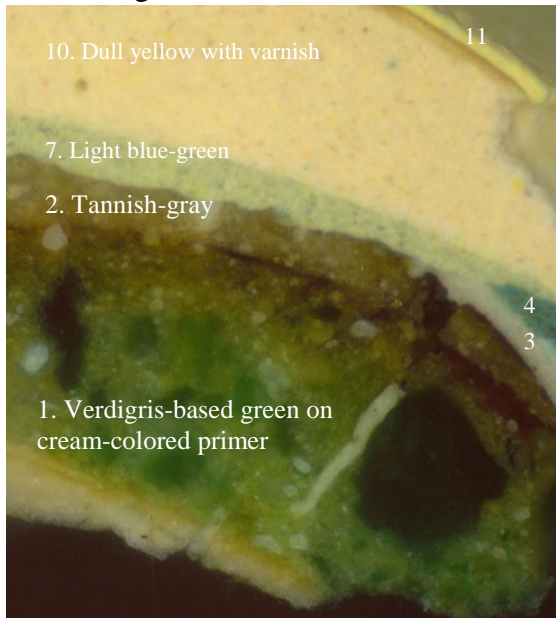
Generation/Layer	SE-2. Window architrave	SE-3. Wainscot	SE-4, Baseboard	Observations
11. Deep yellow	x	x	Red-brown	
10. Dull yellow with varnish	x	x	Red-brown	
9. Green		x		
8. Green	x	x	x	Matches generation 8 in the SW bedchamber and center hall
7. Light blue-green	x	x	x	Matches generation 7 in the SW bedchamber
6. Missing			Pigmented varnish on white base coat	
5. Missing			Dark red	
4. Medium blue	x		Dark brown	
3. Off-white	x	x	Red-brown	More typical of 20 <sup>th</sup> -century commercial paint
2. Tannish-gray	x	x	Pigmented varnish	Very degraded and dirty paint surface
1. Coarse verdigris-based green finish on cream-colored primer	x	x	Dark brown on cream-colored primer	Very degraded and dirty paint surface

x = layer is present; evidence found in cast and uncast portions of the samples

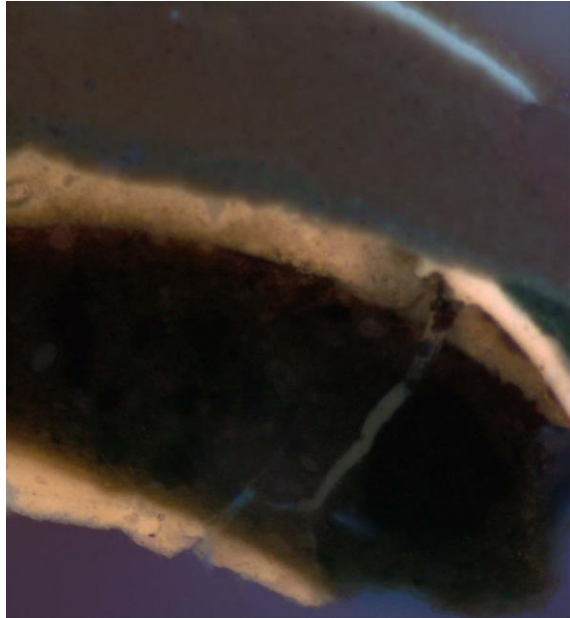


SE-2. East wall, south window, edge of left backband molding.

Visible Light 200X



Ultraviolet Light 200X

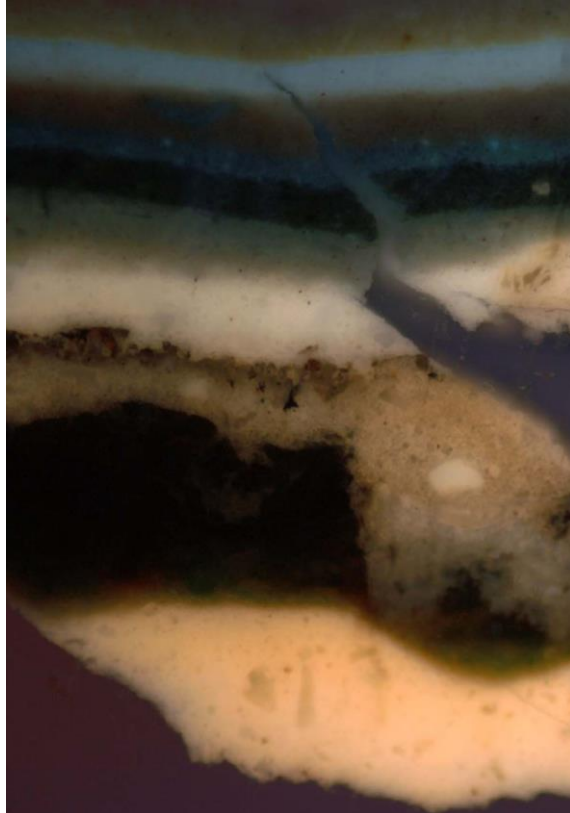


SE-3. East wall, top left corner of wainscot panel just right of fireplace opening.

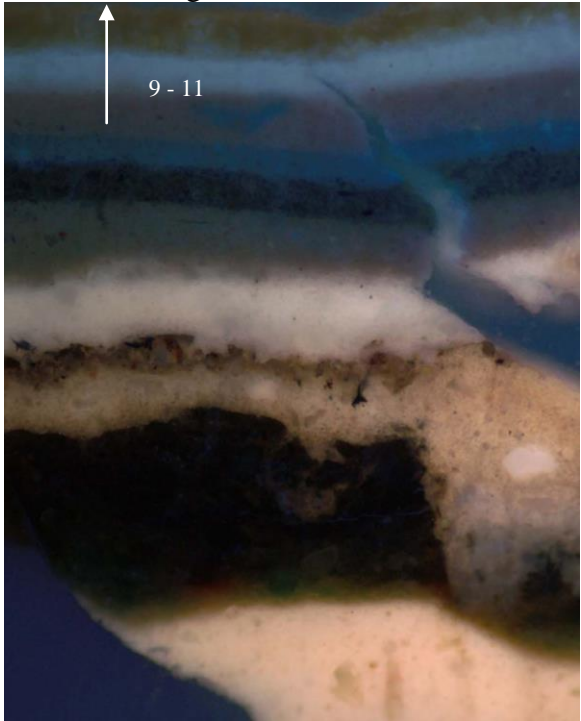
Visible Light 100X



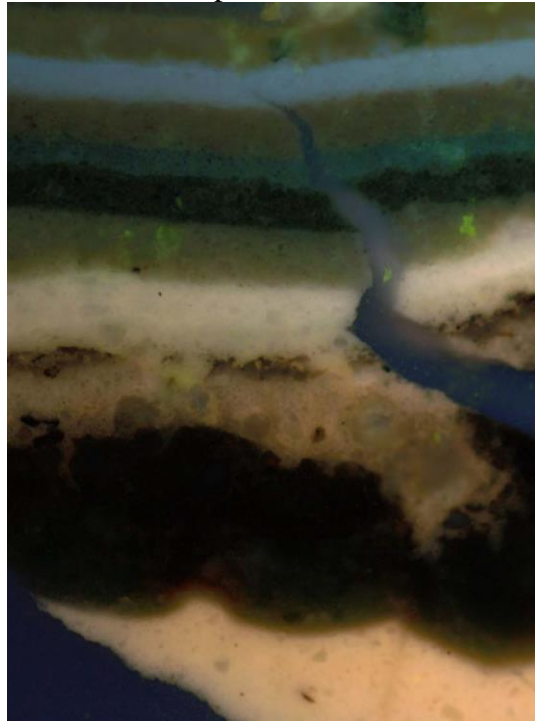
Ultraviolet Light 100X



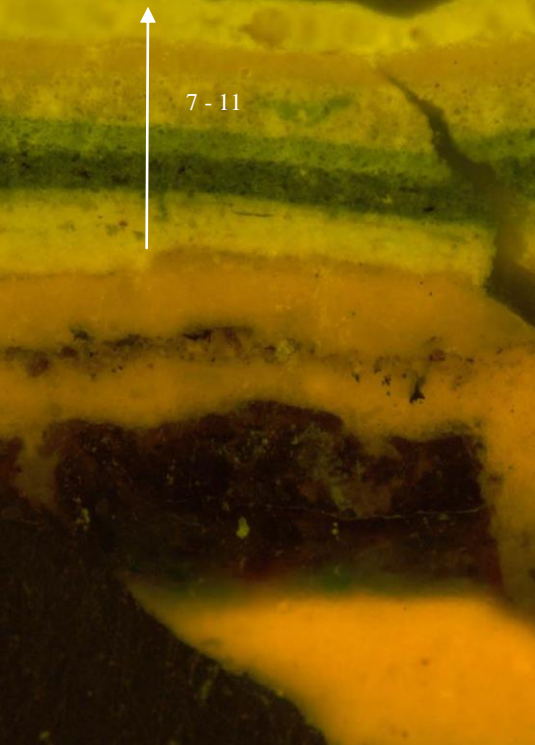
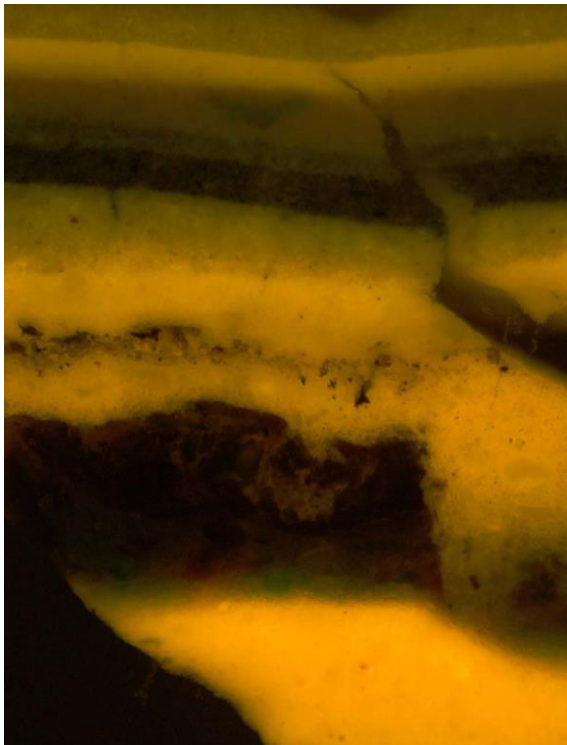
SE-3. East wall, top left corner of wainscot panel just right of fireplace opening.  
UV Light & TTC for carbohydrates 200X    UV Light & DCF for lipids (oils)  
+ reactions in generations 9 to 11                      + reactions in all paints



B-2A filter 200X

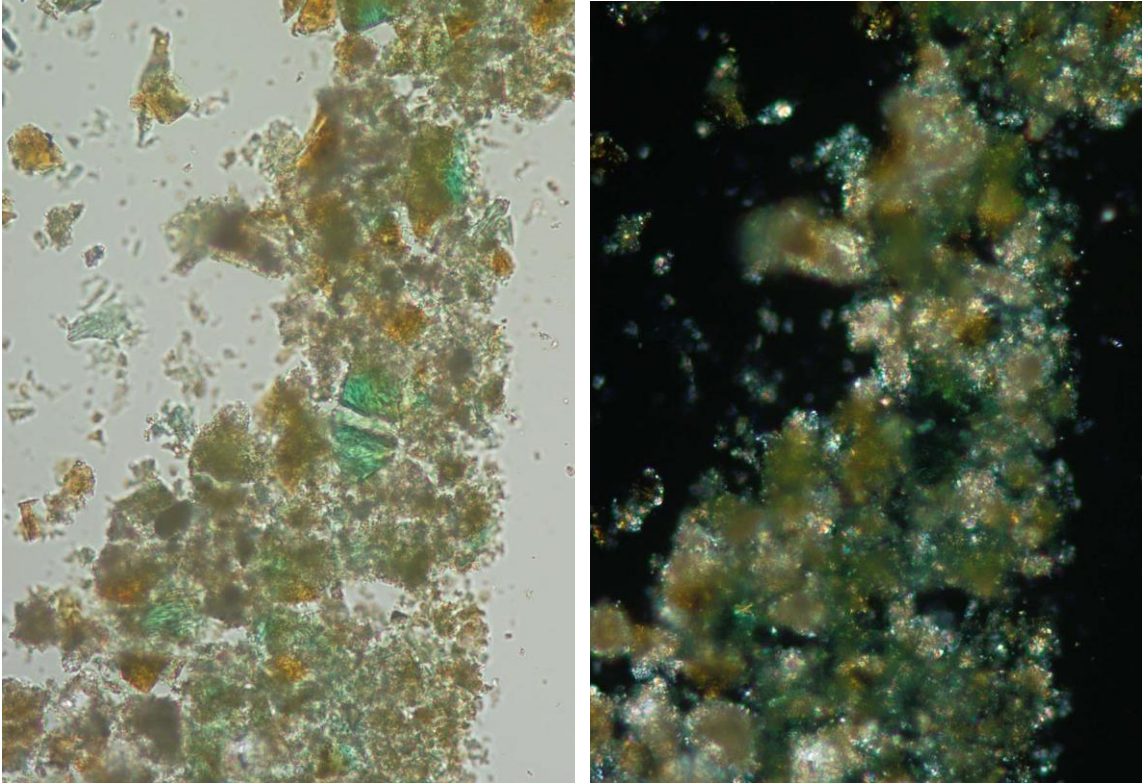


B-2A filter & FITC for proteins 200X  
+ reactions in generations 7 – 11





SE-3. East wall, top left corner of wainscot panel just right of fireplace opening.  
Pigments in the original green paint: verdigris, yellow ochre, calcium carbonate.  
Plane polarized transmitted light 400X      Crossed polars (darkfield) 400X



SE-4. West wall, baseboard cap left of door.

Visible Light 200X

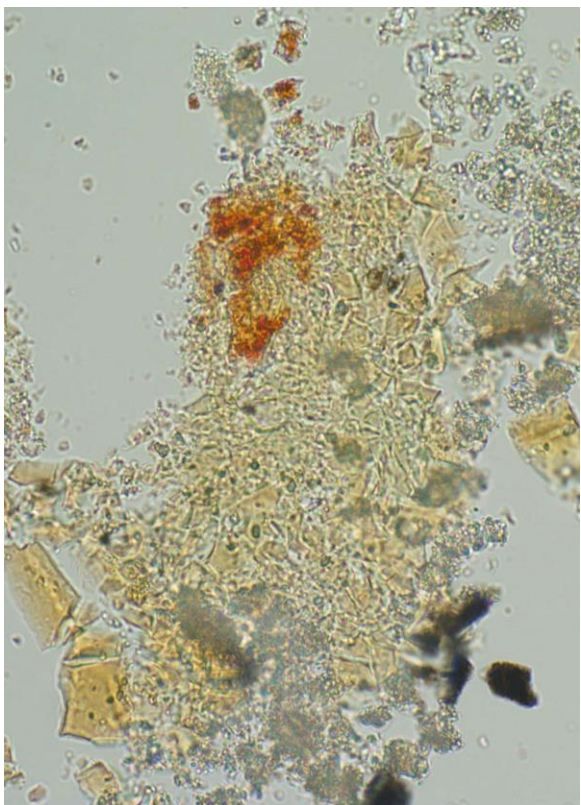


Ultraviolet Light 200X

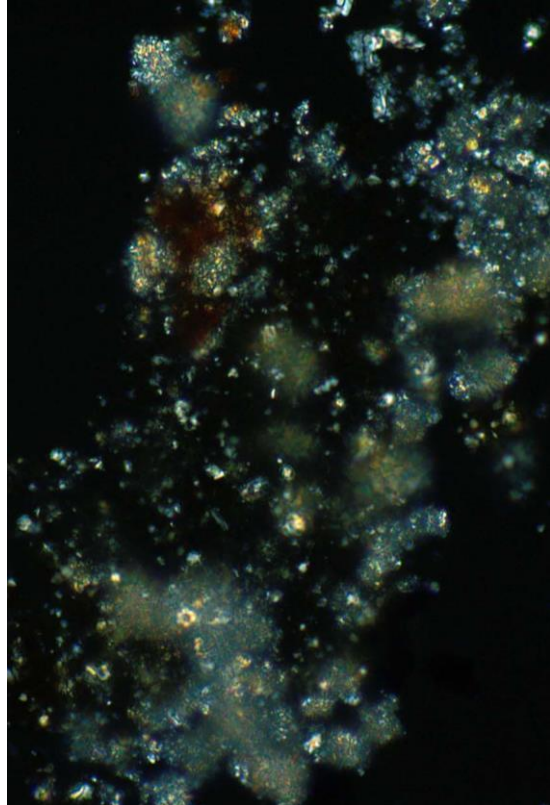


SE-4. West wall, baseboard cap left of door. Pigments in the original dark brown: charcoal black, red ochre, calcium carbonate and varnish.

Plane polarized transmitted light 1000X



Crossed polars (darkfield) 1000X





Second-floor Center Passage.

The wall plaster and woodwork in the second-floor center passage were examined to search for early plaster and for areas of intact early woodwork paints. Examination of the samples at 45X under a binocular microscope showed that no early plaster remains in the areas that were sampled. But despite the fact that the doors were severely stripped, there are still remnants of early paint remaining in the corners of the joinery for the door leading to the southeast bedchamber. A sample from the architrave for the north door on the east wall also retained promising early paint evidence.

All the doors in this center passage are now stripped and have a raw, scarred appearance. In the mid-eighteenth century these doors would never have been left with exposed wood. It was more typical to paint doors in primary spaces to mimic figured wood like mahogany (grain-painting). Doors in secondary spaces might typically be painted to match the surrounding woodwork, painted dark brown or red-brown to match the baseboards. The stripped doors now look quite jarring and out of place.

Northeast Corner of Center Passage



West Wall of Center Hall



Center Hall Sample Locations

- CH-1. Door leading to SE bedchamber, upper left corner, middle left panel.
- CH-2. East wall, right edge of architrave for north door.
- CH-3. West wall, plaster about south door.

CH-1



CH-2



CH-3



**Sample CH-1. Door.** There are remnants of early door paints trapped in the corners of the joinery which provide surprising insights into the original appearance of this door, and likely all the doors in this second-floor passage. In sample CH-1 the first generation consists of a fragmentary brown glaze layer on top of a cream-colored base coat. This brown glaze survives only at the left side on top of the first cream-colored paint in the cross-section. The door was repainted dark brown in the second generation, and then two different shades of cream color in generations 3 and 4. There is a murky accumulation of cream-colored and red-brown paints on the surface of the cross-section which represent residues from the paint stripping process. There is thin synthetic resin varnish on top of the paints.

Binding media analysis with biological fluorochrome stains indicates that all the paints are oil-bound, and there are protein components in the fourth generation of paint and in the paint stripping residues.

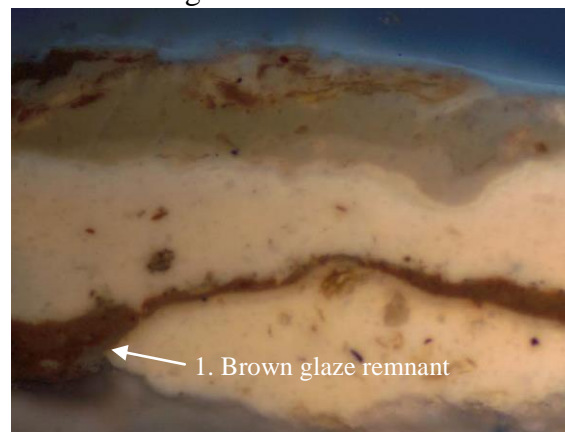
The evidence for the original decorative paint treatment is sparse, but there is enough to suggest the door was originally grain-painted, perhaps to replicate mahogany, which would have been entirely appropriate for a central circulation space in a house of this stature. Perhaps more intact evidence for graining survives on the doors now in the Brooklyn Museum.

CH-1. Door leading to SE bedchamber, upper left corner, middle left panel.

Visible Light 100X



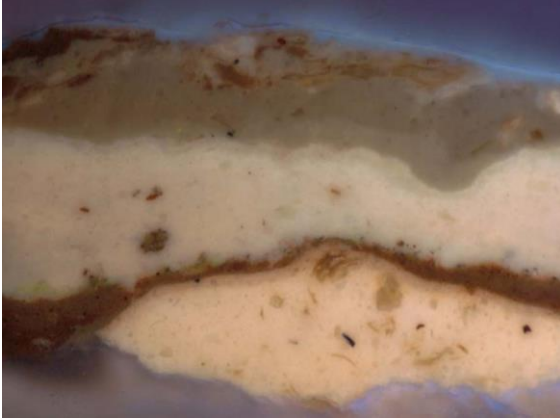
Ultraviolet Light 100X



CH-1. Door leading to SE bedchamber, upper left corner, middle left panel.

UV Light & TTC for carbohydrates 100X

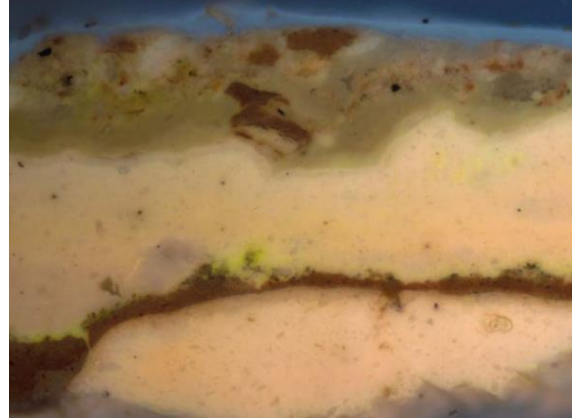
No reactions for carbohydrates



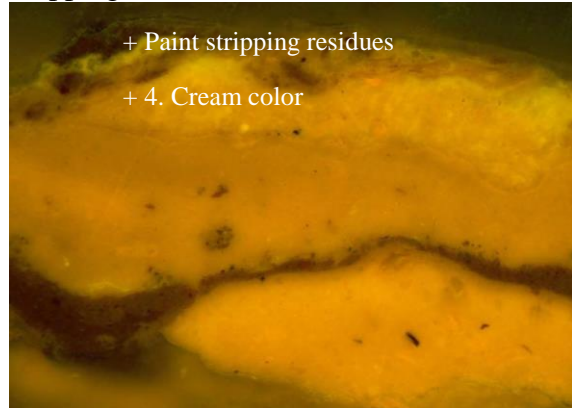
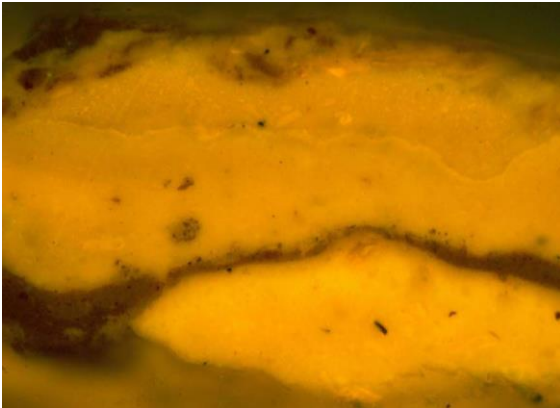
B-2A filter 100X

UV Light & DCF for lipids (oils) 100X

+ for oils in all layers



B-2A filter & FITC for proteins 100X  
+ for proteins in generation 4 and the paint stripping residues



+ Paint stripping residues

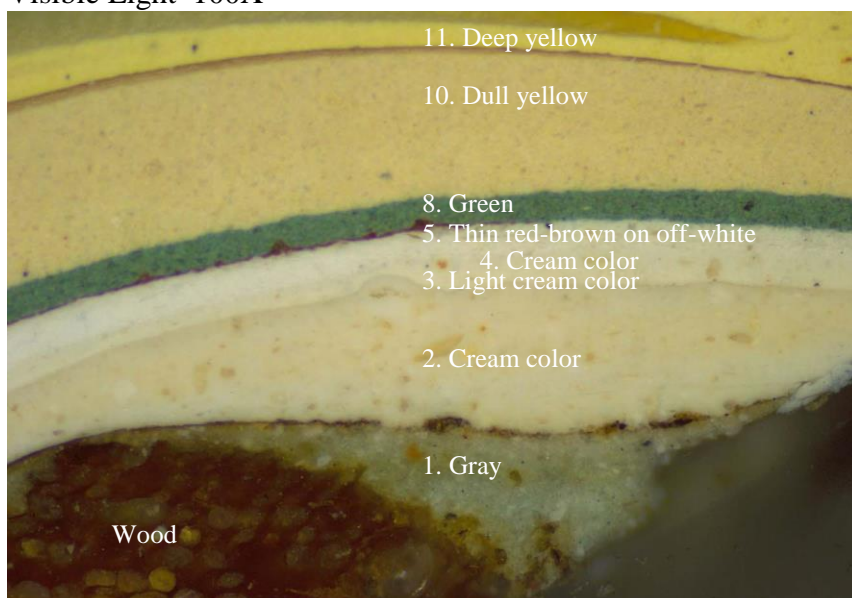
+ 4. Cream color



**Sample CH-2. Door architrave.** The paints in sample CH-2 from the architrave for the north door on the east wall in the passage are intact enough to confidently interpret the original paint color as gray. There is a distinct layer of grime on the surface of this paint, suggesting it was exposed for many, many years before it was painted cream color in the second generation. This is followed by light cream color in generation 3 and cream color in generation 4. The finely ground, nonfluorescent nature of generation 3 suggests it is twentieth-century paint. Generation 5 in this cross-section is a thin red-brown glaze on an off-white base coat. This is followed by a green paint that matches generation 8 in sample SW-2 from the southwest bedchamber. The two most recent paints are dull yellow with a varnish and deep yellow, which match generations 10 and 11 in samples SE-2 and SE-3 from the southeast bedchamber.

Binding media analysis with biological fluorochromes confirms that all the paints in CH-2 are oil-bound. Polarized light microscopy analysis shows that the original gray paint is composed of white lead, calcium carbonate, and widely distributed Prussian blue and carbon black pigments.

CH-2. East wall, right edge of architrave for north door.  
Visible Light 100X



CH-2. East wall, right edge of architrave for north door.

Visible Light 200X



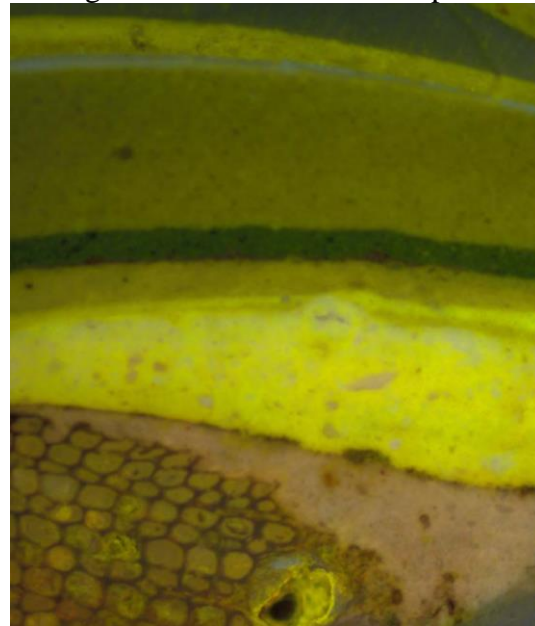
Ultraviolet Light 200X



UV Light 100X

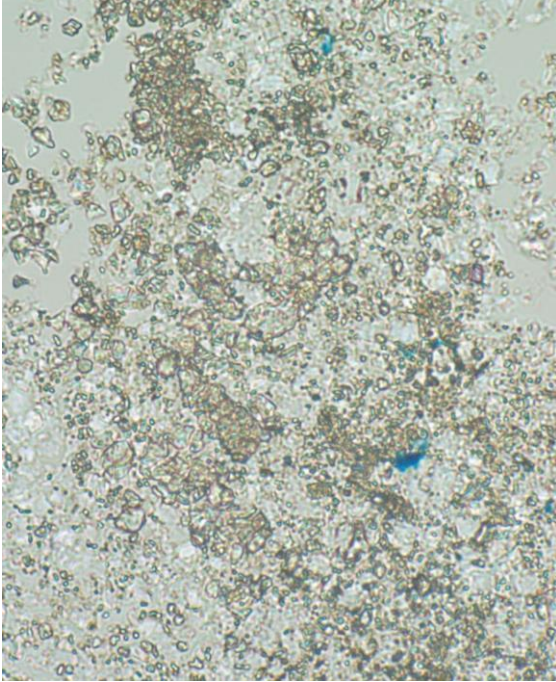


UV Light & DCF for lipids (oils) 100X  
Strong + reactions for oils in all paints

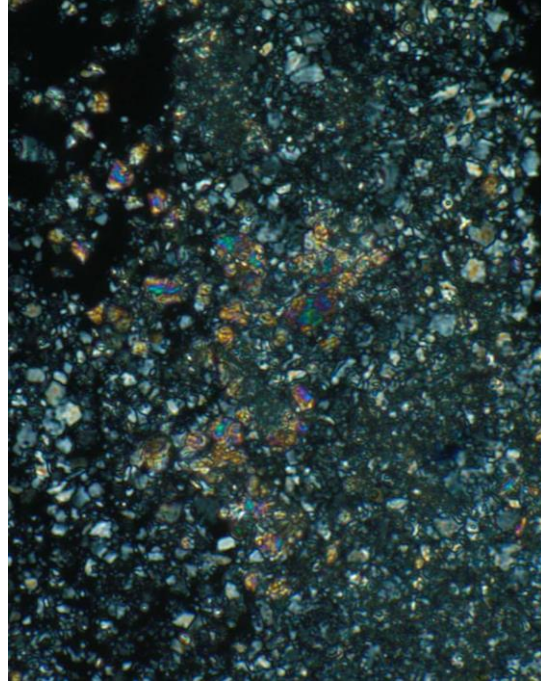


CH-2. East wall, right edge of architrave for north door. Pigments in the original gray paint: white lead, calcium carbonate, scattered Prussian blue and carbon black.

Plane polarized transmitted light 1000X



Crossed polars (darkfield) 1000X





Southwest Chamber.

The woodwork in this room is now painted with a yellowish-green paint that has a slight gloss. When protected areas like the interstices of the overmantel carvings were examined at 10X magnification, it was possible to see a similar early yellowish-green paint trapped deep in the decorations. One sample was taken from the carved bracket on the right side of the overmantel panel and one sample was taken from a section of chair rail for comparison to learn more about the composition of, and context for, this green paint.

West Wall of the Southwest Chamber Examining the Paints at 10X

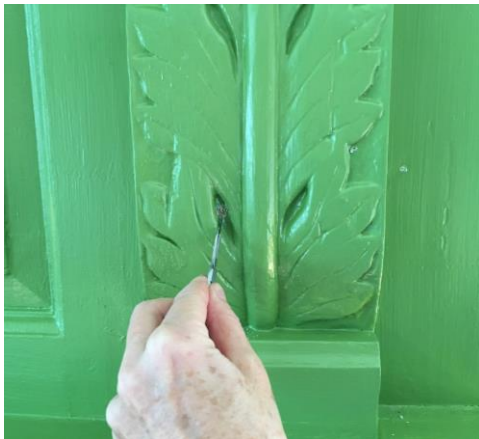


Southwest Chamber Sample Locations

SW-1. West wall, in interstices of leaf carving on right side of overmantel panel.

SW-2. West wall, bead of chair rail just right of fireplace.

SW-1



SW-2





Samples SW-1 and SW-2 Woodwork Paint. Cross-section microscopy analysis shows that there are ten generations of paint in the most complete sample SW-1 from the overmantel. The evidence in this cross-section reveals that the yellow-green paint is actually the second paint generation. The original paint is a tan layer that collected a distinct layer of grime before it was painted over with the distinctive yellow-green paint. This yellow-green layer also became grimy and discolored before it was repainted in the third generation with a finely ground off-white paint. The same evidence was found in SW-2 from the chair rail, which cleaved apart during sampling.

Pigment identification using polarized light microscopy (PLM) analysis provides important insights into the earliest woodwork paint. The original tan paint is composed of white lead, yellow ochre, calcium carbonate and scattered lampblack pigments. The second-generation yellowish-green paint is composed of Prussian blue, chrome yellow, white lead and calcium carbonate. The most important pigment for dating this paint is chrome yellow. The earliest date for chrome yellow in this country is 1812, so this yellowish-green paint could not have been made and applied to the woodwork in the southwest chamber until after that date. The first known reference for chrome yellow in the United States appeared in a May 23, 1812 advertisement in the March 23, 1812 *Federal Republican and Commercial Gazette* for chrome yellow manufactured in New York by Chilton & Jarvis and for sale at No. 26 Water-street, Baltimore.<sup>6</sup>

There are off-white paints in generations 3 through 6. The light blue-green paint in generation 7 is a finely ground, nonfluorescent paint more typical of twentieth-century commercially produced paints. The woodwork was repainted dark green in generation 8. Generations 9 and 10 consist of yellowish-green finish coats on primers which must have been intended to replicate the early yellowish-green.

Binding media characterization with biological fluorochrome stains indicates that all the paints contain oil components (with the fluorochrome DCF). Weak positive reactions for carbohydrates were observed in generations 8 through 10 (with TTC), and positive reactions for proteins were observed in generations 7 through 10 (with FITC). The positive reactions for carbohydrates and proteins in the modern paints are typical of complex paints which contain bulking agents and surfactants.

---

<sup>6</sup> See Fodera, Peter L., Kenneth N. Needleman, and John L. Vitigiano. "The Conservation of a Painted Baltimore Sidechair (ca. 1815) Attributed to John and Hugh Finlay", *JAIC* 26 (1997): 183-92.

Comparative Paint Stratigraphies on the Southwest Bedchamber Woodwork\*

Generation/Layer	SW-1. Overmantel	SE-2. Chair rail	Observations
10. Yellow-green on white primer	x	x	
9. Yellow-green on tan primer	x	x	
8. Green	x	x	Matches generation 8 in the SW bedchamber and center hall
7. Light blue-green	x	x	Matches generation 7 in the SW bedchamber
6. Off-white	x	x	
5. Off-white	x	x	More typical of 20 <sup>th</sup> -century commercial paint
4. Off-white	x	x	
3. Off-white	x	x	
2. Yellow-green paint	x	x	Contains the pigment chrome yellow so paint must post-date 1812
1. Tan paint	x	x	Very degraded and dirty paint surface

x = layer is present, \* includes cast cross-sections and uncast portions of the samples

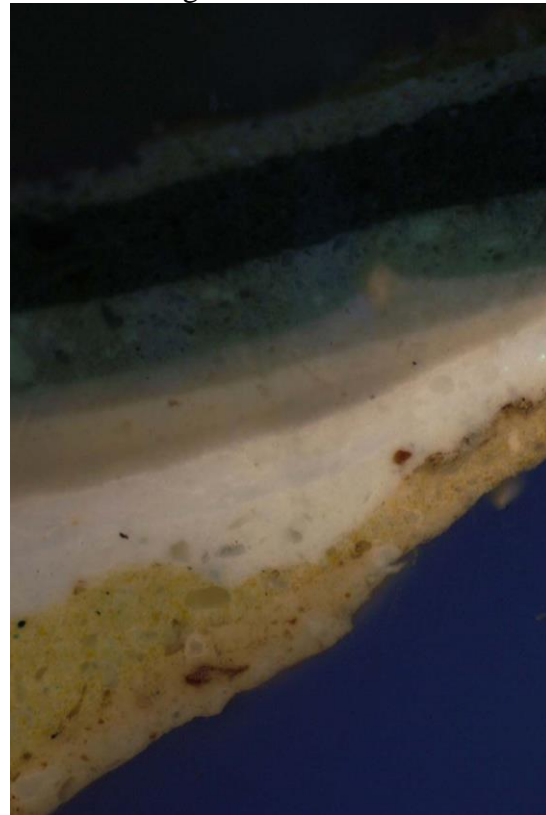
SW-1. West wall, in interstices of leaf carving on right side of overmantel panel.  
Visible Light 100X



Visible Light 200X

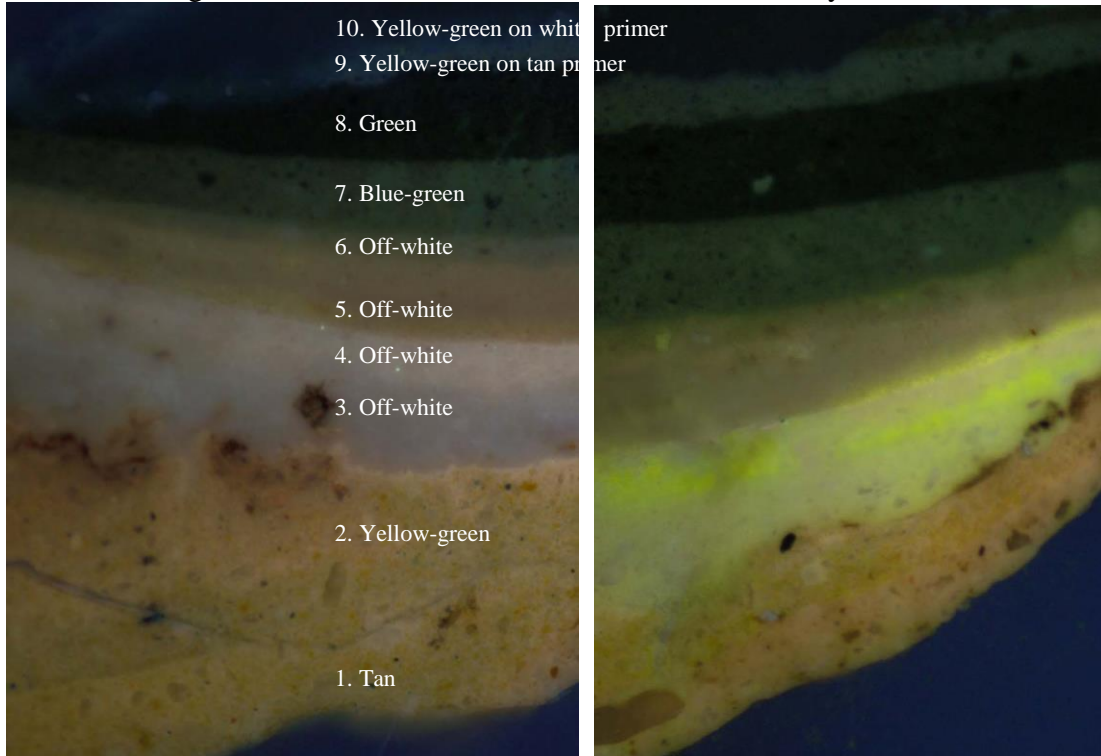


Ultraviolet Light 200X



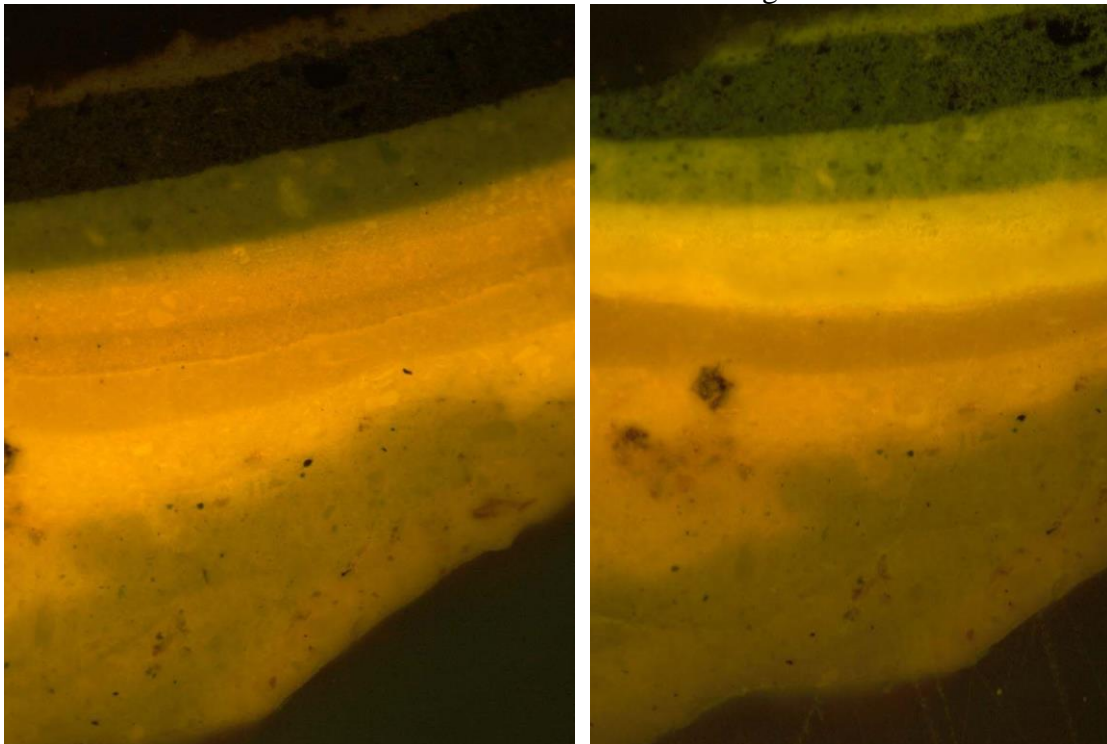
SW-1. West wall, in interstices of leaf carving on right side of overmantel panel.

UV Light & TTC for carbohydrates 200X      UV Light & DCF for lipids (oils) 200X  
+ reactions in generations 8 - 10                      + reactions in all layers



B-2 filter 200X

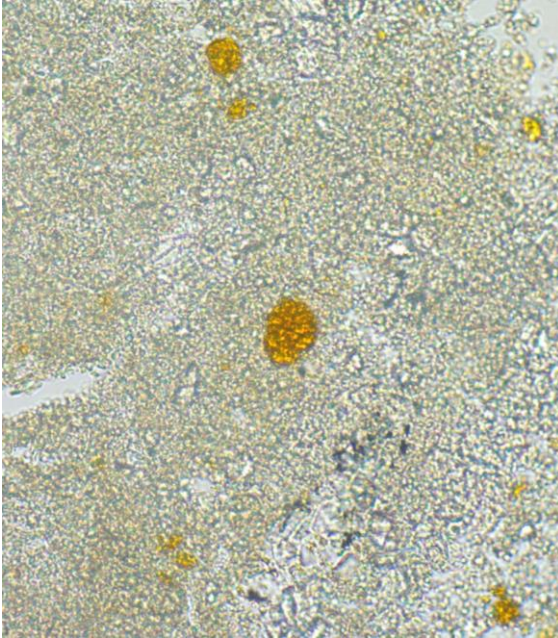
B-2A filter & FITC for proteins 200X  
+ reactions in generations 7 - 10



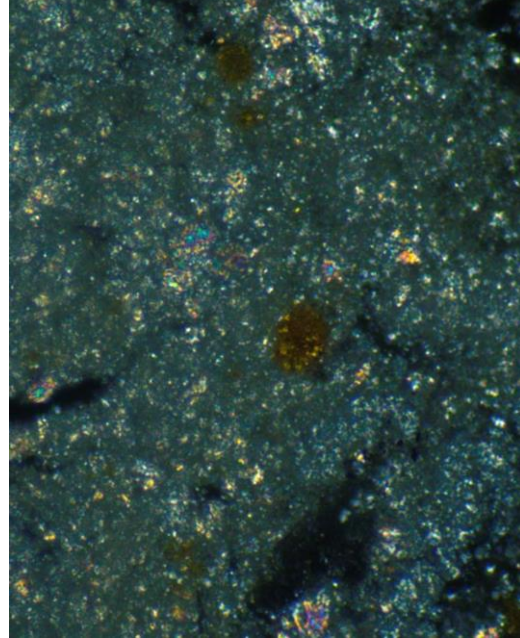


SW-1. West wall, in interstices of leaf carving on right side of overmantel panel.  
Pigments in the original tan paint: white lead, yellow ochre, calcium carbonate, scattered lampblack.

Plane polarized transmitted light 1000X

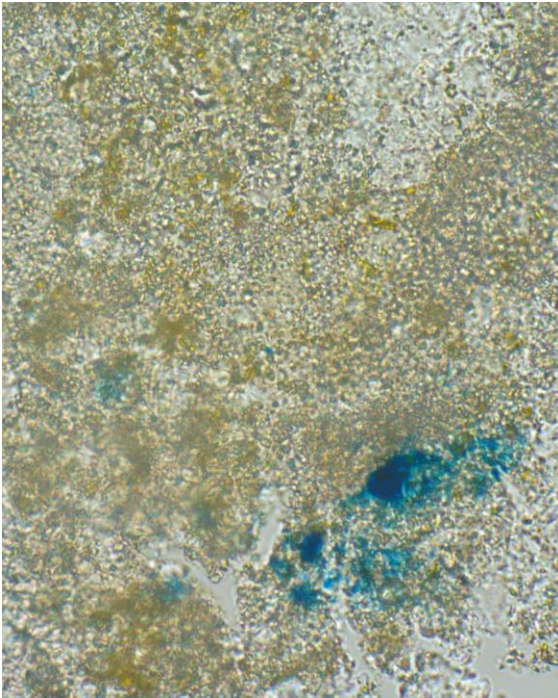


Crossed polars 1000X

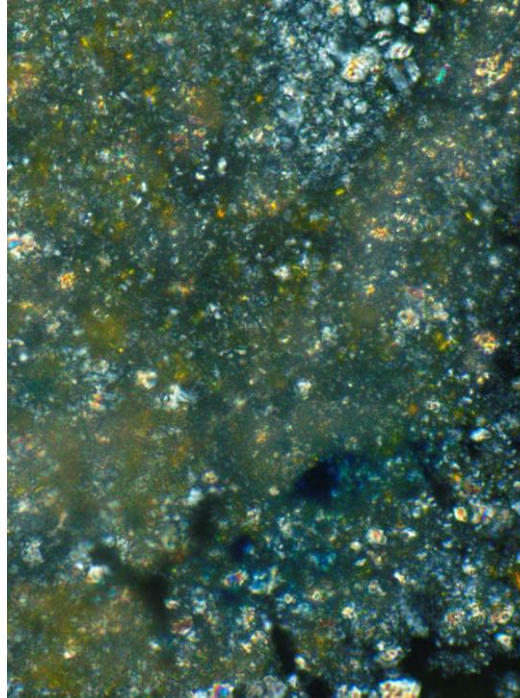


SW-1. West wall, in interstices of leaf carving on right side of overmantel panel.  
Pigments in the second-generation yellow-green paint: white lead, chrome yellow, Prussian blue, and calcium carbonate.

Plane polarized transmitted light 1000X



Crossed polars 1000X

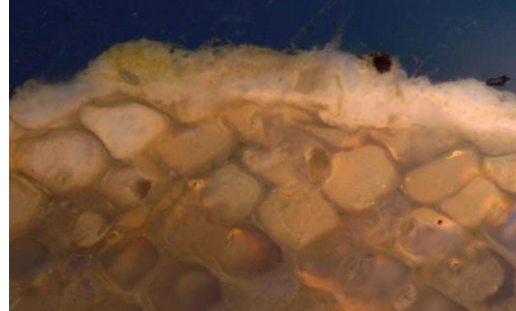


SW-2. West wall, bead of chair rail just right of fireplace.

Visible Light 200X Substrate



Ultraviolet Light 200X



Northwest Chamber.

The woodwork was surveyed to see where the best paint accumulations for analysis. There was some question as to whether the room was originally completely finished, or whether there were some slightly later alterations. The preliminary examination suggested that the cornice might retain slightly earlier paint evidence than the mantel, the boxed-in corner, the south wall door, and the chair rail. One sample was removed from the cornice to see if it was possible to establish the full paint stratigraphy, and one sample was taken from the door architrave to see if it could be contemporary with the cornice.

West Wall of Northwest Chamber



South Wall of Northwest Chamber



Northwest Chamber Sample Locations

NW-1. South wall, bottom edge of cornice, above door.

NW-2. South wall, top edge of door architrave.

NW-1 and NW-2





There are eleven generations of paint in sample NW-1 from the cornice. The stratigraphy begins with an off-white paint which has a thin film of soot on its surface. The second generation is a thinly applied light blue paint, and it is followed by a cream-colored paint in the third generation. This third generation cream color is the first paint layer on the wood in sample NW-2 from the door architrave. The paints in the cross-sections and the uncast samples can be aligned on the cornice and the door architrave after generation 3. Generation 4 is a cream-colored paint with a grimy surface. This paint contains zinc white, so it must date to after about 1845 when zinc white was incorporated into architectural paints.

Binding media analysis with biological fluorochromes shows that all the paints contain oil components, and there is a weak positive carbohydrate reaction in the off-white paint in generation 5.

The absence of the first two generations of paint on the door architrave suggests that this element could be a slightly later addition to the room. This very limited analysis of paints from two areas of woodwork suggest more could be learned about the evolution of this room with more extensive sampling and analysis of the coatings on the mantel, boxed-in corner, baseboard, chair rail and window trim.

Comparative Paint Stratigraphies on the Northwest Bedchamber Woodwork\*

Generation/Layer	NW-1. Cornice	NW-2. Door architrave	Observations
11. Yellow	x	x	
10. Off-white			
9. Graining on pinkish base coat	x	x	
8. Green	x	x	Matches generation 8 in the SW bedchamber and second-floor hall
7. Light blue-green on off-white primer	x	x	Matches generation 7 in the SW bedchamber
6. Off-white	x	x	More typical of 20 <sup>th</sup> -century commercial paint
5. Light gray	x	x	
4. Cream color	x	x	Contains the pigment zinc white so paint must post-date 1845
3. Cream color	x	x	
2. Light blue	x		
1. Off-white	x		Thin film of soot on surface

x = layer is present, \* includes cast cross-sections and uncast portions of the samples

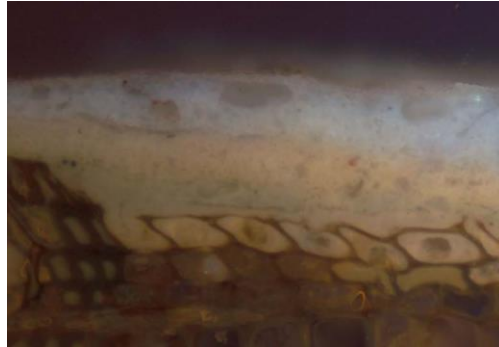


NW-1. South wall, bottom edge of cornice, above door.

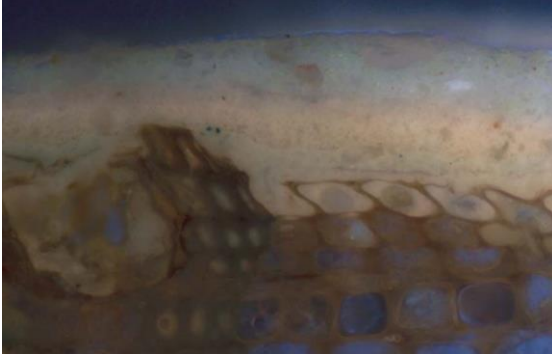
Visible Light 200X



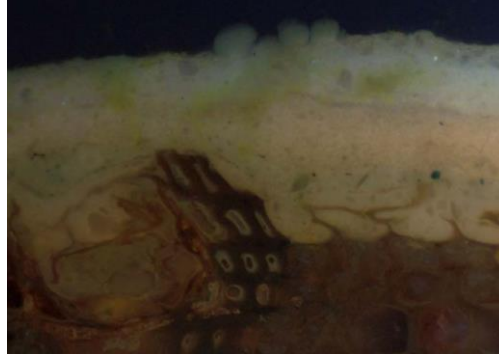
Ultraviolet Light 200X



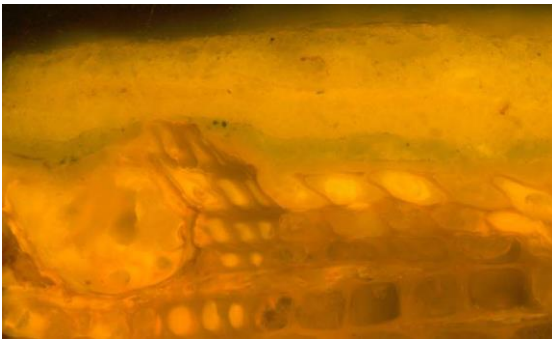
UV Light & TTC for carbohydrates 200X  
Weak + reactions in generation 5



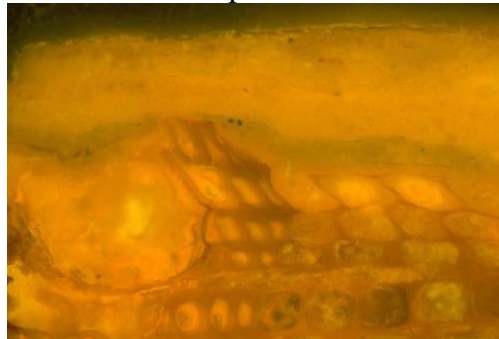
UV Light & DCF for lipids (oils) 200X  
Weak + reactions in all paints



B-2A filter 200X



B-2A filter & FITC for proteins 200X  
No reactions for proteins

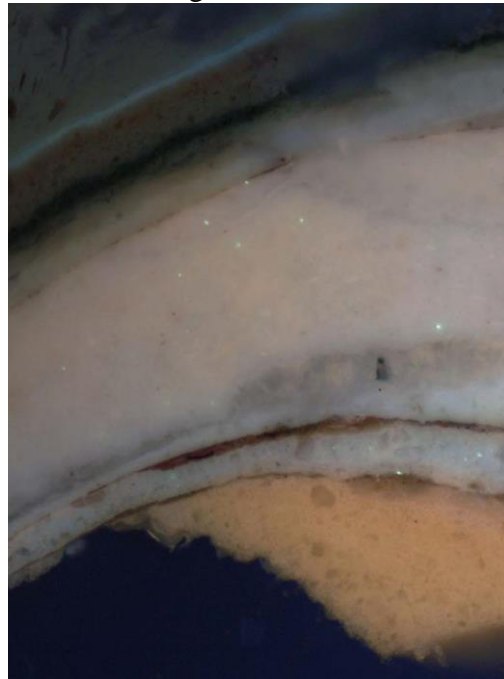


NW-2. South wall, top edge of door architrave.

Visible Light 200X



Ultraviolet Light 200X



Northeast Chamber.

The northeast chamber is the lowest status room on the second floor as it has no fireplace and is considerably smaller than the other three bedchambers. The investigation on site suggested that the woodwork might have originally been a dark blue color, and one sample was taken from the chair rail in the southwest corner of the room to identify the woodwork paint chronology.

Looking East into the Northeast Chamber



Northeast Chamber Sample Locations

NE-1. South wall, southwest corner, surbase of chair rail.

NE-1



There are ten generations of paint in sample NW-1 beginning with a gray-blue paint on a lighter gray primer. The surface of the gray-blue finish coat became darkened and cracked before it was covered over with a dark green paint in generation 2. Generation 3 is an off-white paint which contains zinc white, which dates this particular layer to after about 1845 when zinc white became commercially available. Generations 4 and 5 are also off-whites, and the finely ground, nonfluorescent quality of generation 5 suggests that it dates to the twentieth century. It is followed by the same light blue-green paint that appears as generation 7 in the southwest chamber, so it has been labeled as the seventh paint generation here. Generation 8 is the same green paint found in the same context in the center hall and both south chambers. Generation 9 is a dark blue paint with a varnish coating, followed by the current dark green paint.

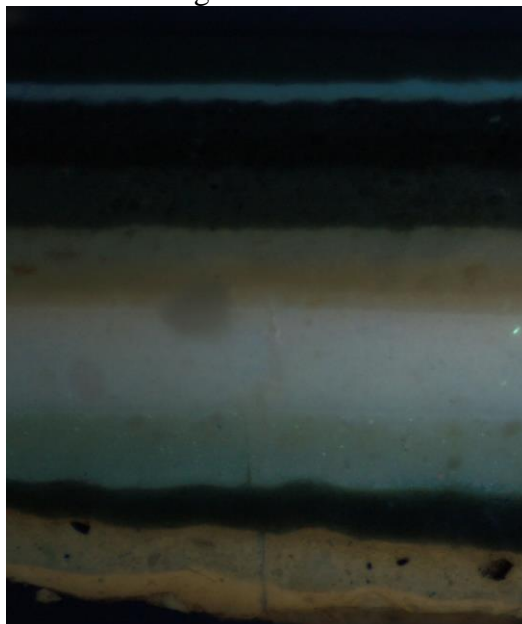
Binding media characterization with biological fluorochrome stains shows that all the paints contain oil components, and generations 8 through 10 have weak carbohydrate additives. There were also positive reactions for proteins in generations 7 through 10. Polarized light microscopy analysis shows that the original gray-blue finish coat is composed of Prussian blue, white lead, calcium carbonate and widely distributed yellow ochre and lampblack. This type of blue paint is consistent with mid-to-late eighteenth-century composition and colors.

NE-1. South wall, southwest corner, surbase of chair rail.

Visible Light 200X



Ultraviolet Light 200X

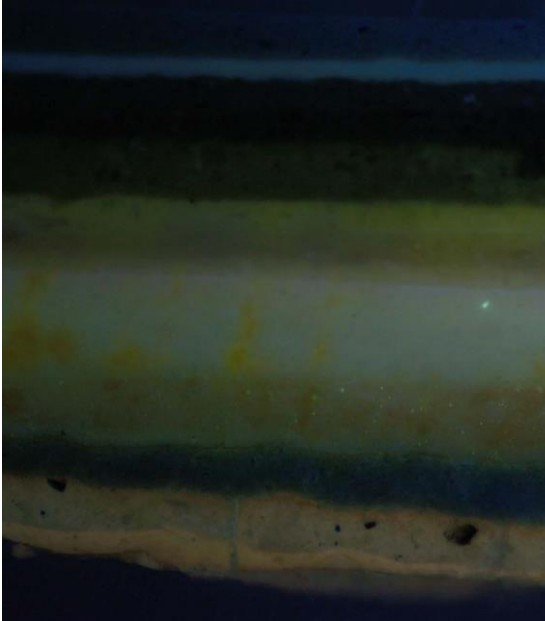




NE-1. South wall, southwest corner, surbase of chair rail.

UV Light & TTC for carbohydrates 100X

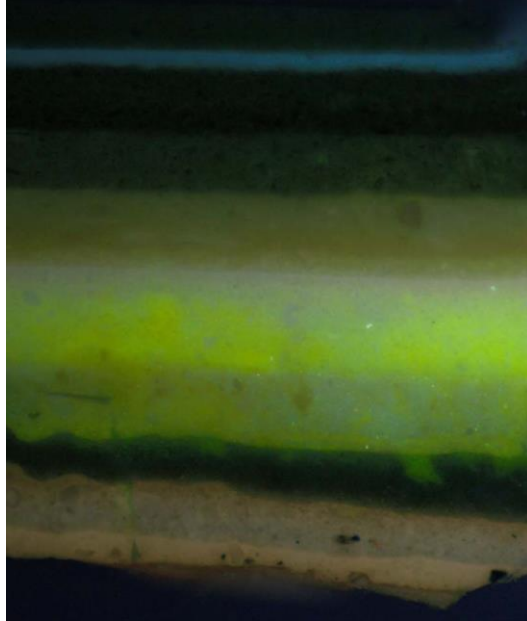
No reactions for carbohydrates



B-2A filter 100X

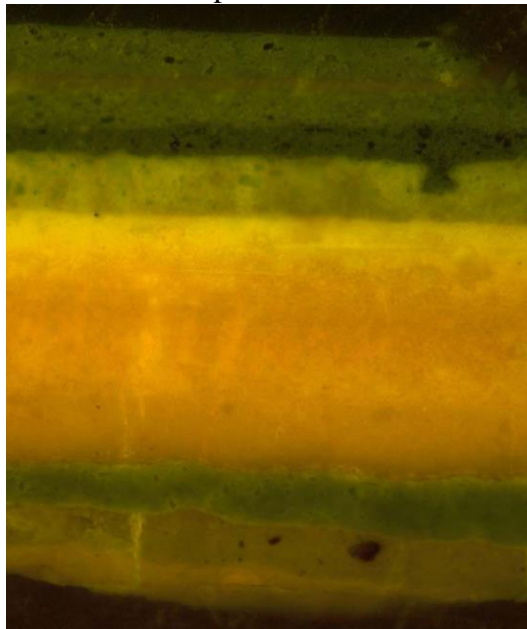
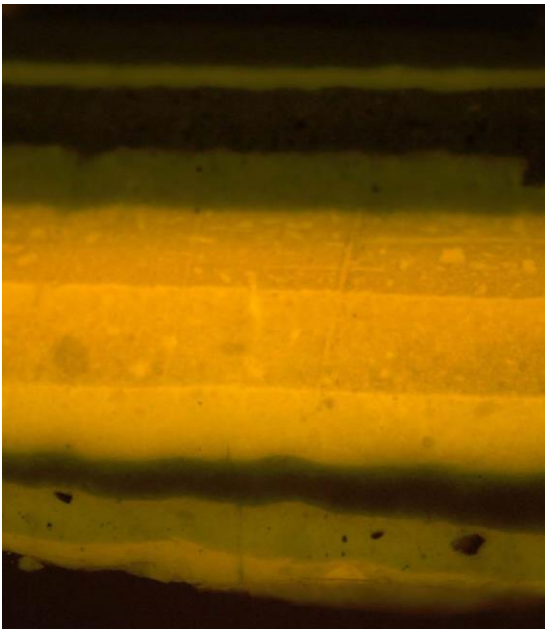
UV Light & DCF for lipids (oils) 100X

+ reactions for oils in all paints



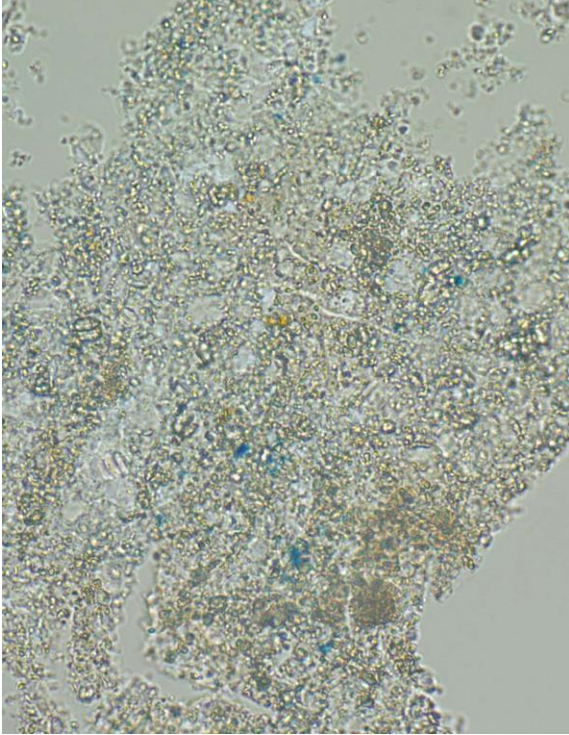
B-2A filter & FITC for proteins 100X

+ reactions for proteins in 7 - 10

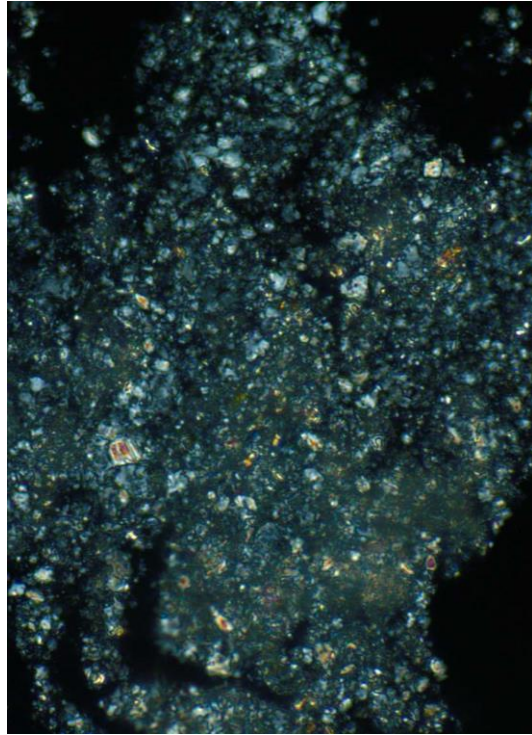


NE-1. South wall, southwest corner, surbase of chair rail. Pigments in the original blue-gray finish coat: white lead, Prussian blue, calcium carbonate, widely scattered yellow ochre and lampblack.

Plane polarized transmitted light 1000X



Crossed polars (darkfield) 1000X



## **Conclusion:**

This investigation has provided the opportunity to study the paints on the exterior and interior of the building in a way that has never been done before, and to build on the findings from earlier investigations of the building fabric and study of the architectural fragments. It was rewarding to find that despite the extremely weathered and damaged condition of the exterior before Cupola House Association bought the building (based on the black and white photograph from about 1918), there are still remnants of the earliest paint remaining on protected trim elements. This current study shows that the early paint evidence on the rusticated siding is compromised by weathering, and possible paint stripping, but it may eventually be possible to study the paint evidence on the sections of rusticated siding that were reused in the porch roof and are currently inaccessible. Other detached exterior fragments, like the shingle and iron bar retain compelling evidence of the earliest protective coatings.

The paint evidence remaining on the woodwork in the second-floor rooms is important and informative. Comparative cross-section microscopy analysis shows that the original paints still remain in place, and the paint histories can be compared from room to room. However, the accumulations of paints and grit on the flooring in the first-floor rooms have so far not provided insights into the earliest paints on the woodwork in the first-floor spaces. It may be possible in the future to collaborate with conservators at the Brooklyn Museum to learn more about the early paint evidence that remains on the woodwork in their Cupola House rooms.

Exterior Paint Evidence. The paint stratigraphy in sample S-5 from the south elevation bracket indicates that the exterior trim was originally painted cream color, and the iron bracket believed to have been part of the cupola walkway was originally painted the same color. The paints on the shutter are quite compromised, but there is a strong likelihood that it was originally painted green, although the earliest layers are fragmentary. Further investigation into the exterior paint evidence might take place if portions of the building are scaffolded, allowing better access to the soffit and cornice of the cupola and to the soffit of the main cornice of the building. The sections of original rusticated siding that are reused in the porch roof are not readily accessible, but if there is a need for repair of the porch roof at some point, that could provide an opportunity to examine and sample some of these boards.

Interior Paint Evidence. This paint analysis project has revealed that there is a tremendous amount of intact paint evidence remaining on the woodwork in the second-floor rooms. The findings clearly show that the rooms were all originally painted different colors, with the best bedchamber in the southeast corner of the house painted a brilliant glossy green with a paint that incorporated the expensive pigment verdigris. This copper-based pigment was difficult to grind and disperse in oil mediums, and would have required a skilled painter to mix and apply it. The baseboards in this room were dark brown when the woodwork was green. And, while the baseboards in the other rooms were not sampled, it is likely they were all originally dark brown as well.

The southwest bedchamber was originally painted tan, and then repainted a distinctive yellowish-green in the second paint generation, after about 1825 because of the presence of chrome green in this paint. The northeast chamber was originally painted gray-blue, while the woodwork in the center hall was lighter blue-gray. In the northwest chamber the cornice was originally painted off-white, but more paint research is needed in this room to comparatively date all the woodwork.

There is enough paint evidence trapped in the joinery of the stripped door leading to the southeast bedchamber to suggest it was originally grain-painted, perhaps to replicate figured mahogany. Further research should include sampling and analysis of all the doors as it is likely they were all painted to match. This type of stylish decorative painting would not be surprising for a house of this date and importance. It may also be possible to learn more about the earliest paints on the first-floor doors through collaboration with the Brooklyn Museum.

The following chart shows how the paints in the second-floor rooms can be aligned to reveal that they were not all painted in a similar manner until generation 7, well into the twentieth century. Color matches for the original woodwork paints in the second-floor rooms are included in the next section of this report.



Comparative Chart of the Cupola House Second-floor Woodwork Paints

Generation	SE Chamber	SW Chamber	Center Hall (door architrave)	Center Hall door	NE Chamber (chair rail)	NW Chamber (cornice)
11	Deep yellow with red-brown baseboards	Yellowish- green on white primer	Deep yellow		Dark green	Deep yellow
10	Dull yellow with varnish with red- brown baseboards	Yellowish- green on tan primer	Dull yellow with varnish		Blue with varnish	Off-white
9	Green					Possible grain- painting
8	Green	Green	Green		Green	Green
7	Light blue-green	Light blue- green			Light blue- green	Light blue- green on off- white primer
6	Glossy tan baseboards	Off-white				Off-white **
5	Dark red baseboards	Off-white**	Thin red-brown on off-white		Off-white	Light gray
4	Medium blue with dark brown baseboards	Off-white	Cream color	Cream color	Off-white	Cream color*
3	Off-white** with red-brown baseboards	Off-white	Light cream** color	Light cream color	Off-white*	Cream color
2	Tannish-gray with brown baseboards	Yellowish- green	Cream color	Dark brown	Green	Light blue
1	Coarse bright green on cream- colored primer with brown baseboards	Tan	Gray	Possible grain- painting on cream-colored base coat	Gray-blue on light blue primer	Off-white

\* Contains zinc white; \*\* Consistent with 20<sup>th</sup> century manufacture

## **COLOR MATCHING PROCEDURES**

The remnants of the original exterior cream-colored paint on the bracket and soffit were matched with the help of a Minolta Chroma Meter CR-241, a tristimulus color analyzer/microscope with color measurement area of 0.3mm. This instrument has an internal, 360-degree pulsed xenon arc lamp and provides an accurate color measurement in a choice of five different three-coordinate color systems. None of the samples from the rusticated siding retained early paint evidence, so it is not possible to determine whether the rusticated siding and trim were originally painted the same color.

For interior paint color matching, the original paints found on the woodwork in the second-floor south chambers, the center passage and the northeast chamber were intact enough for confident color matching.

Uncast portions of the original exterior and interior paint layers were exposed with a scalpel at 30X magnification to provide clean areas for color matching. The exposed layers were measured three times in three different areas of the exposed target layers to establish the color coordinates. The measurements were first generated in the Munsell color system (a color standard used in the Architectural Preservation field), and after the measurements were taken the closest Munsell color swatches from a standard Munsell Book of Color (gloss paint standards) was compared under 30X magnification to the actual samples. The measurements were also generated in the CIE L\*a\*b\* color space system, which is currently one of the most widely accepted industry color space measuring systems.

In the areas where the original paints were too degraded or translucent to allow accurate color measurement, a second round of color matching was done by eye comparing the Munsell swatches to the samples under 30-45X magnifications and a color-corrected light source. The best visual matches for the Munsell swatches were then used to generate close commercial paint matches. The best commercial swatches are provided for reference.

## Generation 1. Original Exterior Cream-colored Paint on the Soffit and Bracket

Samples S-1 and S-5

Color-matched October 5, 2018

Benjamin Moore #OC-36 “Niveous”

Color System\*

Coordinates

Munsell

Hue

Value

Chroma

6.0Y

8.8

1.6

CIE L\*a\*b\*

Black to White

Green to Red

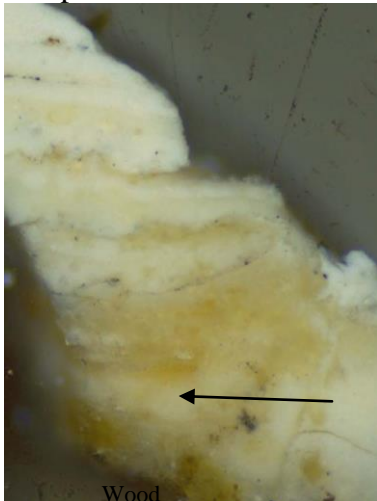
Blue to Yellow

L89.10

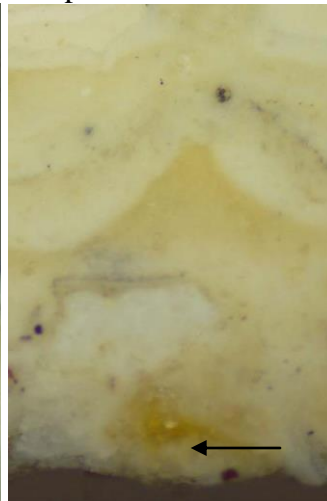
a-2.09

b+11.77

Sample S-1



Sample S-5



The original cream-colored trim paint was matched by eye at 30X under a color-corrected light source because it is too uneven and degraded to allow accurate color measurement. The commercial match #OC-36 is an excellent visual match to the best preserved areas of the cream-colored paint. Optical microscopy analysis suggests that this paint was originally moderately glossy and could be reproduced in a semi-gloss coating.

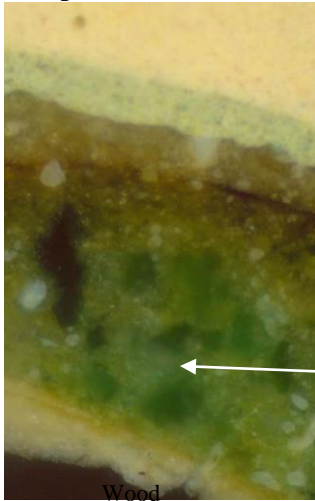
## Generation 1. Original Coarse Green Paint on the Southeast Bedchamber Woodwork

Samples SE-2 and SE-3  
Color-matched October 5, 2018

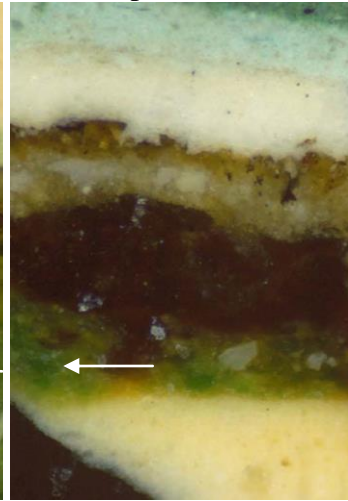
Benjamin Moore #2035-10 “Seaweed”

Color System*		Coordinates	
Munsell	Hue	Value	Chroma
	2.1G	3.7	6.4
CIE L*a*b*	Black to White	Green to Red	Blue to Yellow
	L38.49	a-34.00	b+17.96

Sample SE-2



Sample SE-3



The original green finish coat paint was matched by eye at 30X under a color-corrected light source because it is too grainy, uneven and darkened to allow accurate color measurement. The commercial match #2035-10 is an excellent visual match to the best preserved areas of the coarsely ground green paint. Optical microscopy analysis suggests that this paint was originally moderately glossy, and quite grainy, and could be reproduced in a semi-gloss coating.



**Generation 1. Original Tan Paint on the Southwest Bedchamber Woodwork**

Samples SW-1 and SW-2

Color-matched October 5, 2018

Benjamin Moore #HC-34 “Wilmington tan”

Color System\*

Coordinates

Munsell

Hue

Value

Chroma

1.9Y

7.2

3.9

CIE L\*a\*b\*

Black to White

Green to Red

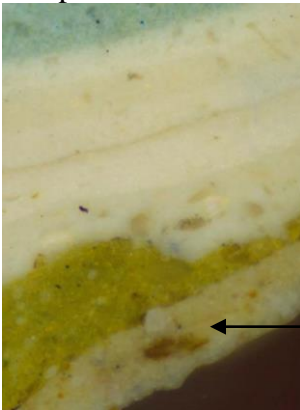
Blue to Yellow

L72.51

a+1.42

b+26.68

Sample SW-1



The original tan paint was matched by eye at 30X under a color-corrected light source because it is too uneven and degraded to allow accurate color measurement. The commercial match #HC-34 is an excellent visual match to the best preserved areas of the first-generation tan paint. Optical microscopy analysis suggests that this paint was originally slightly glossy and could be reproduced in a satin coating.

## Generation 1. Original Gray-blue Paint on the Northeast Bedchamber Woodwork

Samples NE-1

Color-matched October 5, 2018

Benjamin Moore #AC-24 “Charlotte slate”

Color System\*

Coordinates

Munsell

Hue

Value

Chroma

8.4B

4.7

1.8

CIE L\*a\*b\*

Black to White

Green to Red

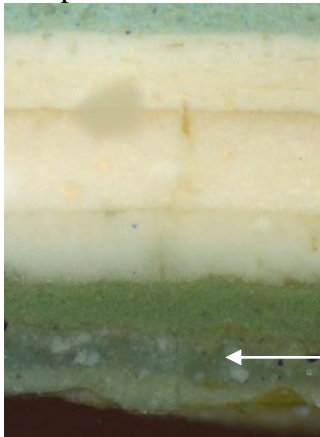
Blue to Yellow

L47.57

a-3.67

b-6.69

Sample NE-1



The original gray-blue paint was matched by eye at 30X under a color-corrected light source because it is too uneven and degraded to allow accurate color measurement. The commercial match #AC-24 is an excellent visual match to the best preserved areas of the first-generation gray-blue paint. Optical microscopy analysis suggests that this paint was originally slightly glossy and could be reproduced in a satin coating.

**Generation 1. Original Gray Paint on the Second-floor Hall Woodwork**

Samples CH-2

Color-matched October 5, 2018

Benjamin Moore #AC-17 “Sea pine”

Color System\*

Coordinates

Munsell

Hue

Value

Chroma

8.8G

5.9

0.7

CIE L\*a\*b\*

Black to White

Green to Red

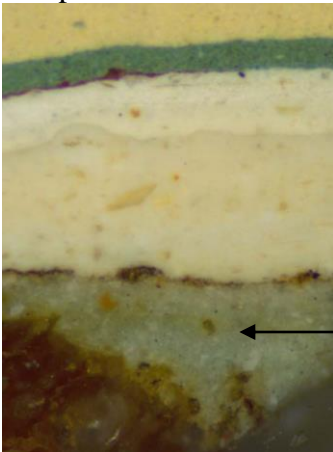
Blue to Yellow

L59.54

a-4.15

b+0.80

Sample CH-2



The original gray paint was matched by eye at 30X under a color-corrected light source because it is too uneven and degraded to allow accurate color measurement. The commercial match #AC-17 is an excellent visual match to the best preserved areas of the first-generation gray paint. Optical microscopy analysis suggests that this paint was originally slightly glossy and could be reproduced in a satin coating.

**\* COLOR SYSTEMS** Derived from the Minolta CR-241 Instruction Manual and Minolta Precise Color Communication

Chroma Meter CR-241 offers five different color systems for measuring absolute chromaticity: CIE Yxy (1931),  $L^*a^*b^*$  (1976), and  $L^*C^*H^*$  (1976) colorimetric densities  $DxDyDz$ ; Munsell notation and four systems for measuring color differences.

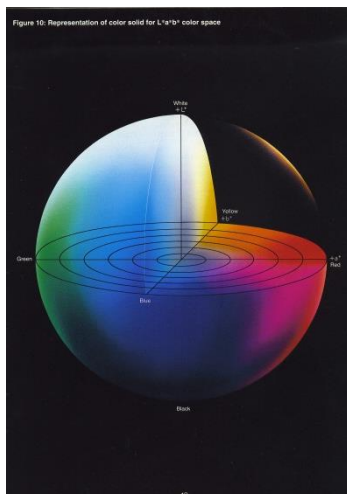
For two colors to match, three quantities defining color must be identical. These three quantities are called tristimulus values X, Y, and Z as determined by CIE (Commission Internationale de l'Eclairage) in 1931.

Color as perceived has three dimensions: hue, chroma and lightness. Chromaticity includes hue and chroma (saturation), specified by two chromaticity coordinates. Since these two coordinates cannot describe a color completely, a lightness factor must also be included to identify a specimen color precisely.

**Munsell Color System:** The Munsell color system consists of a series of color charts which are intended to be used for visual comparison with the specimen. Colors are defined in terms of the Munsell Hues (H; indicates hue), Munsell Value (V; indicates lightness), and Munsell Chroma (C; indicates saturation) and written as H V/C.

**CIE Yxy (CIE 1931):** In the Yxy (CIE 1931) color system, Y is a lightness factor expressed as a percentage based on a perfect reflectance of 100%, x and y are the chromaticity coordinates of the CIE x, y Chromaticity Diagram.

**CIE  $L^*a^*b^*$ :** Equal distances in the CIE x,y Chromaticity Diagram do not represent equal differences in color as perceived. The CIE  $L^*a^*b^*$  color system, however, more closely represents human sensitivity to color. Equal distances in this system approximately equal perceived color differences.  $L^*$  is the lightness variable;  $a^*$  and  $b^*$  are the chromaticity coordinates.





**ΔE:** ΔE (Delta E) is the industry measure used to determine how closely two colors match in the CIE L\*a\*b\*. The symbol Δ means “the change in”. It is based on calculating the sum of the differences between each measure. The calculation is:  $\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$ , or, the color difference equals the square root of the squared sums of the differences between each of the three L\* a\* b\* tristimulus values. Industry color standards indicate a ΔE of 1 is barely perceptible to the human eye, and ΔE of 6 to 7 is acceptable for color matches in the printing industry.

## REFERENCES

### Cross-section Preparation Procedures:

The samples were cast into mini-cubes of polyester resin (Excel Technologies, Inc., Enfield, CT). The resin was allowed to cure for 24 hours at room temperature and under ambient light. The cubes were then ground to expose the cross-sections, and dry polished with 400 and 600 grit wet-dry papers and Micro-Mesh polishing cloths, with grits from 1500 to 12,000.

Cross-section microscopy analysis was conducted with a Nikon Eclipse 80i epi-fluorescence microscope equipped with an EXFO X-Cite 120 Fluorescence Illumination System fiberoptic halogen light source and a polarizing light base using SPOT Advanced software (v. 4.6) for digital image capture and Adobe Photoshop CS for digital image management. Photographs and digital images of the best representative cross-sections are included in this report. UV photographs were taken with the UV-2A filter in place (330-380 nanometers excitation with a 400 nm dichroic mirror and a 420 nm. barrier filter). Please note that the colors in the printed photomicrographs may not accurately reflect the actual color of the samples because the colors in the digital images are affected by the variability of color printing.

The following fluorescent stains were used for examination of the samples:

Triphenyl tetrazolium chloride (TTC) 4.0% in ethanol to identify the presence of carbohydrates (starches, gums, sugars). Positive reaction color is dark red or brown.

Fluorescein isothiocyanate (FITC) 0.2% in anhydrous acetone to identify the presence of proteins. A yellow or yellowish-green colors indicates a positive reaction.

2, 7 Dichlorofluorescein (DCF) 0.2% in ethanol to identify the presence of saturated and unsaturated lipids (oils). Positive reaction for saturated lipids is pink and unsaturated lipids is yellow.

Rhodamine B (RHOB) 0.06% in ethanol to identify the presence of oils. Positive reaction color is bright orange.

The best cross-section photographs for each area were mounted and labeled and are included with this report. Photographs were taken at 100X, 200X and 400X magnifications.

**Information Provided by Ultraviolet Light Microscopy:**

When viewed under visible light, cross-sections which contain ground, paint and varnish may often be difficult to interpret, particularly because clear finish layers look uniformly brown or tan. It may be impossible using only visible light to distinguish between multiple varnish layers. Illumination with ultraviolet light provides considerably more information about the layers present in a sample because different organic, and some inorganic, materials autofluoresce (or glow) with characteristic colors.

There are certain fluorescence colors which indicate the presence of specific types of materials. For example: shellac fluoresces orange (or yellow-orange) when exposed to ultraviolet light, while plant resin varnishes (typically amber, copal, sandarac and mastic) fluoresce bright white. Wax does not usually fluoresce; in fact, in the ultraviolet it tends to appear almost the same color as the polyester casting resin. In visible light wax appears as a somewhat translucent white layer. Paints and glaze layers which contain resins as part of the binding medium will also fluoresce under ultraviolet light at high magnifications. Other materials such as lead white, titanium white and hide glue also have a whitish autofluorescence.

There are other indicators which show that a surface has aged, such as cracks which extend through finish layers, accumulations of dirt between layers, and sometimes diminished fluorescence intensity, especially along the top edge of a surface which has been exposed to light and air for a long period of time.

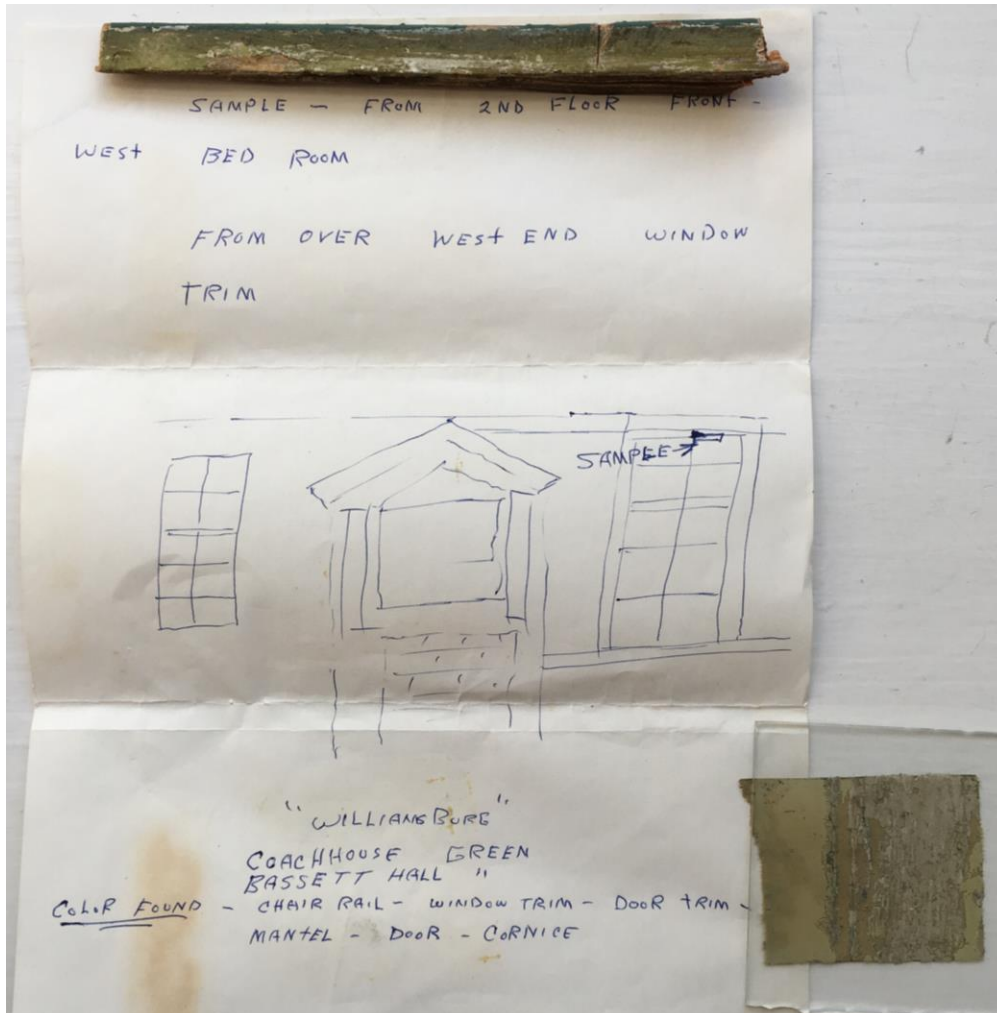
**Appendix A**  
**Samples Removed By Colonial Williamsburg Researchers in the 1980s**

**Second-floor Southeast Bedchamber**

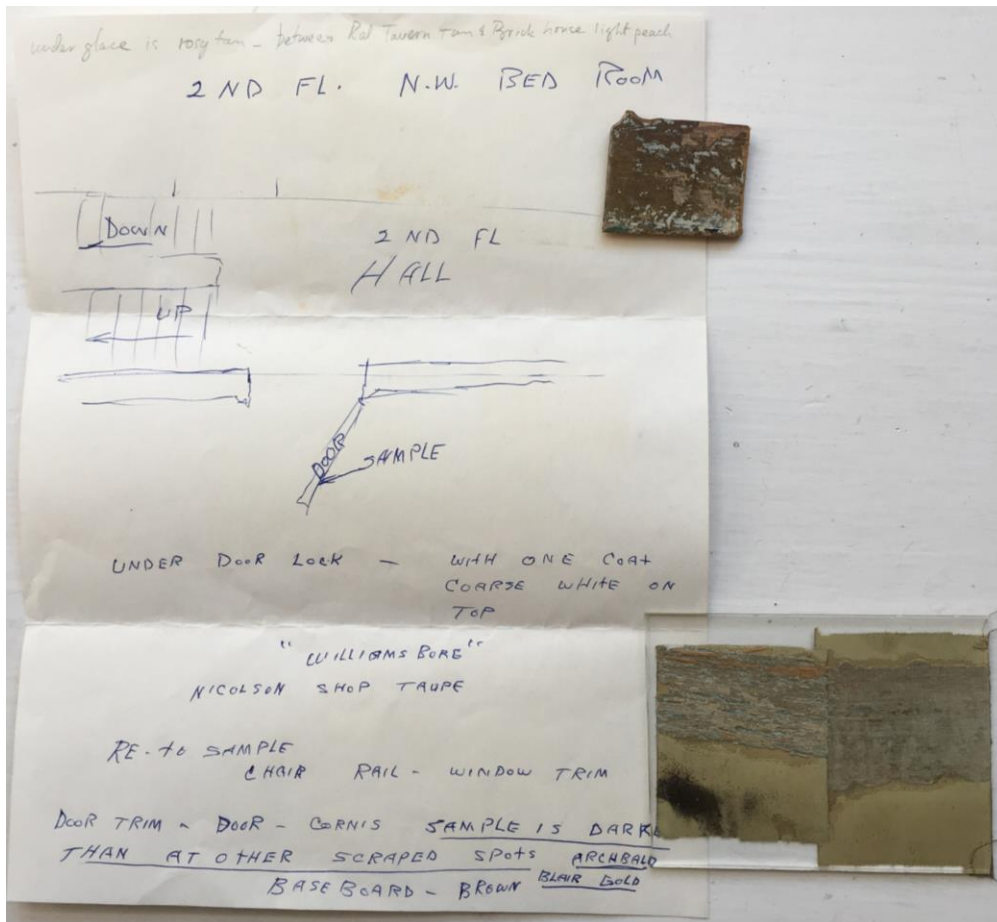




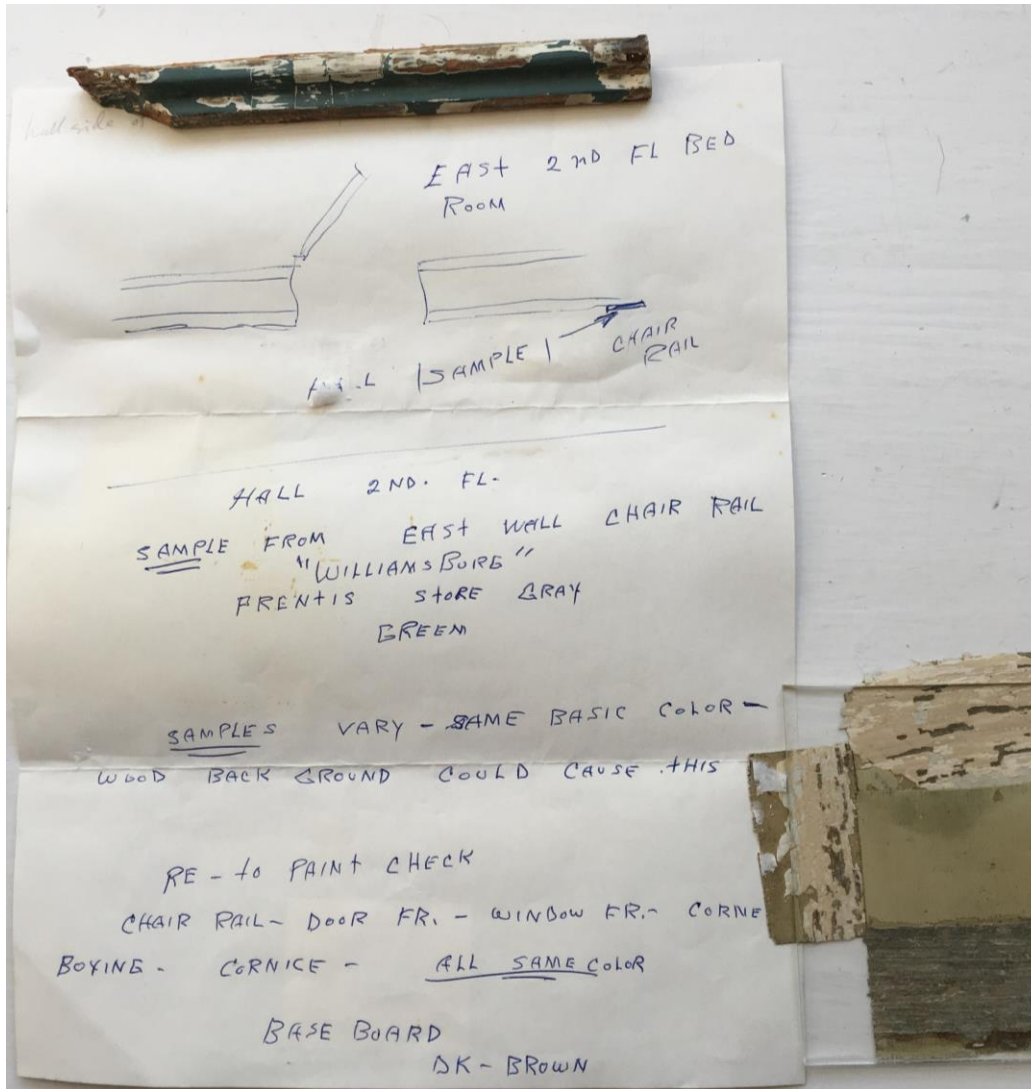
Second-floor Southwest Bedchamber



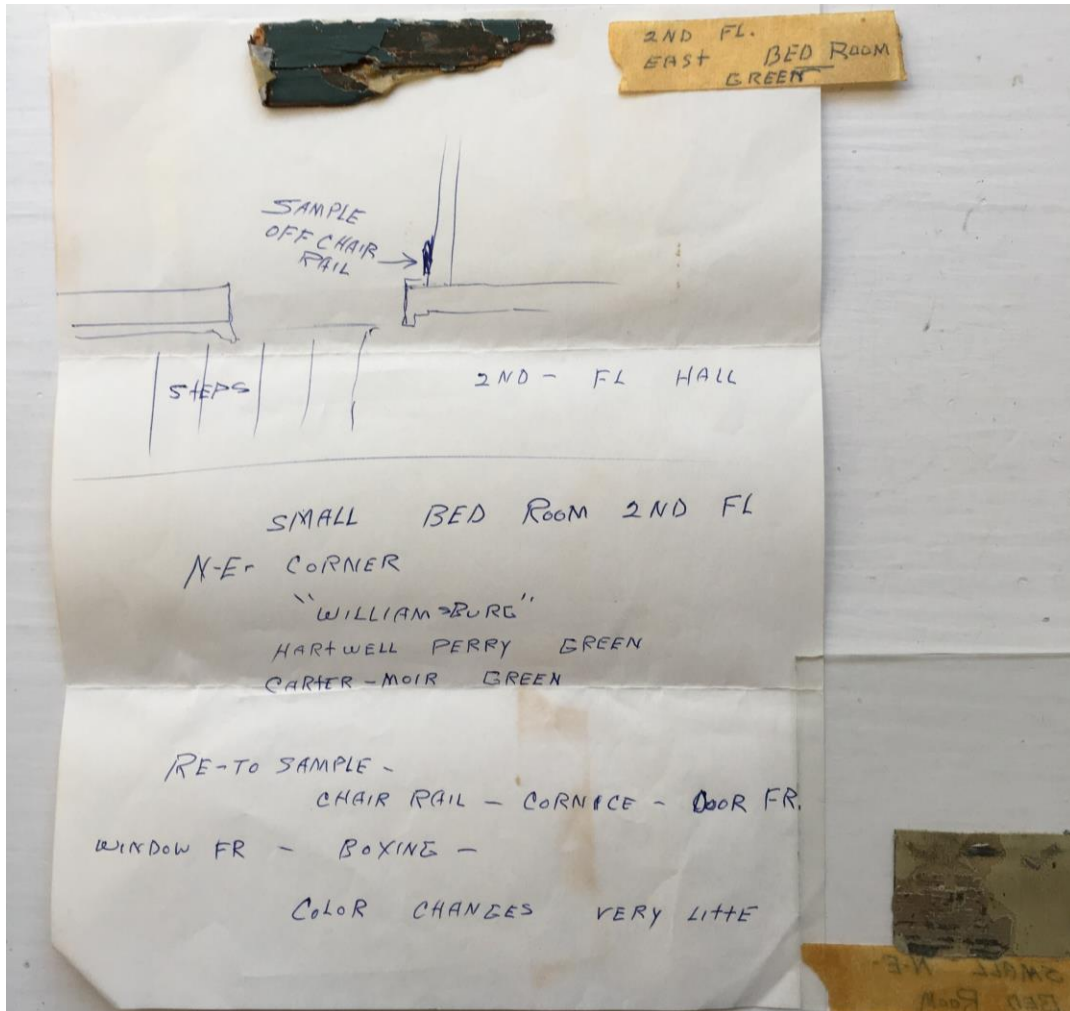
Second-floor Northwest Bedchamber



Second-floor Hall



Second-floor Northeast Room



## **Appendix B**

### **Paint Sample Locations: The Cupola House, Edenton, North Carolina**

Samples removed August 28 and 29, 2018 by Susan L. Buck

#### Exterior

- S-1. South elevation, west side, soffit of overhang.
- S-2. South elevation, west side, bottom molding of cornice of overhang above west window.
- S-3. South elevation, west side, west window, top right corner of architrave.
- S-4. South elevation, weatherboard just right of west window.
- S-5. South elevation, west side, side of bracket
- S-6. South elevation, west side, collection of paints overlapped onto window architrave, possibly from original rusticated siding.
- S-7. South elevation, on pediment of porch cornice, top left corner.
- Shutter-8. Detached shutter, right side of panel, at join with right stile.
- N-9.
- N-10. North elevation, side of window architrave for window just west of door, filler along edges with overlap from rusticated siding.

#### Cupola

- C-1. Interior, window architrave, north window, left corner.
- C-2. Interior, cornice above east window, at bottom edge.
- C-3. Interior, chair rail, corner below below east window.
- C-4. Interior, original flooring, blackened stripe where baseboard paint might have overlapped onto edge of flooring.
- C-5. Exterior surface, east wall window, upper sash, upper left corner at edge of dowel.
- C-6. Exterior, rusticated siding below sill for east window (weathered wood).
- C-7. Exterior, cupola bracket on east elevation at base of carved leaf.

#### Detached Fragments

- 1. Shingle found trapped in second-floor kneehole attic, at edge of blackened coatings.
- 2. Iron bracing bar, possibly from cupola, greenish and whitish paints.
- 3. Cornice bolection molding fragment, along edges.
- 4. Exterior finial from pediment of cornice, south elevation, on side of carving.
- 5. Rusticated siding board from cupola, at edges.
- 6. Blue-green painted board with cut-out for molding.

#### First-floor Interior

##### Central Passage

- CP-1. Raised edge of paint on flooring, west side, southwest corner, possible overlap from baseboard.



CP-2. North wall plaster under stairs.

CP-3. Raised edge of paint on flooring, east side, near electrical outlet.

#### Southeast Room

SE1-1. East wall, north of fireplace, raised edge of paint on flooring that might be overlap from baseboard.

#### Southwest Room

SW1-1. North wall, raised edge of paint along north wall, just right of middle.

#### Second-floor Interior

##### Southeast Bedchamber

SE-1. East wall, left side of overmantel panel, about 5-feet up.

SE-2. East wall, south window, edge of left backband molding.

SE-3. East wall, top left corner of wainscot panel just right of fireplace opening.

SE-4. West wall, baseboard cap left of door.

##### Second-floor Center Passage

CH-1. Door leading to SE bedchamber, upper left corner, middle left panel.

CH-2. East wall, right edge of architrave for north door.

CH-3. West wall, plaster about south door.

##### Southwest Chamber

SW-1. West wall, in interstices of leaf carving on right side of overmantel panel.

SW-2. West wall, bead of chair rail just right of fireplace.

##### Northwest Chamber

NW-1. South wall, bottom edge of cornice, above door.

NW-2. South wall, top edge of door architrave.

##### Northeast Chamber

NE-1. South wall, southwest corner, surbase of chair rail.