RHDC
RALEIGH HISTORIC
DEVELOPMENT COMMISSION

CERTIFICATE OF APPROPRIATENESS PLACARD

for Raleigh Historic Resources

728 W Hargett St
726 W Hargett St
Address

Project Description:

Change existing paint color

Historic District

Joel Lane House
Historic Property

COA-0002-2020
Certificate Number

1/30/2020
Date of Issue

7/30/2020
Expiration Date

This card must be kept posted in a location within public view until all phases of the described project are complete. The work must conform with the code of the City of Raleigh and laws of the state of North Carolina. When your project is complete, you are required to ask for a final zoning inspection in a historic district area. Telephone the RHDC office at 832-7238 and commission staff will coordinate the inspection with the inspections Department. If you do not call for this final inspection, your Certificate of Appropriateness is null and void.

Signature, Collette R Kinsle

Raleigh Historic Development Commission

Pending the resolution of appeals, commencement of work is at your own risk.

Type or print the following:		
Applicant name: Brett Sturm		
Mailing address: 3213 Mid Pines Road		
City: Raleigh	State: NC	Zip code: 27606
Date: January 2, 2020	Daytime phone #: 919-814-6589	
Email address: brett.sturm@ncdcr.gov		
Applicant signature:		

Minor work (staff review) – one copy Major work (COA committee review) – ten copies Additions > 25% of building sq. footage New buildings Demolition of building or structure All other Post approval re-review of conditions of approval	**Office Use Only** Transaction #: _____ File #: COA-0002-2020 Fee: _____ Amount paid: _____ Received date: _____ Received by: _____

Property street address: 726-728 W Hargett Street
Historic district: n/a
Historic property/Landmark name (if applicable): Joel Lane House (Wakefield)
Owner name: National Society of the Colonial Dames of America
Owner mailing address: 728 W Hargett Street, Raleigh, NC 27603

For applications that require review by the COA Committee (major work), provide addressed and stamped envelopes for owners for all properties with 100 feet on all sides of the property, as well as the property owner.

Property Owner Name & Address	Property Owner Name & Address

I understand that all major work applications that require review by the Raleigh Historic Development Commission's COA Committee must be submitted by 4 p.m. on the date of the application deadline; otherwise, consideration will be delayed until the following committee meeting. An incomplete application will not be accepted.

Will you be applying for rehabilitation tax credits for this project? Yes (No) Did you consult with staff prior to filing the application? (Yes) No w/Tania Tully via email dated 12/17/2019.	Office Use Only Type of work: 51

Design Guidelines: please cite the applicable sections of the design guidelines (www.rhdc.org).		
Section/Page	Topic	Brief description of work (attach additional sheets as needed).
2.4/44-5	Paint and Paint Color	Complete paint removal and re-paint for main house, kitchen, and visitor's center. (See attachments)

Minor Work Approval (office use only)

Upon being signed and dated below by the Planning Director or designee, this application becomes the Minor Work Certificate of Appropriateness. It is valid until 07/30/2020.

Please post the enclosed placard form of the certificate as indicated at the bottom of the card. Issuance of a Minor Work Certificate shall not relieve the applicant, contractor, tenant, or property owner from obtaining any other permit required by City Code or any law. Minor Works are subject to an appeals period of 30 days from the date of approval.

Signature (City of Raleigh) Collette R Kruse Date 01/30/2020

January 6, 2020

Tania Tully and Collette Kinane
Raleigh Historic Development Commission
One Exchange Plaza, Suite 300
Raleigh, NC 27601

Dear Tania and Collette:

In my capacity as "buildings chair" of the board of directors at the Joel Lane Museum House (JLMH), I kindly submit this introductory letter to accompany the application seeking a Certificate of Appropriateness for "minor works" currently underway at the landmarked site on the corner of Hargett and St. Mary's Streets.

The project is focused entirely on exterior paint and woodwork, and entails the following scope of work for the Museum's three independent structures—that is, the Joel Lane House, the attendant kitchen outbuilding to the east, and the visitor's center to the north:

1. Complete exterior paint removal via heat gun and hand-scraping. Site fully contained with no open-flame combustion permitted. Existing paint stratigraphy will be preserved as a means of protecting of the buildings' historical paint record in one-to-two inconspicuous locations TBD.
2. Replacement in-kind of any wooden siding or trim material found to be too deteriorated to support a new paint system.
3. Prime coat using a slow-drying, alkyd primer. Any replacement material will be pre-primed on all six sides prior to installation.
4. Two finish coats of a compatible, acrylic-latex paint formulated for exterior use.

As you are aware, this project will highlight a new exterior paint color scheme for the Joel Lane House and the kitchen outbuilding. The palette is derived from an exciting paint analysis project undertaken by the JLMH and Dr. Susan Buck of Williamsburg, VA, who utilized thin-section microscopy to interpret paint samples taken in the field. The visitor's center, meanwhile, will retain the existing color scheme, which dates the property's mid-1970s-era restoration.

For your information I have attached a copy of Dr. Buck's report to this digital submission. Please note that the JLMH currently plans to employ trim and siding colors matched to the earliest paint colors detected in Dr. Buck's analysis. They are, respectively, Benjamin Moore's "Quincy Tan" and "Cottage Red," and are described in-depth on pages 17 and 18 of Dr. Buck's report.

Also attached are a series of photographs I took of the main Joel Lane House, prior to paint removal, on December 9, 2019. If your review of the application should require more any additional information—photographic or otherwise—please let me know.

Sincerely yours,

Brett C. Sturm, Restoration Specialist
State Historic Preservation Office

cc: Lanie Hubbard, Director, Joel Lane Museum House
Ellen Jackson, Board President, Joel Lane Museum House
Claudia Brown, Assistant Treasurer, Joel Lane Museum House

Optical Microscopy Exterior Paint Analysis

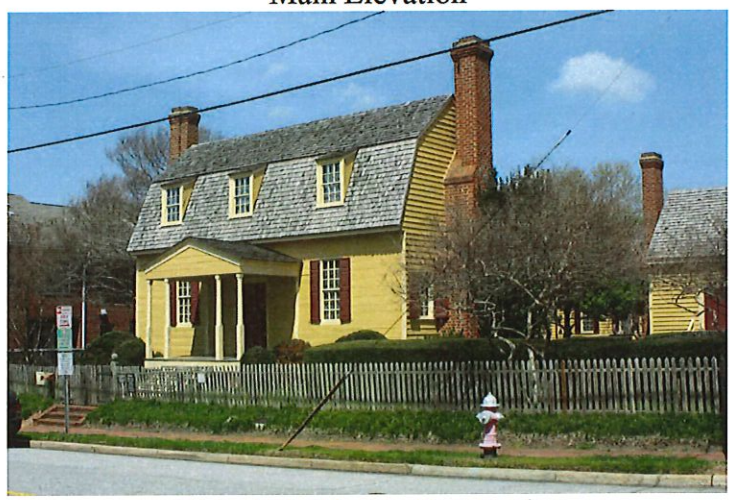
Joel Lane Museum House
728 West Hargett Street
Raleigh, North Carolina 27605

For: Lanie Hubbard, Director
Joel Lane Museum House
Mailing address: P O Box 10884, Raleigh NC 27605
Shipping & physical address: 160 South Saint Mary's Street
Raleigh NC 27603
Tel: 919-833-3431

By: Susan L. Buck, Ph.D. Conservator and Paint Analyst
303 Griffin Avenue
Williamsburg, VA 23185

Date: November 25, 2019

Main Elevation



Michael Worthington, Photographer

Purpose:

The goal of this project is to identify the compositions and colors of the front door, the siding, and the window and door trim on the ca. 1770 Joel Lane House. If the original paints and those related to the second period (1790-95) survive and can be identified through paint analysis, the colors will be matched with a colorimeter/microscope for reference and replication.

Procedures:

Samples from the protected areas of the front door, the window and door trim, and the siding were sent to Susan Buck for analysis. Before casting, the samples were examined at 45X magnification under a binocular microscope to screen them for duplicates. The samples that retained the most complete stratigraphies were 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 rendering do not accurately represent the actual colors.

Paint Analysis Results:

Paint analysis was undertaken to document the surviving paints on the doors, trim and siding. The second period of the house (ca. 1790-1795) is of interest as that is when Joel Lane replaced the original gable roof with a gambrel roof. The best samples were taken from just above the main door, which is an area would not have been affected by roof alterations.

It was also hoped that comparative cross-section microscopy analysis might help to generally date periods of transition in the nineteenth century, before the most recent finely ground, commercially prepared paints appear in the stratigraphies.

Analysis of exterior paints is often complicated by the loss of paint layers because of weathering and deliberate stripping, but there are clues that can help to explain how long a specific layer might have been exposed. Those include the degree of disruption of the paint surface, such as deep cracks, erosion, blanching and darkening. Thick films of dirt are often found on paints which have been left exposed for decades before repainting. Other physical characteristics of traditional 18th and 19th-century hand-ground paints include large and uneven distributed pigments, pale pinkish autofluorescence in paints containing white lead pigments, and variations in paint thicknesses. Commercially prepared 20th-century paints tend to be more thinly applied, have dull autofluorescence colors, and are typically evenly mixed with smooth surfaces.

All of these characteristics help to distinguish early paints from 20th-century paints, but cannot pinpoint specific dates of application. The relative timing of selected paint layers are noted in the cross-section descriptions, although many 19th-century century coatings are likely missing in the samples from the door and siding because of deliberate stripping and exposure.

South Elevation Sample Locations

Sample Locations
Sample 1. Window trim, bottom left corner, window left of door.
Sample 2. Siding right of left pilaster.
Sample 3. Door trim, left side.
Sample 4. Door left side.
Sample 5. Door left side.
Sample 6. Siding above door.
Sample 7. Siding above door.
Sample 8. Siding above door, at join with ceiling.
Sample 9. Door right side.
Sample 10. Door right side.
Sample 11. Door trim right side.
Sample 12. Siding right of door.
Sample 13. Siding right of door.
Sample 14. Siding right of door.
Sample 15. Window trim, bottom left corner, window right of door.

For this analysis project the samples have been divided into groups based on architectural feature. Two samples (5 and 9) were analyzed from different areas of the door, and those findings are described and illustrated first in this section of the report. Only one sample from the door trim was found to retain a full paint chronology, but the door and window trim were likely

originally painted to match each other. The findings for sample 11 from the door trim on the right side of the door opening are described and illustrated after the door paint analysis results. Four samples from the siding retain excellent original paint evidence, and the results for the analysis of those samples 6, 7, 12 and 13 are at the end of this section of the report.

It is actually quite remarkable that so much paint evidence still remains on a building that is almost 250 years old. There is evidence of paint loss in some of the samples, but the discovery of approximately 27 generations of paint in sample 11 from the door trim suggests that the house exterior has generally been maintained in a careful and conscientious manner.

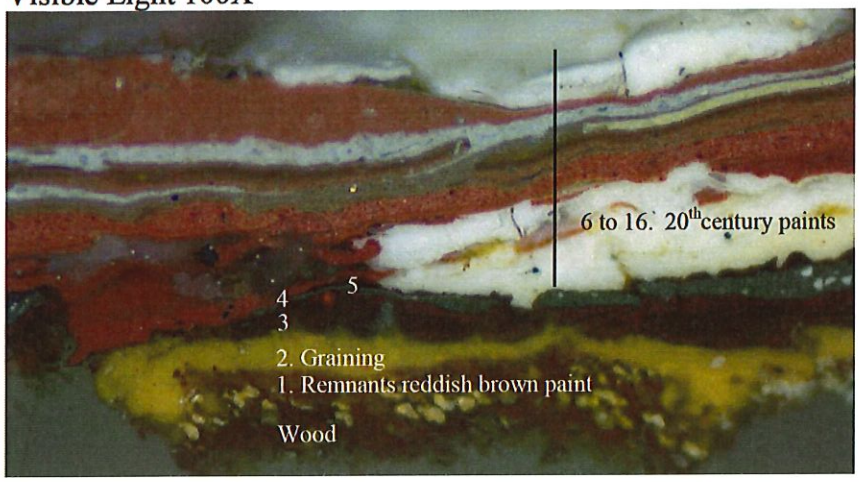
Door. There are approximately 16 generations of paint in samples 5 and 9 from the door. The earliest paints are fragmentary, especially in sample 5 where there are only remnants of a dark reddish paint layer trapped in the wood. In sample 5 the second generation appears to be decorative grain-painting to replicate figured wood. The paints used to create this graining pattern consist of deep yellow base coat, a brown glaze and a layer of plant resin varnish (identified based on its characteristic whitish autofluorescence in reflected ultraviolet light).

The earliest paint in sample 9 from the right side of the door retains more intact evidence of the earliest surviving paint on the door. This sequence of coatings is consistent with decorative graining to replicate figured wood and it begins with an off-white primer, followed by a yellow base coat and a brown glaze layer. The second generation is also graining on a deep yellow base coat which is similar to, but slightly more disrupted, than that found in sample 5. After the initial two generations of graining, the door paint colors varied from dark brown, to dark gray, to off-white, followed by the more recent browns and red-browns. The finely ground, smooth quality of the off-white paint in generation 6 is consistent with commercially prepared 20th-century paints.

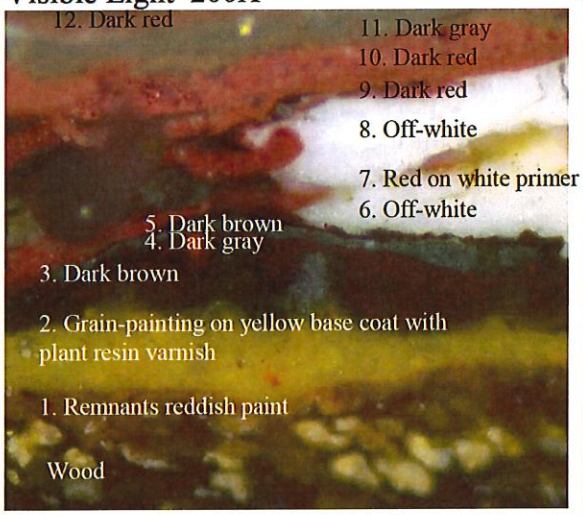
So, while the earliest door paints are more disturbed than the original paints found on the trim and siding, the presence of two early generations of grain-painting suggests that it is appropriate to decoratively paint the front door with graining to replicate figured wood as it may have been re-grained in the second period of the house (1790-95). The most appropriate graining for a late 18th-door in this region would be mahogany. Similar early graining has been found on the main door of Mount Vernon, the main door of the Hammond-Harwood House in Annapolis, and the main door of the Coke-Garrett House in Williamsburg, Virginia (the graining here may be post-Revolutionary). Grain-painting evidence does not often survive on exterior doors because of the damage caused by weathering and repainting.

Binding media analysis of sample 9 shows all the paints are oil-bound. The pigments from the original graining could not be confidently separated for identification as the earliest layers are so thin and disrupted. However, the appearance of the primers and base coats for generations 1 and 2 in reflected visible and ultraviolet light are consistent with white lead-based paints with yellow ochre colorants.

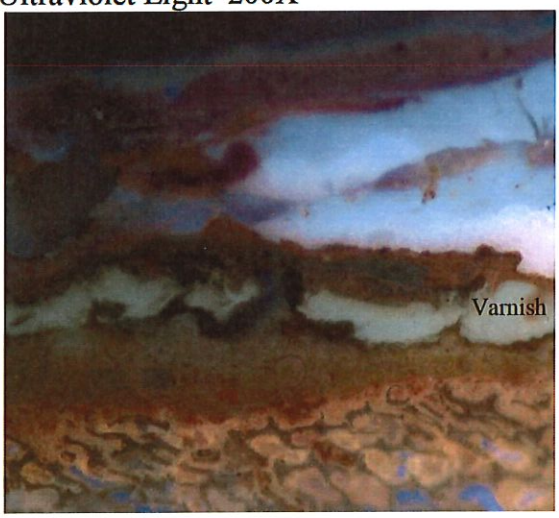
Sample 5. Door left side.
Visible Light 100X



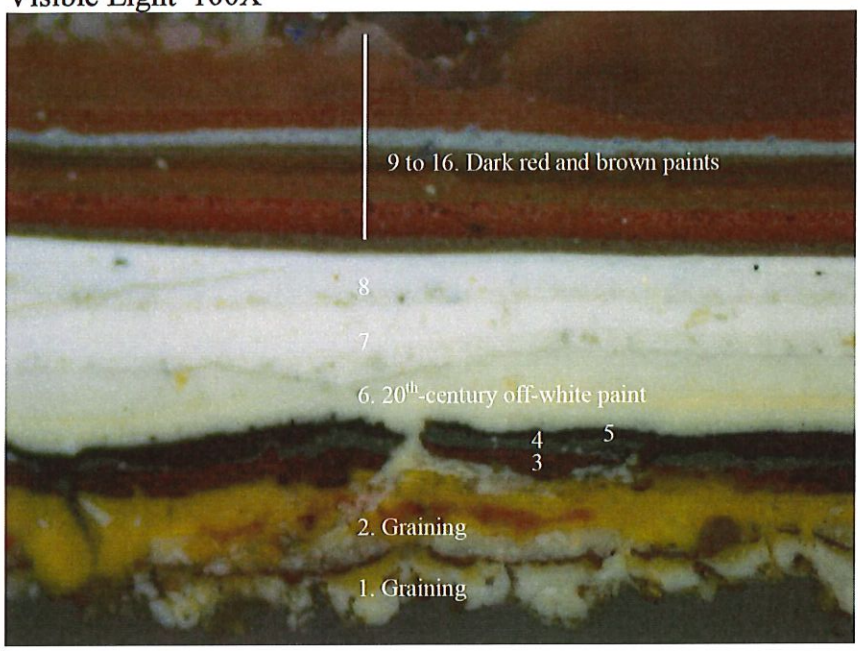
Sample 5. Door left side.
Visible Light 200X



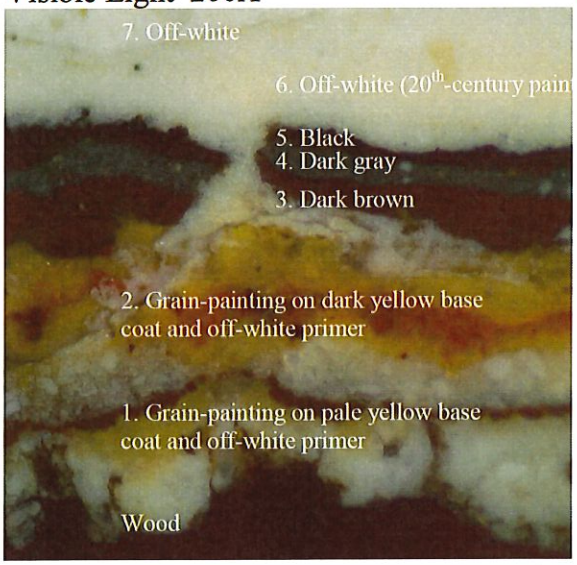
Ultraviolet Light 200X



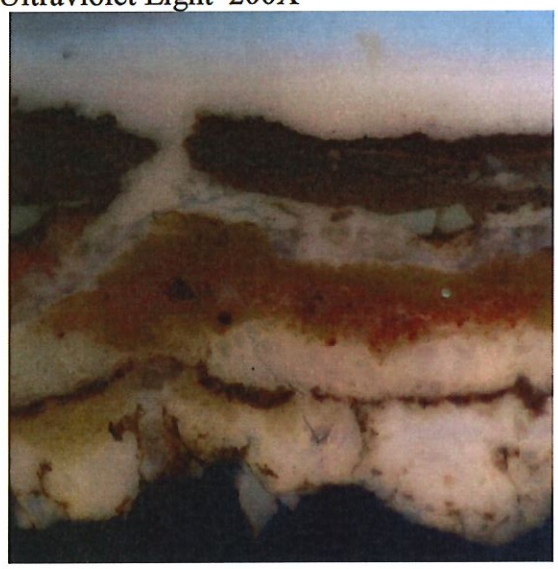
Sample 9. Door.
Visible Light 100X



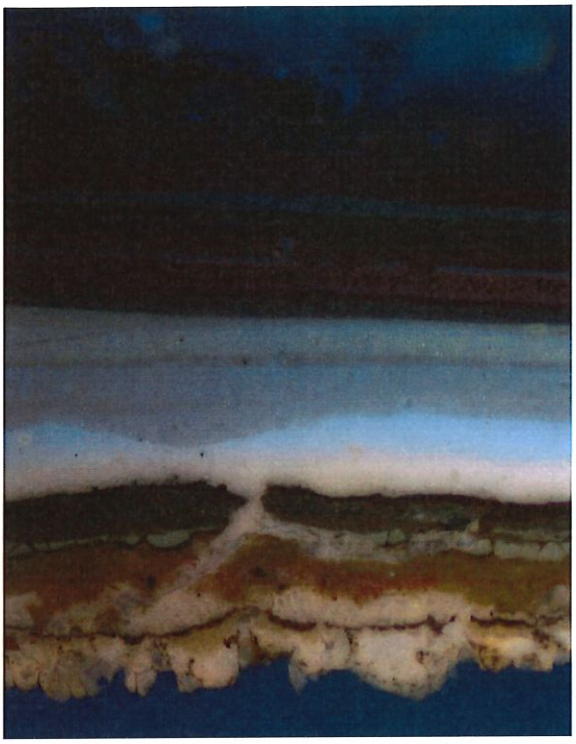
Sample 9. Door.
Visible Light 200X



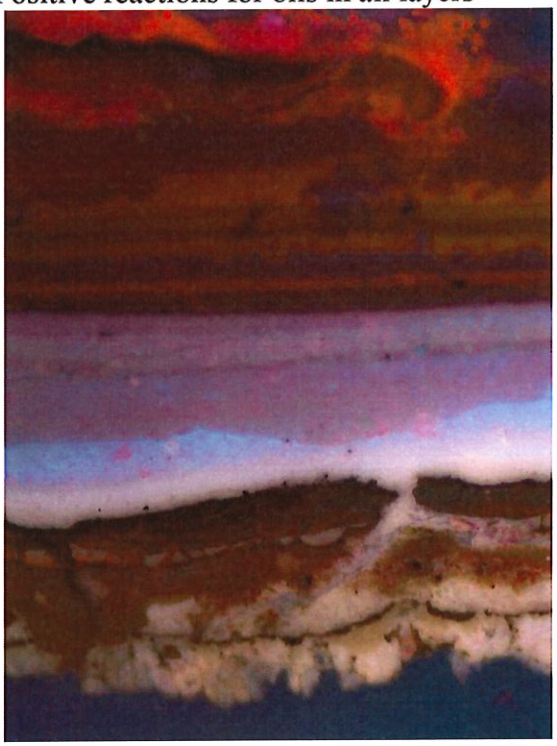
Ultraviolet Light 200X



Sample 9. Door.
Ultraviolet Light 100X



UV Light & RHOB for oils
Positive reactions for oils in all layers



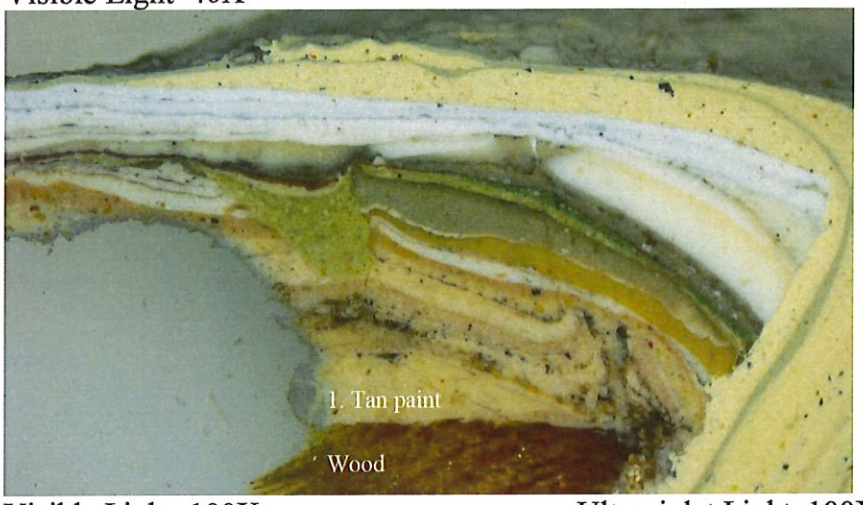
Window and Door Trim. The window and door trim elements are currently painted with a cream color which matches the trim on the porch. The two samples from the windows (1 and 15) do not retain early paints, probably because these elements are so exposed. Door trim sample 3 is also compromised from weathering and partial paint removal. Fortunately, door trim sample 11 appears to retain a full chronology of 27 generations of paint. Window and door trim elements were traditionally painted the same color, so the paints in sample 11 probably represent the chronology of window trim paints as well.

The original paint is a thickly applied, oil-bound, tan-colored paint. The trim was repainted with a white lead-based dark cream color in generation 2, followed by a dark yellow paint in generation 3. The second-generation dark cream color is may have been applied before the end of the eighteenth century. The 40X image of cross-section sample 11 shows that there were distinct color changes over time, including pinkish-tan paint in generation 11, deep yellow in generation 14, and greens in generations 17 and 18. The deep yellow paint in generation 14 contains the pigment zinc white (based on its characteristic sparkly autofluorescence in reflected ultraviolet light), which means this paint must post-date about 1845 when zinc white was available for paint-making. The finely ground, evenly mixed, nonfluorescent paints that start at generation 20 likely date to the twentieth century.

Binding media analysis with biological fluorochromes shows that all the paints are oil-based (with the fluorochrome Rhodamine B). Polarized light microscopy (PLM) analysis shows that the original tan paint contains white lead, calcium carbonate, and widely dispersed yellow ochre and red ochre pigments.

Sample 11. Door trim right side.

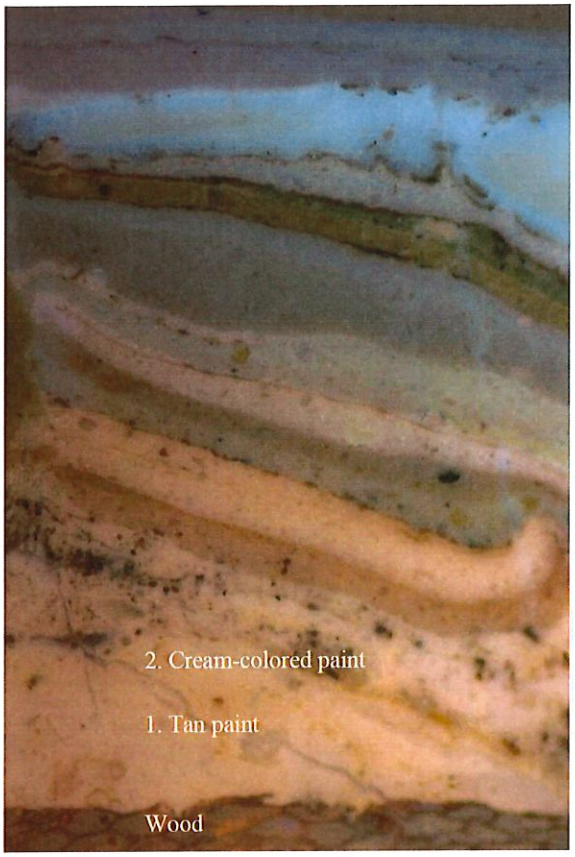
Visible Light 40X



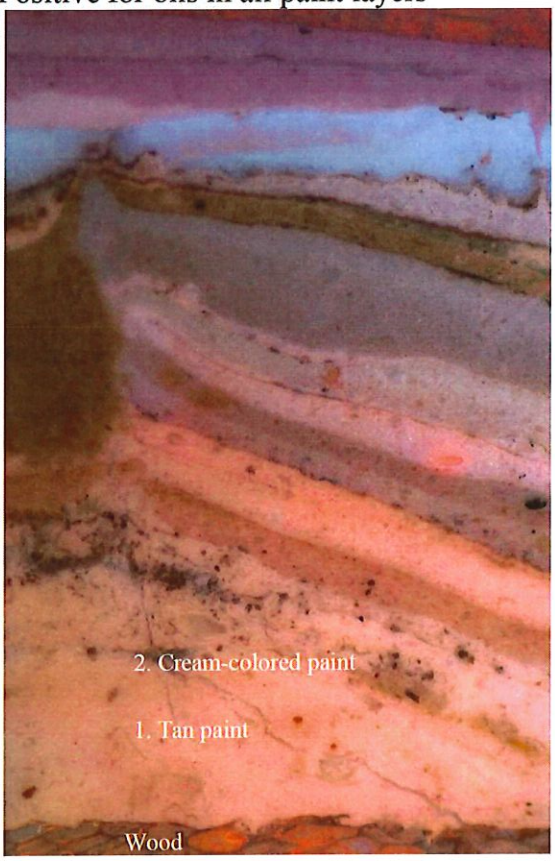
Visible Light 100X

Ultraviolet Light 100X

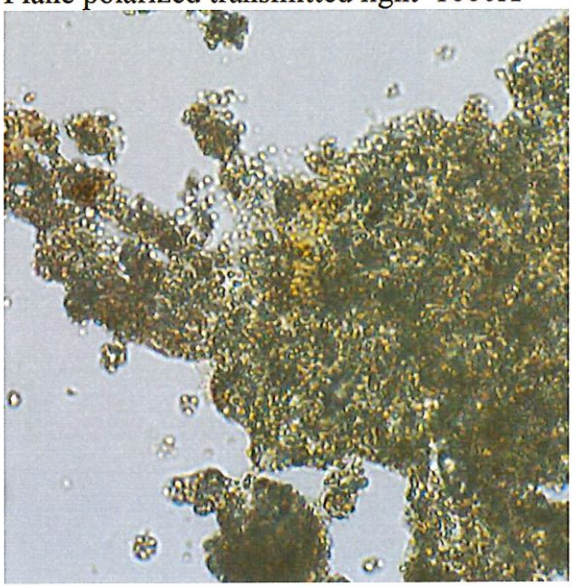
Sample 11. Door trim right side.
Ultraviolet Light 200X



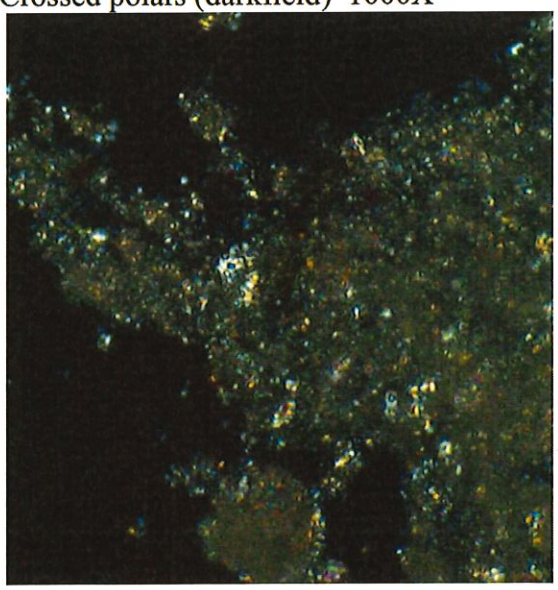
UV Light & RHOB for the presence of oils
Positive for oils in all paint layers



Sample 11. Door trim right side. Pigments in the original tan paint: white lead, calcium carbonate, scattered yellow ochre and red ochre pigments.
Plane polarized transmitted light 1000X



Crossed polars (darkfield) 1000X



Siding. The paint evidence in the siding samples is more fragmentary than the door trim paints in sample 11, but four samples from different areas of siding confirm that the original siding paint was a coarsely ground, deep red paint. In sample 6 there are three generations of white lead-based off-white paints on top of the first coarse deep red. The second generation of off-white paint flowed into cracks in the eroded surface of the original paint, confirming that this deep red paint was left exposed for many years before being painted over.

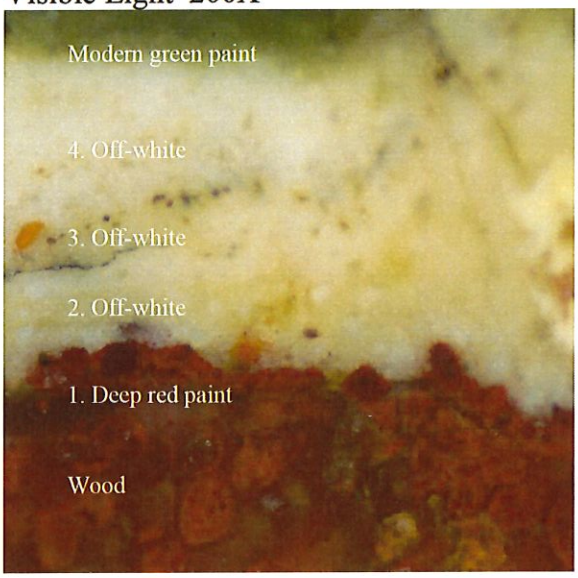
There is compelling evidence to suggest that the original deep red paint remained here in the 1790-95 period when the trim was repainted. In samples 12 and 13 there is a pale yellow paint which seems to align with generation 5, followed by finely ground yellow paints which are consistent with twentieth-century manufacture.

In samples 6 and 7 from siding above the door, there is a light green paint above the fourth generation of off-white paint. This is likely an overlap of later porch ceiling paint as it does not appear in the other two cross-sections from the siding to the right of the door.

Biological fluorochrome staining for oils shows that all the paints are oilbound. PLM analysis helped to identify the pigments in the original deep red paint as red ochre, large haematite particles, and calcium carbonate.

Sample 6. Siding above door.

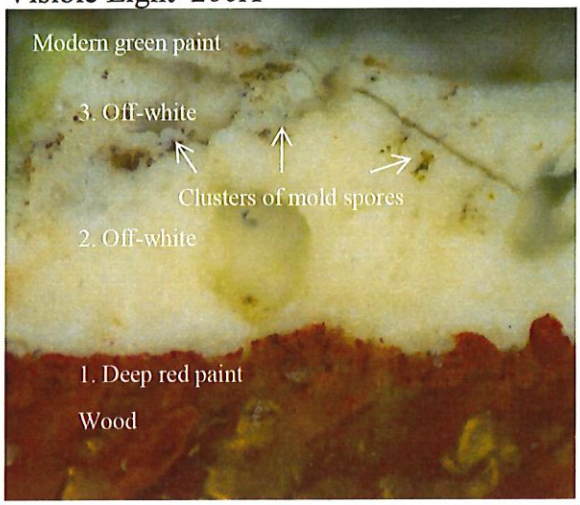
Visible Light 200X



Ultraviolet Light 200X

Sample 7. Siding above door.

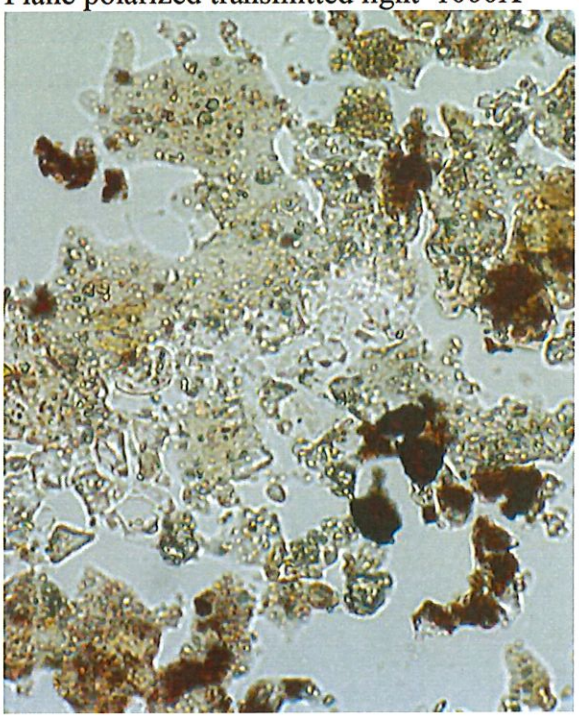
Visible Light 200X



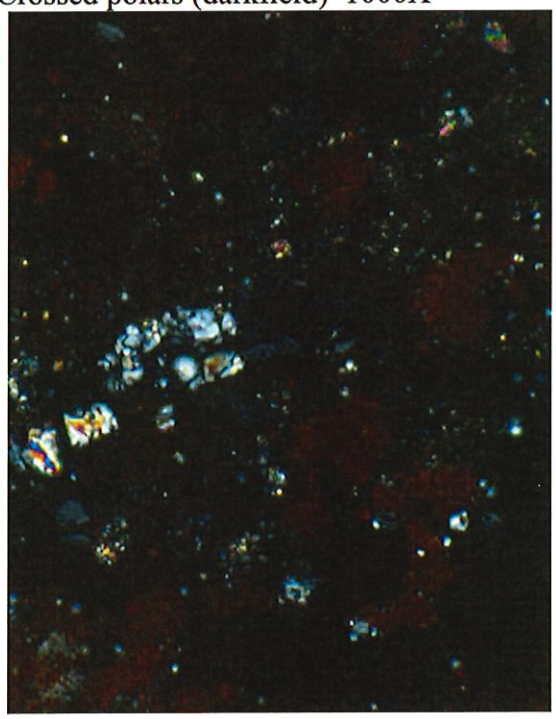
Ultraviolet Light 200X

Siding above door. Pigments in the original deep red paint layer: red ochre, haematite, calcium carbonate.

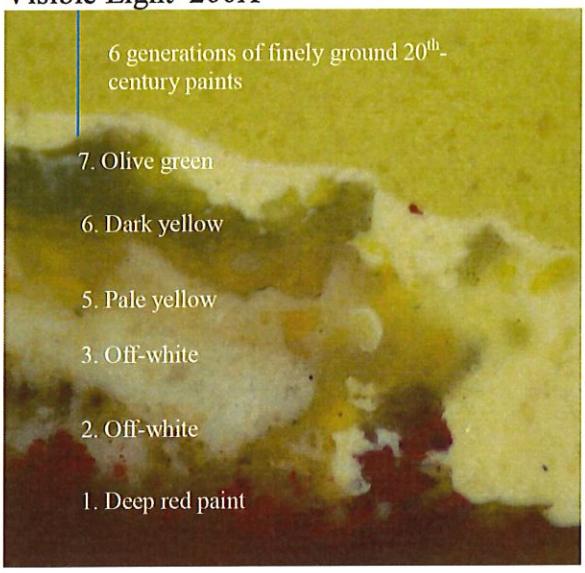
Plane polarized transmitted light 1000X



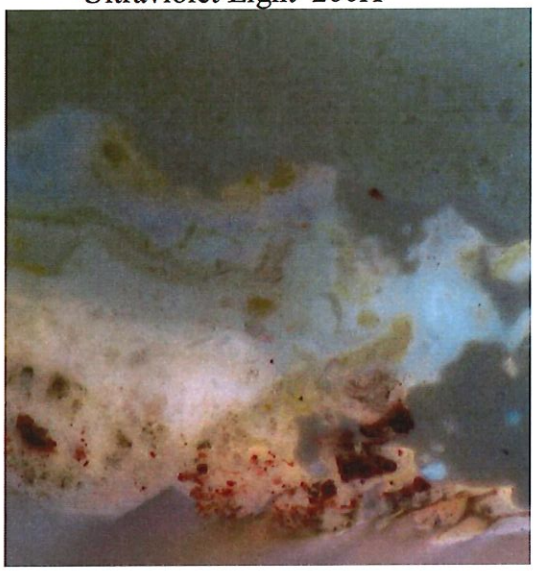
Crossed polars (darkfield) 1000X



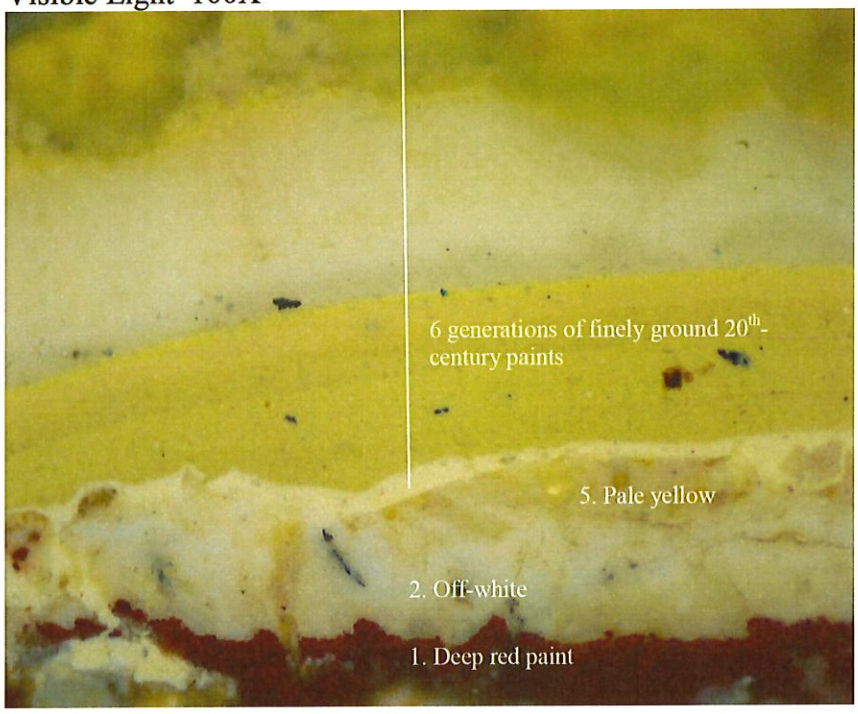
Sample 12. Siding right of door.
Visible Light 200X



Ultraviolet Light 200X

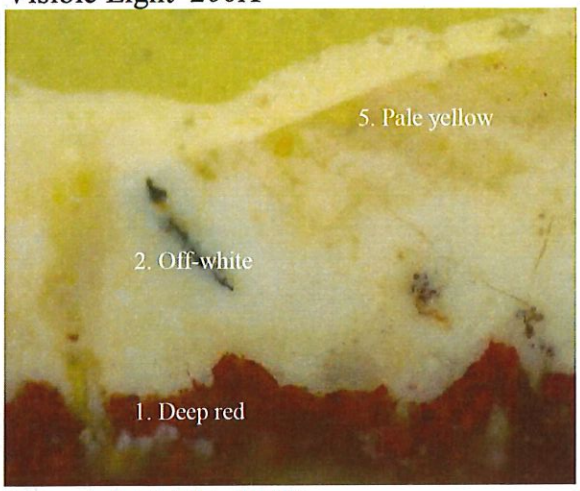


Sample 13. Siding right of door.
Visible Light 100X



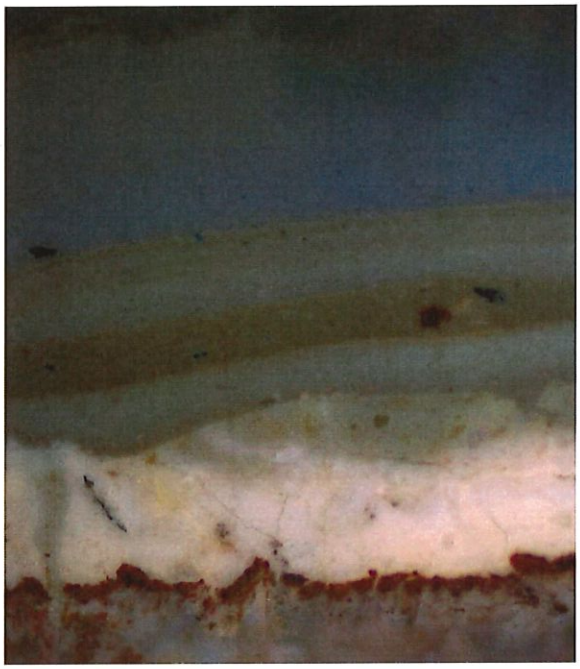
Sample 13. Siding right of door.

Visible Light 200X

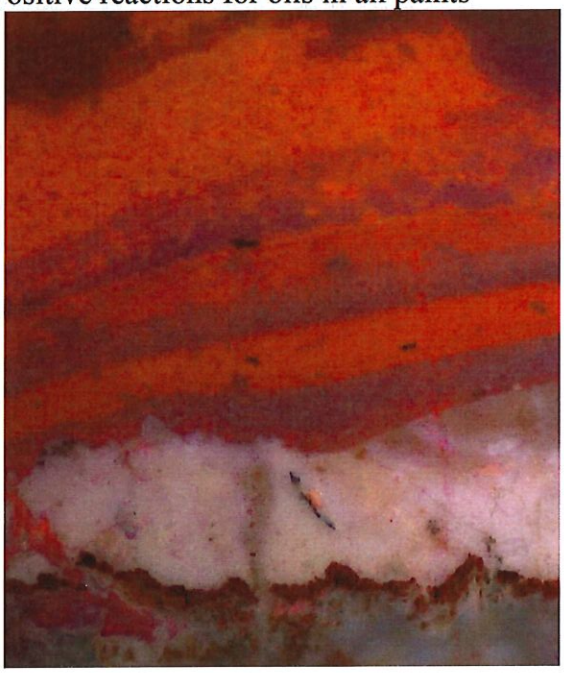


Ultraviolet Light 200X

Ultraviolet Light 100X



UV Light & RHOB for the presence of oils
Positive reactions for oils in all paints



Conclusion:

It was satisfying to determine through cross-section microscopy analysis that the original paints on the door, door trim and siding still remain in the most protected areas of the main elevation. The original palette of dark red siding and tan-colored trim is somewhat unusual for a pre-Revolutionary house. In the Chesapeake region houses of this stature and period were more often painted in a monochromatic manner with matching trim and siding. However, paint research in North Carolina over the last decade has revealed more about the unusual palettes of some early North Carolina buildings, as well preferences for fanciful, and sometimes quite unusual, grain-painted and marbleized finishes.

It is not possible to identify the original pattern for the grain-painting on the door from tiny paint samples. It is also not likely that there is enough of the early paint surviving to reveal a pattern by carefully removing all the later paints that obscure the original decoration. Grain-painting to replicate figured mahogany was common in this period for doors in the Chesapeake region, and it is likely mahogany was considered the most stylish wood to replicate for this house as well.

Color matches for the original deep red siding paint and tan-colored trim paint follow. A color match is also included for the second-generation dark cream-colored paint on the trim which could be appropriate for the 1790-95 interpretation period.

The graining layers could not be confidently matched as these coatings are so degraded and disrupted. However, if the main door is to be replicated with graining by a decorative painter, the base coat for the second period of graining should be dark yellow, and the glaze for the figure of the wood should be brown. An experienced decorative painter will know how to appropriately replicate traditional mahogany graining, even with this limited amount of information.

No samples were analyzed from the shutters as the original shutters do not survive. But, typical period practice would have been to paint solid shutters to match the trim of the building. So, this seems to be an appropriate approach for repainting the shutters on the Joel Lane Museum House.

COLOR MEASUREMENT PROCEDURES

The most intact, representative areas of original paint on the door trim and the siding, and the ca.1790-95 paint on the trim were matched using 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. The color matches were also rechecked at 30X magnification using a color-corrected light source.

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) were 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. The most appropriate commercial matches are included for reference.

Joel Lane Museum House Original Tan Trim Paint

Color Match – October 18, 2019[1]

Sample 11

Benjamin Moore #HC-25 "Quincy tan"

Color System*		Coordinates	
Munsell	Hue	Value	Chroma
	6.5Y	7.0	3.2
CIE L*a*b*	Black to White	Green to Red	Blue to Yellow
	L70.96	a-3.58	b+22.67

Cross-section of sample 11

The Benjamin Moore match #HC-25 is an excellent visual match to the best preserved areas of the original tan-colored trim paint when examined in full spectrum light both at 30X magnification and unmagnified. The evidence suggests that that this layer was somewhat glossy and could be replicated in a satin gloss level.

[1] Color matching conducted after cross-section microscopy analysis by Susan L. Buck, Ph.D., Conservator and Paint Analyst, with a Minolta Colorimeter CR-241.

Joel Lane Museum House Original Dark Red Siding Paint

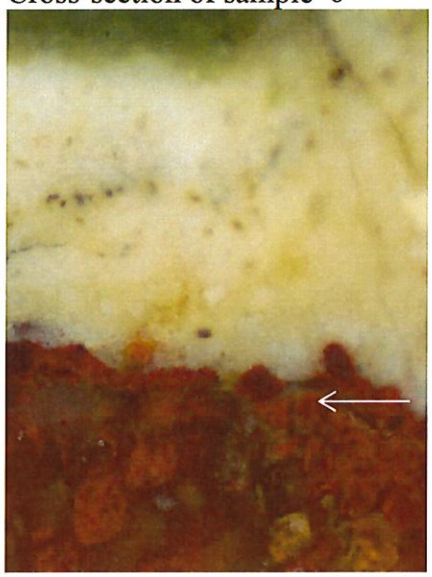
Color Match – October 18, 2019[2]

Samples 6, 7, 12 and 13

Benjamin Moore "Cottage Red" Exterior Ready-Mix

Color System*		Coordinates	
Munsell	Hue	Value	Chroma
	8.1R	2.6	5.5
CIE L*a*b*	Black to White	Green to Red	Blue to Yellow
	L27.38	a+23.62	b+15.85

Cross-section of sample 6



The Benjamin Moore Exterior Ready-Mix match "Cottage Red" is an excellent visual match to the best preserved areas of the original dark red siding paint when examined in full spectrum light both at 30X magnification and unmagnified. The evidence suggests that that this layer was only slightly glossy and could be replicated in an eggshell gloss level.

[2] Color matching conducted after cross-section microscopy analysis by Susan L. Buck, Ph.D., Conservator and Paint Analyst, with a Minolta Colorimeter CR-241.

Joel Lane Museum House 1790-95 Dark Cream-colored Trim Paint

Color Match – October 28, 2019[3]

Sample 11

Benjamin Moore #HC-29 "Dunmore cream"

Color System*		Coordinates	
Munsell	Hue	Value	Chroma
	7.5Y	8.1	3.7
CIE L*a*b*	Black to White	Green to Red	Blue to Yellow
	L82.09	a-5.64	b+26.09

Cross-section of sample 11

The Benjamin Moore match #HC-29 is an excellent visual match to the best preserved areas of the original dark cream-colored trim paint when examined in full spectrum light both at 30X magnification and unmagnified. The evidence suggests that that this layer was somewhat glossy and could be replicated in a satin gloss level.

[3] Color matching conducted after cross-section microscopy analysis by Susan L. Buck, Ph.D., Conservator and Paint Analyst, with a Minolta Colorimeter CR-241.

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.

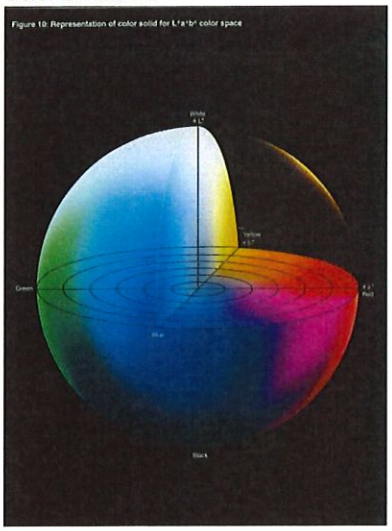
For two colors to match, three quantities defining color must be identical. These three quantities are called tristimulus values X, Y, and Z as determined by CIE (Commission Internationale de l'Eclairage) in 1931.

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 (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: $\Delta E = \sqrt{(L^*)^2 + (a^*)^2 + (b^*)^2}$, 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.

Pigment Preparation

Pigments from individual paint layers were dispersed and crushed onto microscope slides with a scapel. These dispersed samples were permanently mounted under cover slips with Cargille MeltMount with a refractive index of 1.66. The samples were examined under plane polarized transmitted light and crossed polars (darkfield) at 400X and 1000X, and the unknown pigments were compared to standard pigment reference samples.