Jackson Lake Lodge

Grand Teton National Park

Moran, WY

Historic Structure Report

Part 3

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Introduction

Located in Grand Teton National Park, Jackson Lake Lodge contains 39 contributing resources and 23 non-contributing resources and occupies 168 acres. The Lodge is owned by Grand Teton National Park and operated by a concessionaire, Grand Teton Lodge Company, as a family-oriented hotel. In 2002, the property was listed as an historic district on the National Register of Historic Places and, in 2003, was declared a National Historic Landmark (NHL) for its significance as a precursor for the National Park Service's Mission 66 program, its association with architect Gilbert Stanley Underwood, and for its status as one of the first modern structures in the National Park System. In 2007, Shapins Associates completed a cultural landscape inventory, and in 2015 Logan Simpson Inc. completed a cultural landscape report (CLR). In 2014, The Architectural Conservation Laboratory begun in parallel a much needed historic structure report (HSR) for Jackson Lake Lodge.

The Jackson Lake Lodge HSR Part 1, completed in October 2015, presents the developmental history, which includes the contextual history assembled by Elizabeth Engle,[1] the construction chronology, based on the data processing using Access database software, the study of the site evolution, the Central Lodge construction history and building description, design and construction of Shadowood, and a brief building description of guest lodges, employee's dormitories, and staff housing. Along with these finding, the project team provided architectural and interpretative drawings, an historical architectural drawing chronology and inventory, and a photo documentation inventory.

HSR Part 2 focuses on the patterns of deterioration of the NHL contributing building and presents the condition assessment in the form of narrative, photo documentation and annotations on base drawings delineated ad hoc. Drawing on the capabilities of the GIS software, the project team prepared a site plan as a tool to rank and prioritize the preservation efforts. The Central Lodge received special attention.

At this time, HSR Part 3 defines a preferred ultimate treatment for managing the historic structures. The Preferred Treatment Recommendations chapter provides general guidance following preservation standards as well as recommendations for a maintenance program and material conservation. Drawing in Part 2, the chapter includes a prioritized list of conservation issues requiring attention and treatment in the near future. Specific attention has been given to hazardous materials and building efficiency.
The Finishes Analysis chapter presents the results of the investigation on architectural finishes carried out by team members, both in The Architectural Conservation Laboratory and the Sigh Center for Nanotechnology at the University of Pennsylvania.

The Appendices include the identification of the character defining elements of Jackson Lake Lodge, a master sample list for the finishes study and their respective location, cross-section microphotograph datasheets, scanning electron microscopy (SEM) datasheets, the color palette for each guest lodge,

1 M.A. Thesis, University of Virginia, 2009

conclusions about the paint removal test carried out during summer 2016, and, finally, trade literature from the 1940s and 1950s, and annotated drawings.

In addition, Araba Prah, graduate student of the Graduate Program in Historic Preservation at the School of Design, has developed a methodology for recreating the historical finishes with mineral silicate paints and testing its durability through her master's thesis. This effort provides an alternative to retreating the concrete at Jackson Lake Lodge with acid-stains. A topic that was investigated by Alice Gilmore in 2016.

1. Management Summary

1.1 Statement of work

As a continuation of previous efforts and under the Cooperative Agreement P14AC00921, a Task Agreement P15AC00913 was signed with the purpose of preparing the third and final segment of the HSR, Part 3. The objective is to provide a preferred treatment recommendation for managing the historic structures.

This report was prepared by members of the Architectural Conservation Laboratory at the University of Pennsylvania. The project was led by Professor Frank Matero, as principal investigator (PI), and Cesar Bargues as research associate. Cesar Bargues and the two graduate interns, Nicole Declet and Araba Prah comprised the field inspection team during the summer 2016. Data processing as well as the finishes analysis took place during fall 2016 and spring 2017.

1.2 Executive Summary

As ultimate treatments, this report recommends preservation of the Jackson Lake Lodge historic structures with limited restoration where necessary. The recent interest in reinstating the exterior coloration of the Central Lodge offers an extraordinary window of opportunity to be more ambitious. Its restoration necessitates to implement measures to remediate structural damage, deteriorated roofing materials, spalling, leaching staining, cracking, and impact damage. Consideration should be given to develop a proper repair technique for the concrete (restoring the shadowood texture where necessary) and to replace the exterior stucco of the Blue Heron Bar.

Preservation of the guest lodges cannot be ignored. As in the Central Lodge, repairs on the precast concrete foundation, the carpentry elements, and the cement shingle siding must be done before any work leading to reinstate the color palette. This includes the replacement of the vertical board and batten siding by a more historically appropriate cement shingle siding.

The technical recommendations contained herein are organized by architectural element preceded by an overview of the deterioration pattern based on a review of the condition assessment provided for the second segment of the project. These recommendations indicate a possible alternative approach to the realization of the ultimate treatment when testing different methodologies is particularly desired. After defining the preferred ultimate treatments and providing general recommendations, the section containing the technical recommendations presents a prioritization of conservation issues. The priorities can be read as a recommended course of action for the Central Lodge and the NHL contributing outbuildings respectively.

In any case, it is necessary to put into effect a preservation-oriented maintenance program on site. Besides the business and operative needs, the existent maintenance program must prioritize the tasks involving the most vulnerable assemblies, such as roof systems and exterior walls, as well as character-defining elements both in the interior and the exterior. Two tables, one for the Central Lodge and another for the outbuilding, contains recommendations based on common conservation issues found on the site that could be addressed on a routine basis with minimal repair.

2. Priorities and Treatment Recommendations

2.1. Maintenance Program

"Maintenance in historic buildings terms is preservation maintenance consisting of all those day-to-day activities necessary to prolong the life of an historic property."[1] Preservation maintenance typically involves periodic inspection and routine, cyclical non-destructive cleaning, minor repair, and refinishing operations, as well as limited replacement of damaged and deteriorated materials that are impractical to save.

By maintaining the material integrity of historic structures, not only the deterioration of original materials is prevented, but possible hazards and risks for occupants and staff are avoided as well. The maintenance program must prioritize the maintenance tasks involving the most vulnerable assemblies, such as roof systems and exterior walls, as well as character-defining elements both in the interior and the exterior. The following tables contain recommendations to upgrade a cyclical program for maintenance of both the Central Lodge and the guest and staff cabins and service buildings. These recommendations do not preclude or limit other actions carried out on site as a part of past or existing maintenance programs. They are intended to bring the owner's attention to a series of issues detected during the visual survey conducted during the 2015 and 2016 fieldworks.

Central Lodge

Feature/actions	**Visual Inspection Frequency**
Roofs: - Removal of tree litter and bio growth. - Redistribution of ballast to cover exposed areas of asphalt lining. - Check condition of sealants and connections at chimneys and vents. - Manage plantings particularly overhanging branches rubbing against the roof and the eaves.[2] - Removal of icicles on the eaves.	Annually or after a major weather event.
Flashing: - Correction of misaligned flashing, refastening of loose flashing, and repair of failing connections. - Replacement with historically appropriate material when necessary.	Annually

[1]Chambers, J. Henry. Cyclical Maintenance for Historic Buildings. Washington, DC: National Park Service, 1976

[2]The Cultural Landscape Report (CLR) for Jackson Lake Lodge include a series of recommendations for the planting management. Using the CLR as a guidance, it should be considered that new or replaced planting keep a proper distance to prevent damage to the historical fabric, sidewalks and roads (p. 93).

Exterior architectural concrete: - Chimneys and vents. - Repair of concrete eaves when new spalling and cracking occur. - Repair of window sills and jambs when new scaling and cracking occur.	Annually
Windows and doors: - Replacement of sacrificial materials, such as caulking, when failed. - Refinish when necessary.	Annually

Outbuildings

Feature/actions	**Visual Inspection Frequency**
Roofs: - Removal of tree litter and bio growth. - Redistribution of ballast to cover exposed areas of asphalt lining. - Check condition of sealants and connections at chimneys and vents. - Look for areas were water can infiltrate. Check fascia and soffits to see evidence of water infiltration. - Manage plantings particularly overhanging branches and trunks rubbing against the roof and the eaves.[3]	Annually or after a major weather event.
Flashing: - Correction of misaligned flashing, refastening of loose flashing, and repair of failing connections. - Cleaning of debris that accumulates on surfaces from the neighboring trees. - Restore/repaint with historically appropriate paint color schemes.	Annually
Carpentry elements: - Refinishing when necessary	Annually
Exterior walls: - Evidence of excessive moisture or uncontrolled infiltration. - Inspection and cleaning of vent grilles. - Removal of bio growth and soiling. - Ensuring uniform cleanliness.	Annually
Cement shingle siding: - Asbestos Containing Materials (ACM) or Presumed Asbestos Containing Materials. Any ACM damage or deterioration require that corrective actions will be taken. - Prepare an Operation and Maintenance program. Further guidance	Prior to the season opening/end of the season

[3] The Cultural Landscape Report (CLR) for Jackson Lake Lodge include a series of recommendations for the planting management. Using the CLR as a guidance, it should be considered that new or replaced planting keep a proper distance to prevent damage to the historical fabric, sidewalks and roads (p. 93).

can be found in "How to Develop and Maintain a Building Asbestos Operations and Maintenance (O&M) Program" by the United States Environmental Protection Agency. - Visual and physical evaluation of the ACM on a regular basis and previous to any renovation, demolition, and regulated activity, by an appropriate trained inspector.	
Windows and doors: - Replacement of sacrificial materials, such as caulking, when failed. - Refinishing when necessary with compatible and historically appropriate paints.	Annually
Masonry foundation - Inspection and provision of a proper grading away from the foundation. This includes the concrete porches. - Sealing of butt joints between masonry units. - Monitoring of recent cracking leading to spalling. - Monitoring of efflorescence and peeling paint that can be indicative of moisture infiltration. - Monitoring saplings, plantings and tree roots near the foundation.	Annually or after a major weather event.

Keeping records of the work executed, as well as the evaluation and monitoring of repairs are required for proposing and implementing future adjustments on the maintenance program. Typically, a maintenance plan includes but it is not limited to:

- Schedules and checklist for inspections.
- Forms for recording work, blank base plans and elevations to be filled in during inspections and upon completion of work.
- A set of base-line photographs to be augmented over time.
- Current lists of contractors for help with complex issues or in case of emergencies.
- Written procedures for the appropriate care of specific materials, including housekeeping, routine care, and preventive measures. This includes proper warnings, precautions, and procedures for the maintenance of materials that are potentially hazardous to occupants and workers.
- Record-keeping sections for work completed, costs, warranty cards, sample paint colors, and other pertinent material.

Periodic review of this program by external consultants is advisable. After preservation and restoration work, buildings must receive ongoing maintenance.

2.2. Exterior Material conservation

2.2.1. General Recommendations

Applicable general guidance

36 CFR 68 The Secretary of Interior's Standards for the Treatment of Historic Properties

Preferred Ultimate treatment[4]

The primary treatment will be Preservation. According to the Secretary of Interior's Standards, Preservation involves applying measures necessary to sustain the existing form, material, and integrity of a historic property, while protecting its heritage value. "Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historical materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project."

Subsidiary to preservation, in the case of interior public spaces as well as of non-historical elements and materials that deviate from the original design and intent, limited restoration is advised. Restoration allows for "the depiction of a building at a particular time in its history by preserving materials from the period of significance and removing materials from other periods."[5]

Retreatibility & reversibility

The application of a specific treatment does not preclude future interventions and continued maintenance, such as cleaning, consolidating or renewal of sacrificial materials. When choosing between different treatments or interventions, consider the potential reversibility or retreatability of changes without damaging or altering the original fabric.

Material compatibility

Intervene as little as possible and retain as much of the original fabric as possible. The introduction of new materials should be compatible with original materials and should not compromise their continued performance. Where necessary, replacement should be made using in-kind materials and excellent craftsmanship.

Trials

Any proposed preservation and restoration work must contain specifications about treatment trials and mock-ups for testing and observation and for establishing standards by which workmanship will be judged. The following technical parameters will be included: the materials,

[4] As defined by the *NPS-28: Cultural Resource Management Guideline*

[5] Kay D. Weeks and Anne E. Grimmer. The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings (National Park Service: Washington DC, 1995)

methods, and equipment to be used, the working procedures, and any health and safety requirements, as well as proper statutory consent.

Outcome monitoring and evaluation

Monitor and assess regularly the impact of any maintenance, repair, conservation, and restoration work to determine its effectiveness.

Record Keeping

Work to the building will be properly documented so that the evolution of the building, as well as intervention success or failure is understood in the future. This includes recording and archiving parts of significant elements and materials that will be removed or altered prior to and during the work.

Required qualifications

Ensure that any preservation, restoration or maintenance project engages consultants with demonstrated expertise in preservation, restoration, and maintenance of historic resources, and because of the particular characteristics of Jackson Lake Lodge, knowledge in conservation of concrete and surface treatments of asbestos containing materials. Confirm that contractors have the required certification according to regulations, as well as experience with the required equipment, materials, and workmanship to perform the works.

Code compliance

Balancing health and safety, accessibility, and other issues with conservation objectives is an extremely important aspect of any conservation project. The challenge often involves meeting requirements such as fire codes, hazards abatements, while minimizing the negative impact on a historic place's heritage value.

As confirmed by laboratory analysis, some historical materials (namely earlier paints and cement shingles) contain substances that are potentially hazardous to people. All workers involved in the encapsulation or repair of known toxic materials should be adequately trained and should wear proper personal protective gear.

Employee Orientation

Staining, material loss as well as impact damage were noted during the visual inspection of the shingle siding of the employee dormitories. Extensive replacement was noted on the unit JL-45. Typically, the exterior siding on the housekeeping areas of JL-11 and JL-30 shows excessive damage. It is recommended that the on site employee training includes opportunities to recognize the heritage values, as well was education about how to use and protect the historical fabric.

2.2.2. Technical Recommendations

During the condition assessment in the HSR Part 2, the project team identified a series of conservation challenges affecting the exterior concrete of the Central Lodge as well as the materials employed for the NHL contributing outbuildings. These issues have been prioritized in the following manner:

Priority One (I): Existing conditions that pose a structural threat to the building and affect the safety and comfort of both the staff and the visitors. This category includes potential moisture infiltration issues that put the building assemblies and their performance at risk.

Priority Two (II): Existing conditions that are not structural in nature but represent moderate to severe progressive damage to the building fabric.

Priority Three (III): Existing conditions that are minor or affect the aesthetic appearance of the building.

Due to the diverse nature of the materials, the priorities are divided into two groups: the Central Lodge and the outbuildings. A preliminary list of preferred action is presented below. Actions will be undertaken under the limits established by the ultimate treatment Preservation, as defined by the NPS-28: Cultural Resource Management Guideline, except when Restoration is advised.

Central Lodge

Priority	**Conservation Issue**	**Action**
I	South chimney shaft and cap	Repair
I	Deflection of the roof slope over the Engineering Shop (structural failure)	Repair
I	Crack and displacement of the southern retaining wall (structural failure)	Repair
I	Disintegration of waterproofing membrane on the Porte-cochere	Restoration
I	Deteriorated metal fascia	Replacement
I	Spalling on the eaves	Repair
II	Leaching on the eaves	Repair
II	Cracks on the eaves	Repair
II	Surface cracking	Repair
II	Impact damage	Repair
II	Efflorescence	Removal
III	Previous repairs	Restoration
III	Discoloration of concrete surface	Restoration

III	Paint coating related issues such as color mismatch or detachment	Restoration
III	Treatment of insensitive additions	Restoration
III	Exterior stucco of the Blue Heron Bar	Replacement
III	Vegetation	Refer to CLR

NHL Contributing Outbuildings

The following is a prioritized list of conservation issues detected on the outbuildings:

Priority	Conservation issue	Action
I	Rot in carpentry elements	Replacement
I	Deteriorated asphalt linings	Repair
I	Failing previous repairs in the roofing system	Repair
I	Spalling and incipient spalling in masonry units	Repair
I	Missing units in shingle siding	Replacement
I	Material loss in shingle siding	Replacement
I	Open corner in shingle siding	Repair
II	Flashing failures, including open corners and displacement	Repair
II	Improper repairs in flashing	Repair
II	Material loss, broken sections, and open corners in carpentry elements	Repair
II	Cracking in masonry units	Repair
II	Efflorescence in masonry units	Removal
II	Deterioration in vertical board and batten siding	Repair
III	Previous improper repairs in the roofing system	Repair
III	Impact damage, improper installation and rust in flashing	Repair
III	Impact damage in carpentry elements	Repair
III	Impact damage in shingle siding	Replacement
III	Cracks and fractures in shingle siding	Repair
III	Improper repairs and installations in shingle siding	Replacement
III	Deterioration of wood frame in windows	Repair
III	Issues related to the current paint coatings (see Jackson Lake Lodge HSR Part 2)	Restoration
III	Historically inappropriate vertical board and batten siding	Restoration

Note: A three-digit alphanumeric code precedes each group of detailed technical recommendations. This code is used on the set of annotated drawings to illustrate the specific areas where the recommendations should be implemented. This set of annotated drawings must be consulted together with the set provided in HSR, Part 2.

A. **Central Lodge**

Conservation Treatment for Original Structural Concrete

A001 Crack and displacement of the southern retaining wall

Deflection and cracking produced by externally applied loads nonexistent at the time of construction, or, possibly flawed design. If the crack is active, the wall function can become seriously impaired.
Recommendations:

- Monitor the cracks and displacement
- Investigation below grade
- Repair in collaboration with a structural engineer. Intervention or repair must preserve or replicate the historical wood grain texture as well as rusticated joint pattern of the exposed surfaces.

A002 Crack and deflection of the roof slope over the Engineering Shop

Recommendations:

- Monitoring and repair in collaboration with a structural engineer. If repair is not technically feasible, replacement is acceptable. The intervention must replicate the historical form, detailing, material and architectural finish, without detriment to adding more reinforcement if necessary.
- Management of the evergreen trees adjacent to the roof, either by selective removal or trimming. Procedure must balance CLR recommendations.

Conservation Treatment for Period Concrete

Applicable Guidance

ACI 562-16 Code Requirements for Assessment, Repair and Rehabilitation of Existing Concrete Structures
ACI 546R-14: Guide to Concrete Repair
ACI 546.3R-14: Guide to Materials Selection for Concrete Repair
ICRI 310.1R-2008 Guideline for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
ICRI 310.2R-2013 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
ICRI 210.3R-2013 Guide for Using In-Situ Tensile Pull-Off Tests to Evaluate Bond of Concrete Surface Materials

A003 Chimneys

The chimney that corresponds to the abandoned incinerator stack is extensively deteriorated. The other two chimneys in the central section show good condition except for staining and distressed metal flashing.

Recommendations:

- On the south chimney, removal of all loose parts, repair and restore shaft with historically appropriate mortar repair. Replacement in kind of the concrete cap if it is too deteriorated for repair. In the case of replacement, the overall form and detailing of the existing cap must be used as a model to reproduce the element. Repair and reinstallation of the mesh wire hood. (See Underwood_CentralLodge (37) on HSR Part 1)
- On the fireplace chimneys, replacement in kind of flashing that is too deteriorated to repair.

A004 Spalling

Spalling due to corroding reinforcement is visible on both the masonry foundation of the guest lodges and throughout the building envelope of the Central Lodge, in selected locations such as the eaves.

Corrosion of steel in concrete is usually caused by carbonation of the concrete or initiated by chlorides. Being a natural continuous process, in moist environments, carbonation occurs when the alkaline components –calcium, sodium and potassium hydroxides- of the cement react with the carbon dioxide in the atmosphere. With reduced alkalinity, particularly below pH 10, the embedded steel will lose its protective passivated layer, leading to corrosion and, ultimately, to cracking and spalling caused by the forces exerted by the expanding corrosion products. In absence of chlorides, the pore solution following carbonation is composed of almost pure water. This means that the steel in humid carbonated concrete corrodes as if it was in contact with water.[6]

As revealed by tests using a solution of phenolphthalein on concrete samples from the Central Lodge taken for HSR Part I, pH values are below of 8.6 suggesting the concrete is at risk of rebar corrosion failure. Chlorides content is unknown.

For the cast-in-place concrete, Underwood's specifications suggests the use of calcium chloride or equal as an accelerating agent. Calcium chlorides bound with cement compounds; however, free chlorides are conceivable. Other possible sources can be the mixing water, de-icing salts, and the environment. Dissolved chlorides in water can seep through cracks in sound concrete.

If chlorides are present, calcium chloroaluminate hydrates form, making the wet medium more aggressive. The excess of chlorides in the pore solution of concrete will cause disintegration of the protective oxide layer on the surface of the embedded steel reinforcement, causing it to

[6] Bertolini, Luca, Elsener, Bernhard, Pedeferri, Pietro. *Corrosion of Steel in Concrete: Prevention, Diagnosis, Repair*, 79

depassivate. As a consequence, corrosion cells[7] are created on the surface of the steel, and since the chloride ions are not consumed during the corrosion reaction, they are free to continue the process indefinitely, acting as a catalysts.[8]

Concrete repair involving steel corrosion is typically repaired by removing the concrete or by applying cathodic protection. The latter is employed in areas where a small percentage of the steel in the spalled areas is seemingly intact. Cathodic protection stops corrosion without concrete removal, and it changes the electrochemical nature of the rebar by impressed current.[9]

A corrosion inhibitor, such as calcium nitrate, is often applied to re-passivate the reinforcing steel bar from chloride-induced corrosion damage. This type of corrosion inhibitor can be admixed into the plastic concrete repairs. If the concrete surface is contaminated with large chloride concentrations, these might block the nitrite from penetrating. In these situations, the contaminated layer is to be removed. Testing for chloride level in the concrete is necessary.[10]

For carbonated concrete, re-alkalization, a process to restore the alkalinity of the carbonated concrete can take place. This process involves soaking the concrete in an alkaline solution to increase the alkalinity of the concrete around the reinforcement.[11]

At Jackson Lake Lodge, testing to determine the type of corrosion in steel is required prior to treating the rebar.

Recommendations:

- Confirm concentration of chloride ions at various depths in order to determine the likelihood of further corrosion of the reinforcing steel due to chlorides.
- Test carbonation depths and rebar cover prior to apply anti-carbonation coatings. Once the average carbonation depth has reached the average depth of cover, it is too late for an anti-carbonation coating to provide any significant benefit.
- Executing mortar repair:

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[7] The mechanism of corrosion is an electrochemical process similar to that of a simple battery. The surface of the steel, once de-passivated, contains both anodic (more negatively charged) and chatodic (positively charged) regions. At the anodic site, positively charged metal ions (Fe2+) are released into the free pore water while negatively charged free electrons e- travel trough the metal to the cathode. Here they combine with water and oxygen to form hydroxyl ions (OH)-. Fe2+ arte attracted to these hydroxyl ions, with which they combine to form rust (hydrated ferric oxide).

[8] English Heritage Practical Building Conservation Concrete (London: English Heritage, 2012), 86

[9] John E. Slater, *Corrosion of Metals in Association with Concrete*. Ann Arbor, Michigan: American Society for Testing and Materials, 1893, 58.

[10] Neal Berke, S., Dallaire, M. P., Weyers, R. E., Henry, M., Peterson, J.E., and Prowell, B., "Impregnation of Concrete with Corrosion Inhibitors", Corrosion Forms and Control for Infrastructure, ASTM STP 1137, Victor Chaker, Ed., American Society for Testing and Materials, Philadelphia, 1992, 1-3.

[11] Paul Gaudette and Debora Slaton. "Preservation Brief 15: Preservation of Historic Concrete." National Park Service. 2007. Accessed June 21, 2016: 15. https://www.nps.gov/tps/how-to-preserve/briefs/15-concrete.html

- Work shall not proceed when snow or below freezing temperature are expected within the next 24 hours. Surfaces to be repaired shall be free of standing water, snow and ice.
- Spall repair involves removal of loose parts, corrosion products, passivation of corroding rebar, and re-alkalization of concrete, and the application of the repair mortar ensuring color and texture match. The removal strategy should retain as much of the original fabric as possible, while removing any loose concrete in order to provide a sound substrates for a long lasting repair.
- Exposed reinforcement shall be brushed back to sound metal if possible and coated with epoxy-based paint. Supplement or replace rebar as needed.
- The mortar repair must match the historic concrete as much as possible as well as share similar properties and characteristics, such as compressive strength and permeability.

A005 Cement Patching (impact damage, previous repairs and spalls on the wall)

After the areas with exposed reinforcement bars and failing concrete are identified and removed, and the exposed steel rebar is coated to resist corrosion, the area will require re-patching. The repair measures selected should retain as much of the original fabric as possible, while removing any unsound concrete in order to provide a sound substrate for a long lasting repair. The repair must match the historic concrete as much as possible as well as share similar properties and characteristics, such as compressive strength and permeability.

The concrete mix used should meet the performance and appearance requirements (color, proper aggregate, cement type, and water content to cement ration). Mockups should be constructed and tested to assure the materials and methods proposed produce an acceptable repair. The new concrete mix can include addition of materials and admixtures that increase durability, such as air-entrained agents. The area of concrete to be repaired is to be cleaned with air and water prior to patching. The area should be kept wet overnight in order to achieve a strong bond.

Depending on the repair area, the preferred techniques are hand placement and the form and pump technique. For small areas of patching, it is recommended to do rectangular patches. 1 inch to 2 inches of the edge of the old concrete should be trimmed to a vertical face to eliminate any thin edges. The depth of repair should be a minimum of 6 inches. There should be a clearance of a 1 inch or more around any exposed reinforcement bars in the concrete.[12] Sufficient adhesion between the historic and new concrete is achieved by creating a rough surface or by placing anchors between the old and new concrete.

For larger areas of repair, it is recommendable to remove an entire section of exterior concrete spanning between vertical and horizontal joints or original formwork marks –typically one width of form plywood board- . As above, 1 to 2 inches of the edge of the old concrete should be

[12] T. W. Love, Construction Manual: Concrete & Formwork (Craftsman Book Company: Carlsbad, CA 2001), 135

trimmed to a vertical face to eliminate any thin edges. The depth of repair should be a minimum of 6 inches. There should be a clearance of a 1 inch or more around any exposed reinforcement bars in the concrete.

A well designed and properly constructed formwork is an important component to hold the new concrete in place while achieving the historically significant woodprint finish. A significant portion of the conservation and restoration effort at Jackson Lake Lodge will focus on the replication of the original Shadowood texture. One option is to make a cast of the original concrete, prepare a plaster or rubber replica of the unit, and use this new mold to cast the concrete unit. Another option is to construct formwork boards. These should be selected individually for grain and finish while replicating original construction and replication methods. The formwork designed should not bulge or leak when used.

Recommendations:

- The mortar repair must match the historic concrete as much as possible as well as share similar properties and characteristics, such as compressive strength and permeability.
- Work must include removal of corrosion products and passivation of rebar if necessary.
- The use of a saw to remove unsound concrete should not be too evident. Consider the size of the chipping hammer or tool used in order to conceal the joint between the original concrete and the patching material. In areas where old and new concrete meet, the old concrete should be perfectly sound. Existing joints should be used as guides for removal.
- For the mortar repair, Underwood suggested[13]:
    - "Prepare mortar of same materials, proportions, as used for concrete except remove coarse aggregate; substitute sufficient quantity of white cement for mortar of grey cement so that patching mortar when dry will match surrounding concrete."
    - "Compact mortar thoroughly into place; screed to leave patch slightly higher than surrounding surfaces, leave it undisturbed for one to two hours to permit initial shrinkage, finish to match adjoining work."
    - Replicating architectural finish: "obtain form mark with Shadowood plywood for exterior exposed walls. Fit boards with close ends so that vertical joint marks will be as inconspicuous as possible. Remove excess fins, rough edges, as directed."
    - Protect finished surfaces with damp burlap and plastic to allow full curing.

A006 Cracking and leaching on the eaves

Micro cracks and leaching stains are visible on the soffits, probably aggravated by the absence of expansion joints. Typically, these cracks start at the edge of the overhang and extend partially or completely to the wall following a perpendicular direction. The existing damage is namely noticeable on the lower eaves of the shed roofs. This has allowed rain and more significantly, melting snow, to penetrate the cantilever's thin concrete section, forming characteristic

[13] Gilbert Stanely Underwood and Co, Architects-Engineers. *Specifications, Jackson Lake Lodge Development, Moran, Wyoming* (1953)

leaching deposits on its soffit. Where penetration is severe, rebar corrosion and spalling are noticeable. On a reduced number of locations, cracks are wider or correspond to structural failure.

Recommendations:

- Existing damage is not likely to escalate and, if it is not causing structural damage, monitoring should be enough. To avoid further leaching, correct performance of the built-up roofing and flashing must be assured.
- Consideration should be given to the cleaning of the leaching stains, application of water repellent and a historically appropriate coating in due time. See *Paint Removal and Cleaning of Exterior Walls* and *Conservation Treatment for Period Painting and Coating.*
- Wider cracks and areas of significant damage should be addressed. Active cracks shall be filled with flexible sealant to accommodate continued movement without allowing water to enter. This process involves routing and sealing the cracks, thus treating it as a joint. Active cracks should be repaired using a bond breaker at the base of the routed channel. A flexible sealant is then placed in the routed channel. It is important that the width-to-depth ratio of the channel is usually 2 or more inches. This permits the sealant to respond to movement of the crack with high extensibility.
- Color of sealant shall be matched to the color and texture of the cleaned concrete. Sealant must be compatible with the type of finish eventually chosen, e.g.: mineral silicate paints. Prepare various mock-up sealant dusted with aggregate. Backer rods and bond breakers shall be as recommended by the sealant manufacturer. The repaired crack must be finished with same paint technique as that of the surrounding concrete surface.

A007 Note on the Second story service walkway

This second story service walkway is directly accessible from the sun deck, emergency door and an exterior stairway. Similar to the Central Lodge eaves, the soffit of the exterior service walkway leading to the sun deck exhibits multiple cracks that correlate to the floor cracks. White leaching deposits and staining are visible. In addition to the treatment of cracks as above, it is recommended the testing of hydrophobic treatments (silanes) to offer additional protection to the exposed (and weathered) concrete. The testing program must include initial documentation of the selected area, repair and application of the selected water repellent coatings and examination of penetration depth after a year cycle.

A008 Surface cracking: cracks at re-entrant corners

Re-entrant corners provide a location for the concentration of stress, and therefore, are prime locations for the initiation of cracks.[14] Nonetheless, the safety of the structure is not in question. Cracks may not penetrate the full thickness of the concrete element, but can allow transport of water and contaminants to the reinforcing steel.

14 ACI 224.1R-07 Causes, Evaluation, and Repair of Cracks in Concrete Structures

Recommendations:

- Due to the intrusive visual character, creating new joints to control this type of cracking is not a feasible solution. Repair with expandable materials must accomplish these objectives: provide watertightness, improve durability, and improve appearance of the concrete surface. In case of larger damage, the installation of diagonal reinforcement should be considered.

A009 Surface cracking: drying shrinkage

It is likely that these cracks are stabilized. It is therefore recommended to test hydrophobic treatments (silanes) to offer additional protection to the exposed surfaces. The testing program must include initial documentation of the selected area, repair and application of the selected water repellent, compatibility with coatings to be applied subsequently, and examination of penetration depth after a one year cycle.

Conservation Treatment for Roofing Assemblies

Cyclical maintenance has resulted in the good overall condition of the built up roof system on the Central Lodge. However, on the sun deck areas of standing water, cracking and a significant detachment of the waterproofing membrane were noted. As indicated in the HSR Part 2, staining, efflorescence and detachment of coatings visible on the ceiling spans underneath in the port-cochere are related to the faulty waterproofing.

A010 Sun Deck

While a historical photo (RAC_149) suggests a different floor finish for the sun deck -presumably the acid etched concrete indicated in Underwood's drawing- there is no enough evidence to confirm the colors as well as the pattern size. A similar pattern is recognizable on the exterior terraces in front of the Upper Lobby.

Recommendations:

- Prior to any intervention, removal of a small section of the current waterproofing materials and coatings to investigate the presence of original acid etched with ground joints concrete flooring.
- In the presence of enough physical evidence, sensitive restoration improving the detailing to ensure drainage and thermal movements is advisable. Any cementitious topping to promote drainage must be tested for compressive strength, freeze-thaw durability and bond strength.
- In the absence of substantial evidence or technical feasibility, removal of later membranes and replacement with an appropriate waterproofing system, proper drainage and expansion joints are recommended.
- Aluminum pipe railing is original as well as the location of the three main flagpoles brackets. Later railing and flag poles are not consistent with Underwood's intent, but do

not detract from the significance of the port-cochere. It is recommended to check the condition of the grips and connections periodically.

A011 Deteriorated flashing

Refer to the maintenance program above. Where the flashing is too deteriorated to repair, replacement in kind is advisable. This implies limited temporary removal and repair of the roofing materials if necessary.

Conservation Treatment for Openings

A012 Windows and doors

On the Central Lodge, windows and doors range from Underwood's designed assemblies to replaced and upgraded systems during later remodeling campaigns (see HSR Part 1, drawing sheets JLLO B-1.12, B-1.13, & B-1,14)). Typically, historical windows and doors are in good condition, and deterioration namely focus on finishes and sacrificial materials.

However, special attention must be given to past character defining elements, now lost. Originally, nearly all the windows were window awning type opening out. This configuration not only provided ventilation, it emphasized the distinctive horizontal lines of the Central Lodge as well as the deeply rusticated joints. In 1960, the exterior upper story openings of the Central Lodge were enlarged to accommodate new windows destroying the rhythm of the exterior surface grid and the squared module.

These alterations to the windows and window openings over time have demonstrated a misunderstanding of their highly important role in the original design. The horizontality was deliberate, and was meant to maintain the Central Lodge's low profile on Moose Hill when viewed from the Valley. Although the changes in the windows have maximized the view of the Teton Range from the interior, they have radically altered the experience of the building from the exterior. The exterior color palette has also shifted from an original dawn grey or pale yellow/green to a new dark anodized bronze/brown finish.

Recommendations:

- Retention and repair of the existing windows from Underwood period, including hardware and hinges, and limited replacement in kind where necessary.
- Replacement of individual glass panels should match the color, reflectivity, and translucence of the existing glass. Upgrading glazing is acceptable. If it becomes necessary or feasible to replace or improve current panes to achieve better thermal properties, historical character and perception must be considered.
- In due time, replacement of later windows to convey Underwood's fenestration pattern and marked horizontality. This includes reconstructing the openings and the rusticated grid. If this is not technically feasible, de-emphasizing the rusticated finish of the lintels to replicate the Shadowood finish is advisable.

- Refinishing windows and doors to replicate original color palette. In addition to the information contained in this HSR, it is necessary to perform window exposures on the field to confirm results.

A013 Openings filled in with glass block

Several windows on the west elevation were replaced with glass block. This disrupts Underwood window configuration and transparency.

Recommendations:

- In due time, removal of glass block and installation of historically appropriate windows to convey Underwood's fenestration pattern.

A014 Cracking, Scaling and spalling in the window sills

A number of concrete window sills exhibit cracks, scaling and spalling probably related to moisture infiltration and mechanical damage by freeze-thaw cycles.

Recommendations:

- Repair following the recommendations for *Cement Patching* listed in the *Conservation Treatment for Period Concrete*. Providing a slight slope to assure water drainage is advisable.
- Application of a water repellent to minimize moisture infiltration. As previously mentioned, it is recommended to test hydrophobic treatments (silanes) prior to their application. The testing program must include initial documentation of the selected area, repair and application of the selected water repellent, compatibility with coatings to be applied subsequently, and examination of penetration depth after a year cycle.

Paint Removal and Cleaning Of Exterior Walls

Underwood's treatment of the exposed concrete created a variegated finish, somewhat semitransparent, that together with the Shadowood imprints was intended to create the illusion of wooden panels. In the early 2000s, the exterior was stained and painted brown. This later coating conceals the expressiveness of the concrete as it substantially diminishes the effect of the wood grain. All around the lodge elevations, this finish exhibits stains, discoloration, as well as weathered sections. Carbonate leaching deposits are also visible in areas exposed to rainwater runoff from the eaves.

A015 Paint removal

Recommendations:

- Cleaning of the carbonate leaching deposits, biogrowth, and removal of later paint coatings to expose the original stained Shadowood surface.
- In addition to the wet abrasive blasting technique tested in summer 2016 (see Appendix V), it is recommended to perform mock-ups with other commercially available surface

preparation and cleaning methods, including Spongejet[15] and IBIX. In choosing the appropriate technique, consideration should be given to the workers' safety, environmental implications, efficiency and effectiveness of the removal, preservation of the concrete wood grain texture, containment requirements, residue retrieval and cost.

- The exterior treatment of the Blue Heron Bar will require replacement to match the original Shadowood texture and configuration more accurately.

A016 Efflorescence

Recommendations:

- To avoid recurrent efflorescence correct performance of the roof and terraces waterproofing and proper functioning of the water disposal system must be assured. Inspect and confirm possible sources of moisture infiltration, see *2.1 Maintenance Program*.
- Remove all the visible surface deposits by scrubbing with water alone or with water under high pressure. Consider and test the use of diluted solvents and poulticing for deposits difficult to remove. To this end, avoid chemicals such as Hydrocloric Acid, which is corrosive to concrete.

A017 Staining/Soiling

- Remove visible soiling and staining by scrubbing with water alone or with water under high pressure. Use only stiff bristle non-metallic brushes. Consider and test the use of diluted detergent where necessary. Areas must be rinsed and dried thoroughly after applying the cleaning agent.

Conservation Treatment for Period Painting and Coating

A018 Underwood's color palette replication

Recommendations:

- Perform a mock up program to replicate or make a reasonable facsimile of the original Shadowood surface coloration either with acid stains or mineral silicate paints. In choosing the appropriate technique, consideration should be given to the visual qualities and performance of the mock up, and the research by Gilmore[16], Prah[17] as well as the report prepared by KEIM Mineral Coatings of America after the evaluation and silicate stain mockup application conducted in June 2017.

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[15] Sponge-jet is a dry blasting technique that uses distinct or composite abrasives encapsulated in a synthetic urethane sponge. The sponge captures up to 95% of the contaminants and removed particles.

[16] Alice Louise Gilmore, *Recreating Acid Stains on Historic Concrete*. Master Thesis. (Philadelphia, PA: University of Pennsylvania, 2016)

[17] Araba Prah, *A Performance Evaluation and Assessment of Mineral Silicate Stains for the Restoration of the Exterior Concrete at Jackson Lake Lodge*. Master Thesis. (Philadelphia, PA: University of Pennsylvania, 2017)

B. **Guest Lodges, Employee Dormitories, and Staff Housing**

Conservation Treatment for Period Structural Concrete

B001 Spalling and Incipient Spalling in Masonry Units

Spalling and incipient spalling, which can eventually compromise the concrete foundation performance, are largely present on the north cluster of guest lodges. For a detailed explanation of the factors causing corrosion of the steel reinforcement in concrete, see *Conservation Treatment for Period Concrete: Spalling* in Section A. Central Lodge.

Recommendations:

- Protect and maintain pre cast concrete masonry units by preventing water infiltration and by maintaining proper grading and drainage.
- Consultation with a structural engineer for assistance.
- The mortar repair must match the historic concrete as much as possible, including color and texture, as well as share similar properties and characteristics, such as compressive strength and permeability.
- See recommendations in the *Spalling* section of the *Conservation Treatment for Period Concrete*.

B002 Cold Joints Cracks in Masonry Units

Cracks on cold joints, particularly on the bathroom area foundation, typically coincide and reveal construction phases. These crack may be still developing or have a cyclical nature.

Recommendations:

- Fill in the crack with expandable materials to allow movement. It must accomplish these objectives: provide watertightness, improve durability, and improve appearance of the concrete surface.
- Color of sealant shall be matched to the color and texture of the cleaned concrete. Sealant must be compatible with the type of finish eventually chosen.
- Concrete surface repair following the recommendations in the *Cement Patching* section of the *Conservation Treatment for Period Concrete*.

B003 Cracking in Masonry Units

Recommendations:

- Fill in the crack with expandable materials to allow movement. It must accomplish these objectives: provide watertightness, improve durability, and improve appearance of the concrete surface.
- Color of sealant shall be matched to the color and texture of the cleaned concrete. Sealant must be compatible with the type of finish eventually chosen.
- Concrete surface repair following the recommendations in the *Cement Patching* section of the *Conservation Treatment for Period Concrete*.

B004 Efflorescence in Masonry Units

Recommendations:

- Investigate and confirm source of moisture; probably the water table and intense episodes of wetting, such as heavy rain and snowmelt. Ensure positive grade that slopes away from the foundation, see *2.1 Maintenance Program*.
- Remove all the visible surface deposits by scrubbing with water alone or with water under high pressure. Consider and test the use of diluted solvents and poulticing for deposits difficult to remove. To this end, avoid chemicals such as Hydrocloric Acid, which is corrosive to concrete.

B005 Crazing

Crazing cracks may be sight unpleasant, but rarely affect to the structural integrity of concrete; however, the cracks may lead to surface scaling in the long term, particularly when the concrete components are exposed to exterior conditions of freezing and thawing.

Recommendations:

- Affected areas must be trated if the potential for scaling appears to be imminent. See *B006 Scaling.*

B006 Scaling

When scaling is light or medium, repair is acceptable. In front of severe or very severe scaling, restoration is mandatory.[18]

Recommendations:

- Removal of any loose material prior to intervention to create a surface that ensures good adhesion of the repair materials. Before work proposal, create a test panel using both a range of repair materials and floor treatments to ensure effectiveness.
- The repair material must match the historic concrete as much as possible, including color and texture, as well as share similar properties and characteristics, such as compressive strength and permeability.

B007 Impact Damage

Exposed concrete damaged by impact are prone to moisture infiltration easily and may further deteriorate under exterior conditions of freezing and thawing.

Recomendations:

[18] Light: when there is a loss of surface mortar without coarse aggregate exposure. Medium: when the loss of surface mortar is 5 to 10 mm deep and there is exposure of coarse aggregate's upper surface. Severe: When the loss of surface mortar is 5 to 10 mm deep and there is some loss of mortar surrounding aggregate particles 10 to 20 mm in depth. Very severe: when there is loss of coarse aggregate particles as well as mortar, generally to a depth greater than 20 mm. See *ACI 201 "Guide for Making a Condition Survey of Concrete in Service."*

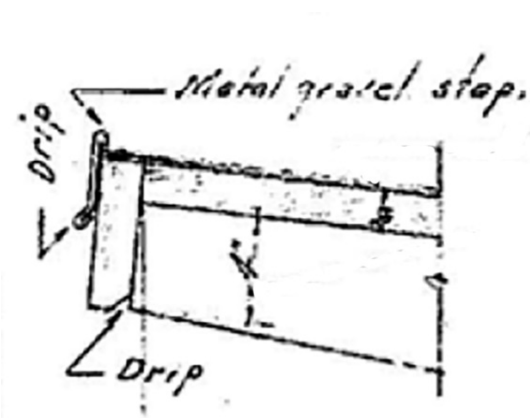
- Removal of any loose material prior to intervention to create a surface that ensures good adhesion of the repair materials. Before work proposal, create a test panel using both a range of repair materials and floor treatments to ensure effectiveness.
- The repair material must match the historic concrete as much as possible, including color and texture, as well as share similar properties and characteristics, such as compressive strength and permeability.

Conservation Treatment for Period Wood

B008 General Approach

- Repair or replacement of deteriorated members should use the same species. The Center for Wood Anatomy Research, USDA Forest Service, Forest Products Laboratory, in Madison, WI, can identify and confirm a maximum of five wood samples.
- Repair wood should match species, grain orientation, moisture content, growth characteristics and section orientation.
- Exposed elements do not accept partnering timber or supplemental elements, except as a temporary shoring.
- Limit the use of epoxy resins to minor repair and hidden areas. Consider in kind Dutchmen and face repair for larger and exposed areas.
- A face repair is the appropriate approach where the surface of the carpentry has deteriorated. This applies for material loss, and impact damage if repair is required. Broken sections can be glued and refinished.
- If the decay of a component is more extensive, it is recommended to cut out the deteriorated section and scarf in a new section for its full cross-sectional area.

B009 Rotten Eaves Fascia and Soffits



Recommendations:

- Prior to any repair and on a routine basis, check condition of flashing and roofing materials covering both the eaves ant the fascia. Repair flashing and built up roof accordingly.
- The replacement should be finished and molded to match existing work. Typically a second drip edge was specified by Underwood by chamfering the lower interior face of the fascia.
- See note about porch frame re-detailing.

B010 Eaves Fascia Board Displacement

During the condition survey, it was noted that the 2x6 inch fascia board was constructed by addition of wood section of different length. While the fascia board fastening relies on the rafter at the higher and lower end of the sheds, on both ends of the guest lodge, fascia stability relies on a 2x3 inch nailer. It is recommended to secure the nailers when displaced to ensure the fascia is kept on place.

B011 Eaves Fascia Open Corners and Ends

Moisture related deterioration, particularly on the fascia ends, can occur where the wood grain has been exposed to a source of moisture.

Recommendations:

- Shingle siding covering fascia ends must be removed for visual inspection and repairs done where necessary.
- On the corners, the fascia require mitering for appearance and a tight fitted joint. But miter joined assemblies and fascia ends require edge-sealing with a compatible, non-visible, protective coating. Repair of loose flashing trim and inspection of the roofing materials must be done in advance.

Conservation Treatment for Roofing Assemblies

B012 Deteriorated Asphalt Linings

Areas of exposed asphalt lining show different rates of decay from alligatoring to severe disintegration. Typically, this condition occurs where the surface gravel is missing. Typically, asphalt roofing detaches from corners and, in a few instances, flashing trim remains exposed.

Recommendations:

- Prior to any repair work it is strongly encouraged the determination of asbestos content in the roofing materials.
- Retaining sound roofs or roof elements, or deteriorated roofs or roof elements that can be repaired. Alligatored asphalt linings can be rejuvenated and repaired.
- Removal of highly deteriorated areas of built up roofing and replacement in kind with a compatible material. New work should match the existing elements in form and detailing.
- Remove failing previous repairs. Patch detached asphalt lining with a flexible roofing cement formulated to withstand expansion and contraction while ensuring good adhesion. Consider the use of a polyester reinforcing fabric when needed.
- Repair of blisters and ripples on the roof.
- Redistribution of surface gravel to ensure that there are no exposed asphalt linings or repairs.

Conservation Treatment for Flashing

B013 Flashing Failures, Including Open Corners and Displacements

During rain episodes, it was noted that water was dripping from the fascia rather than from the drip edge of the gravel stop. There are two possible causes:

- Insufficient drip edge.
- Failures on the flashing or the roofing system. Typically, sections of the flashing trim out of plane, and poor connections facilitates moisture infiltration.
- Covering half the fascia with flashing is historically appropriate. Note that the metal was painted to emulate cooper.

Once moisture penetrates the wood, paint coatings can increase rot risk by preventing evaporation.

Recommendations:

- Protect and maintain exterior wood elements by preventing water infiltration and allowing evaporation. Prior to any repair and on a routine basis, check condition of flashing and roofing materials covering both the eaves ant the fascia. Look for areas where water can infiltrate. Check fascia and soffits to see evidence of water infiltration. Repair deteriorated built up roof accordingly, pay particular attention to edges and corners.
- Fasten loose flashing trim.
- Remove overlapping flashing and reinstall properly.
- Consider improving the flashing detail by spacing the drip edge away from the roof fascia at least ¼ inch and providing more slope.
- Inspect and paint flashing with a historically appropriate color on a routine basis.

B014 Improper Repair in Flashing

A few buildings show new flashing covering the full extent of the fascia board, which deviates from the original design. In addition to difficult routine visual inspection, if water eventually infiltrates, evaporation is constrained and wooden elements will deteriorate.

Eave intersections show either closed or open connections with a supplemental piece for flashing. Closed connections are typically characterized by poor detailing, with added flashing presumably pushing earlier flashing out of plane after thermal movements. Open connections might be a later change deviating from the original design.

Recommendations:

- Evaluation and improvement of detailing for both the eave intersections and the roof ridge connections by applying a unified repair.
- Repair bowed trim and refinish roof ridge connections. Covering the horizontal connection with a ballasted built up roof may prevent further deterioration and future leaks. (See roof in JL-25)

B015 Paint Coatings on Flashing

Historical flashing on the outbuilding is typically galvanized metal. The historical photos show that flashing was finished with a reddish brown paint to emulate copper, which was the material specified by Underwood for the Central Lodge.

Elsewhere, particularly on new sections of galvanized metal flashing, the coating has lost its adhesion to the substrate, as evidenced by blistering or peeling paint. Possible causes for this condition are:

- New galvanized metal is usually smooth and is coated with either a layer of oil to prevent rust or is passivated. Paint applied over this surface will peel quickly.
- If applied over an existing coating, material incompatibility.
- Earlier galvanized metal can exhibit corrosion products. Improper cleaning and priming may develop in lack of adhesion over time.
- Alkyd/oil paints will adhere initially, but will eventually fail. The zinc of the galvanizing will chemically react with the alkyd binder of the paint causing the coating to peel.
- Application during inappropriate weather conditions: too cold or high humidity.[19]

Recommendations:

- Flashing must be protected and painted with a historically appropriate color. Prior to any paint campaign, trial and test of the new coatings is advisable to ensure adhesion and color match.
- Surface preparation is key. Oil and passivator coatings on new galvanized metal must be cleaned. Most acrylic coatings will adhere directly to cleaned galvanized metal. However, consultation with the manufacturer is advisable to choose the proper paint system, including the appropriate sealer, wash primer, or acrylic passivation prior to preparing the surface.
- Removal of rust products prior to any application of new coatings. Exposed metal must be primed the same day it is cleaned.

Conservation Treatment for Period Windows, Doors, and Trims

B016 Windows and doors

Overall, window and door trim are in a remarkable good condition. Some window openings in JL-4 and JL-12 were enlarged. At employee dormitories JL-44, JL-51, & JL-52, windows have been replaced or enlarged in later refurbishment interventions.

Recommendations:

- Protection and maintenance of wood and architectural metals that comprise the window frames, sashes, muntins and surrounds through appropriate surface treatments such as cleaning, rust removal, limited paint removal and re-application of protective coating systems in kind.

[19] Sherwin-Williams, paint manufacturer. www.sherwin-williams.com accessed April 10, 2017

- Removal of sacrificial materials and re-puttying. Installation of weather stripping when possible to improve thermal efficiency.
- Retention of sound windows and window trim, as well as elements that can be repaired.
- Retention, repair and stabilization of window screens when deteriorated.
- Replacement in kind when extensively deteriorated. New windows should match the historical in form, material and detailing, including moldings. Limited upgrades to improve thermal efficiency are advisable when necessary and justified.
- Future upgrades of both windows and doors shall follow Underwood's fenestration configuration. In due time, consideration should be given to restore opening that have been enlarged in units JL-4 and JL-12.

Conservation Treatment for Period Wall Coverings

<u>Applicable Guidance</u>

ASTM E2394 *Standard Practice for Maintenance, Renovation, and Repair of Installed Asbestos Cement Products*
ASTM E1368 *Practice for Visual Inspection of Asbestos Abatement Projects*
ASTM E2356 *Practice for Comprehensive Building Asbestos Survey*
National Institute of Building Sciences *Guidance Manual. Asbestos Operations and Maintenance and Practice*

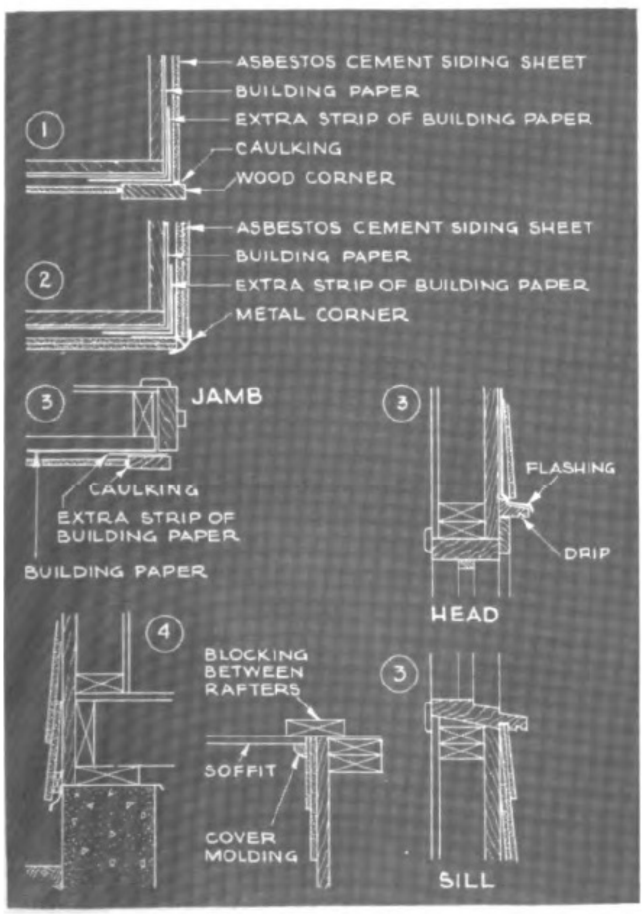


Figure A71 Details of external corners (1, 2); jamb, head, and sill at openings (3); at grade (4); and at roof overhang (5).

As a general practice, the goal is to preserve as much of the historical siding as possible, while replacing in kind when necessary. Preferred treatment include the following:

- B017 Repair of Open Corners.
- B018 Improvement of Architectural Detailing on the First Course of Shingles.
- B019 Replacement In Kind When: Missing Units, Material Loss, Deteriorated Shingles By Impact Damage, Improper Installations And Improper Repairs.
- B020 Refastening Loose Shingles
- B021 Repair of Cracks and Fracture in Shingle Siding.
- B022 Replacement of Vertical Board and Batten Siding With a Historically Appropriate Siding.

As indicated in section 2.5. *Asbestos Containing Material Considerations*, any work that sands, grinds, cuts, abrades or extensively breaks the siding would make the material and the work activity regulated. As a general practice, the work must be performed using wet methods and preventing visible emissions. If more than 160 SF of work becomes regulated, then the employees performing the work must be trained as Asbestos Contractor/Supervisors or Abatement Workers. Regulated work bust be notified at least 10 days in advance to the Asbestos Control Program coordinator for the Wyoming Department of Environmental Quality should be contacted prior to any work being done.

B017 Repair of Open Corners

Shingle units abut one another on the guest lodges corners. Typically, this arrangement is prone to deterioration and shows open likely due to moisture infiltration and swelling of insulation materials. Thermal movements must be considered as well.

Technical literature of the period suggests the use of exposed metal flashing to reinforce the corners.[20] This solution can be seen on some locations on the outbuildings. However, this addition deviates from Underwood's intention

Recommendations:

- Evaluation and improvement of the roof detailing to divert rainwater and snow melt from the corners when necessary.
- Partial removal of shingles to replace deteriorated insulation fiberboard and repair wooden frame when necessary.
- Evaluation and installation of vertical metal flashing to reinforce the corner.. However, developing a system to install the metal flashing behind the abutting shingles will limit the visual impact on Underwood's design.

B018 Improvement Of Architectural Detailing

The shingles are durable and slightly flexible, but weak in impact damage as evidenced by the various cracks and fractures noted during the visual inspection. The siding is nailed directly to a 25/32" insulation fiberboard. On the first course close to the grade, material loss caused by mechanical impact is evident. Historically, it was recommended that the architectural detailing of the horizontal joints at grade included horizontal metal Z clips or wooden strips that provided enough backing to prevent damage to the shingles. [21] Underwood, included specs to paint and caulk the lower end of the insulation. The use of strips or z clips is unclear (see Underwood Miscellaneous (01) in Jackson Lake Lodge HSR Part 1). Where shingles were missing or loose, there was no evidence of any type of backing installed.

Recommendations:

- Evaluation, selection and installation of a proper backing material to assist on the correct performance of the shingles installed on the course at grade.

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[20] Caleb Hornbostel, *Material for Architecture: An Encyclopedic Guide* (Reinhold Publishing Corporation: New York, 1961) 67

[21] Ibid.

- During improvement, determine source of moisture when blistering is present. Inspect grade, condition of insulation and waterproofing, repair and replace if necessary prior to the reinstallation of the shingles.
- Replacement in kind of the shingles showing material loss or blistering (if friable). For proper finish see *Conservation Treatment for Period Painting and Coating*.
- Ensure enough clearance between grade and siding. Water can splash up from the ground onto and behind the siding, or in the case of accumulation, soil can act a giant sponge that transfers moisture to the foundation masonry units, frame components vulnerable to rot and to the siding.

<u>B023 Removal and Replacement of Deteriorated Fiberboard Boards</u>

Typically, open corners and distressed sidewall flashing are accompanied by deterioration of the fiberboard insulating panels underneath.

Recommendations:

- Partial removal of the shingle siding to allow for visual inspection of both the fiberboard panels and the insulating batch between the frame studs.
- Removal of the damaged areas and replacement in kind. Improvement of insulation is advisable with the proper energy audit and consultation.

Conservation Treatment for Period Painting and Coating

<u>B024 Painted Exterior Carpentry Elements</u>

As the flashing, carpentry elements are typically painted green, which differ from Underwood's design.

Recommendations:

- Retaining new coatings help to protect the exterior wood from moisture and ultraviolet light. Paint removal should be considered only when the original color palette is going to be implemented. In the meantime, tasks should be limited to routine maintenance and repainting in kind, ensuring color match.
- If lead-based coatings are present, it is strongly recommended to use wet and safe practices for removing damaged or deteriorated paints to the next sound layer suitable for application other coating.

<u>B025 Soiling and Staining Cleaning</u>

Recomendations:

- Remove visible soiling and white leaching staining (see 2.4. Building Efficiency Considerations) by scrubbing with water alone or with water under high pressure. Use only stiff bristle non-metallic brushes. In the case of tar staining, consider and test the use of diluted detergent where necessary. Areas must be rinsed and dried thoroughly after applying the cleaning agent.

B026 Paint Removal in Siding

Guest lodges are clad with Johns-Manville 2' by 1' Asbestos Cement Shingles with a wood-grained textured surface. Four different colors were noted during the 2016 fieldwork, three of which were specified by Underwood: Autumn Brown, Silver Gray, and Weathered Gray.[22] Currently, the shingles are painted brown showing some variations as new coatings are applied. In due time, paint removal and consolidation of exposed surface is the preferred treatment.

Recommendations:

- Evaluate and determine a paint removal methodology to expose the historical finish. Because the cement shingles are an ACM material, safe work practices using wet methods are strongly encouraged (see 2.5. Asbestos Containing Materials in Jackson Lake Lodge). After paint removal, exposed surfaces must be consolidated.
- Evaluate and determine a painting technique to replicate the historical finish on the replaced shingles according to the color scheme included in this report.

B027 Paint Removal in Windows, Doors & Trim

Complete removal of paint coatings from historical elements should be avoided unless absolutely essential. Once conditions warranting removal have been identified the general approach should be to remove paint to the next sound layer using the gentlest means possible, then to repaint.

Recommendations:

- As evidenced by laboratory analysis, the earlier paint layers on windows, doors and trim contain lead. It is strongly recommended the use of wet safe work practices and proper containment. See section 2.6. *Lead-based Paint Consideration*.
- Ensure compatibility between paint coatings.
- In due time, paint the windows, doors and trim according to the historically appropriate color scheme included in this report.

Other Conservation Issues

B028 Form and Massing

Throughout the guest lodges clusters, new electrical pipes are exposed and electrical meters are housed in exterior sheds disrupting the original massing.

Recommendations:

- Reinstating exterior form by installing the current building systems in a more sensitive manner, according to or compatible with Underwood's approach of integrating the installations into the walls and massing intention.

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[22] Jackson Lake Lodge, HSR Part III, 3; Jackson Lake Lodge, HSR Part I, 2.1.5 Outbuildings Building Description, 107

- Addition of future engineered systems or features to meet new health, safety, security or accessibility requirements must be done in a manner that respects the exterior massing and minimize the visual impact on the historical resource.

B029 Fixtures and Fittings

- Exterior fixtures and fittings such as the wall sconces (similar to Thomas Lighting SL875-3) shall be replaced in kind.

B030 Improving Architectural Detail Guest Lodge Porches

Although the porches are a deviation from Underwood's intent, they were installed after Spencer & Lee Architects design which completed the landscaped environment considering Underwood's initial idea (see CLR by Logan Simpson). Nevertheless, at the lower end of sloping roofs, the porch connections allow for moisture and debris retention compromising the maintenance and performance of the eaves assembly. In addition, ledgers make for difficult maintenance.

Recommendations:

- Evaluate and devise a new porch detailing that prevents damage to the eaves as reported in the Jackson Lake Lodge HSR Part 2. To build a frame separated from Underwood's fabric is advisable.
- Correct and ensure slope for on grade concrete porches to divert rainwater and snow melt from the building masonry foundation. Repair deteriorated and cracked exposed aggregate concrete and replace in-kind when needed.

B031 Staff Housing & Employee Dormitories Siding

Recommendations:

- The vertical board and batten siding deviates from Underwood's idea of creating a unified plan for Jackson Lake Lodge. Priority will be given to the removal of the vertical board and batten siding and cladding with cement shingles. This recommendation should be extended to non-contributing outbuildings.

2.3. Interiors

General guidelines

Recommendations:

- Exhaustive documentation of interior arrangement, form, materials and current condition prior to and after any intervention work.
- Special attention, protection and maintenance of the interior character defining elements as listed in Appendix VI.

Central Lodge

Recommendations:

- Retention and preservation of Underwood's circulation and sequence of spaces from the Porte-Cochere to the Upper Lobby. In due time, consideration should be given to a limited restoration of the Lower Lobby to recreate a more confined entry zone to reinforce the element of surprise to the Upper Lobby. New interventions must conform to Underwood's material palette.
- Limited restoration and preservation of the character defining elements in the following spaces: Upper Lobby (including the Eagle's Nest Gallery and Crow's Nest), Mural Room and the Pioneer Grill.

Guest Lodges

Typically, each guest room comprises an open vestibule with storage space on one side, and a full bathroom and a bedroom.[23] While the overall form, proportion, and circulation are Underwood's, as is, this interior scheme represents a room remodel designed by Sharon Burdick in 1989-1990. Based on the interior spaces the project team surveyed, the following character-defining features were identified as historical:

- 4" by 12" exposed wood ceiling rafters as well as the wooden boards in between.
- exposed insulation boards on the ceiling and cover molds
- Shadowood plywood wall panels and cover molds
- Triple and double sash windows depending on the elevation

Recommendations:

- Any type of new addition or installation must be done in a manner that minimizes the impact on the character-defining elements listed above, which require singular protection and maintenance.
- Strip and refinish Shadowood panels to reveal the visually rich plywood pattern.

[23] A longer building description can be found in 2.1.5 Outbuildings Building Description in Jackson Lake Lodge, Historic Structure Report, Part 1 Development History

Employee Dormitories

Unlike the staff housing, a layout with a central corridor running in the longer axis with rooms on both sides is Underwood's preference for the employee dormitories. The remaining metal partitions in the bathrooms, interior walls and ceiling veneered with shadowood panels are original. These elements needs to be preserved. An intervention similar to the one carried out in the Dormitory 1 is not advisable.

2.4. Building Efficiency Considerations

During the summer 2016 fieldwork session, it was observed that various original building efficiency techniques were in place. Examples of techniques found were: deep eaves incorporated into the design of the Central Lodge, guest cabins, staff housing, and employee dormitories; louver and roller solar shading devices; large windows for natural lighting; and the installation of efficient lamps (compact fluorescent lamps [CFLs] and light emitting diodes [LEDs]) in lighting devices. Any work to improve the energy efficiency of the buildings on site should first be verified and approved by a certified energy specialist. It is important to keep in mind that “historic building construction methods and materials often maximized natural sources of heat, light and ventilation to respond to local climatic conditions.”[24] Any changes to the buildings should take into account maintaining the historical integrity and character defining features. Below are some recommendations.


Left photo: Example of solar shades being used in the Upper Gallery to reduce solar gain through windows
Right photo: Example of efficient lamps being used in lighting devices
Source: Architectural Conservation Laboratory

Recommendations

Character Defining Elements

Any decision regarding the implementation of energy conservation or saving measures should include a phase where the total environmental cost of these measures is considered against the overall environmental costs of retaining the existing features. If it is determined that retrofitting measures are appropriate, such work then needs to be carried out with particular care to ensure

[24] US National Park Service, "Preservation Brief 3: Improving Energy Efficiency in Historic Buildings," National Parks Service, December 2011, accessed January 20, 2017, https://www.nps.gov/tps/how-to-preserve/briefs/3-improve-energy-efficiency.htm.

that character-defining elements of Jackson Lake Lodge are not concealed, damaged, or eliminated (about the character-defining elements see Appendix VI).

Sustainability goals must be balanced with heritage conservation principles. This includes considering the inherent performance and durability of their character-defining assemblies, systems and materials, and the minimal interventions required to achieve the most effective sustainability improvements.

Consult an Energy Specialist

It is strongly recommended that an energy specialist with experience working with historic structures and conservation specialist be consulted early if any building efficiency changes are to take place. This is meant to ensure that unnecessary changes and applications are not implemented. Exploring equivalent energy efficiency systems, methods or devices that may be less damaging to character-defining elements is essential.

Energy Audit of Buildings

Before any changes or additions are made, it is strongly recommended that a detailed audit of the buildings be conducted. This audit will evaluate the current energy use and identify deficiencies in the building envelope and/or mechanical systems of the Central Lodge and outbuildings. The purpose of the assessment is to "establish a baseline of building performance data to serve as a reference point when evaluating the effectiveness of future energy improvements". An auditor who does not have financial interests in the results should be used. [25]

Check for Sources of Air Infiltration

Another major contributor in energy loss is air infiltration. "Leakage of air into a building can account for 5 to 40 percent of space-conditioning costs, which can be one of the largest operational costs for buildings."[26] Infiltration can occur between: foundations and rim joists; around doorways and windows; around electrical and telecommunication service entrances and outlets; outdoor water faucets entrances; and cracks/missing cladding in the buildings envelope. A useful tool in identifying these sources are blower door tests, which use differential pressure to make sources of infiltration more evident. Another option is using infrared thermography, which uses an infrared camera to spot hot or cold spots that could indicate air infiltration. These tools/tests are often part of an energy audit and should be performed by a qualified professional.

It is important to note that deficiencies in particular building elements does not necessitate replacement. Studies have shown that repairing and adding weatherstripping to building components (such as windows) can be as beneficial as new replacements. Observations from the summer fieldwork show that most windows are original and in good condition and may require minimal modifications (such as adding weather-stripping, re-glazing, and ensuring that they close and lock completely) to improve efficiency. It is preferable to repair the windows rather than replace due to a number of factors:

- Retention of the historical character of the structure

[25] Ibid

[26] John Krigger and Chris Dorsi, "Air Leakage," in *Residential Energy: Cost Savings and Comfort for Existing Buildings.* Helena, Montana: Saturn Resource Management, 2004, p. 73.

- Properly repaired original windows can be just as efficient as new windows
- Repairing windows can be more cost effective
- Repairing windows is more environmentally sustainable

Installing new replacement windows should be used as a last resort, and the replacements should match the existing windows in shape, proportion, and design.

Check Building Systems and Equipment

The behavior of systems and equipment can be one of the greatest factors in energy use. For instance, updating old mechanical systems or even just changing the way in which systems are operated can lead to significant improvements. In addition, it is important to make sure systems remain clean and that ventilation areas remain unobstructed. This can cause systems and equipment to work harder than required, resulting in inefficiency and wasted costs. If not already in place, systems and equipment should be checked and serviced regularly.

Close off unused portions of the Central Lodge and Outbuildings

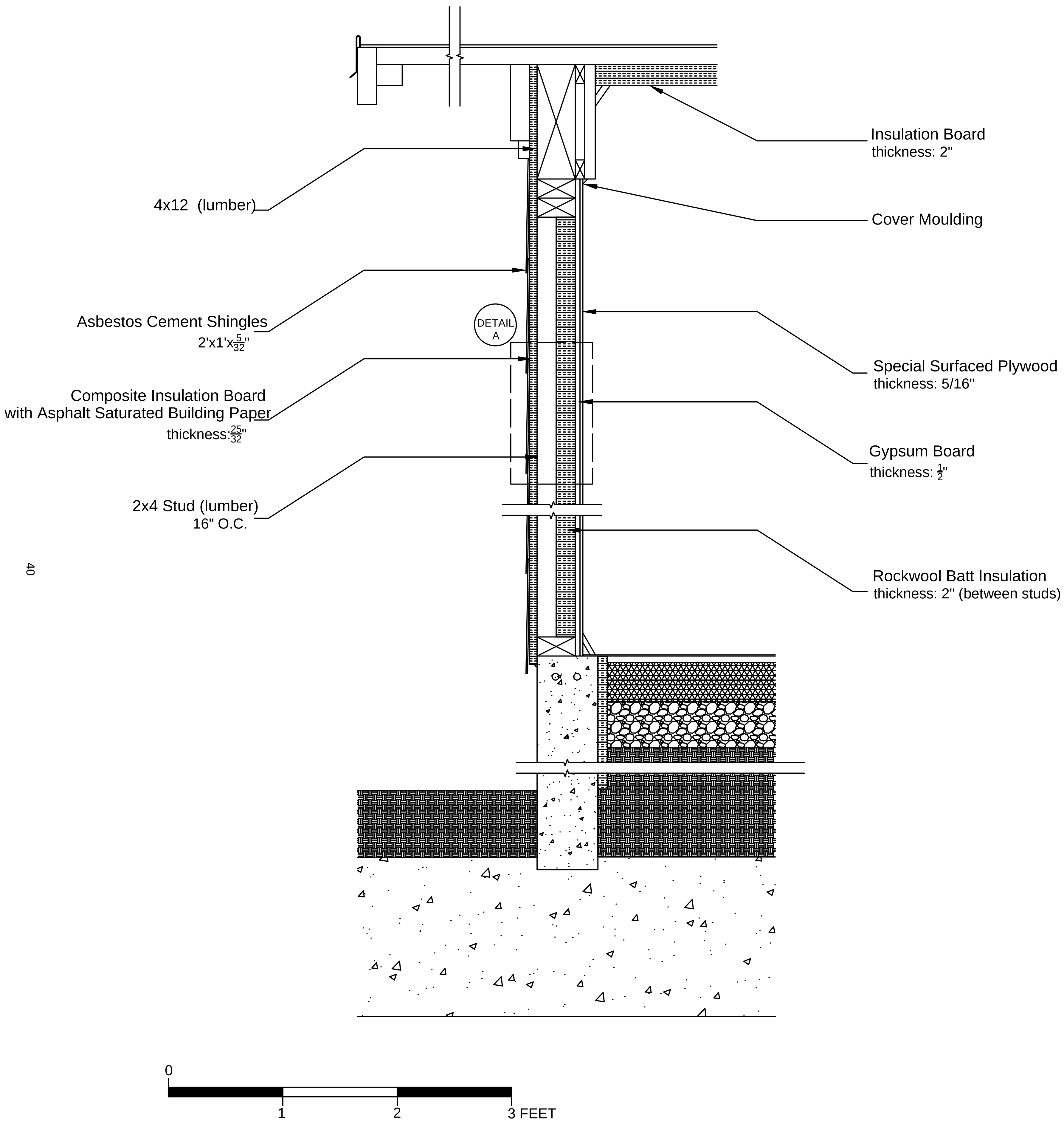
If not already implemented, areas in the Central Lodge or outbuildings that are not in used during the off season should be closed off. If possible heating to these areas should be lowered.

Check for Moisture Problems

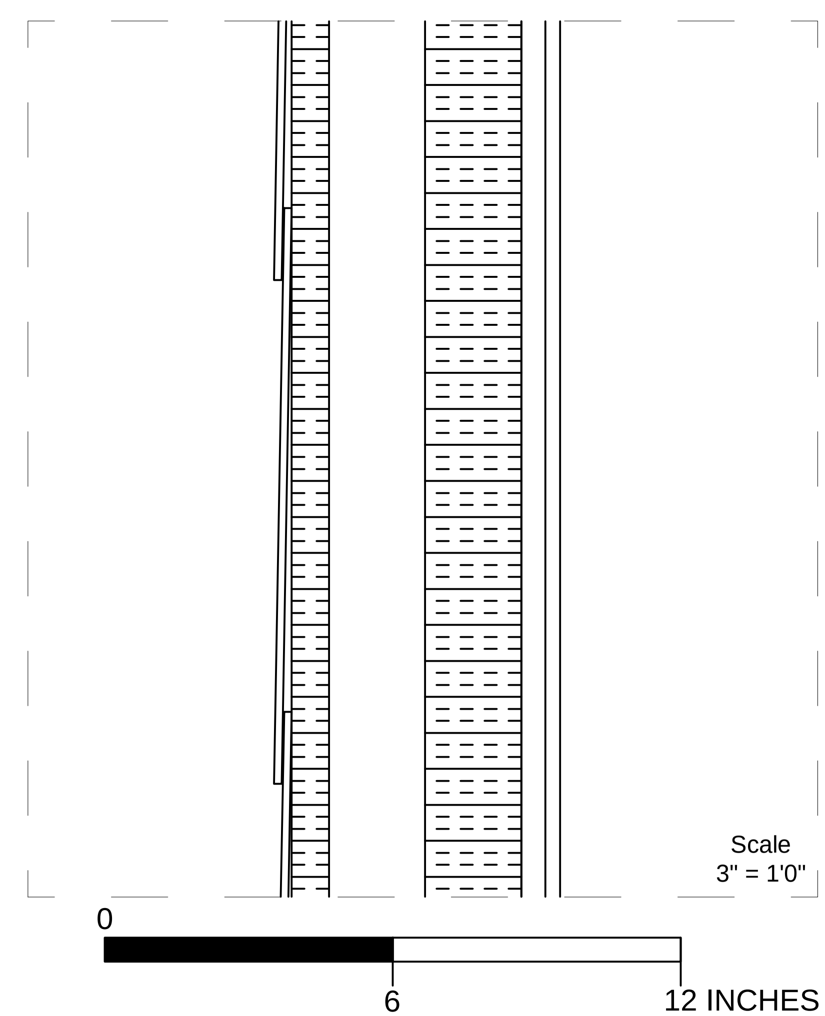
During the summer it was noted that condensation was found on the interior face of several guest lodge windows. At the time of the visit, the frequency at which condensation occurred could not be ascertained. It is strongly recommended that the reason (or reasons) behind this condition be found and addressed. Condensation could be a sign that the interior humidity is too high. Prolonged exposure to moisture can warp and deteriorate the wood components of the interior (such as the window), allowing for decreased efficiency and increased air infiltration.

It was also noted that white leaching stains were found on the exterior cladding of the guest cabins. The exact cause of this phenomenon is unknown, but it could be a sign that moisture is collecting somewhere behind the shingles. This water may be eroding components behind the shingle, resulting in white deposits on the shingle surface. If there is a perforation in the composite insulation board behind the shingles, it could lead to mold growth and the deterioration of the various components within the wall assembly. It is important that this condition be assessed by a qualified specialist. Using infrared thermography is a nondestructive means of determining if moisture is collecting within the wall. Additionally, it is recommended that the components of the wall assembly be verified against the digitized original construction drawings (see next page). It may also be beneficial to have the R-value of the wall assembly calculated.

Left: Example of window with condensation on the interior face of the glass.
Right: Example of the white leaching stains found on the surface of shingles See the *Conditions Glossary* in Part 2 of the historic structures report for more details on this condition
Source: Architectural Conservation Laboratory.



DETAIL A



JACKSON LAKE LODGE

Grand Teton National Park (Moran, Wyoming)

JLLO

WALL SECTION (GUEST LODGE)

Delineated By: Araba Prah
6/8/2016

Scale
1" = 1'0"

Jackson Lake Lodge HSR Part 3

2.5. Asbestos Containing Materials Considerations

Manufactured by the Johns-Manville Corporation, the exterior wall shingles were fabricated to resemble wood with colorful mineral granules pressed into their surface. There are primarily three shingle colors found at Jackson Lake Lodge- Winter Grey, Silver Grey, and Autumn Brown. A fourth color was found at JL-45 (Dorm 3), in which the granules were pressed into a pink finish grout rather than white.[27] Over the years the shingles have been painted, altering their original appearance. Due to the brittle nature of the product many of the shingles have cracks and/or missing portions. Alterations and disposal of the shingles must follow certain guidelines because of the asbestos contained in the product.

Asbestos is a mineral that naturally forms in rocks and soil. The Environmental Protection Agency (EPA) refers to asbestos as fibrous silicate minerals from two main classifications: serpentines (chrysotile) and amphiboles (amosite, crocidolite, tremolite, actinolite and anthophyllite). Of this group chrysotile and amosite are the most common types found in manufactured products. Despite having a similar fibrous appearance, the varieties have different molecular structures. The molecular formula for serpentine asbestos –such as chrysotile— is $Mg_3Si_2O_5(OH)_4$. Similar to serpentines, amphiboles contain magnesium and silicon, but they also contain other elements such as sodium, calcium, manganese, magnesium, iron(II), iron(III) and aluminum.[28] Analysis of the bulk samples, via EPA 600/R-93/116 method using polarized light microscopy, confirmed the presence of chrysotile in both the substrate and on the white grout containing the mineral granules. The content is 15% and 4% respectively.[29]

Asbestos was a popular additive in many products-particularly building products. The material was characterized as being flame, heat, and electrical resistant, in addition to having a high tensile strength.[30] With increased concerns on the health risks of asbestos exposure, the use of the material began to be phased out by various companies in the 1970s and 1980s. It was also during this time that the EPA began banning asbestos in a variety of products such as spray-applied fireproofing; certain types of insulation; and wall patching compounds. Once workers and the general public began to understand the link between asbestos and serious illnesses such as lung cancer, there was an avalanche of lawsuits against manufactures-one of which was the Johns-Manville. Because of these lawsuits the company filed bankruptcy in 1982.[31] In 1989, the EPA issued a final rule under Section 6 of Toxic Substances Control Act (TSCA) banning most asbestos-containing products.[32] However, this act was overturned in 1991. In subsequent years,

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[27] See Appendix V: Paint Removal Techniques Investigation- Cement Shingles
[28] Roberta C. Barbalace, "Asbestos: its Chemical and Physical Properties," Environmental Chemistry, October 2004, accessed February 14, 2017, https://environmentalchemistry.com/yogi/environmental/asbestosproperties2004.html.
[29] Analysis conducted by EMSL Analytical, Inc. through the Penn Department of Environmental Health & Safety. February 14, 2017
[30] "What Is Asbestos?" Mesothelioma. Accessed February 14, 2017. https://www.mesothelioma.com/asbestos-exposure/what-is-asbestos.htm.
[31] "Johns Manville - History, Litigation & the Manville Trust," Asbestos.com, January 20, 2017, accessed February 15, 2017, https://www.asbestos.com/companies/johns-manville.php.
[32] "U.S. Federal Bans on Asbestos." EPA. December 19, 2016. Accessed February 15, 2017. https://www.epa.gov/asbestos/us-federal-bans-asbestos.

the EPA has created guidelines and prohibited the use of asbestos in particular instances and products, and implemented regulations on proper disposal.[33]

It is important to note that asbestos is only hazardous in a friable condition. This allows the asbestos fibers to be released into the air, thus causing the health risk. Because of this it is often recommended that if asbestos containing materials are present and in a non-friable state, they should not be disturbed or manipulated. Asbestos fibers are microscopic, allowing them to be easily inhaled. These microscopic fibers are difficult to exhale and often cling to the respiratory system. Furthermore, the human body cannot break down the asbestos, so it accumulates in soft tissue.[34]

Any activity that sands, grinds, cuts, abrades or extensively breaks the siding would make the material and the work activity regulated. Under these circumstances, the siding is classified as Category I non-friable Asbestos-Containing Material (ACM).

As a general practice, the work must be performed using wet methods and preventing visible emissions. If more than 160 SF of work becomes regulated, then the employees performing the work must be trained as Asbestos Contractor/Supervisors or Abatement Workers. The broken debris would need to be taken to a landfill that can accept regulated waste. If the siding shingles can be worked on or removed intact, with only minimal breakage, then disposal can be done in a local landfill, and the previous requirements may not apply.[35]

Regulated work must be reported to the Asbestos Control Program coordinator for the Wyoming Department of Environmental Quality who should be contacted prior to any work being done.[36] Chapter 3 (General Emission Standards)- Section 8 (Emission Standards for Asbestos) of the Wyoming Air Quality Standards and Regulations (WAQSR) requires written notification of demolition or renovation operations at least ten days prior to beginning activities, but it would be beneficial to contact the office sooner.

As stipulated in the program requirements, individuals supervising or performing abatement must be certified. According to the WAQSR website there is not a registration or licensure program in Wyoming for Asbestos Building Inspectors, but surrounding states (with the exception of Idaho) have these programs. It may be worth looking at surrounding states for registered Asbestos Building Inspectors if required for future work. In the event that abatement is needed, it is strongly recommended that the contractors also have experience working with asbestos cement shingles.

The Wyoming Department of Environmental Quality will be able to provide up to date information on specific regulations and other resources to ensure the safety of individuals involved on the project and reduce the likelihood of compliance/regulation infractions occurring.

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[33] For more information see the EPA’s webpages on asbestos at www.epa.gov/asbestos
[34] "What Is Asbestos?"
[35] Linda Dewitt, Asbestos Program Coordinator, Wyoming Asbestos Program, email to the author on March 3, 2017.
[36] See http://deq.wyoming.gov/aqd/asbestos/ for the most up to date information.

2.6. Lead-Based Paint Considerations

The State of Wyoming does not have primary enforcement responsibility (also known as primacy) regarding lead-based coating. It is recommended that the steward/contractor contact EPA Region 8 Lead, Pesticides & Children's Health Unit to obtain information about up-to-date requirements. EPA's Lead Renovation, Repair and Painting Rule (RRP Rule) requires that firms performing renovation, repair, and painting projects that disturb lead-based paint in homes, child care facilities and pre-schools built before 1978 have their firm certified by EPA (or an EPA authorized state), use certified renovators who are trained by EPA-approved training providers and follow lead-safe work practices.[37]

The guest cabins would be classified as zero bedroom dwellings, therefore the rule would not apply. Nevertheless, EPA strongly encourages the use of wet safe work practices and containment to reduce potential exposure to dust and airbone lead.[38] The same is valid for the employee dormitories and functional spaces in the Central Lodge. However, any activity that disturbs lead-based paint in housing and child-occupied[39] facilities built before 1978, which is the case of the earlier staff housing, would be subject to the EPA requirements. Requirements include complying with certification, safe work practices, clearance standards, and record keeping.

OSHA's Lead Standard establishes maximum limits of exposure to lead for all workers covered, including a permissible exposure limit (PEL) and action level (AL), level at which an employer must begin specific compliance activities outlined in the standard.

General recommendations to reduce hazardous worker lead exposures during lead abatement and residential renovation include the following:

- Use enclosure, encapsulation, and replacement methods instead of on-site paint removal methods where possible.
- Do not remove paint by torch burning, dry manual scraping, and conventional power tools; instead use vacuum power tools and wet scraping.
- Use general dilution ventilation to provide adequate outside air when working in sealed or contained work areas.
- Employ good hygiene practices and administrative controls, including worker and supervisor training.

How to proceed:

- Recognition: lead in paint cannot be determined by normal visual inspection, it requires laboratory analysis of samples collected on site.

Removal of hazardous materials:

- Limit exposure to portions of the structure remaining in use

[37] www.epa.gov/lead/renovation-repair-and-painting-program
[38] Chris Frye, email to the author, April 4, 2017
[39] The RRP Rule defines child as an individual less than six years of age. The rule applies if the child resides or is expected to reside in such housing.

- Limit exposure to occupants and workers performing the abatement
- Determine the amount of disruption to historic fabric in implementing the removal program
- Determine effective method of containment
- Completely clean all work areas to be free from contamination of the hazardous material that is being removed
- Properly dispose of waste materials according to regulatory framework

General recommendations to reduce hazardous worker lead exposures during lead abatement and residential renovation include the following:

- Use enclosure, encapsulation, and replacement methods instead of on-site paint removal methods where possible.
- Do not remove paint by torch burning, dry manual scraping, and conventional power tools; instead use vacuum power tools and wet scraping.
- Use general dilution ventilation to provide adequate outside air when working in sealed or contained work areas.
- Employ good hygiene practices and administrative controls, including worker and supervisor training.

3. Finishes Analysis

3.1 The Role of Color in The Design

Technological advancements, post war optimism and prosperity opened an era of innovation and enthusiasm that had a lasting impact on everyday objects. The magazine Industrial Design offered an insight into these preferences as it celebrated the freshly conspicuous and uninhibited use of color as integral to the object in its 1955 Second Annual Design Review[1].

Fig1. "For car watchers, 1955 is the year of brilliant

Architecture was not oblivious. By presenting and analyzing roughly 180 buildings across residential, school, lodging, industrial, and administration modernist designs, the authors of *Color in Architecture: A Guide to Exterior Design*, argued that "things are not composed of form and color, but are one in form and appearance, then color cannot as a medium be relegated to second rank."[2]

This statement underpins the indissoluble relationship between form and color that dominated all aspects of consumer culture including architecture and interior design as reflected in the original schemes for Jackson Lake Lodge, and particularly in the guest lodge clusters. As introduced in Part 1, Gilbert Stanley Underwood utilized a varied palette of colors and textures that enlivened the repetitive variation of setbacks and common elements such as doors and windows, that defined the guest cabin clusters within the unified master plan. By so doing, Underwood's color specification recalled the words of architect-thinkers, such as Fritz Schumacher, -quoted in the above publication-: "color, besides the refining power contained in its specific value, also possesses the coarser power of articulation, which lies mainly in its degree of brightness, and which can be utilized in a uniting or dividing manner."

Updating the traditional wooden references of the National Park Service 'rustic' style, Underwood selected commercial textured and integrally colored Johns-Manville Asbestos Cement Shingles in order to imitate wood shingles. The appearance of these shingles ranged in color from subtle reds and ochres (Autumn Brown), to grays of variety intensity (Silver Gray and Weathered Gray). Aiming to counter the potential monotony of the repetitive forms, Underwood used different colors on each four-room unit and each two-room unit of the Guest Lodges.[3] In alternating fashion, blues, yellows, and oranges, accentuated architectural elements – such as windows and doors – and secured the articulation of the outbuildings. Texture, trim and flashing unified the entire composition. Later interventions of

[1] *Industrial Design. Annual Design Review* vol. 2 no. 6 (December 1955), 33-38
[2] Konrad Gatz & Wilhelm O. Wallenfang. Color in Architecture: A Guide To Exterior Design. (New York: Reinhold Publishing Corporation, 1961), 8
[3] Konrad Gatz & Wilhelm O. Wallenfang. Color in Architecture: A Guide To Exterior Design. (New York: Reinhold Publishing Corporation, 1961), 8

monochrome brown and tan removed this important character-defining feature of the design, censuring a distinguishing architectural component and cultural marker of 1950s society and Jackson Lake Lodge.

Fig. 2. Guest Lodges. North group. Ca. 1959. The complete cabin in the middle ground corresponds to JL-26, which was used as a location for the architectural finishes analysis. Source: The Rockefeller Archive Center. Grand Teton Lodge Company records.

Conversely, while maintaining a dialogue with the rest of the complex, the Central Lodge stood by itself in its special exterior concrete treatment: a distinguishing character-defining element of the lodge that did not preclude the use of color. Underwood used "Shadowood", an integrally colored wood patterned surface finish on the exposed concrete of his lodge. The overall result was a stark geometric gridded exterior that recalled the rustic wooden lodges of the past without a literal imitation of timber construction. Previous phases of this HSR have extensively studied this architectural finish.

As highlighted in the NCPTT conference *A Century of Design in the Parks*,[4] after 50 years of continued operation, Jackson Lake Lodge has remained remarkably resilient in its original design to accommodate the needs of visitors and staff. Over the years, the subtle mixture of autumnal and vivid color palettes has been substituted by dull greens and browns that weakens Underwood's original use of color in the service of the architectural idea. This section aims to deepen the understanding of how color was used at Jackson Lake Lodge, and provide a series of recommendations that will restore the original vision for the site created by Underwood and Rockefeller.

[4] Cesar Bargues-Ballester, Julianne Wiesner-Chianese, John B. Hinchman, Frank G. Matero. "Modern in the Mountains: Rustic Reinterpreted at Jackson Lake Lodge" in NCPPT A Century of Design in the Parks, Santa Fe, NM, 2016.

3.2. The Exterior Paint System

For the Central Lodge trim, windows, and doors, Underwood specified a three coat painting system– confirmed through microscopical analysis. According to the specifications a House Paint Exterior Primer was applied, followed by two coats of Verdura Trim & Sutter Finish. Pratt & Lambert manufactured both products.[5] In addition, the exterior trim was to be back prime before installation.

The Pratt & Lambert House Paint Exterior primer was advertised as a primer specifically formulated to seal all surfaces. It served as a bond between the substrate – either wood, concrete, stucco, cement, asbestos, or brick – and the finish coats.

Verdura Trim & Shutter Finish was similar to Pratt & Lambert House Paint, whose color card was suggested for body colors and other trim colors reference. This group was "made of highest quality pigments and pure linseed oil (…)"[6] and the colors were "ground in a specially designed vehicle to ensure maximum durability, gloss, and color retention."[7] The company attributed this paint's good performance and weatherability to its "unusual hiding and retains its color and gloss for a long time."[8]

Reflected in Underwood's specs, Pratt & Lambert recommended the following procedure for new exterior woodwork: "On new wood apply a first coat of P&L House Paint Exterior Primer in accordance with directions on the can. This should be followed by a coat of Verdura Trim & Shutter Finish, each gallon thinned with one pint of turpentine. Then apply a finish coat of Verdura Trim & Shutter Finish in the consistency supplied."[9] A two-coat painting system, even one coat reapplication, depending on the surface condition was recommended for repainting jobs.[10]

[5] A timeline of the company can be found here: http://www.prattandlambert.com/about-us/
[6] Pratt & Lambert Specification Manual: Painting, Varnishing, Enameling (New York: Pratt & Lambert, ca. 1950), 10
[7] Ibid., 11
[8] *Verdura Trim & Shutter Finish. Color Card* (Buffalo, NY: Pratt & Lambert, ca. 1940)
[9] Ibid.
[10] An extended explanation about this practices and their evolution can be found in *House Paints, 1900-1960: History and Use* by Harriet Standeven and published by the Getty Foundation.

3.3. Cross-Section Analysis

The research and analysis of architectural finishes aims to document and confirm the color palette and plan schemes designated by Underwood for both the Central Lodge and the outbuildings. This included original windows, doors, and exterior trim, as well as the asbestos cement shingle siding.

3.3.1. Methodology

Field investigation of architectural finishes included a phase to reveal and document original paint coatings as well as to remove representative samples for further analysis in the Architectural Conservation Laboratory and the Singh Center for Nanotechnology at the University of Pennsylvania.

Sampling Methodology

Archival documentation, including colored historical photos,[11] paved the way for preparing a sampling plan prior to the 2016 summer fieldwork. The view in Fig. 2 established the preferred location for the architectural finish analysis: JL-26 Guest Lodge Rooms 400-418 and 601-619. After a first evaluation, the project team expanded the number of sample locations and elements (see Appendix I Master Sample List and Location). Simultaneously with other tasks, members of the team identified original elements and collected nine samples from windows and doors on five locations at the Central Lodge, including both the interior and the exterior, and twelve samples from the outbuildings. This group included three windows, and original linen room door (now ice room), two rafters, and a post on JL-26, as well as a rafter at the JL-46 Employee Recreation Hall and a window sash in JL-45 Dorm 3. Sample size was approximately 0.25 x 0.25 inch and included all the finish layers and the substrate. Due to their brittleness, samples were contained in masking tape, deposited in sampling envelopes, and labeled with an alpha-numeric code.

With the aid of a scalpel, the team was able to collect enough data to draft color palette datasheets involving the NHL contributing outbuildings, including the cement shingle colors. Six shingles were sampled from broken pieces found during the visual survey, including two samples provided by GTLC staff members. Sample size ranged from one full shingle to small pieces 1 x 1 inch. Samples were properly contained and labeled with an alphanumeric code.

As stated in the 9-30-16 Investigators Annual Report, preliminary findings were as followed:

- Presence of orange, blue, and yellow colors on the exterior window trim confirms the pattern visible in the historical photographs. A fourth color, a light blue hue, was detected on the windows of JL-45 Dorm 3.
- Most of the doors have been replaced. The color association between doors and windows rely on the visual features observable in the historical photographs.

[11] See RAC_020, RAC_025, RAC_158, RAC_177, RAC_238, RAC_248 in Jackson Lake Lodge Historic Structure Report Part 1 Photodocumentation Inventory. RAC_193, RAC_195, RAC_200, RAC_206, GTLC_042, GTLC_043, GTLC_044 offer a vivid glimpse into the finishes and fabrics used for interiors.

- It is possible to discern at least three paint campaigns on the rafters at the Employee Recreation Hall.
- Visual survey confirmed the use of cement shingles with different finishes: “Autumn Brown”, “Silver Gray”, and “Weathered Gray”, as described in the Jackson Lake Lodge Development Specifications, as well as the manufacturer Johns-Manville. In addition, a fourth finish was found at JL-45 Dorm 3. The supplier is unknown.
- Physical investigation shows that the outer colored layer of the cement shingles has weathered but is intact.

Analysis Methodology

Laboratory analysis included examination of the bulk sample under a stereomicroscope; preparation of comparable cross sections for analysis under visible and UV illumination; as well as elemental analysis (EDS) with Scanning Electron Microscopy of selected and representative cross-sections.

Examination of the bulk sample aimed to gain a general understanding of the substrate; in addition to the number and character of layers present in each sample. In many instances, paint layers were detached from the substrate, which is most likely related to the presence of lead in either the primer or the earliest layers. The following section contains a more extensive description of this appearance.

Prior to microscopic study, samples were embedded in a polyester resin, cured, cut, and polished to expose the layer structure. The project team viewed the polished cross sections using a Nikon Alphahot YS2 under visible (reflected quartz halogen) and UV (Nikon mercury lamp) lights. Digital microphotographs were taken with a Nikon DS Fi-1 camera and NIS Elements BR software. These photographs along with written notes have been assembled into datasheets (see Appendix II Cross-Section Microphotograph Datasheets).

Material elemental analysis with a FEI Quanta 600 FEG Mark II Environmental Scanning Electron Microscope supplemented the previous study for a limited number of selected samples. This technology provided an elemental characterization within a layer, as well as elemental maps showing the spatial distribution of elements throughout the layers. The project team used this basic information to identify paint composition as well as the presence of hazardous materials such as lead. Paint binders were not analyzed.

3.3.2. Findings

In this section, only the most relevant findings are displayed and interpreted. For further information, see Appendix II, where the photomicrographs (visible light and UV light) are annotated. The cells containing information about the original layers are shaded.

<u>Outbuildings</u>

GC3 Guest Lodge JL-26 Ice Room Window Sash

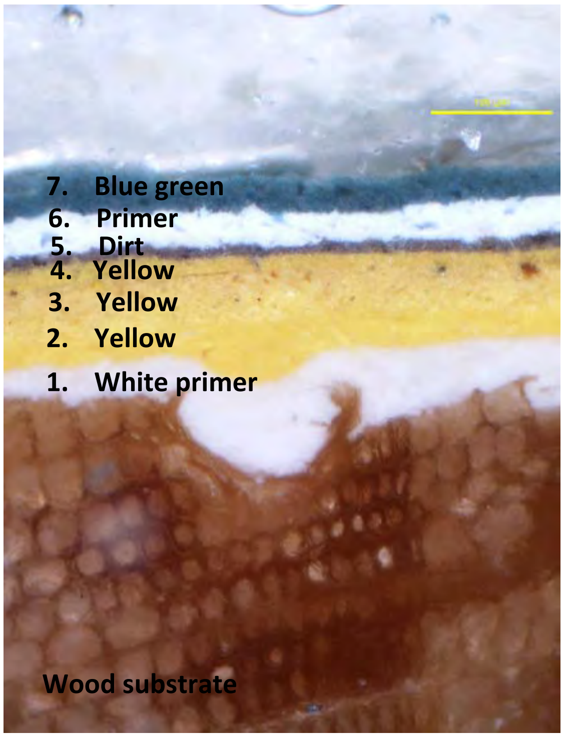


Fig. 3. GC3, visible light, 10X

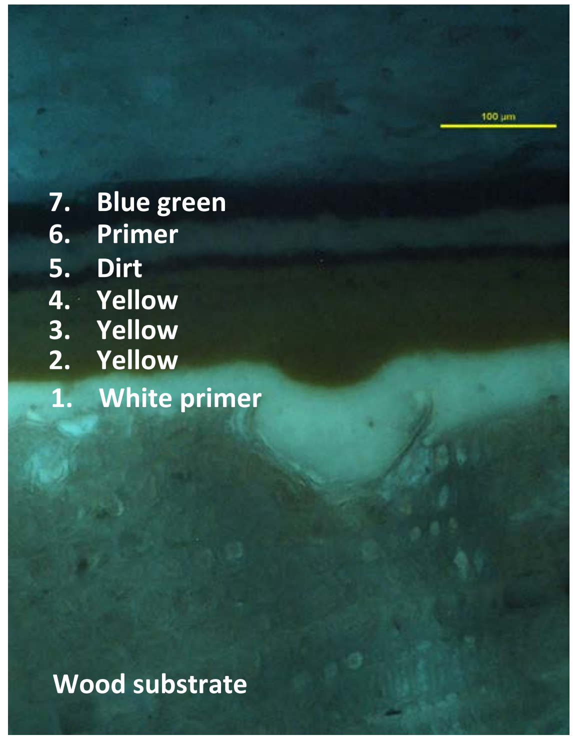
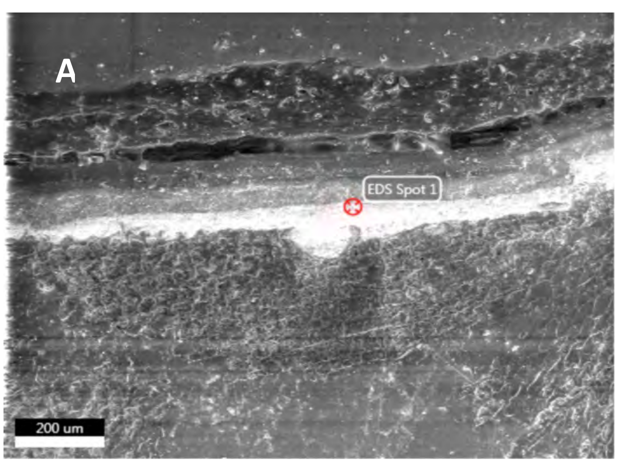


Fig. 4. GC3, UV light, 10X

Above, figs. 3 & 4 show the cross-section of the sample taken from the window sash in the south elevation of the ice room at JL-26, both under visible light (left) and UV light (right). A white primer was



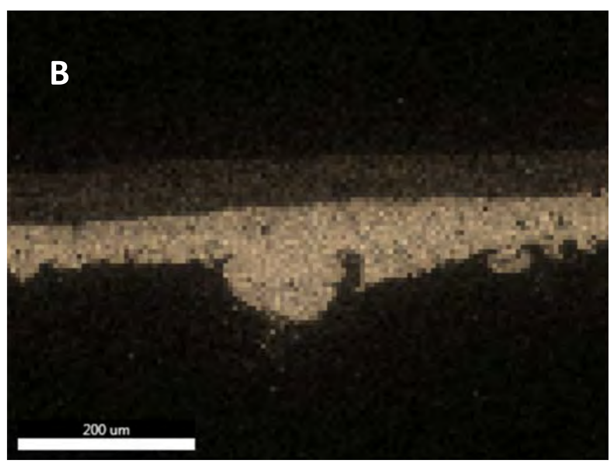


Fig. 5. SEM images from cross-section sample GC3. A) Back-scattered Electron Detector (BSE) image. B) EDS elemental mapping showing lead (Pb).

used to seal the wood before painting. The yellow layers 2 and 3 correspond to the original scheme. According to Munsell, a best match to the yellow is 2.5 Y 8/12 (chrome yellow). Trim of rooms 400, 402, 601, and 603 are the same color. Sometime later, a different white primer was applied over a dirt layer followed by the current finish-a blue green paint.

Under UV light conditions, the bluish fluorescence of the white primer suggest the presence of lead. This has been confirmed by SEM-EDS analysis. As seen in Fig. 5, the primer contains lead in higher proportion than subsequent paint layers. On the right, the bright cream area corresponds to the maximum amount of lead. The earlier yellow coating contains lead to a lesser degree.

Chemical elements present in the original coating were magnesium (Mg), lead (Pb), calcium (Ca), titanium (Ti), iron (Fe), and chrome (Cr), as depicted in Fig.6. The presence of these elements suggest that the pigments are likely chrome yellow (PbCrO4), lead white ($(PbCO_3)_2{\cdot}Pb(OH)_2$) and titanium white ($TiO_2$).

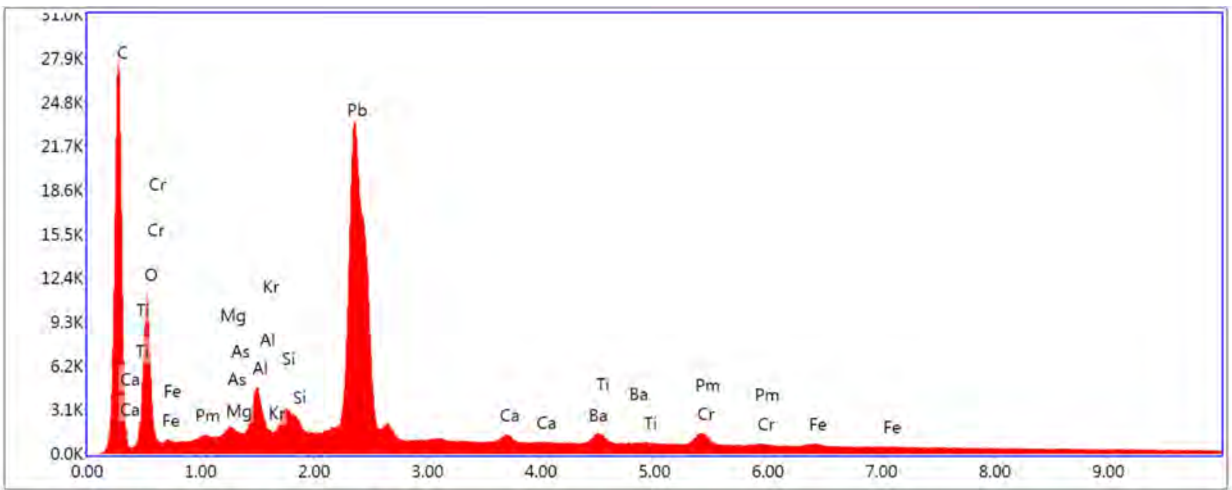


Fig. 6. Localized elemental analysis of layer 2 Yellow.

GC6 Guest Lodge JL-26 Window Sash Room 607

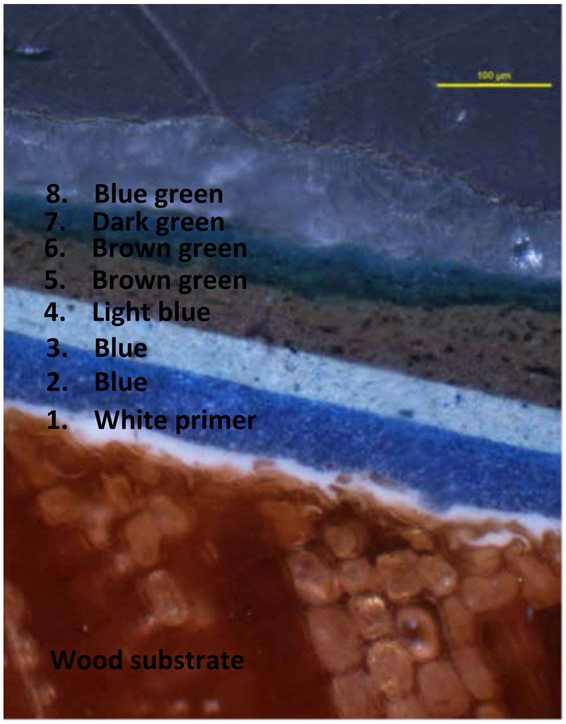


Fig. 7. GC6, visible light, 10X

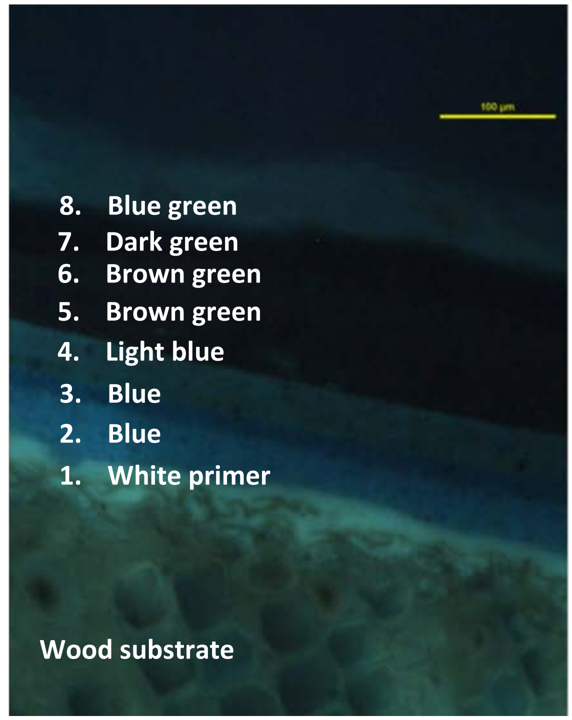
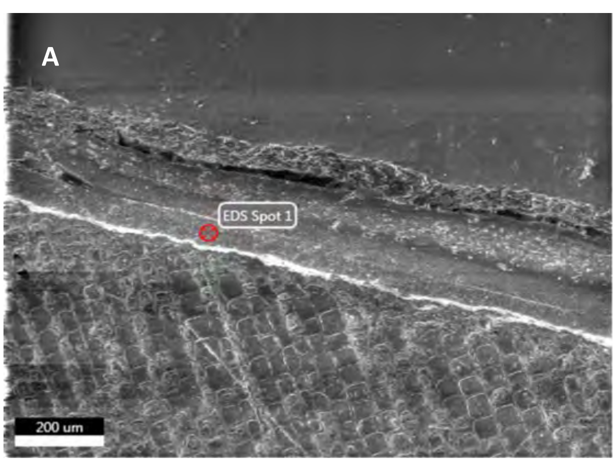


Fig. 8. GC6, U light, 10X

In sample GC6 a similar white primer has been used to seal the wood before painting. The blue layers 2 and 3 correspond to the original job. According to Munsell, a best match to the blue is 5 PB 3/8 (purple blue). Sometime later, a light blue coating was applied. This light blue color approximately matches layer 2 in sample ED2 taken from a window sash in Dorm 3.

In Fig. 8, the bluish fluorescence suggests the presence of lead (Pb). SEM-EDS confirmed the presence of this element in both the white primer and the two layers applied over it (see Fig. 9). Also, note the absence of lead in the light blue layer. Conversely, the analysis revealed a high presence of Titanium (Ti).



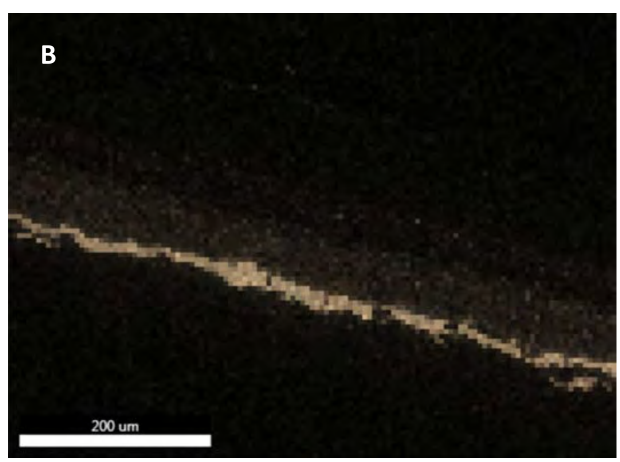


Fig. 9. SEM images from cross-section sample GC6. A) Back-scattered Electron Detector (BSE) image illustrating position of spot analysis (see fig. 10) B) EDS elemental mapping showing lead (Pb

Below, the spectrum indicates the presence of sodium (Na), silicon (Si), Aluminum (Al), Titanium (Ti), Magnesium (Mg), and lead (Pb) in the first blue layer (see Fig. 9.). These chemical elements suggest that the finish was composed of ultramarine ($Na_6Al_6Si_6O_{24}$) in a titanium and lead white base.

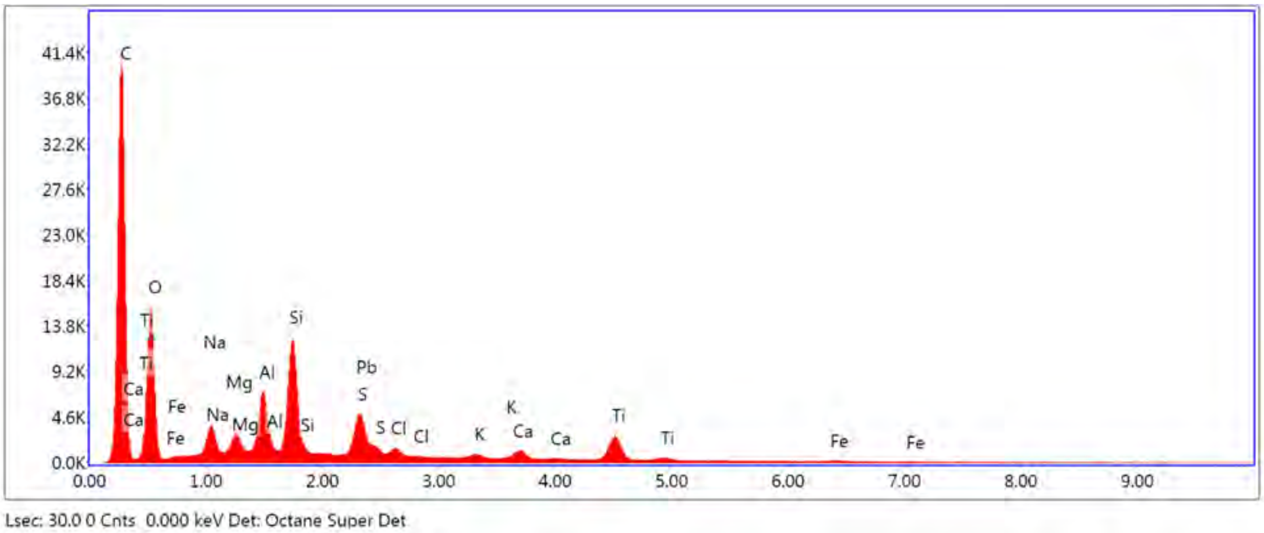


Fig. 10. Localized elemental analysis of layer 1 Blue.

GC7 Guest Lodge JL-26 Window Sash Room 609

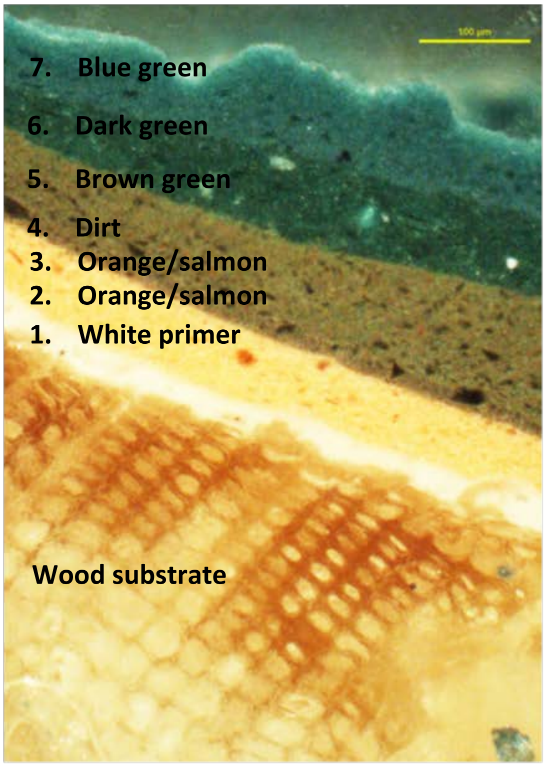


Fig. 11 GC7, visible light, 10X

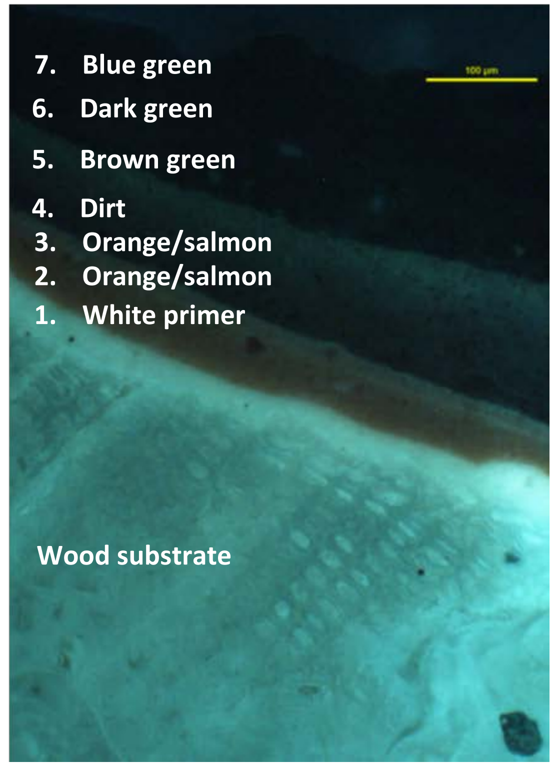


Fig. 12 GC7, UV light, 10X

In sample GC7, a typical three coat painting system can be observed under visible and UV light (Figs. 11-12). A thin layer of primer was applied before painting. As seen in earlier microphotographs, the bluish fluorescence suggests the presence of lead. This was followed by a first application of a smooth textured orange coating. Then, a thinner orange layer was applied. According to Munsell, a best match for this finish would be 10 R 7/10 (light reddish orange).

SEM confirmed the presence of lead (Pb) in both the white primer and the two following layers a lesser extent. Conversely, the analysis revealed a high content of Titanium (Ti) (see Fig. 13).

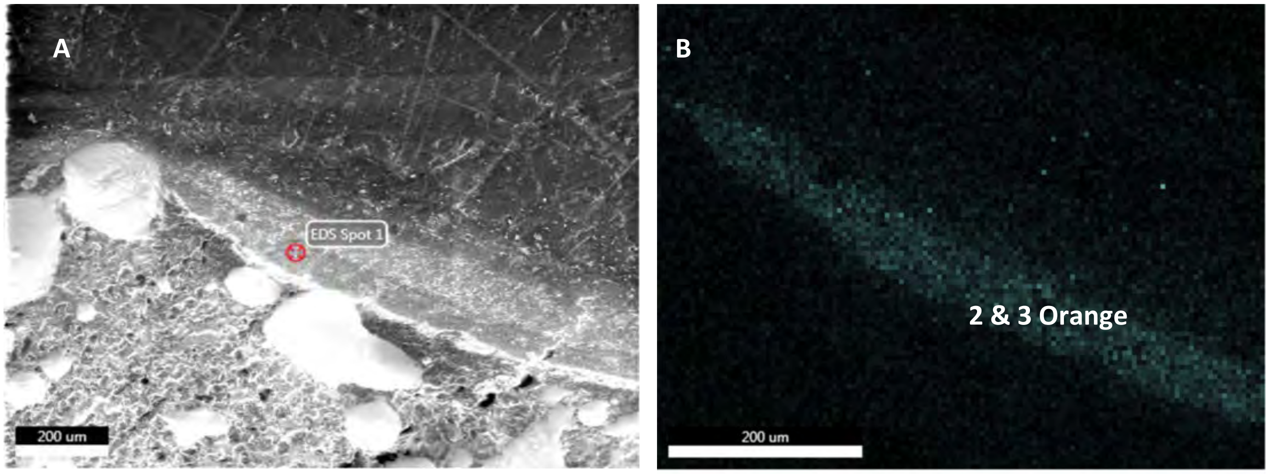


Fig. 13. SEM images from cross-section sample GC7. A) Back-scattered Electron Detector (BSE) image illustrating position of spot analysis (see fig. 14) B) EDS elemental mapping showing titanium (Ti).

SEM-EDS analysis indicates the presence of bromine (Br), sodium (Na), calcium (Ca), titanium (Ti), silicon (Si), sulfur (S), lead (Pb), and iron (Fe). The exact type and composition of the orange pigments is currently being evaluated.

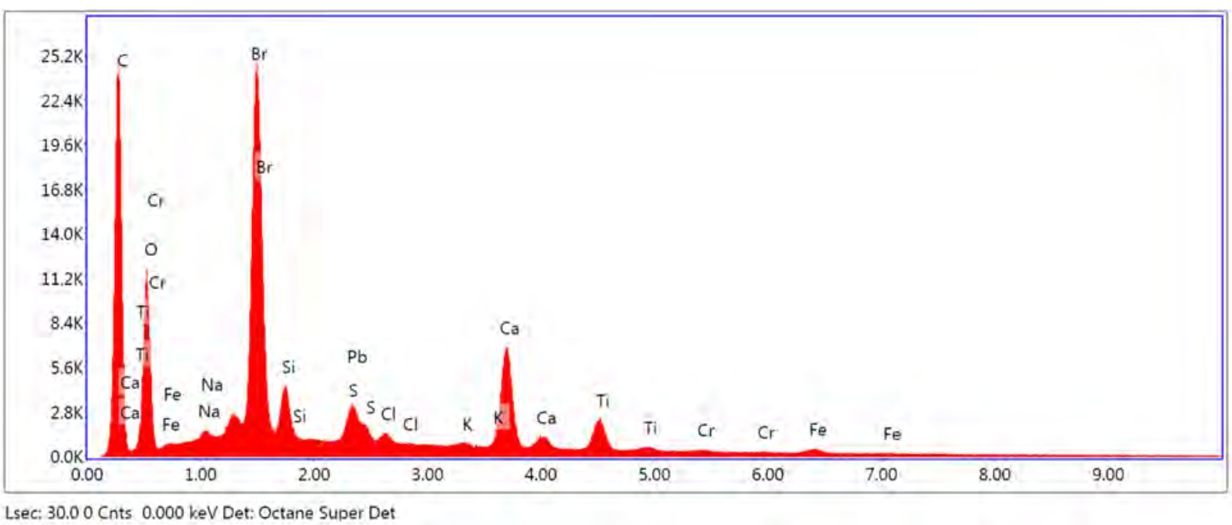


Fig. 14. Localized elemental analysis of layer 1 orange.

GC4 Typical rafter on JL-26, west elevation.

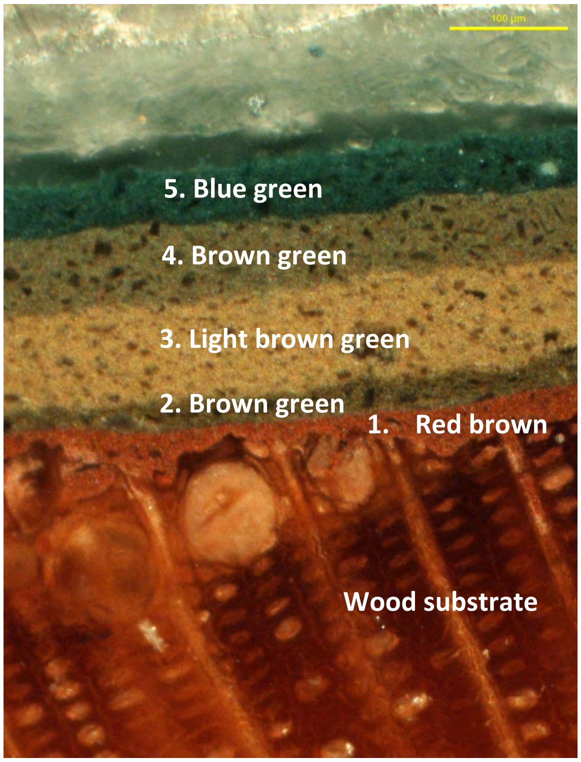


Fig. 15 GC4, visible light, 10X

Fig. 16 GC4, UV light, 10X

In sample GC4 an orange autofluorescent material in the wood cells of the substrate may suggest that shellac was used to seal the wood surfaces before applying the red brown coating (Munsell code: 7.5 R 3/6). There is no mention of this in Underwood's specifications. Later in time, the red brown coating was covered with a brown green paint. A light brown green, brown green, and blue green finish was applied in later painting campaigns. In GC8, a sample from the east elevation, the brown stain is absent. As evidenced by the condition of the wood substrate surface, this circumstance is attributable to stripping. Nonetheless, in the dorm area, another sample (ED1) shows the same initial red brown paint, thus, confirming this is the original finish across the complex.

SEM detected minor traces of lead (Pb). Conversely, the red brown paint is rich in iron (Fe) as evidenced by the bright yellowish color in Fig. 17 (right).

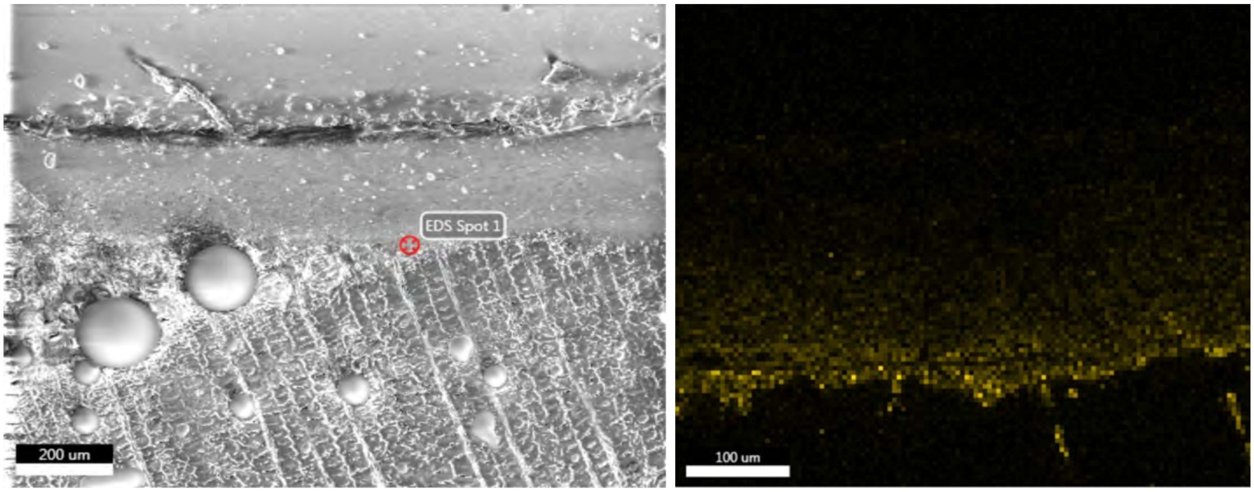


Fig. 17. SEM images from cross-section sample GC4. A) Back-scattered Electron Detector (BSE) image illustrating position of spot analysis (see fig. 18). B) EDS elemental mapping showing iron (Fe).

SEM-EDS of the brown stain, indicates presence of iron (Fe), calcium (Ca), aluminum (Al), silicon (Si), Titanium (Ti), and minor traces of magnesium (Mg) and lead (Pb). These chemical elements suggest that the red brown coating was primarily based on an iron oxide pigment.

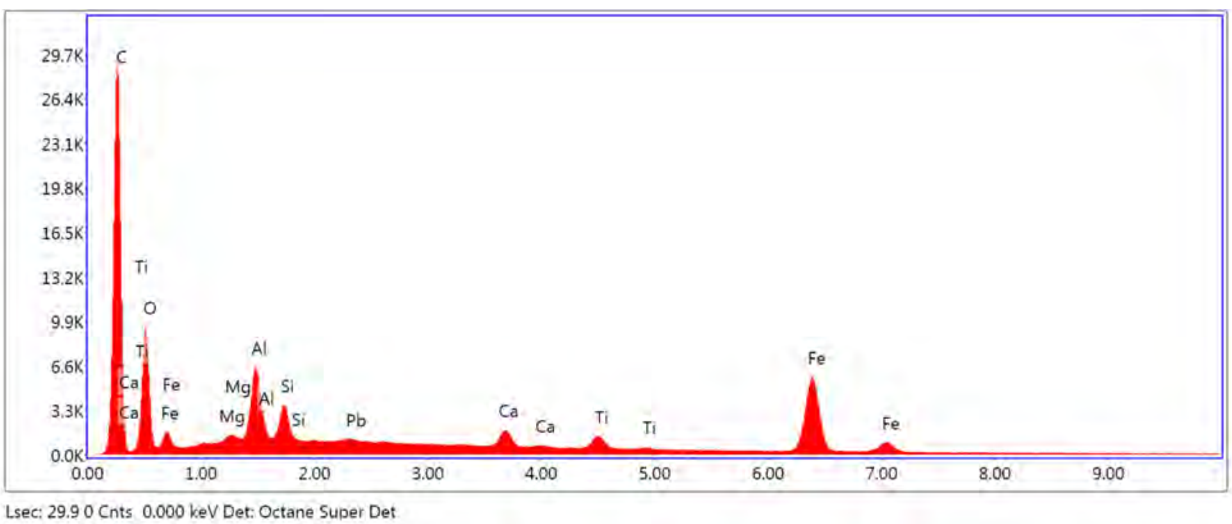


Fig. 18. Localized elemental analysis of brown stain

<u>Central Lodge</u>

CL3 Window Q1 on the employee dining room at the Central Lodge, South elevation (exterior)

Fig. 19, CL3, visible light, 10X

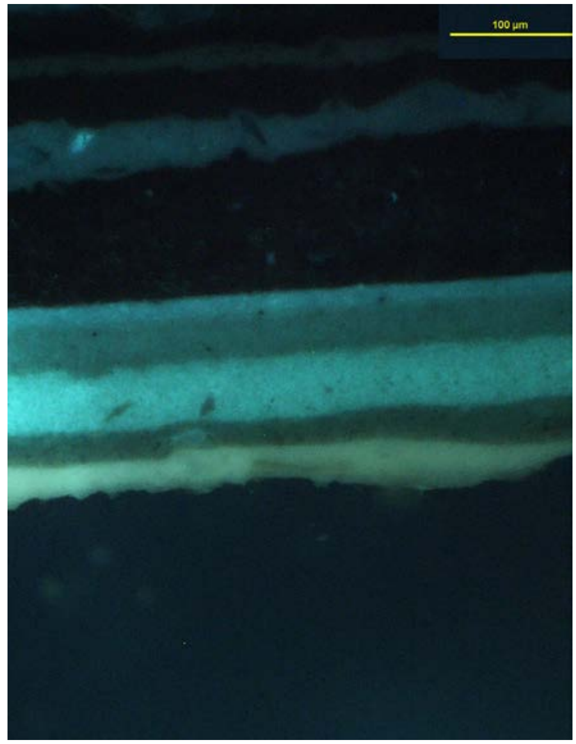


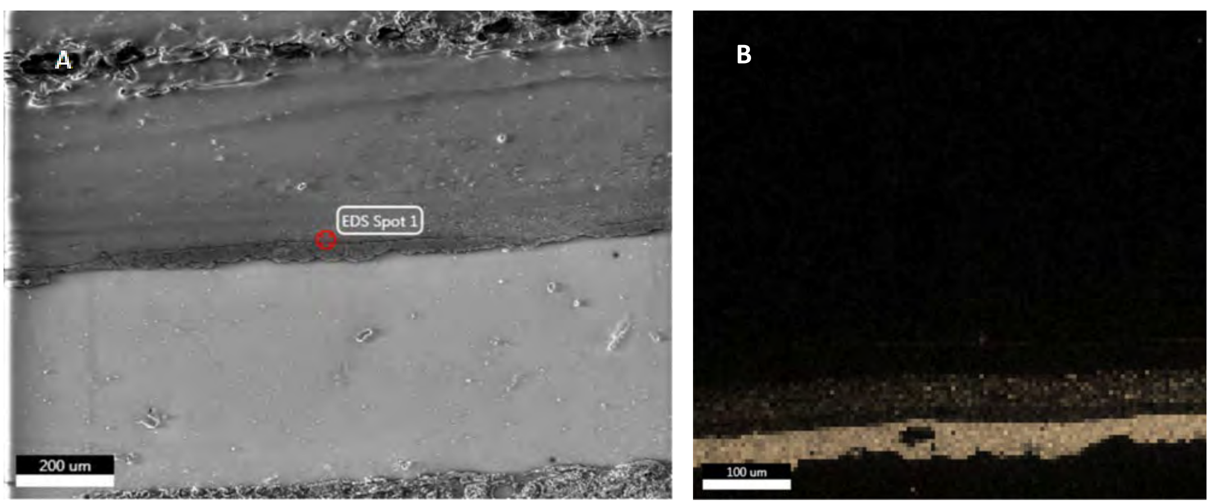
Fig. 20, CL3, UV light, 10X

In CL3, a white primer coat was used for sealing the wood substrate before applying a yellow green coating (Munsell code: 2.5 GY 9/2). Small blue pigment particles are visible. Since there is no evidence of a three coat painting system in this sample, it is assumed that the original finish corresponds to this layer.

Samples CL1, CL4, CL6, and CL8 reveal that this color was consistent on windows throughout the Central Lodge. However, CL9, a sample taken from the door on the north, shows a first brown paint coating. This result would be consistent with the archival documentation available. A rear view of the Central Lodge (see image below) shows window trim painted a light color while the door is painted different hue, presumably the brown paint found in CL9.

Fig. 21, Post Card - Jackson Lake Lodge, front view looking south on Signal Mountain. Ca. 1955. Color photo by Bob Van Luchene.
Source: Rochefeller Archive Center

The white layer visible in the cross section of the paint sample contains a large amount of lead (Pb0, which suggests, as in the previous samples, to a lead-based primer. The presence of chlorine (Cl) and phosphorus (P) in this layer was detected as well.



SEM images from cross-section sample CL3. A) Back-scattered Electron Detector (BSE) image illustrating position of spot analysis (see fig. 18). B) EDS elemental mapping showing lead (Pb).

As revealed by SEM-EDS, the yellow green layer contains a significant amount of titanium (Ti), as well as lead (Pb), silicon (Si), magnesium (Mg), aluminum (Al), and calcium (Ca). Minor traces of Zinc (Zn), sodium (Na), phosphorus (P), potassium (K), and chromium (Cr) were present too. Copper (Cu) a common element in green pigments was absent.

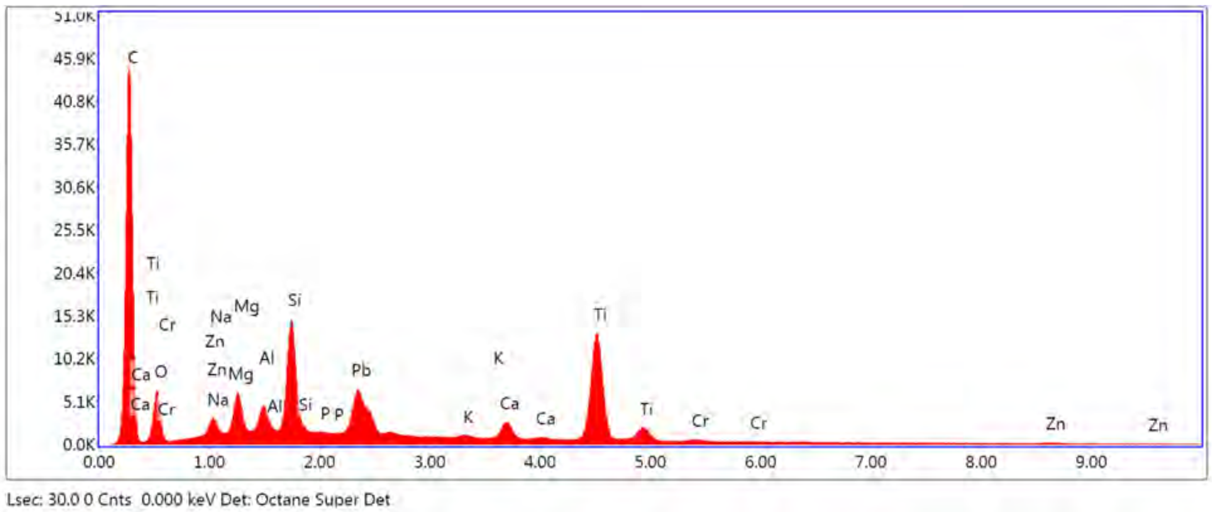


Fig. 22. Localized elemental analysis of yellow green coating.

3.3.3. Conclusions

This analysis confirms evidence visible in historical photo documentation. The three coat painting system is clearly discernible throughout the cross sections, particularly in GC3 (Figs. 3 & 4), GC6 (Figs. 5 & 6), and GC7 (Figs. 7 & 8). These three samples contain respectively three colors: yellow (GC3), blue (GC6), and orange (GC7); and confirm the color palette for JL-26 as well as Underwood's stated aspiration of replicating the wild flower colors native to the area. GC10, a sample taken from the mullion, reveals this element was painted tan to match the shingle siding. The same was true for the posts that support the door canopies (see GC9). According to the surface, the original paint coatings were stripped off. Nonetheless, examination under UV light revealed traces of white primer and a cream-colored paint.

Concerning the Central Lodge, a first yellow-green finish is consistent throughout the samples, except for samples CL7 and CL8. Taken from the exterior of the ground lobby on the south elevation, CL7 shows a stripping job or replacement occurred in a more recent time. The brown layer correspond to the most recent application throughout the rest of the samples. In addition, the white primer applied over the wood substrate does not show the bluish fluorescence typical of the 1950s period. In the case of CL8, the layer structure is indicative of a different exterior treatment. Bearing in mind the historical documentation, it should be noted that the first brown layer is likely the original intent.

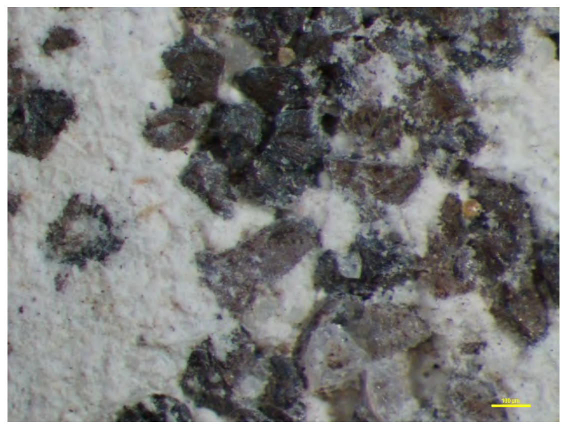
To summarize, this analysis has confirmed the vivid use of color by Underwood, supporting the historical research presented at the outset. According to the specifications and the trade catalogs, Verdura Trim & Shutter were oil-based paints. However, further analytical techniques could be employed to identify the nature of the binder adequately, such as FTIR and FT-Raman spectroscopy. Although it offers critical technical data about original finishes, <u>all these results will need to be verified in the field by creating exposure windows to obtain a better color match</u>

3.4.Cement Shingles

Microscopical examination of selected samples of the shingles under low magnification, revealed an integrally colored surface of different colored aggregates for each specified color. Each sample revealed the same structure comprised of two layers: a light grey cement substrate with asbestos followed by a thin white cementitious layer with coarse colored mineral particles embedded within it in striations related to the grooved texture of the shingle surface.

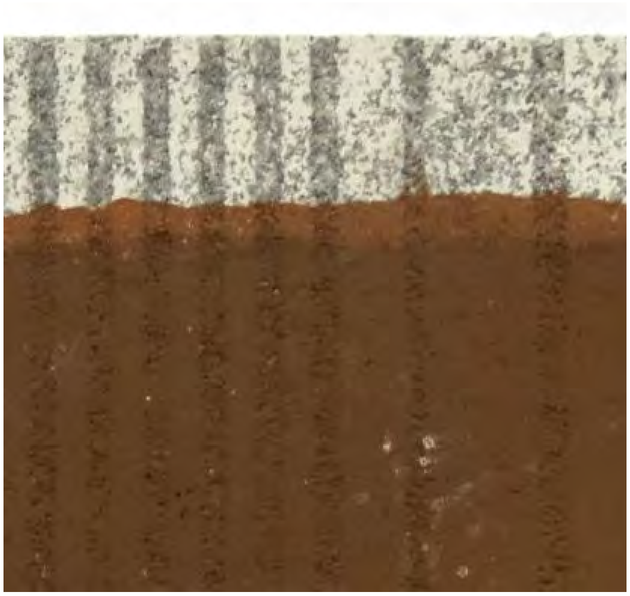
Specified as Johns-Manville manufacturer, at least two patents offer a glimpse into the possible manufacturing process.[12] To obtain the textured decorative surface, a mixture of mineral particles together with a binder were spread on the top surface of a “moist compressible asbestos-cement base sheet.” An assembly of press rolls embedded the aggregate particles in the surface ‘grout’ at the same time the striated pattern was created on the surface. The composite sheet so formed was trimmed at the end and subsequently cured.

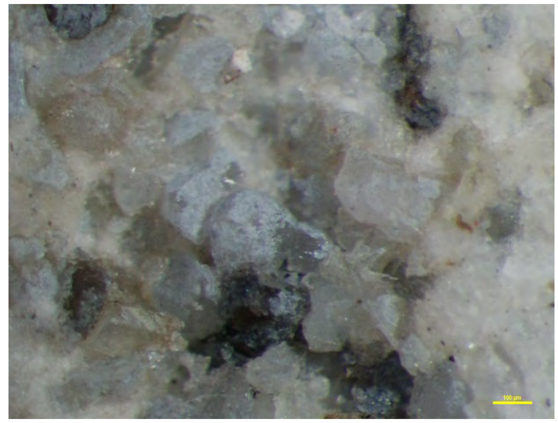
The following microphotographs are of the four distinct colored surfaces recorded on site through visual survey:



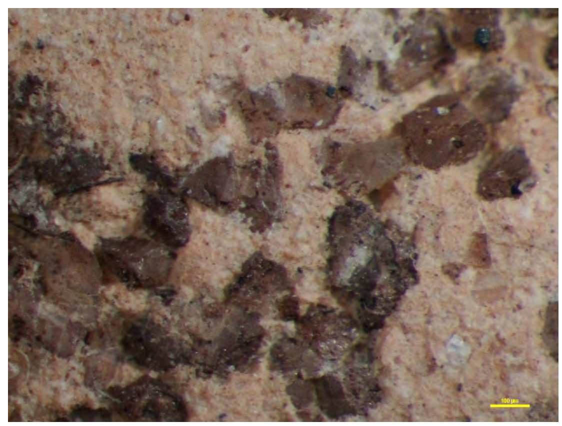
SD3, visible light, 10X
Dark gray cement shingle
Munsell color match:
-2.5 Y 4/1 (Dark gray)

[12] Harold J. Otis and Jack Hesse, Manufacture of Cementitious Sheets. Application January 26, 1946, Serial no. 643798 United States Patent Office

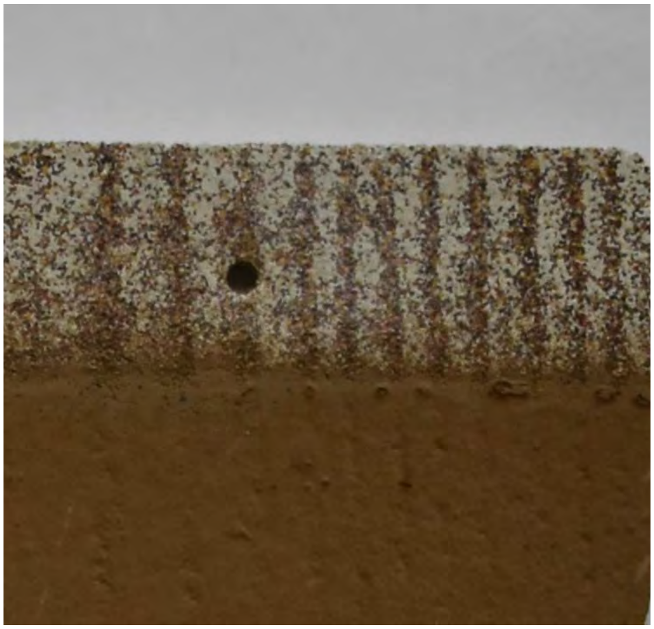


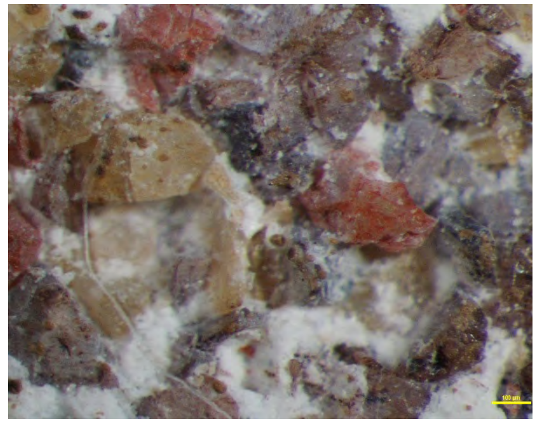


SD6, visible light, 10X
Light gray cement shingle
Munsell color matches:
-GLEY 2 6/10B (Bluish gray)
-7.5 YR 5/3 (Pink)



SD1, visible light, 10X
Light brownish cement shingle
Munsell color match
-2.5YR 4/2 (Weak red)





SD4, visible light, 10X
Autumn Brown cement shingle
Munsell color matches:
- -7.5R 4/6 (Red)
- -2.5 Y 7/4 (Ochre)
- -7.5 YR 4/2 (Brown)

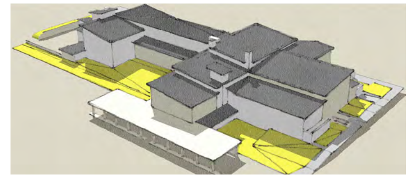
4. Appendices

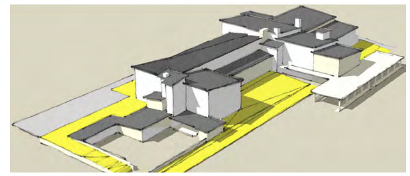
4.1 Character Defining Elements

JACKSON LAKE LODGE

CHARACTER-DEFINING ELEMENTS

The Central Lodge: Overall visual character





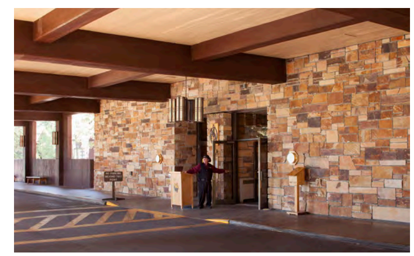
Access

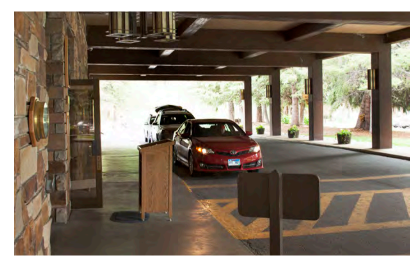
• Central footpath and entrance driveway sequence through a 180-foot wide porte-cochere.
• Ashlar sandstone masonry veneer on the Lower Lobby entry.
• Three central flagpoles and their respecti e brackets.
• Aluminum pipe railing enclosing the Sun Deck.

Right: 2015 (above) vs. ca. 1958 (below) views of the west elevation.
Left: orte-cochere by Joseph Elliott.

Shape and Massing

• Assymetrical composition of interlocking rectangular volumes, anchored by a central block of three, stepped cubes covered with deep cantil verd shed roofs forming deep eaves.
• The shape is strongly horizonal to accomodate to the landscape.





JACKSON LAKE LODGE

CHARACTER-DEFINING ELEMENTS

The Central Lodge: Overall visual character of openings

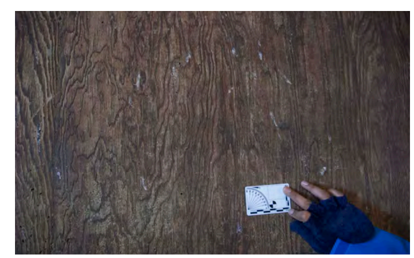
Windows

- Two-story picture windows.
- The horizontal fenestration strengthens the horizontality of the building composition.
- Underwood's awning type windows with horizontal muntins (see drawing sheets JLLO B-1.12, B-1.13, & B-1.14 on Jackson Lake Lodge HSR Part 1)

Exposed concrete

- Grid pa ern of recessed v-shaped joints creating the ill - sion of regularized wood panel cladding.
- Wood grain finish of the x- posed concrete "Shadowood".

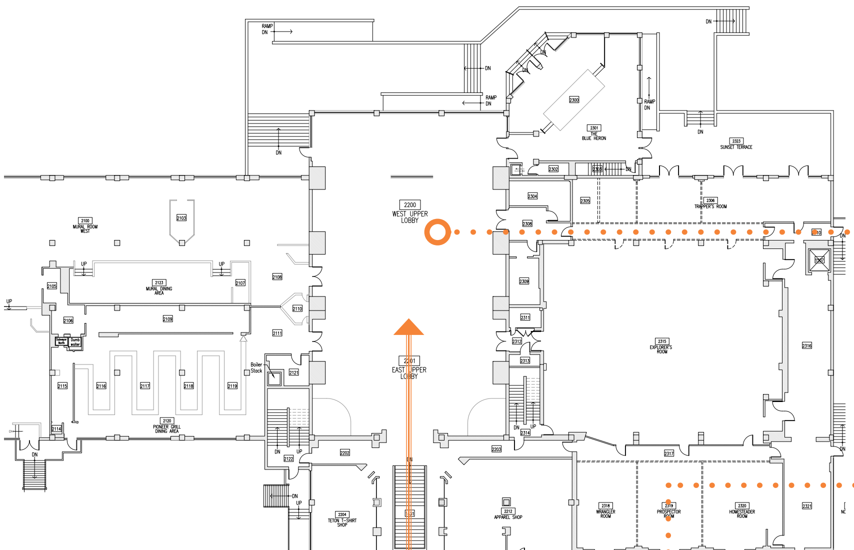
Left: 2015 (ab ve) vs. ca. 1959 (below) views of the west elevation. No e the awning type windows configu ation; a character that now is partially lo t. Right, from top to bo om: historical view of the Central Lodge, towards the SE; typical awning type window by Un- derwood, exterior exposed concrete, and Shadowood's original finish.



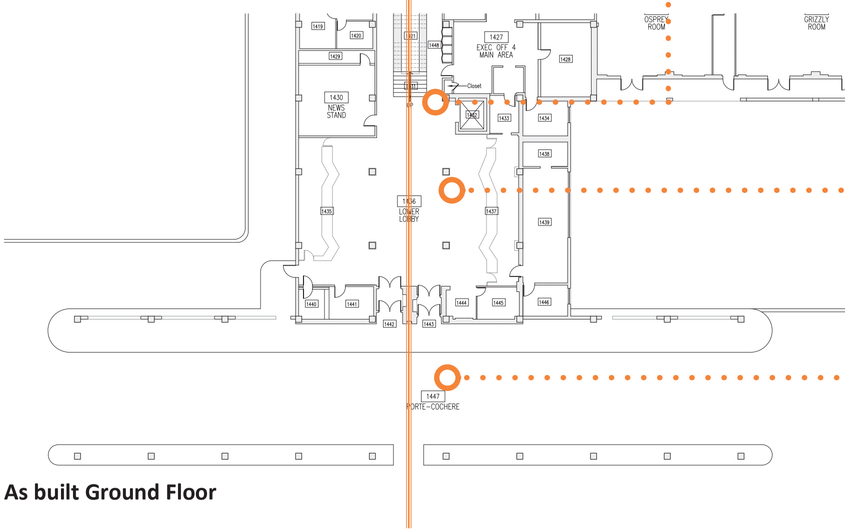
JACKSON LAKE LODGE

CHARACTER-DEFINING ELEMENTS

The Central Lodge: interior

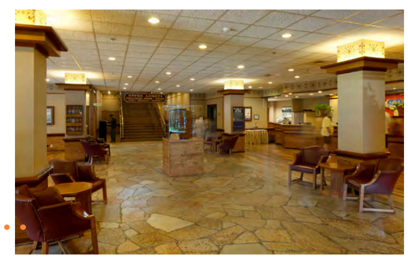


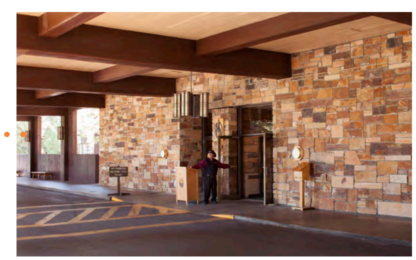
As built 1st Floor



As built Ground Floor

Spatial sequence





Architectural sequence of spaces from the Lower to the Grand Staircase to the Upper Lobby, which is the stage for the dramatic p esentation of the Teton range view still highly appreciated by guests and visitors.

From top to bo om: Upper Lobby, Grand Staircase, Lower Lobby, and entrance at the Porte-cochere.
Photos by Joseph Elliott.

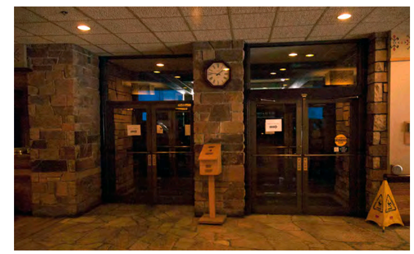
JACKSON LAKE LODGE
CHARACTER-DEFINING ELEMENTS

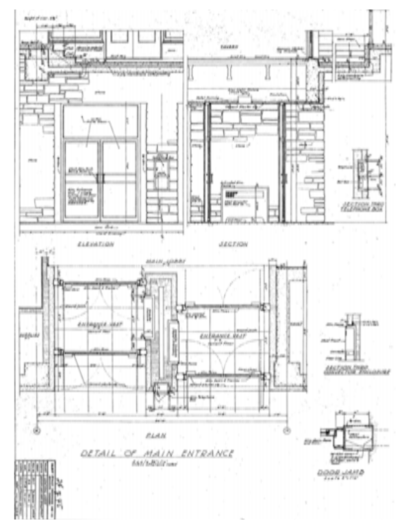
The Central Lodge: Lower Lobby

Elements

- Front entry with staggered and recessed double-leaf doors.
- Convectors on the both entrance vestibules.
- Ashlar masonry veneer on the entry.
- Grand Staircase leading to the Upper Lobby (altered in 1957).
- Telephone booths (relocated on the staircase's right corridor).

Note: See drawing sheet JLLO B-1.6 (Jackson Lake Lodge HSR Part 1) for more information about alterations in the L wer Lobby.





Left: 2015 vi w of the Grand Staircase vs. view ca. 1957.
Right: Underwood's detail of the main entrance. 1953.

JACKSON LAKE LODGE

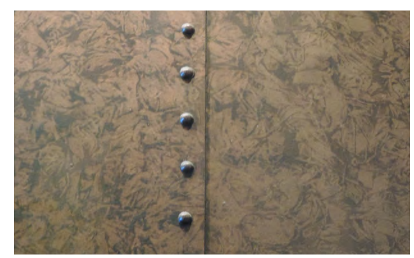
CHARACTER-DEFINING ELEMENTS

The Central Lodge: Upper Lobby 1

Elements

- Visual connection with sho s, Eagle's Nest Gallery and Crow's nest.
- Fireplaces on both eastern corners, including moose-inspired and-irons, hammered steel hood with round head exposed rivets, steel screens, sandstone masonry veneer, and fi e brick masonry.
- Eagle's Nest Gallery with canted balcony and wooden railings (comb end grain)
- Exposed concrete roof trusses.
- The two-story sandstone veneered piers.
- Paintings on the alls.

Note: See drawing sheet JLLO B-1.7 (Jackson Lake Lodge HSR Part 1) for more informatio about alterations in the Uppe Lobby.



Left: 2015 vi w of the Upper Lobby towards the east vs. view ca. 1957.
Right: close-up view of moose-inspired andirons and hammered steel hood and rivets.

JACKSON LAKE LODGE

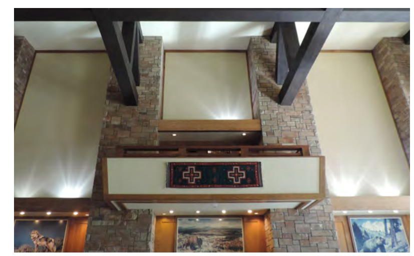
CHARACTER-DEFINING ELEMENTS

The Central Lodge: Upper Lobby 2

Elements

• Canted balcony known as Crow’s Nest and its wooden railings (comb end grain).
• Exposed concrete roof trusses.
• The two-story stone veneered piers.
• Verti ally oriented picture windows that overlook the Teton Range. Even though original windows were replaced and lights and frame proportions esized, muntins r ythm was preserved.
• Acid stained concrete floor onsisting of al ernating squa es of di er-ent colors and marked ground joints.

Note: See drawing sheet JLLO B-1.7 (Jackson Lake Lodge HSR Part 1) for more information about alterations in the Upper Lobby.



Left: 2015 vi w of the Upper Lobby toward the west vs. view ca. 1957.
Right: close-up view of the roof concrete trusses, Crow’s Nest, and acid stained concrete flooring.

JACKSON LAKE LODGE

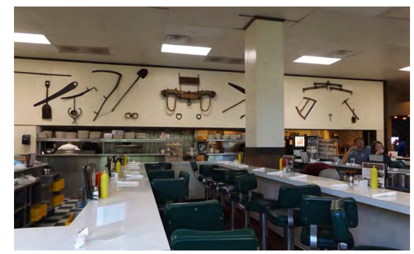
CHARACTER-DEFINING ELEMENTS

The Central Lodge: Pioneer Grill (formerly Fountain Room)

Elements

- Countertop footprint and dinner-style arrangement.
- Shadowood panels covering walls, columns, and counters.
- Seating di tribution. No e: the stool structure is likely original, while the seats appear to be replaced.
- Footrest under the counters.
- Open kitchen area towards the counters. Note: wall tiles and ormi-ca surfaces are likely original (see image on the lower right corner).
- Triparti e windows with louvers. Note: these windows have been replaced, but their configu ation ollows Underwood's design.

Note: See drawing sheet JLLO B-1.8 (Jackson Lake Lodge HSR Part 1) for more informatio about alterations in the Pionee Grill.



Left: 2015 vi w of the Upper Lobby toward the west vs. view ca. 1957.
Right: view of the countertops towards the kitchen, close-up of the footrest, and Pioneer Grill's Dish Room.

JACKSON LAKE LODGE

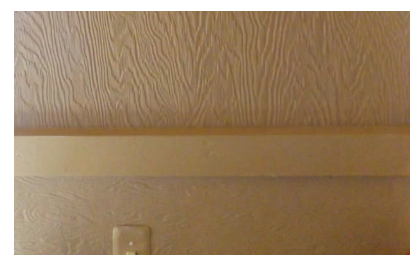
CHARACTER-DEFINING ELEMENTS

The Central Lodge: Mural Room

Elements

- Views of the Teton range.
- Visual relationship with the Pioneer Grill and the Mu al Room East section
- Wall murals.
- Shadowood on interior walls, including their horizontal and verti al pa ern, and waiscot cap.
- Triparti e windows. Note: the muntins a e original, the lovers have been removed.

Note: See drawing sheet JLLO B-1.8 (Jackson Lake Lodge HSR Part 1) for more informatio about alterations in the Mu al Room.



Left: 2015 vi w of the Mural Room toward the Teton Range vs. view ca. 1957. Right: view of the wall murals, a typical window, and close-up view of the shadowood panels.

JACKSON LAKE LODGE

CHARACTER-DEFINING ELEMENTS

Typical Guest Lodge: Exterior

Elements

- One-story structures grouped in di erent lengths with shallow shed roofs (built-up roofin system protected with ballast and metal flashing). The basi unit (a rectangular block of two or four rooms of conventiona wood frame) are deliberately staggered, creating s tbacks and deep eaves.
- Guest Lodges are articul ted through plantings and ootpahts in addition o the street pa ern. (See Cultural Landscape Report)
- Canopy and posts in the access.
- Triple shash windows typically on the higher fronts and double sash windows on the lower fronts. Both types with screens.
- Fascia with beveled lower edge supported by exposed tapered wood ra ers ends.
- Pre-cast concrete foundation
- Wood grain colored textured cement shingles.
- Integrated installation
- Mid-century modern fi tures.

Left: 2015 vi w of a typical guest lodge with porches addition s. view ca. 1957. Right: views of typical higher front, lower front, ice room, and close-up view of mid-century modern light fi ture.

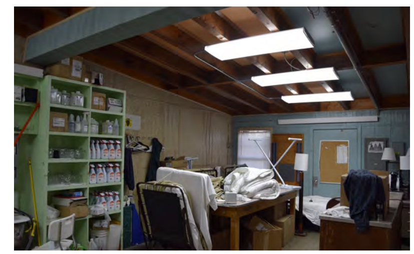
JACKSON LAKE LODGE

CHARACTER-DEFINING ELEMENTS

Typical Guest Lodge: Interior

Elements

- 4” by 12” exposed wood ceiling ra ers as well as the wooden boards in between.
- Exposed insulation boa ds on the ceiling and cover molds.
- Shadowood plywood wall panels and cover molds.
- Triple and double sash windows, including trim.



Left: 2015 vi w of a typical guest room vs. view before 1960.
Above right: view of the housekeeping room in JL-30 (above) the northern shadowood finish is li ely original.
Below right: Entry for 1956 Institution Interiors Award Program with decorati e scheme employed in the guest rooms.

JACKSON LAKE LODGE

CHARACTER-DEFINING ELEMENTS

Typical Employee Dormitory: Exterior

Elements

- One-story rec linear structure of conventional wood frame convered by a shed roof creating deep e ves.
- Double ra er on the building ends.
- Adjoining shed extension for bathrooms.
- Double sash windows with screens.
- Sheltered entryways on both ends.
- Built-up roofing ystem protected with ballast and metal flashing
- Fascia with beveled lower edge suported by exposed tapered wood ra er ends.
- Pre-cast concrete foundation   alls.
- Wood grain colored textured cement shingles.

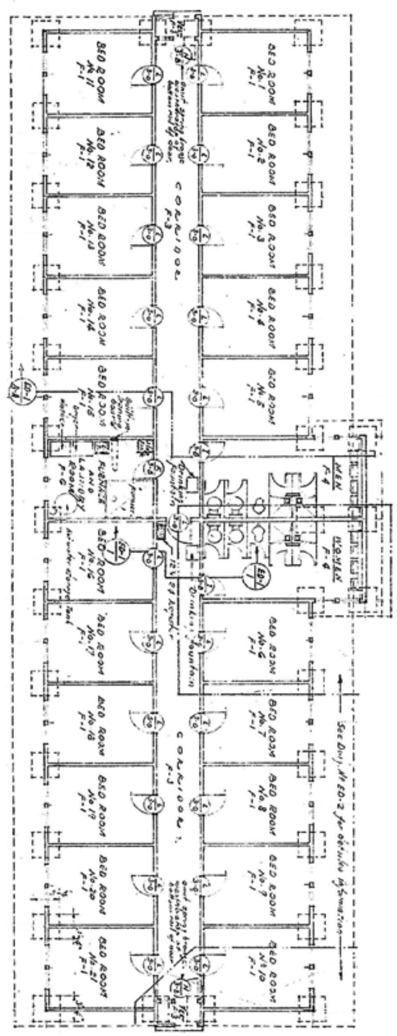
Note: See Underwood's drawing NPS No. NP-GT-1036 or Underwood_EmployeeBuilding_Dorm (1), (2), (3) for original plan, elevations and sections

Left: 2015 vi w of a typical dormitory vs. view ca. 1957.
Right: view of a typical dormitory with adjoining extension, close-up view to the double ra er on the building ends, and typical double sash-window and screens.

JACKSON LAKE LODGE

CHARACTER-DEFINING ELEMENTS

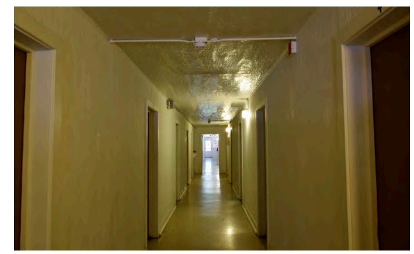
Typical Employee Dormitory: Interior



Elements

- Central corridor serving bed room on both sides.
- Centralized bathrooms for men and women.
- 3” by 12” exposed wood ceiling ra ers as well as the wooden boards in between.
- Exposed insulation boa ds on the bedrooms ceiling and cover molds.
- Shadowood plywood wall panels, cover molds, and baseboard.
- Double sash windows including moldings.
- Metal bathroom partitions and xboard ceilings.
- Resilient flooring

Note: See Underwood’s drawing NPS No. NP-GT-1036 or Underwood_EmployeeBuilding_Dorm (1), (2), (3) for original plan, elevations and sections



Left: ypical layout as designed by Underwood. This is recognizable in dormitories JL-45, JL-47, JL-50, JL-51, and JL-52.
Right: view of the central corridor (above) and metal bathroom partition (below)

CHARACTER-DEFINING ELEMENTS

Typical Staff Housing: Exterior

Elements

• Staff housing is articu   ted through plantings and ootpahts in addition o the street pa   ern. Parking area in front of each unit. (See Cultural Landscape Report)
• One-story structure of conventional   ood frame covered by shed roofs with deep eaves.
• Built-up roofing   ystem protected with ballast and metal flashing.
• Quadruple, double, and single sash windows depending on the function. Quadruple sash   orrespond to the living room.
• Pre-cast concrete foundation   alls.

Note: Unit JL-43 divert from Underwood's design. Building footprints have been enlarged later   . The wood grain textured shingles were replaced. See assessment of integrity in Jackson Lake Lodge HSR Part 2.

Typical Staff Housing: Interior

Elements

• Compatime talized layout.
• 3"x12" exposed ra   ers and wood boards in between.
• Exposed insulation boa ds on the bedrooms ceiling and cover molds.
• Shadowood plywood wall panels and cover molds.
• Venetian blinds (al eady replaced).

Left: S aff Housing Units 2 and 4.   erspecti e view, looking NE.
Right: Unit 2, interior view of living room. Both photographs by Joseph Elliott.

4.2. Master Sample List and Location

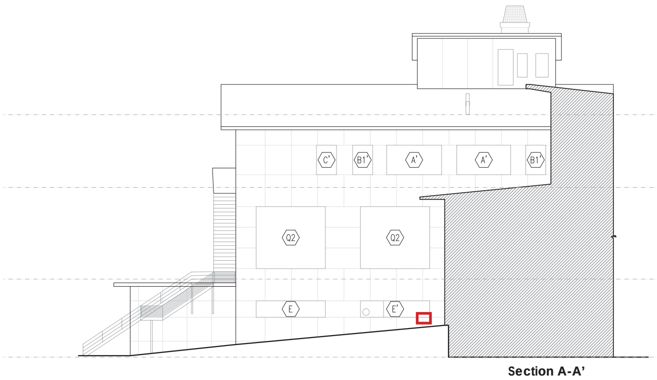
Central Lodge				
Location	**Number**	**Date**	**Sampled By**	**Description**
1	CL#1	7/1/2016	Cesar Bargues	Central Lodge. Northern laundry window (exterior)
1	CL#2	7/1/2016	Nicole Mariel Declet	Central Lodge. Northern laundry window (interior)
2	CL#3	7/1/2016	Araba Prah	Central Lodge. Employee dining room window. South elevation (exterior I)
2	CL#4	7/1/2016	Nicole Mariel Declet	Central Lodge. Employee dining room window. South elevation (exterior II)
2	CL#5	7/1/2016	Nicole Mariel Declet	Central Lodge. Employee dining room. South elevation (interior)
3	CL#6	7/1/2016	Nicole Mariel Declet	Central Lodge. Administrative office at the south of ground lobby (exterior I)
3	CL#7	7/1/2016	Araba Prah	Central Lodge. Administrative office at the south of ground lobby (exterior II)
4	CL#8	7/12/2016	Cesar Bargues	Central Lodge. North elevation. Window exterior
5	CL#9	7/12/2016	Cesar Bargues	Central Lodge. North elevation. Door exterior

Outbuildings

Location	Number	Date	Sampled By	Description
JL-26	GC#1	7/5/2016	Nicole Mariel Declet	Ice room door
JL-26	GC#2	7/5/2016	Cesar Bargues	Ice room door (back)
JL-26	GC#3	7/5/2016	Nicole Mariel Declet	Ice room window sash int. sill
JL-26	GC#4	7/5/2016	Araba Prah	Rafter on west elevation
JL-26	GC#5	7/5/2016	Nicole Mariel Declet	Ice room window sash
JL-26	GC#6	7/5/2016	Nicole Mariel Declet	East elevation. Room 607. Window bottom sash ext.
JL-26	GC#7	7/5/2016	Araba Prah	East elevation. Room 609. Window bottom sash ext.
JL-26	GC#8	7/6/2016	Cesar Bargues	East elevation. Rafter on room 607
JL-26	GC#9	7/7/2016	Nicole Mariel Declet	East elevation. Post on room 609
JL-26	GC#10	7/8/2016	Araba Prah	East elevation. Mullion room 609
JL-45	ED#1	7/14/2016	Araba Prah	Northwest elevation. Window sash. Dorm 3
JL-46	ED#2	7/14/2016	Nicole Declet	Southwest elevation. Rafter. Employee Recreation Hall.

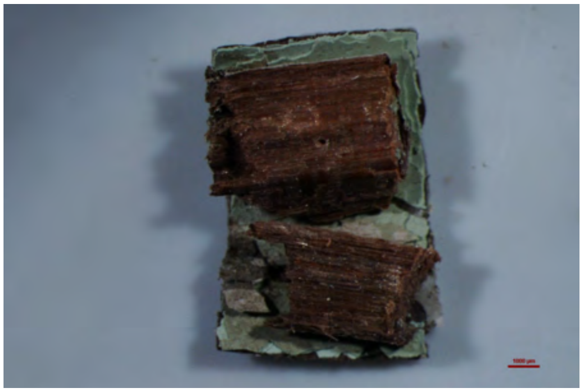
Shingles				
Location	**Number**	**Date**	**Sampled By**	**Description**
JL-45 Dorm 3	SD#1	7/4/2016	Cesar Bargues	"Pinkish" asbetos cement shingle
JL-43	SD#2	7/4/2016	Cesar Bargues	North elevation. Light gray asbestos cement shingle
JL-26	SD#3	7/4/2016	Cesar Bargues	East elevation. Dark gray asbestos cement shingle
JL-47 Dorm 7	SD#4	6/30/2016	GTLC Staff	Autumn brown asbetos cement shingle
JL-28	SD#5	7/1/2016	Cesar Bargues	Light gray asbestos cement shingle
Unknown	SD#6	6/30/2016	GTLC Staff	Light gray asbestos cement shingle
JL-6	AF#1	7/7/2016	Cesar Bargues	Loose asphalt lining collected during the roof assessment

Sample Location for CL1



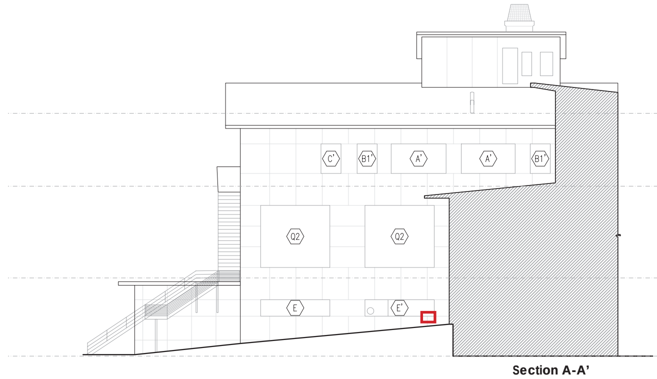
Sampling Metadata	
Sample ID	CL1
Location	Central Lodge.
Sampling date	7/1/2016
Sampled by	Cesar Bargues
Description	North Elevation. Laundry window E' (exterior).

Microscopic Analysis for CL1



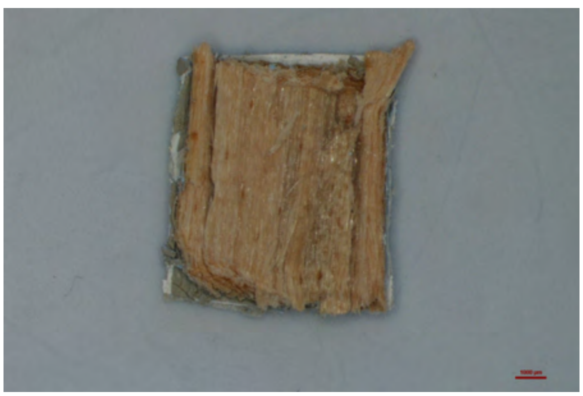
Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Paint side covered in masking tape

Sample Location for CL2



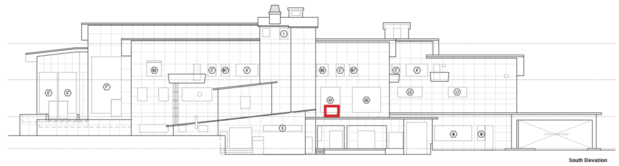
Sampling Metadata	
Sample ID	CL2
Location	Central Lodge.
Sampling date	7/1/2016
Sampled by	Nicole Mariel Declet
Description	Northern laundry window (interior)

Microscopic Analysis for CL2



Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Paint side covered in masking tape

Sample Location for CL3

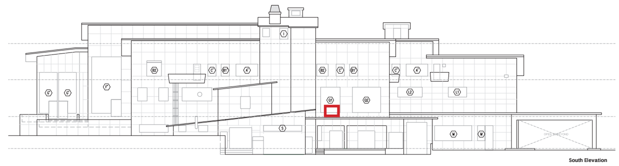


Sampling Metadata	
Sample ID	CL3
Location	Central Lodge.
Sampling date	7/1/2016
Sampled by	Araba Prah
Description	Employee dining room window. South elevation (exterior I)

Microscopic Analysis for CL3

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for CL4

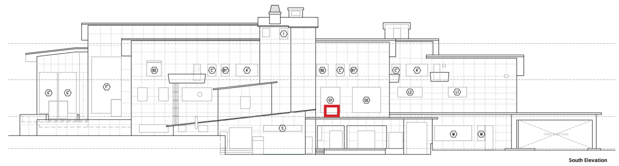


Sampling Metadata	
Sample ID	CL4
Location	Central Lodge.
Sampling date	7/1/2016
Sampled by	Nicole Mariel Declet
Description	Employee dining room window. South elevation (exterior II)

Microscopic Analysis for CL4

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for CL5

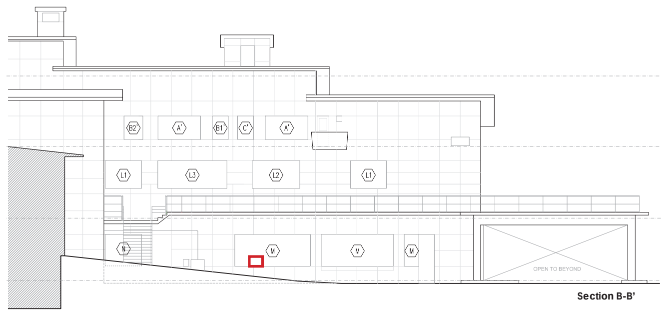


Sampling Metadata	
Sample ID	CL5
Location	Central Lodge.
Sampling date	7/1/2016
Sampled by	Nicole Mariel Declet
Description	Employee dining room. South elevation (interior)

Microscopic Analysis for CL5

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for CL6

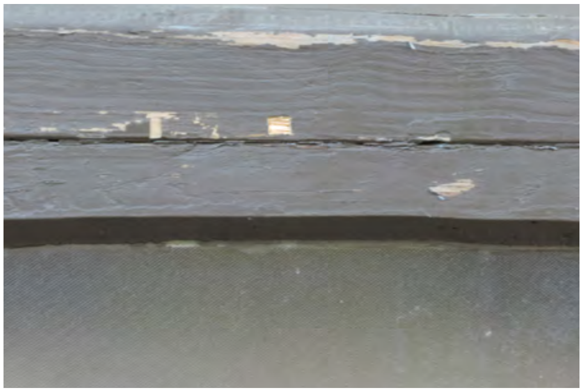


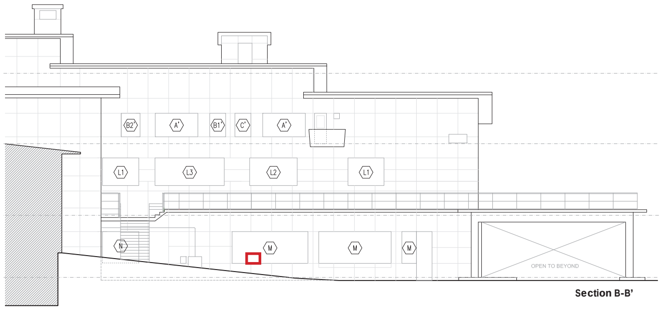
Sampling Metadata	
Sample ID	CL6
Location	Central Lodge.
Sampling date	7/1/2016
Sampled by	Nicole Mariel Declet
Description	Administrative office at the south of ground lobby (exterior I)

Microscopic Analysis for CL6

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

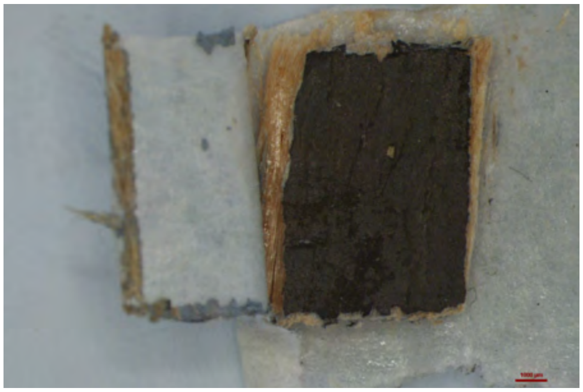
Sample Location for CL7





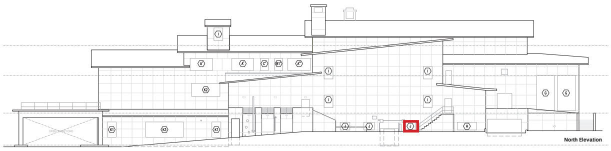
Sampling Metadata	
Sample ID	CL7
Location	Central Lodge.
Sampling date	7/1/2016
Sampled by	Araba Prah
Description	Administrative office at the south of ground lobby (exterior II)

Microscopic Analysis for CL7



Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for CL8

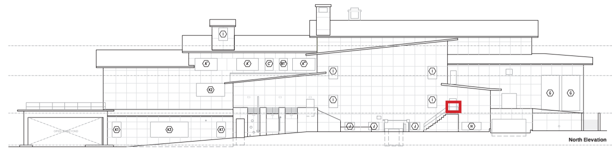


Sampling Metadata	
Sample ID	CL8
Location	Central Lodge
Sampling date	7/12/2016
Sampled by	Cesar Bargues
Description	North elevation. Window exterior

Microscopic Analysis for CL8

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. No maskinig tape

Sample Location for CL9

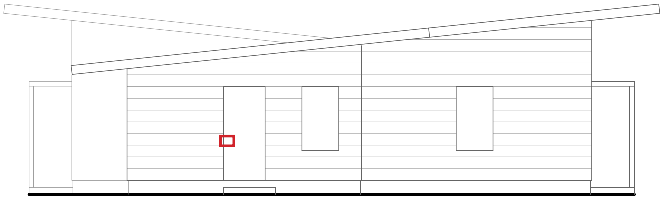


Sampling Metadata	
Sample ID	CL9
Location	Central Lodge.
Sampling date	7/12/2016
Sampled by	Cesar Bargues
Description	North elevation. Door exterior.

Microscopic Analysis for CL9

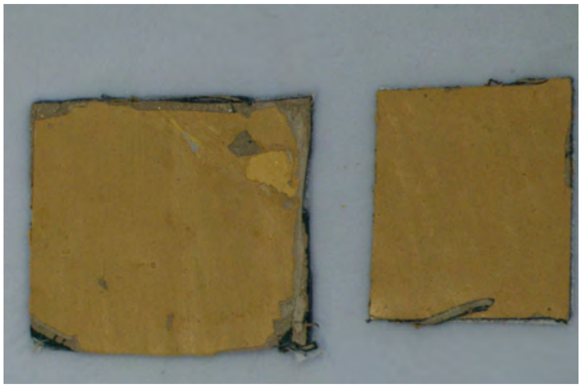
Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Paint side covered in masking tape

Sample Location for GC1



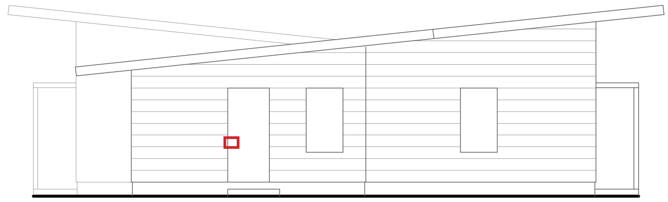
Sampling Metadata	
Sample ID	GC1
Location	JL-26
Sampling date	7/5/2016
Sampled by	Nicole Mariel Declet
Description	Ice room door

Microscopic Analysis for GC1



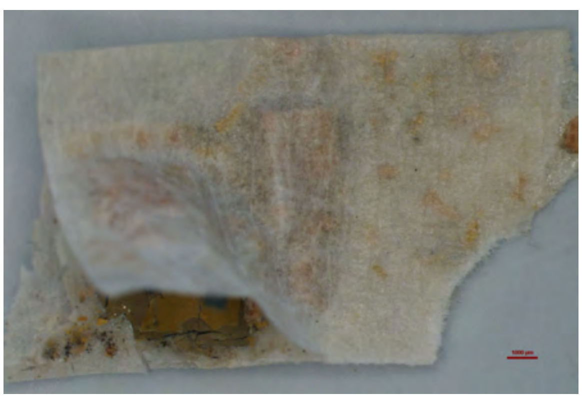
Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Substrate missing. Sample has masking tape on one side.

Sample Location for GC2

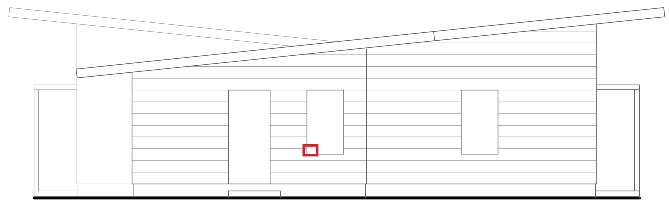
Sampling Metadata	
Sample ID	GC2
Location	JL-26
Sampling date	7/5/2016
Sampled by	Cesar Bargues
Description	Ice room door (back)

Microscopic Analysis for GC2



Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape and very fragmented

Sample Location for GC3

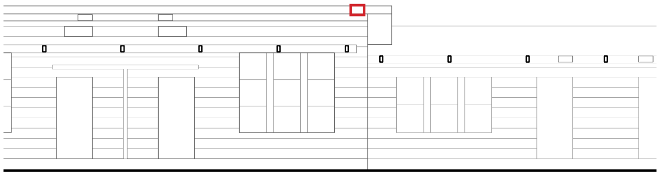



Sampling Metadata	
Sample ID	GC3
Location	JL-26
Sampling date	7/5/2016
Sampled by	Nicole Mariel Declet
Description	Ice room window sash. Interior sill

Microscopic Analysis for GC3

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for GC4

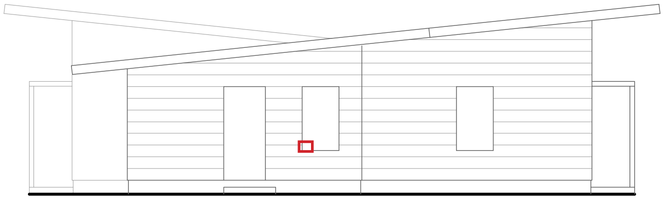


Sampling Metadata	
Sample ID	GC-4
Location	JL-26
Sampling date	7/5/2016
Sampled by	Araba Prah
Description	Rafter on west elevation

Microscopic Analysis for GC4

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for GC5

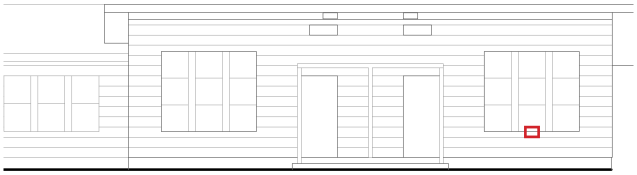


Sampling Metadata	
Sample ID	GC5
Location	JL-26
Sampling date	7/5/2016
Sampled by	Nicole Mariel Declet
Description	Ice room window sash

Microscopic Analysis for GC5

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for GC6

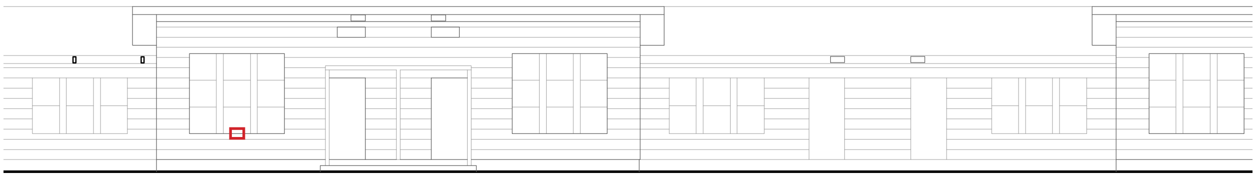


Sampling Metadata	
Sample ID	GC6
Location	JL-26
Sampling date	7/5/2016
Sampled by	Nicole Mariel Declet
Description	East elevation. Room 607. Window bottom sash exterior

Microscopic Analysis for GC6

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for GC7

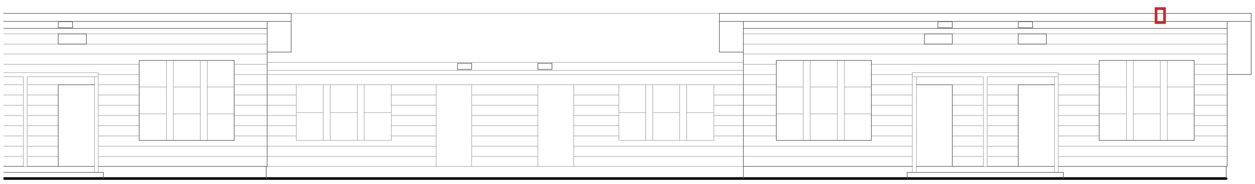


Sampling Metadata	
Sample ID	GC7
Location	JL-26
Sampling date	7/5/2016
Sampled by	Araba Prah
Description	East elevation. Room 609. Window bottom sash exterior.

Microscopic Analysis for GC7

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape.

Sample Location for GC8

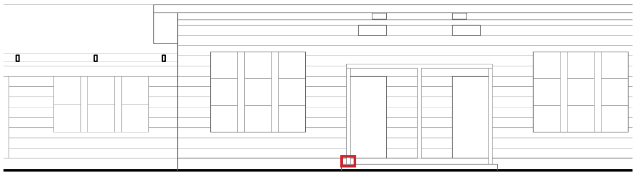


Sampling Metadata	
Sample ID	GC8
Location	JL-26
Sampling date	7/6/2016
Sampled by	Cesar Bargues
Description	East elevation. Rafter on room 607

Microscopic Analysis for GC8

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample has masking tape on face side.

Sample Location for GC9

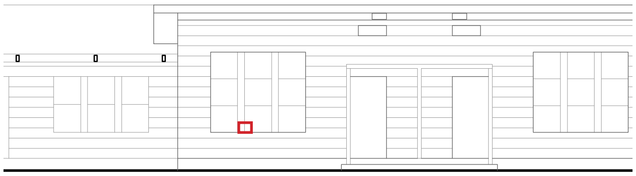


Sampling Metadata	
Sample ID	GC9
Location	JL-26
Sampling date	7/7/2016
Sampled by	Nicole Mariel Declet
Description	East elevation. Post on room 609

Microscopic Analysis for GC9

Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample wrapped in masking tape

Sample Location for GC10

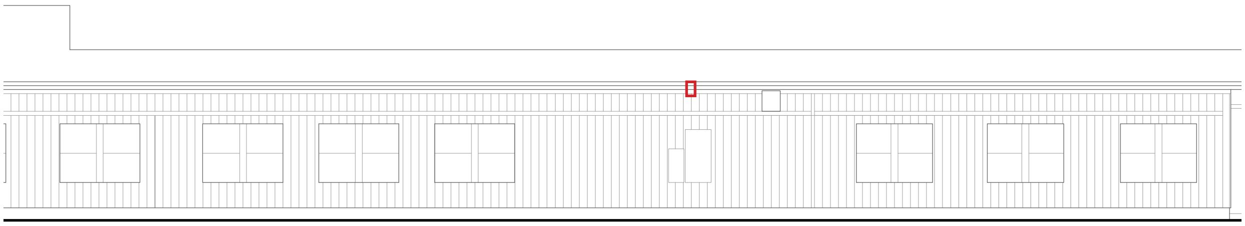


Sampling Metadata	
Sample ID	GC10
Location	JL-26
Sampling date	7/8/2016
Sampled by	Araba Prah
Description	East elevation. Mullion room 609

Microscopic Analysis for GC10

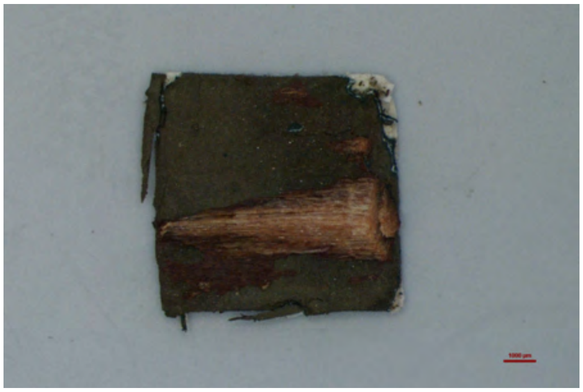
Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample has masking tape on face side.

Sample Location for ED1



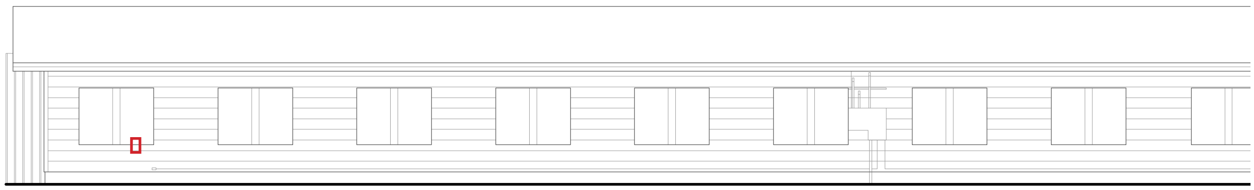
Sampling Metadata	
Sample ID	ED1
Location	JL-46
Sampling date	7/14/2016
Sampled by	Araba Prah
Description	Southwest elevation. Rafter. Employee Recreation Hall.

Microscopic Analysis for ED1



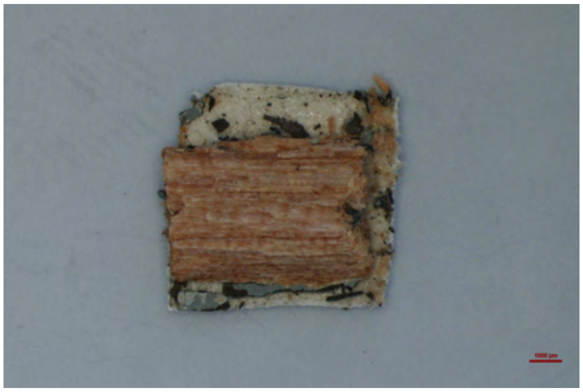
Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample has masking tape on face side.

Sample Location for ED2



Sampling Metadata	
Sample ID	ED2
Location	JL-45
Sampling date	7/14/2016
Sampled by	Nicole Declet
Description	Northwest elevation. Window sash.

Microscopic Analysis for ED2

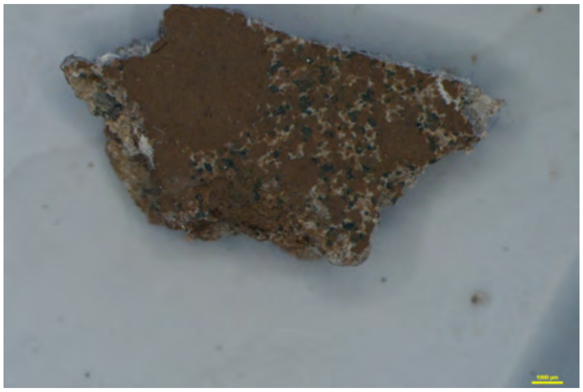


Microscopy Metadata	
Examination date	10/25/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Wood substrate. Sample has masking tape on face side.

Sample Location for SD1

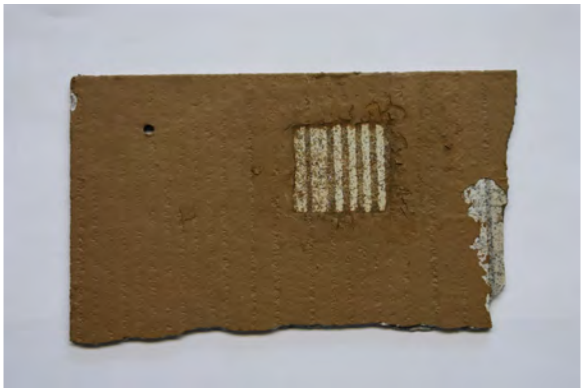
Sampling Metadata	
Sample ID	SD1
Location	JL-45
Sampling date	7/4/2016
Sampled by	Cesar Bargues
Description	"Pinkish" asbetos cement shingle

Microscopic Analysis for SD1



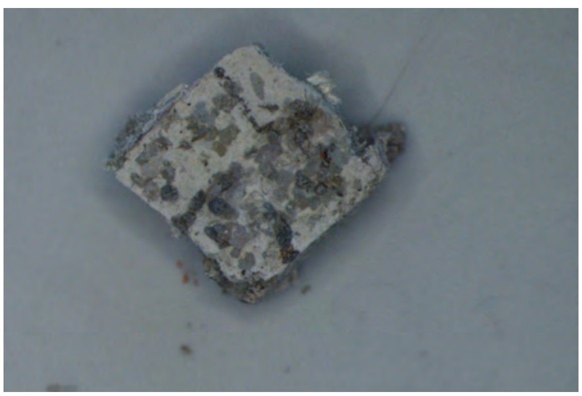
Microscopy Metadata	
Examination date	11/04/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Brown aggregates on a pink surface

Sample Location for SD2



Sampling Metadata	
Sample ID	SD2
Location	JL-43
Sampling date	7/4/2016
Sampled by	Cesar Bargues
Description	North elevation. Light gray asbestos cement shingle

Microscopic Analysis for SD2

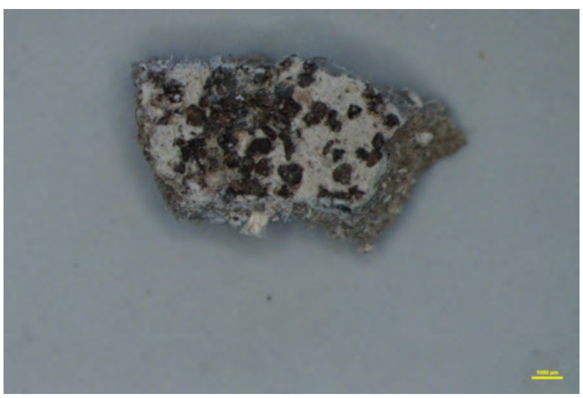


Microscopy Metadata	
Examination date	11/04/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. 2-3 shades of gray aggregates on a white matrix.

Sample Location for SD3

Sampling Metadata	
Sample ID	SD3
Location	JL-26
Sampling date	7/4/2016
Sampled by	Cesar Bargues
Description	East elevation. Dark gray asbestos cement shingle

Microscopic Analysis for SD3

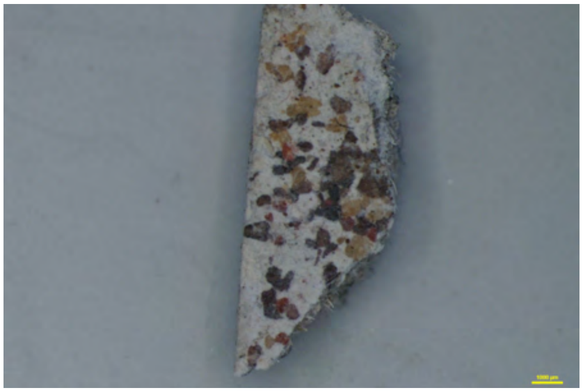


Microscopy Metadata	
Examination date	11/04/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. 2 shades of dark gray aggregates.

Sample Location for SD4

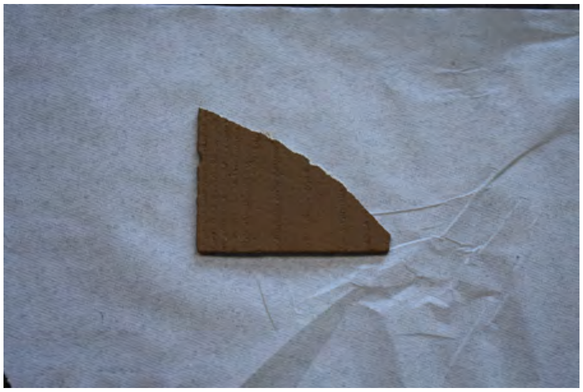
Sampling Metadata	
Sample ID	SD4
Location	JL-47
Sampling date	6/30/2016
Sampled by	GTLC Staff
Description	Autumn brown asbestos cement shingle.

Microscopic Analysis for SD4



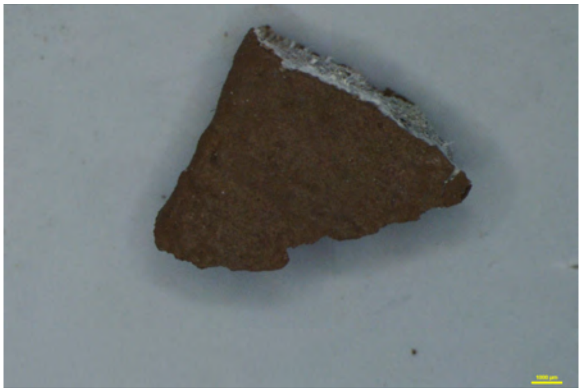
Microscopy Metadata	
Examination date	11/04/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Tan, red, brown, and gray aggregates on a white matrix

Sample Location for SD5



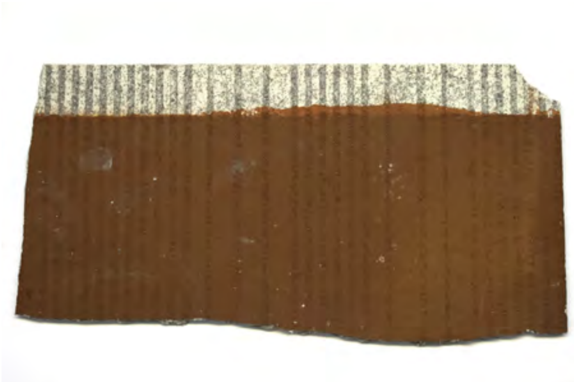
Sampling Metadata	
Sample ID	SD5
Location	JL-28
Sampling date	7/1/2016
Sampled by	Cesar Bargues
Description	Light gray asbestos cement shingle

Microscopic Analysis for SD5



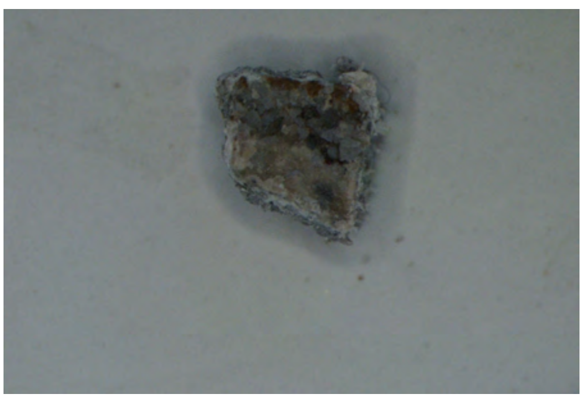
Microscopy Metadata	
Examination date	11/04/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. Face and back covered with brown paint.

Sample Location for SD6



Sampling Metadata	
Sample ID	SD6
Location	Unknown
Sampling date	6/30/2016
Sampled by	GTLC Staff
Description	Light gray asbestos cement shingle

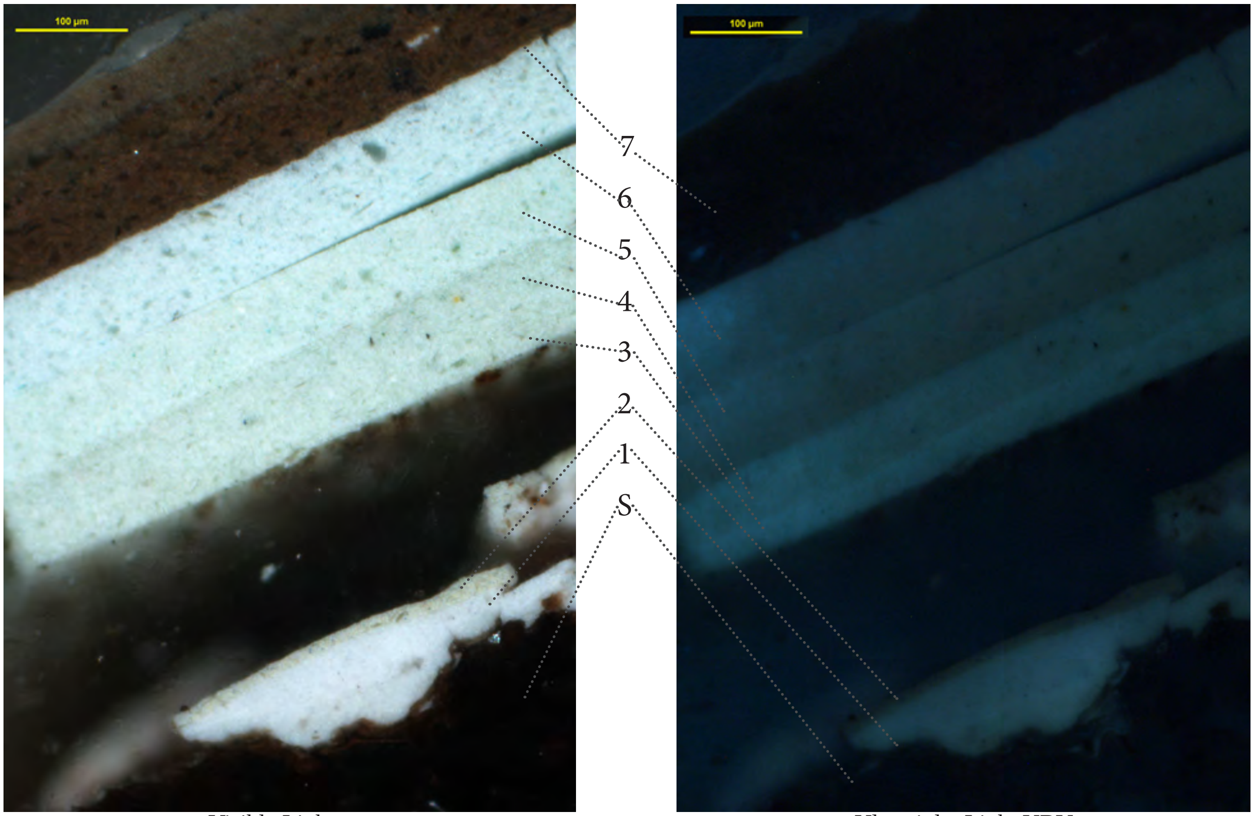
Microscopic Analysis for SD6



Microscopy Metadata	
Examination date	11/04/2016
Analyzed by	Araba Prah
Microscope	Leica M216
Description	Magnification: 2X. 2-3 shades of gray aggregates on a white matrix

4.3. Cross-Section Microphotograph Datasheets

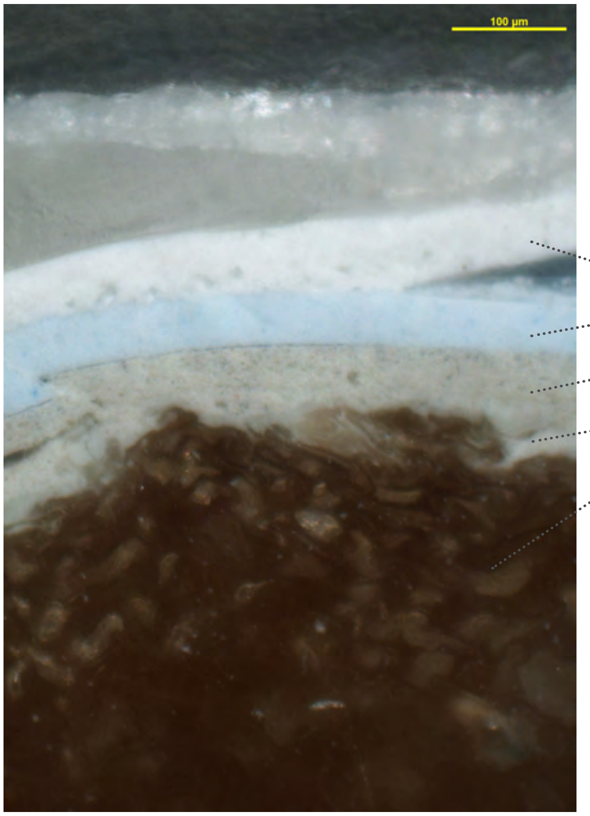
Architectural Finishes Analysis of CL1



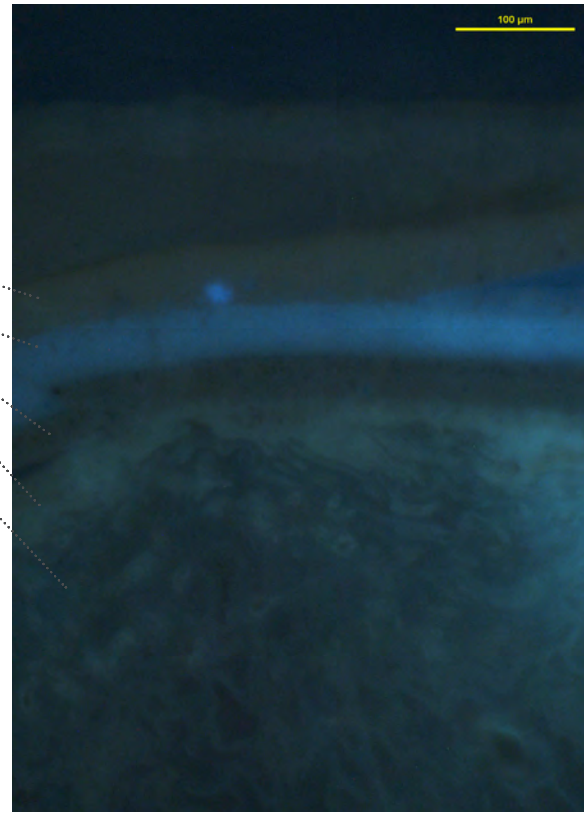
Visible Light — Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Analysis Date
Central Lodge. North Elevation. Laundry window E' (exterior).	Cesar Bargues	7/1/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	Pale yellow green coating			
Layer 3	Pale yellow green coating			
Layer 4	Pale yellow green coating			
Layer 5	Pale yellow green coating			
Layer 6	White coating			
Layer 7	Brown coating			

Architectural Finishes Analysis of CL2



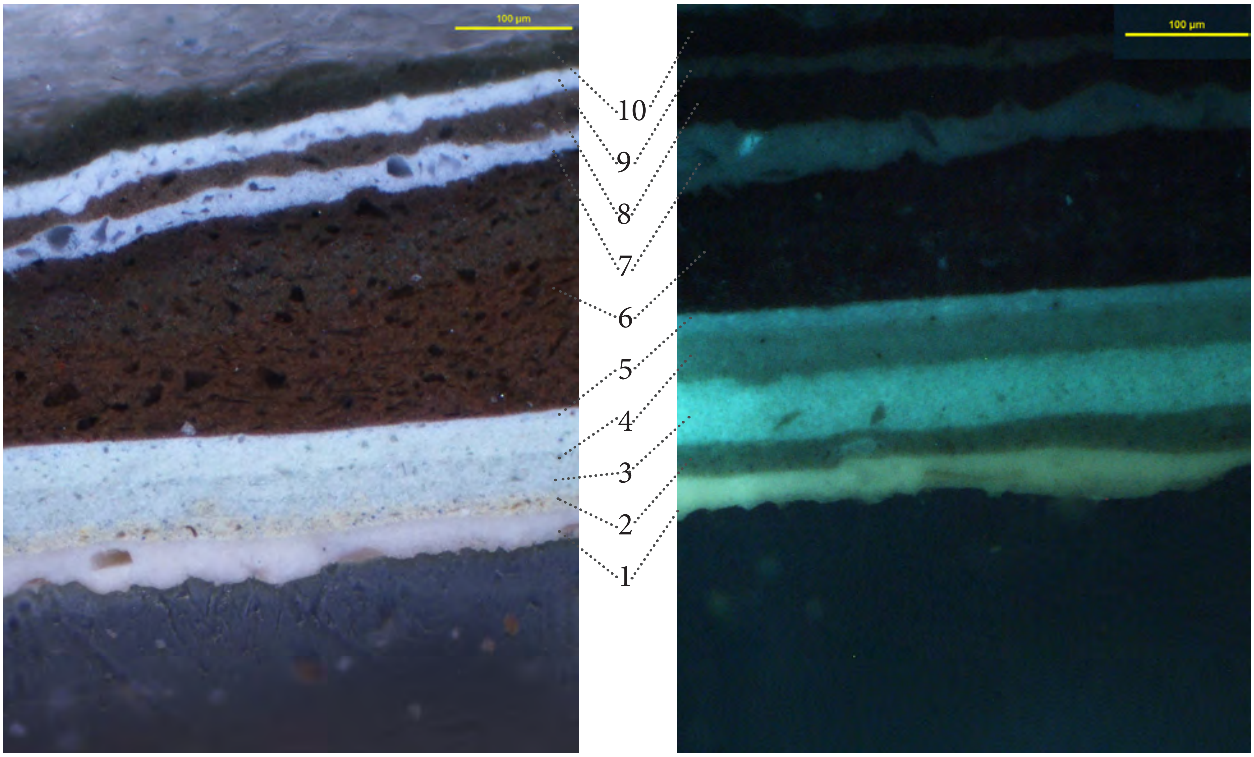
Visible Light



Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Analysis Date
Central Lodge. North Elevation. Laundry window E' (interior).	Nicole M. Declet	7/1/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	Beige/gray coating			
Layer 3	Light blue coating			
Layer 4	White coating			

Architectural Finishes Analysis of CL3

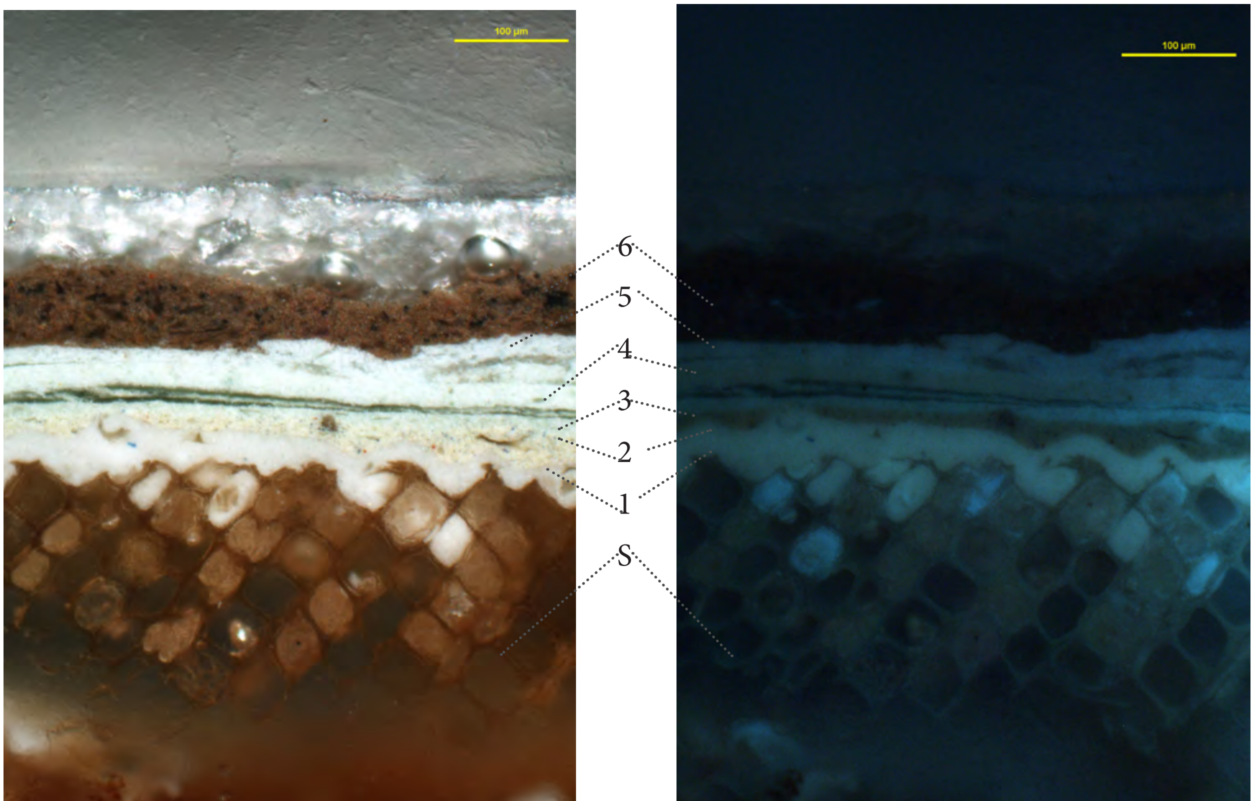


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Central Lodge. South elevation. Employee dining room window Q1 (exterior).	Araba Prah	7/1/2015	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood (outside frame)			
Layer 1	White primer coating			
Layer 2	Yellow green coating			
Layer 3	Light blue coating			
Layer 4	Light white blue coating			
Layer 5	Light white blue coating			
Layer 6	Brown green coating			
Layer 7	White coating			
Layer 8	Brown coating			
Layer 9	White coating			
Layer 10	Brown coating			

Architectural Finishes Analysis of CL4

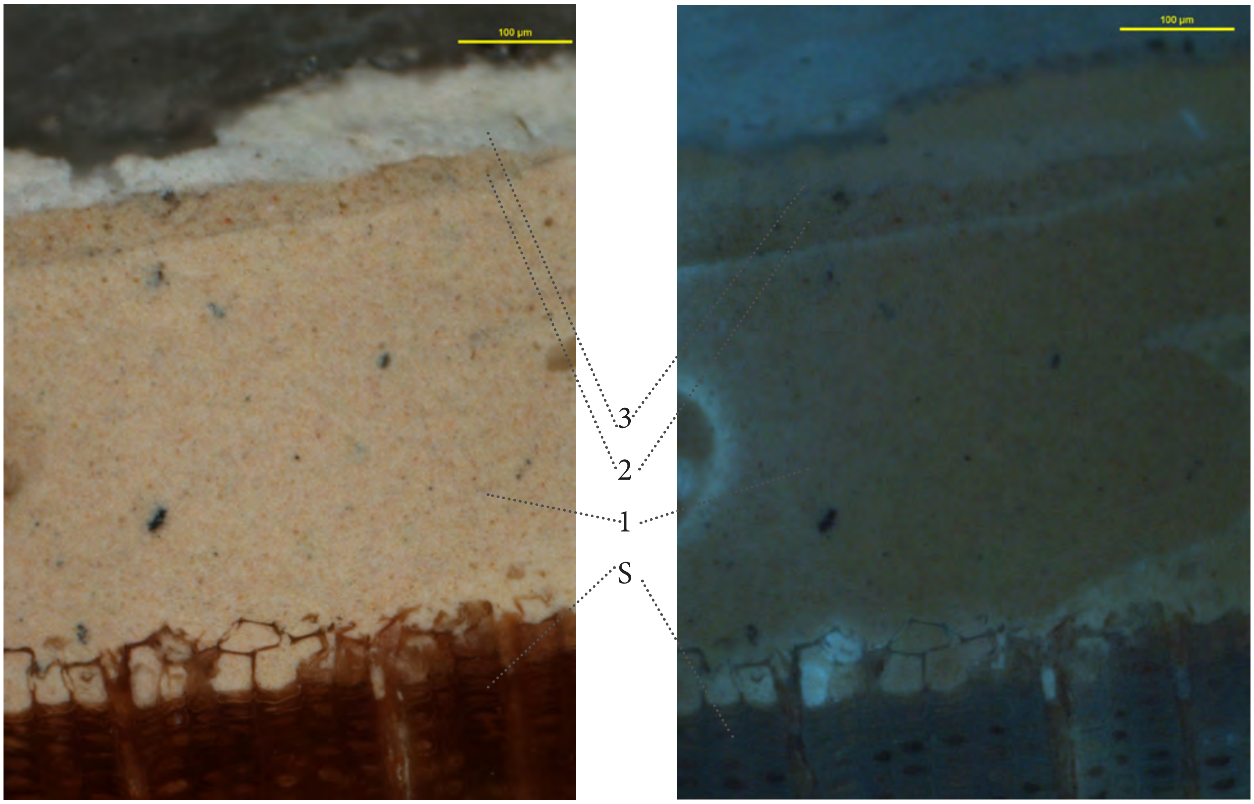


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Analysis Date
Central Lodge. South elevation. Employee dining room window Q1 (exterior).	Nicole M. Declet	7/1/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	Yellow green coating			
Layer 3	Light blue coating			
Layer 4	Light white blue coating			
Layer 5	Light white blue coating			
Layer 6	Brown coating			

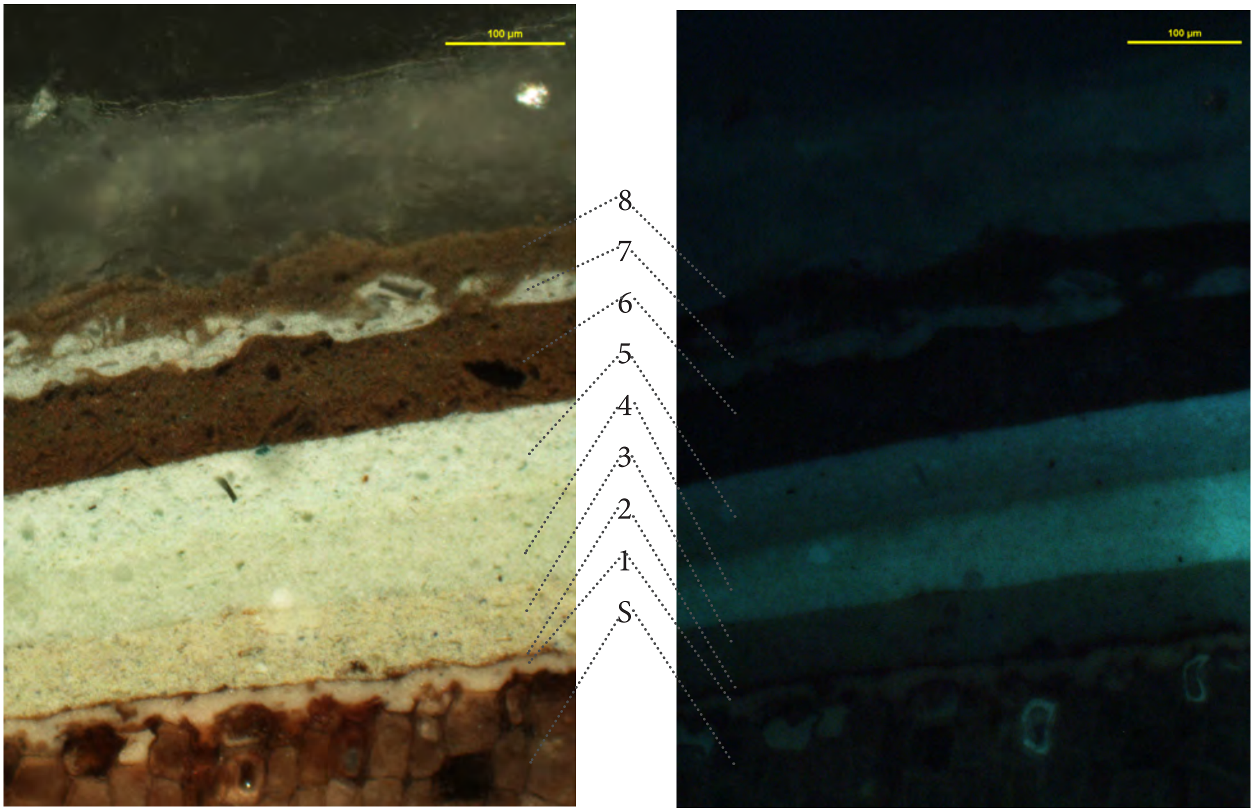
Architectural Finishes Analysis of CL5



Visible Light | Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Analysis Date
Central Lodge. South elevation. Employee dining room window Q1 (interior).	Nicole M. Declet	7/1/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	Cream coating			
Layer 2	Darker cream coating			
Layer 3	Light blue/grey coating			

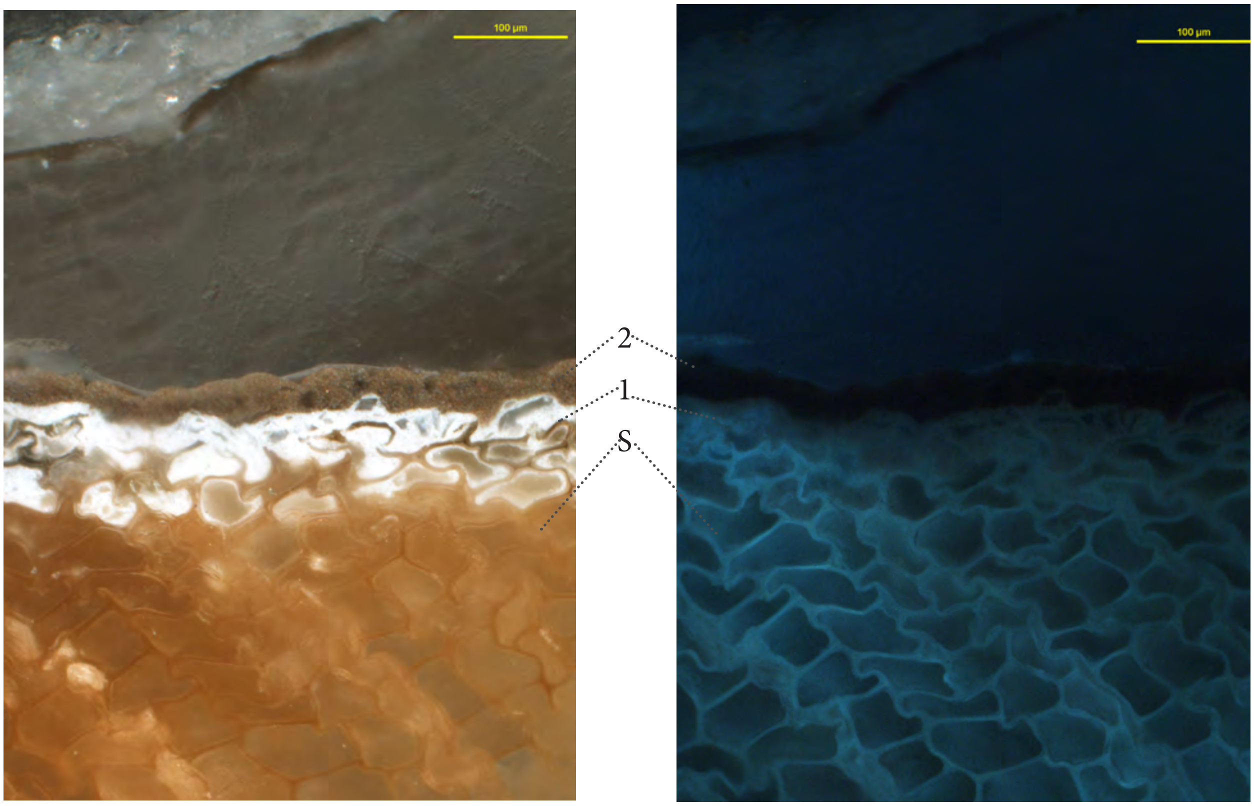
Architectural Finishes Analysis of CL6



Visible Light   Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Analysis Date
Central Lodge. South elevation. Adminis-trative ground lobby. Window M (exterior).	Nicole M. Declet	7/1/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	Light pink coating			
Layer 2	Dirt/soiling			
Layer 3	Pale yellow green coating			
Layer 4	Pale yellow green coating			
Layer 5	White coating			
Layer 6	Brown coating			
Layer 7	White coating			
Layer 8	Brown coating			

Architectural Finishes Analysis of CL7

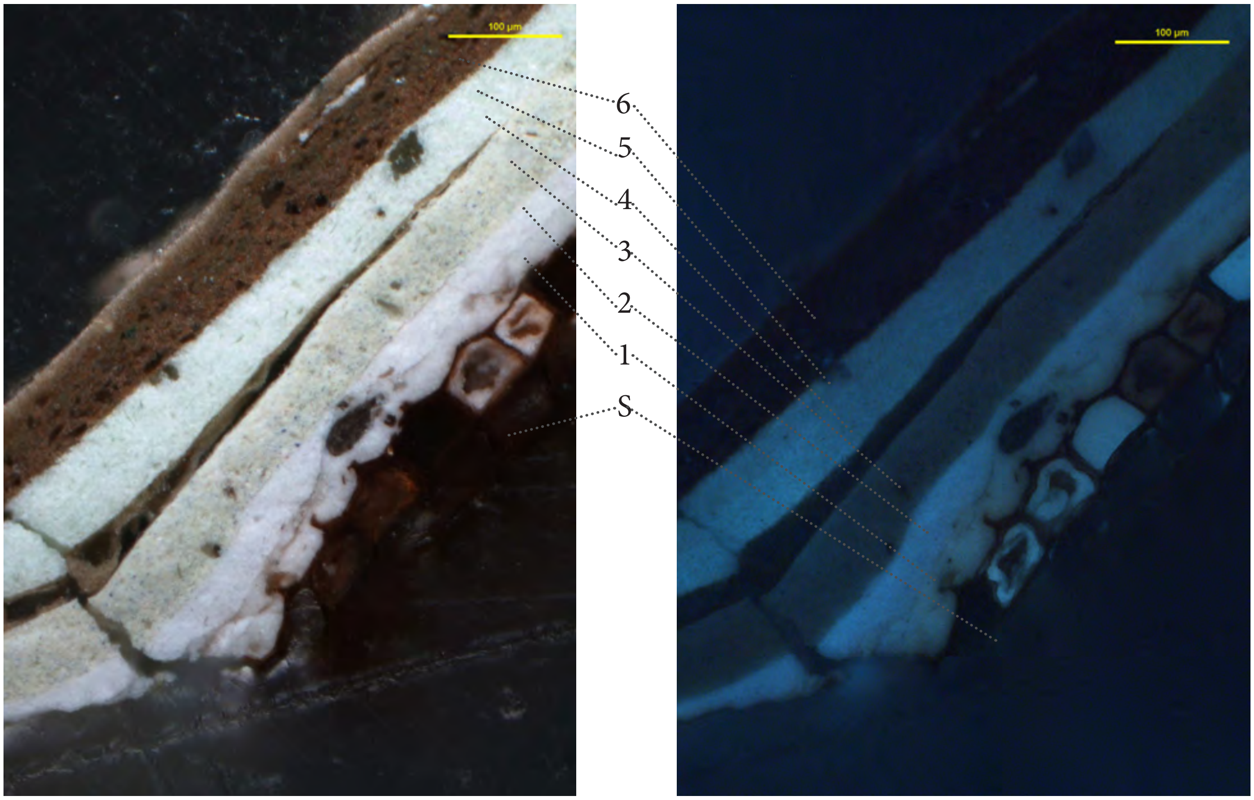


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Analysis Date
Central Lodge. South elevation. Adminis-trative ground lobby. Window M (exterior).	Araba Prah	7/1/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	Brown coating			

Architectural Finishes Analysis of CL8

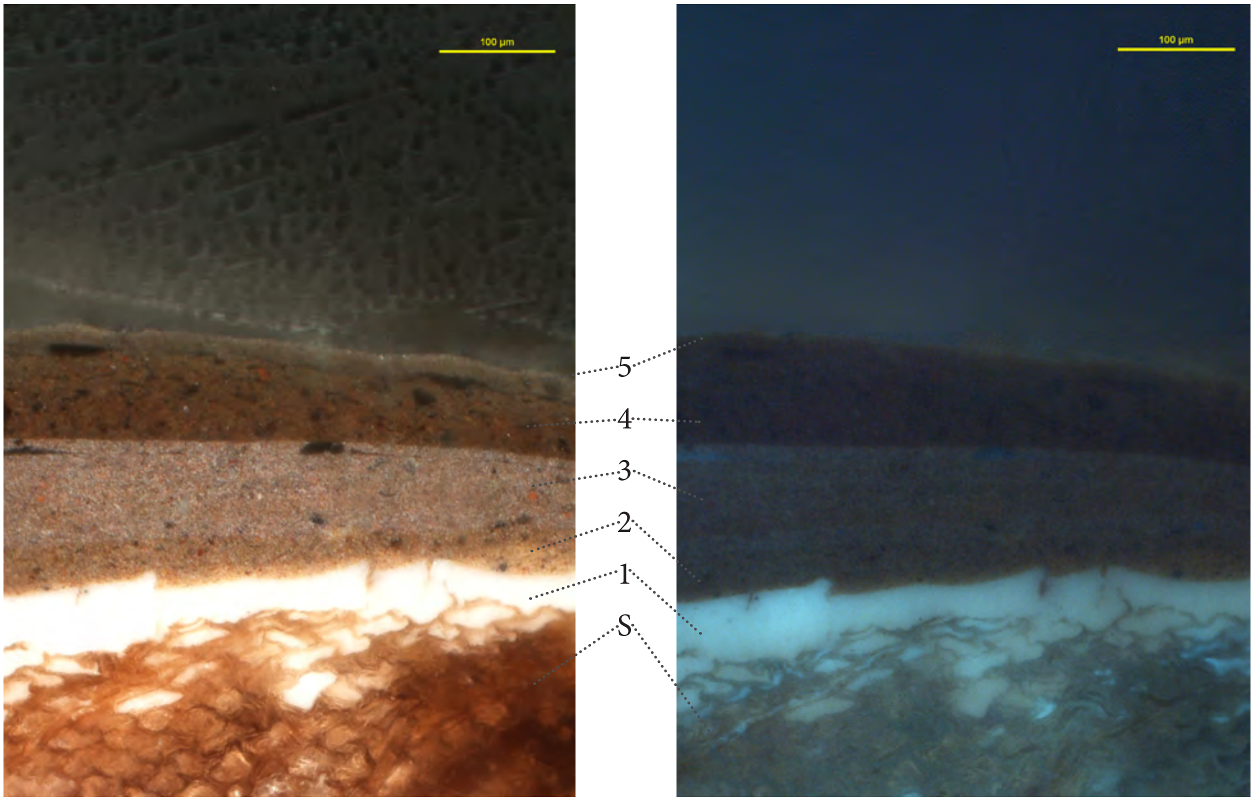


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Analysis Date
Central Lodge. North Elevation. Window J.	Cesar Bargues	7/1/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	White coating			
Layer 3	Pale yellow green coating			
Layer 4	Pale yellow green coating			
Layer 5	White coating			
Layer 6	Brown coating			

Architectural Finishes Analysis of CL9

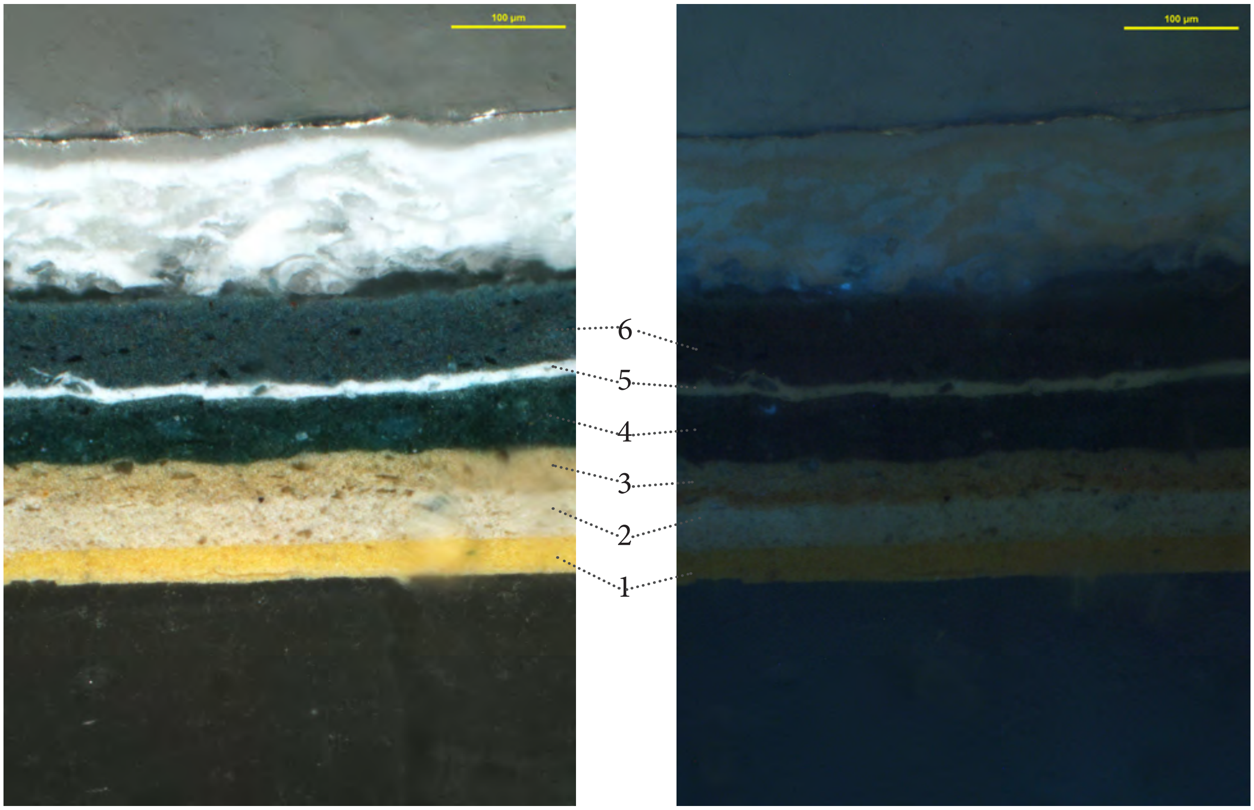


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Analysis Date
Central Lodge. North elevation. Wooden door on right side. Exterior.	Cesar Bargues	7/1/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	Brown coating			
Layer 3	Light brown coating			
Layer 4	Brown coating			
Layer 5	Light brown coating			

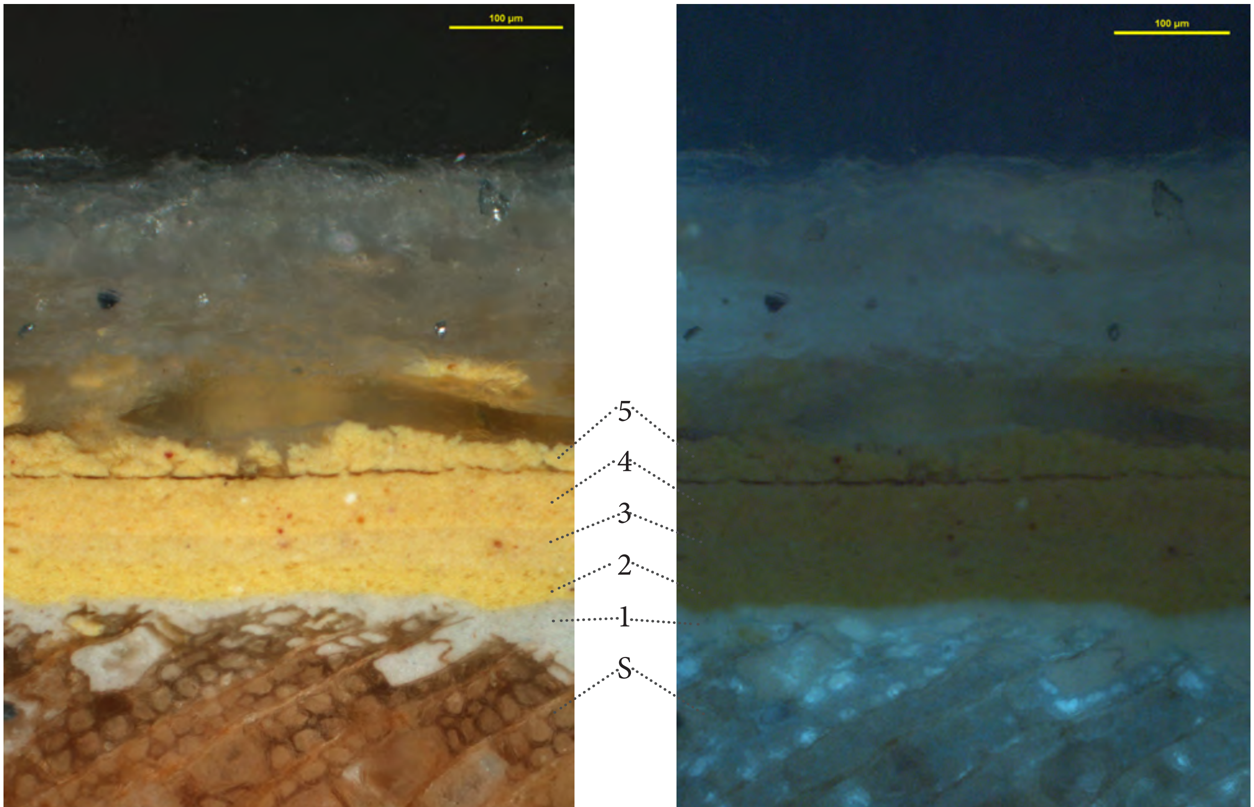
Architectural Finishes Analysis of GC1



Visible Light Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. South elevation. Ice room door.	Nicole M. Declet	7/5/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood, white primer missing, and first yellow coating missing			
Layer 1	Yellow coating			
Layer 2	Cream coating			
Layer 3	Beige coating			
Layer 4	Green coating			
Layer 5	White coating			
Layer 6	Green coating			

Architectural Finishes Analysis of GC2

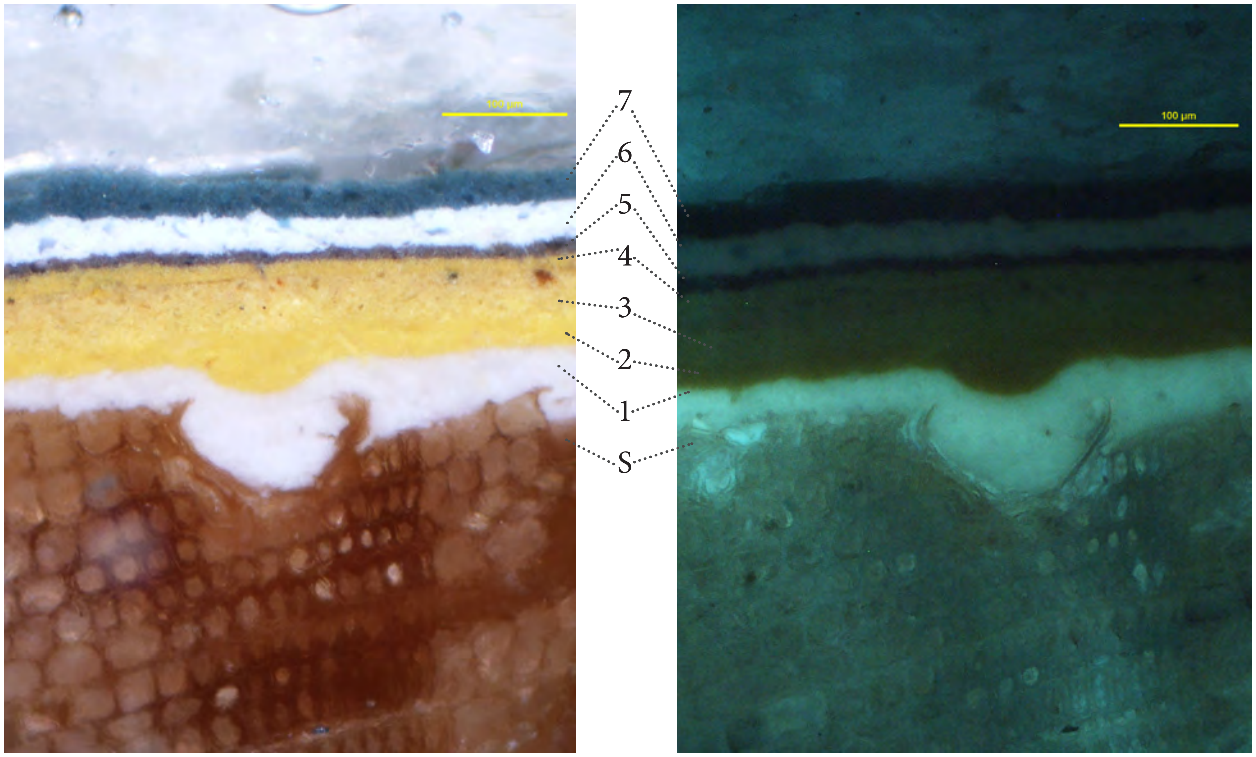


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. South elevation. Ice room door.	Cesar Bargues	7/5/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	Yellow coating			
Layer 3	Yellow coating			
Layer 4	Yellow coating			
Layer 5	Yellow coating			

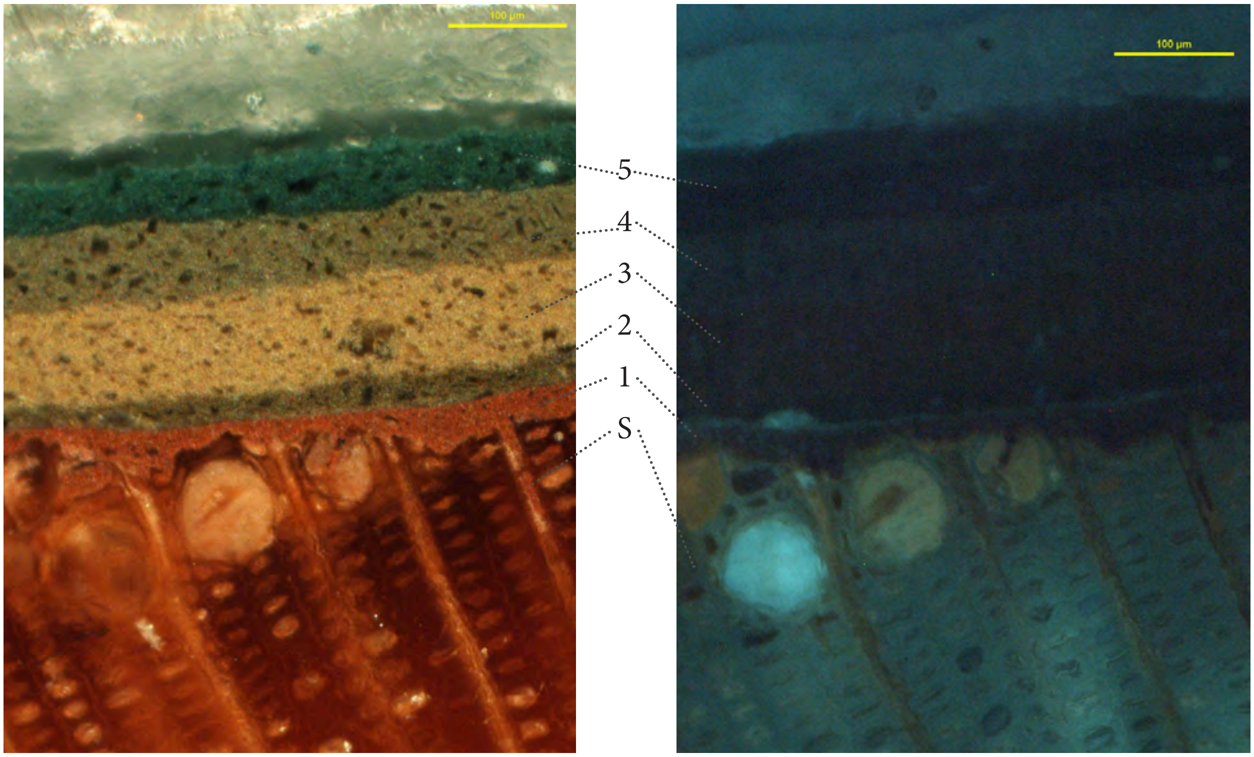
Architectural Finishes Analysis of GC3



Visible Light | Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26 Ice room window sash	Nicole M. Declet	7/5/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer (possibly House Paint Exterior Primer as mentioned in specs)			
Layer 2	Yellow coating			
Layer 3	Yellow coating 2			
Layer 4	Yellow coating 3			
Layer 5	Dirt accumulated			
Layer 6	White coating (possibly primer)			
Layer 7	Blue green coating			

Architectural Finishes Analysis of GC4

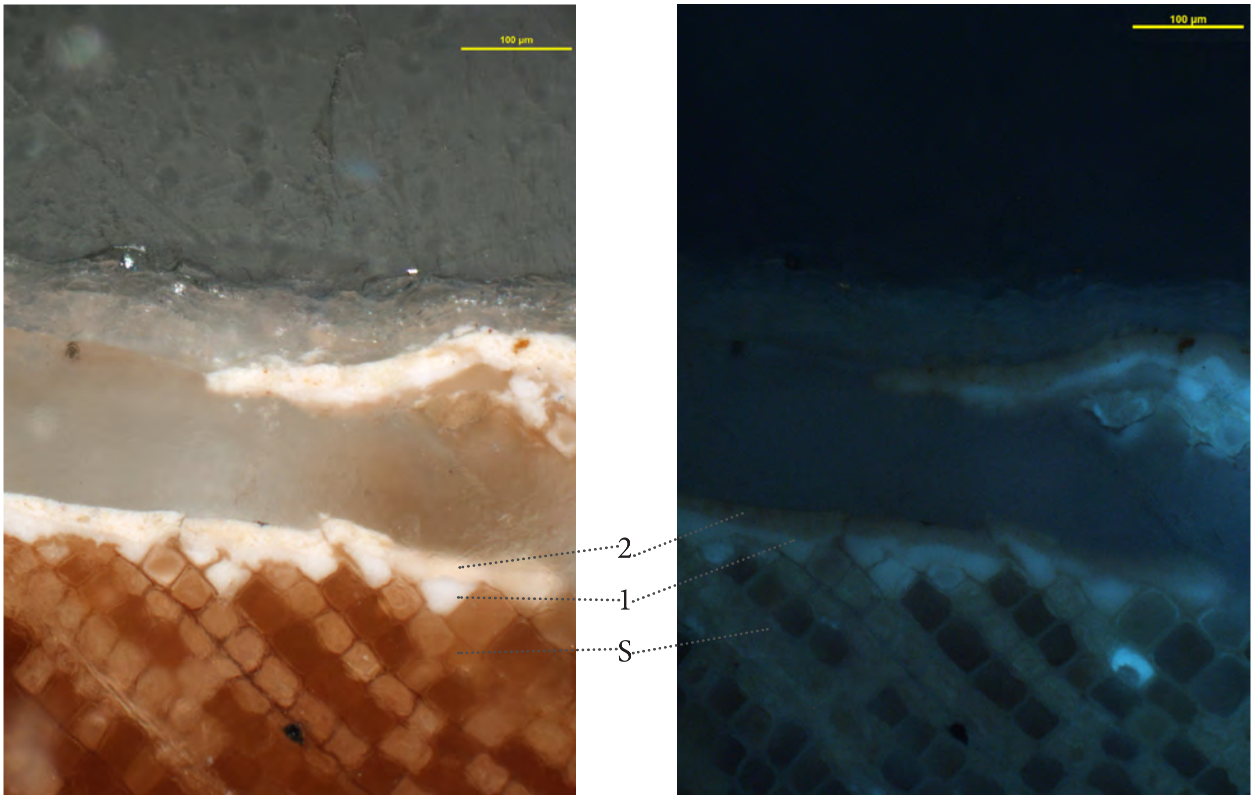


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. Rafter on west eleva-tion.	Araba Prah	7/5/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	Reddish brown stain			
Layer 2	Brown green coating			
Layer 3	Light brown coating			
Layer 4	Brown green coating			
Layer 5	Blue green coating			

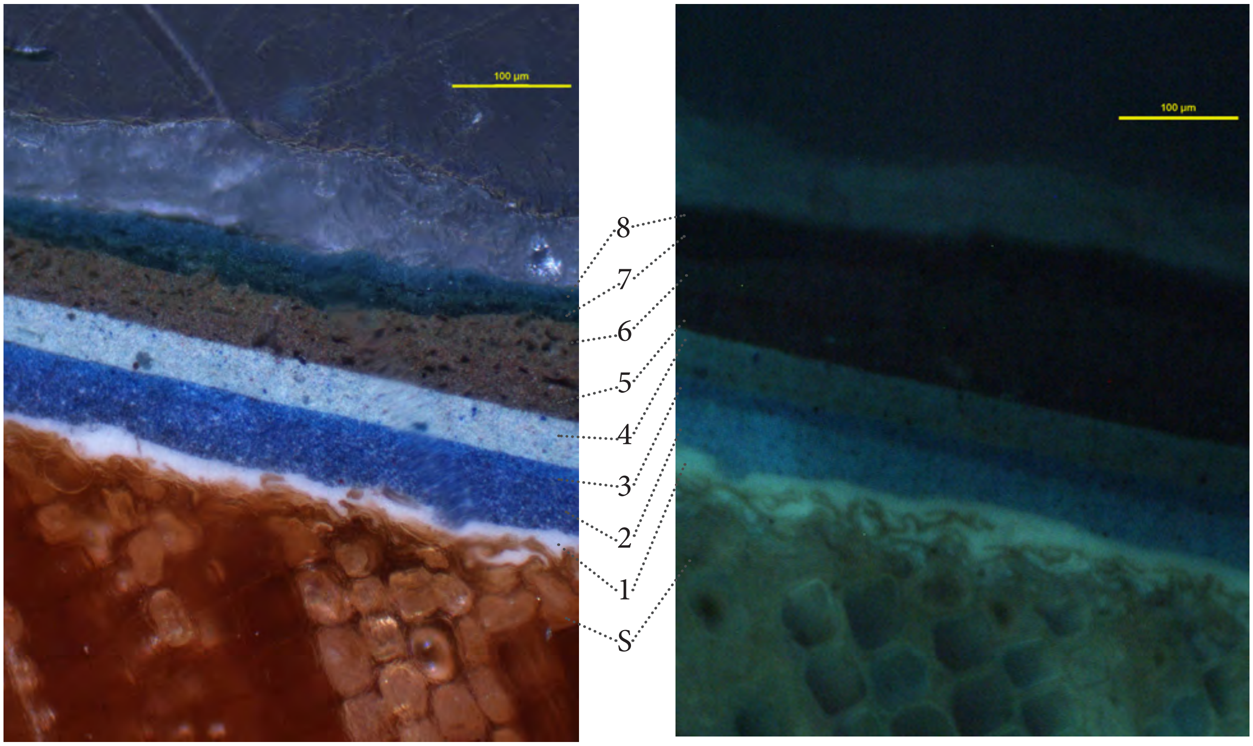
Architectural Finishes Analysis of GC5



Visible Light Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. East elevation. Room 607. Window bottom sash interior.	Araba Prah	7/5/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer			
Layer 2	Cream coating			

Architectural Finishes Analysis of GC6

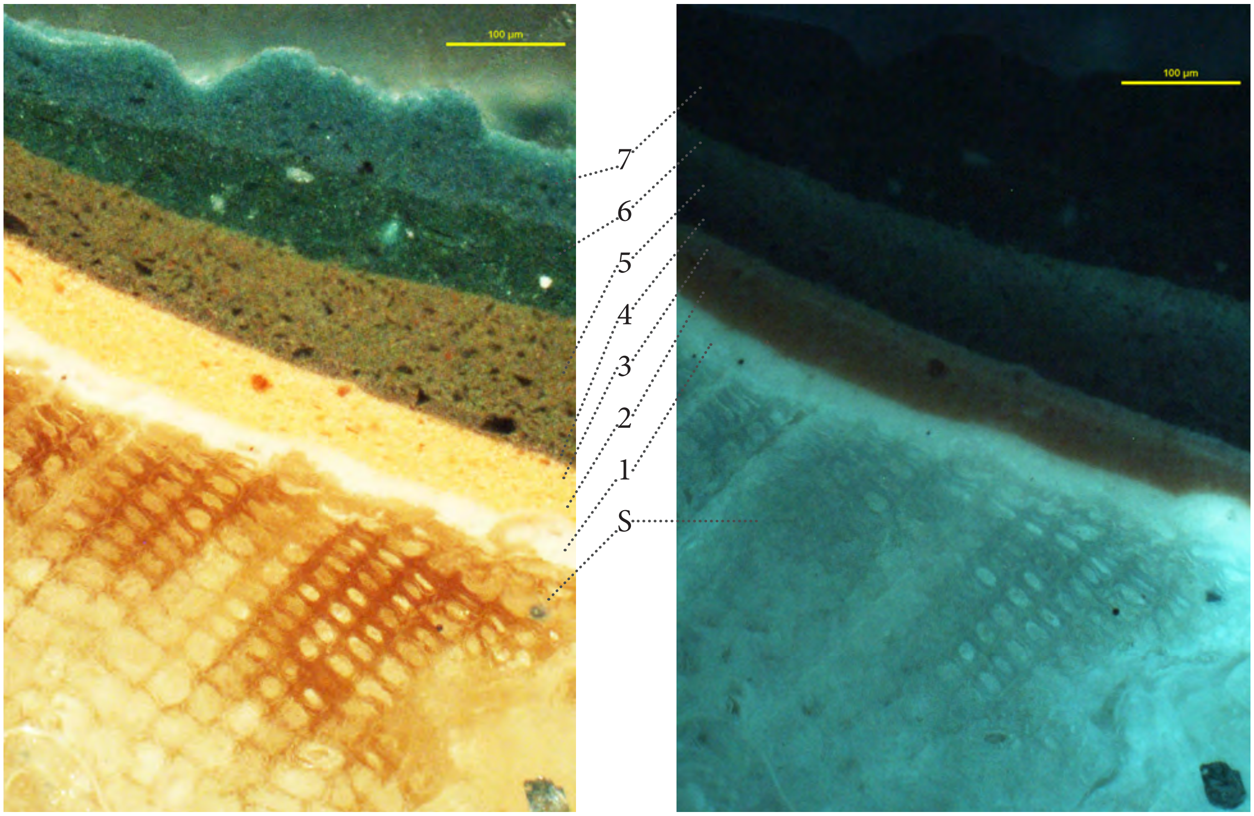


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. East elevation. Room 607. Window bottom sash exterior.	Nicole M. Declet	7/5/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer (possibly House Paint Exterior Primer as mentioned in specs)			
Layer 2	Purple ultramarine blue coating			
Layer 3	Ultramarine blue coating			
Layer 4	Light blue coating			
Layer 5	Brown green coating			
Layer 6	Brown green coting			
Layer 7	Dark green coating			
Layer 8	Blue green coating			

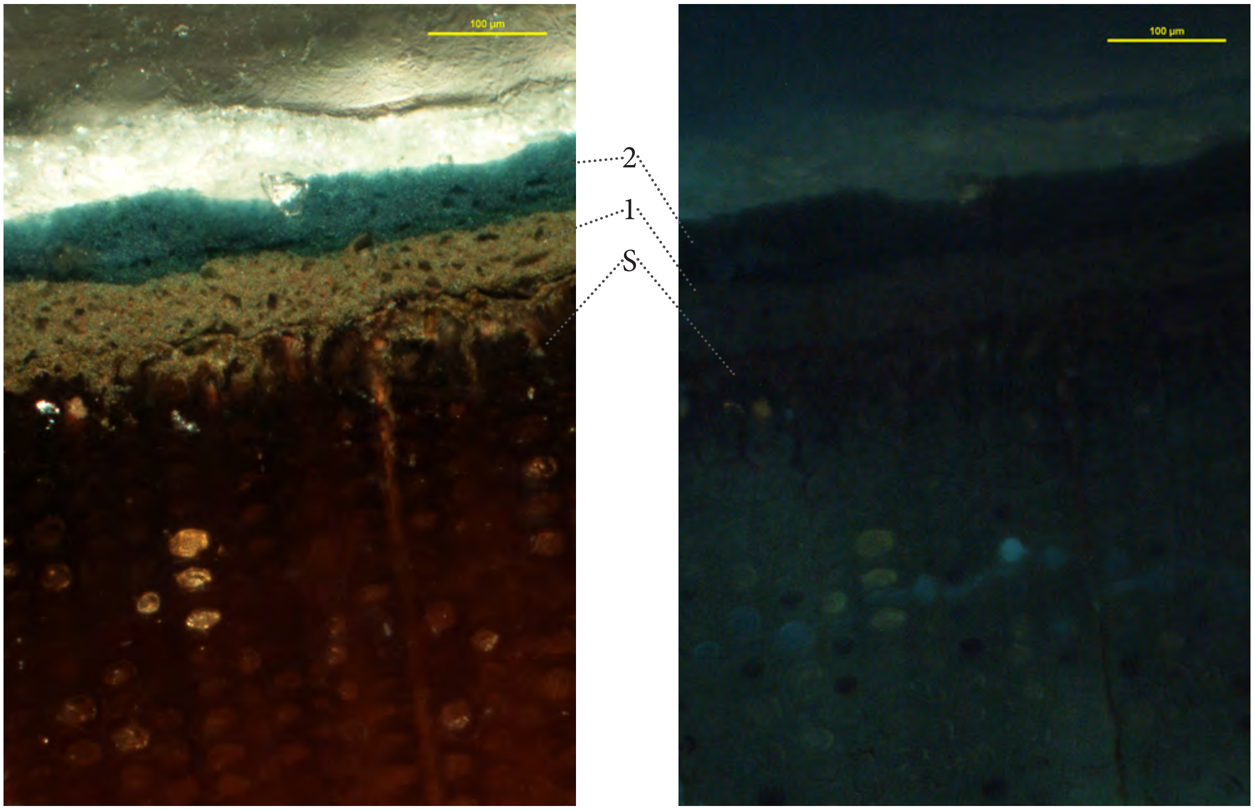
Architectural Finishes Analysis of GC7



Visible Light | Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. East elevation. Room 609. Window bottom sash exterior.	Araba Prah	7/5/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer (possibly House Paint Exterior Primer as mentioned in specs)			
Layer 2	Light orange/salmon coating			
Layer 3	Light orange/salmon coating			
Layer 4	Dirt			
Layer 5	Brown green coating			
Layer 6	Dark green coating			
Layer 7	Blue green coating			

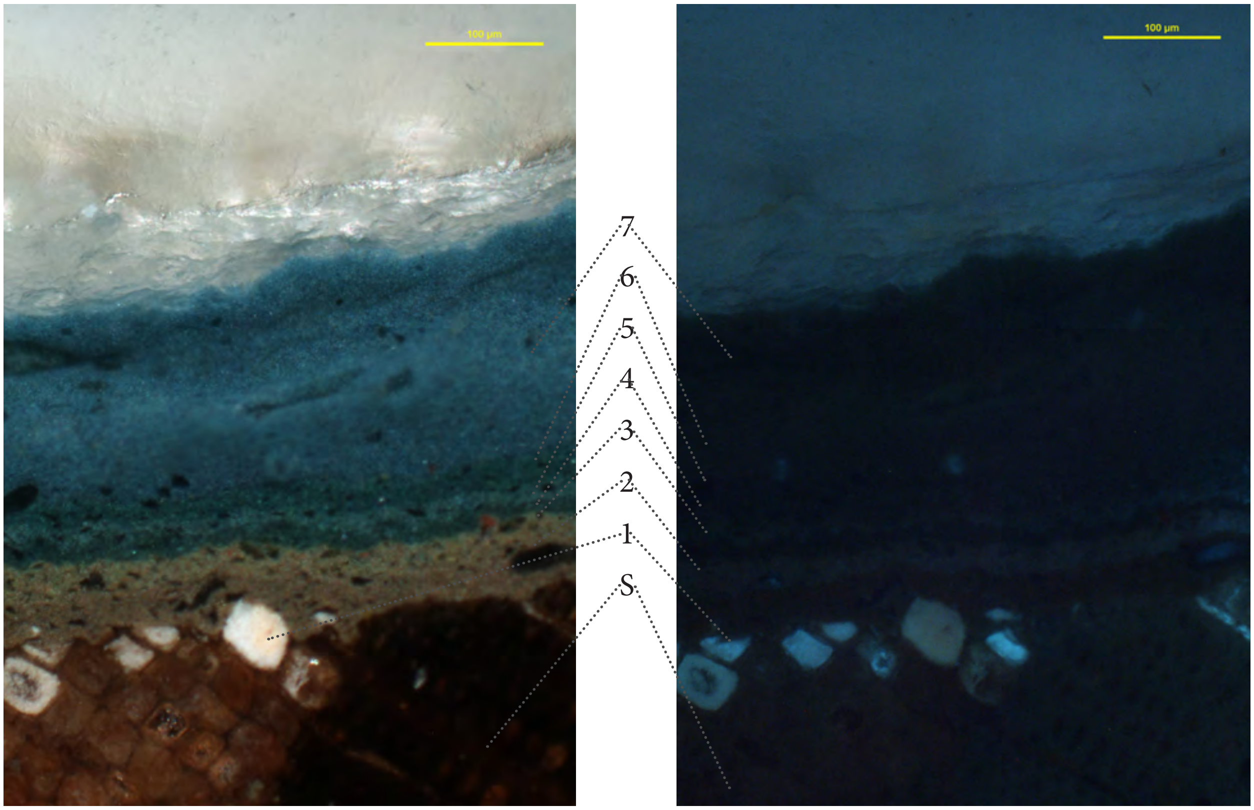
Architectural Finishes Analysis of GC8



Visible Light | Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. East elevation. Rafter.	Cesar Bargues	7/6/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	Brown green coating			
Layer 2	Blue green coating			

Architectural Finishes Analysis of GC9

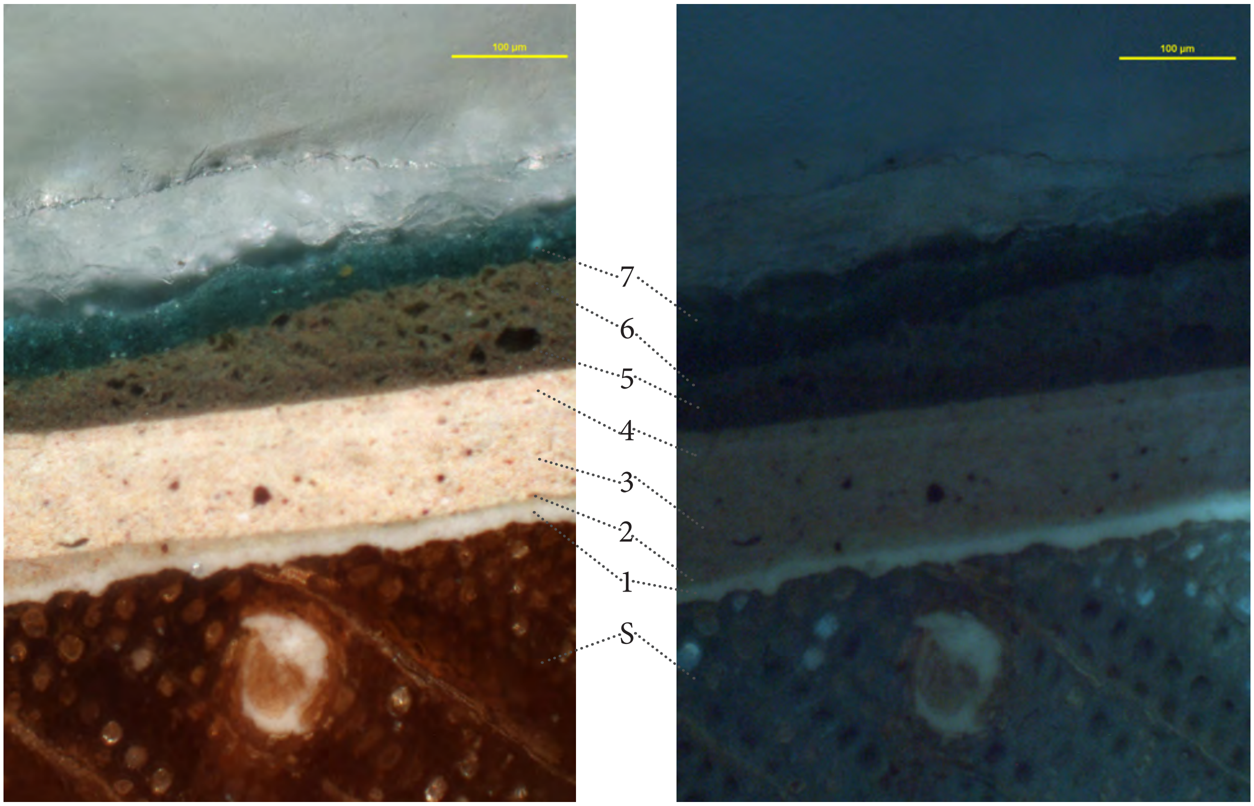


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. East elevation. Room 609. Canopy upright.	Nicole M. Declet	7/7/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating (residue)			
Layer 2	Brown green coating			
Layer 3	Light brown green coating			
Layer 4	Dark green coating			
Layer 5	Dark green coating			
Layer 6	Dark green coating			
Layer 7	Blue green coating			

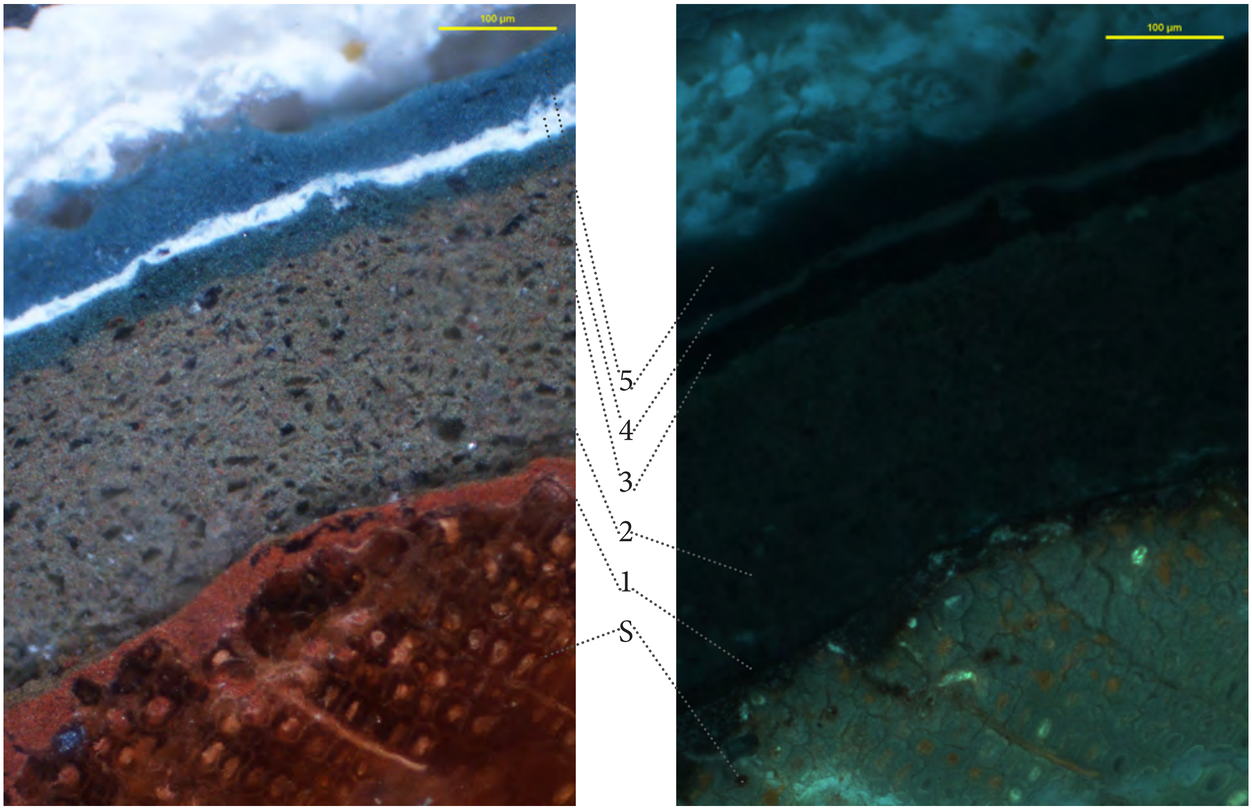
Architectural Finishes Analysis of GC10



Visible Light | Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. East elevation. Room 609. Window mullion.	Araba Prah	7/8/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	Beige coating			
Layer 3	Light beige coating			
Layer 4	Light beige coating			
Layer 5	Brown green coating			
Layer 6	Light brown green coating			
Layer 7	Blue green coating			

Architectural Finishes Analysis of ED1

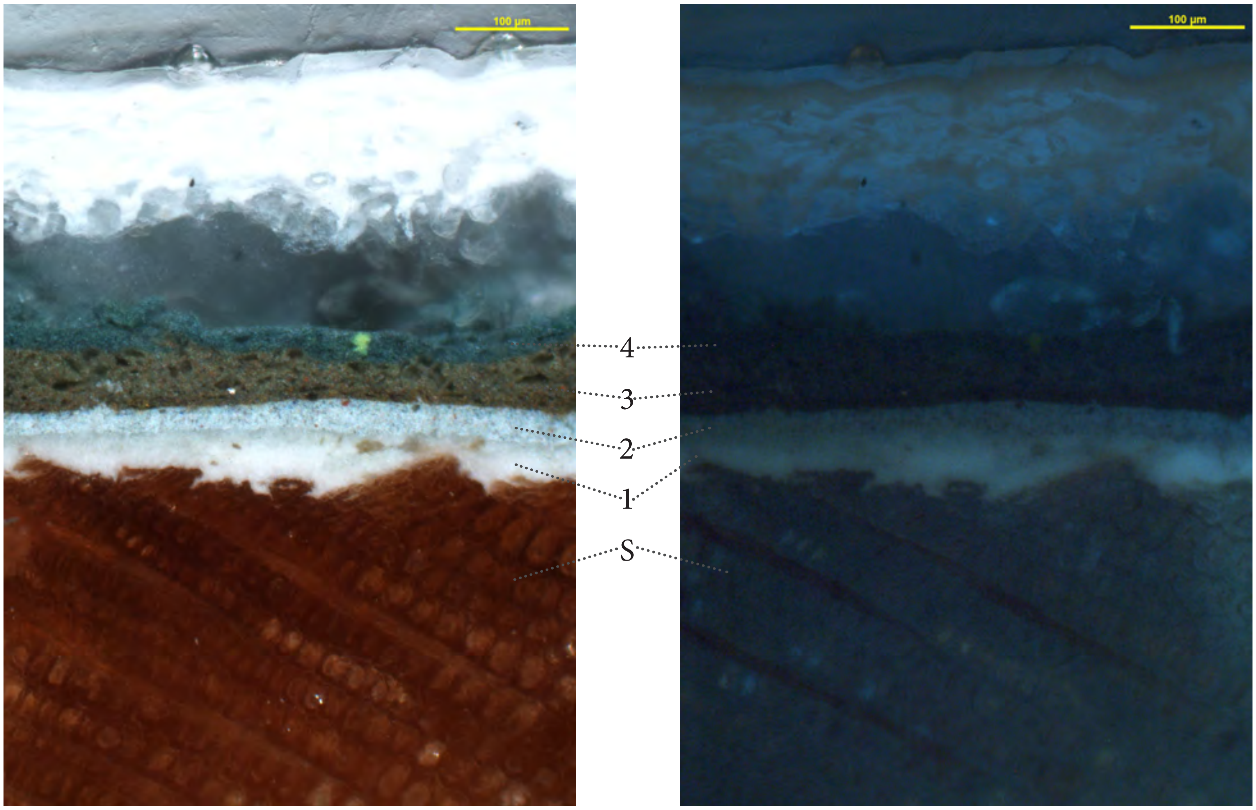


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Employee Recreation Hall. Southwest Elevation. Rafter.	Nicole M. Declet	7/14/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	Reddish brown coating			
Layer 2	Brown green coating			
Layer 3	Blue green coating			
Layer 4	White coating			
Layer 5	Blue green coating			

Architectural Finishes Analysis of ED2

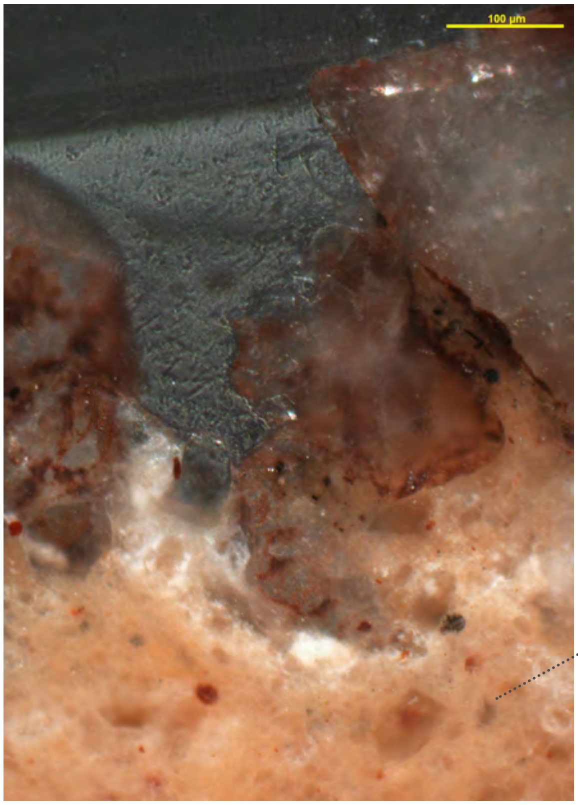


Visible Light

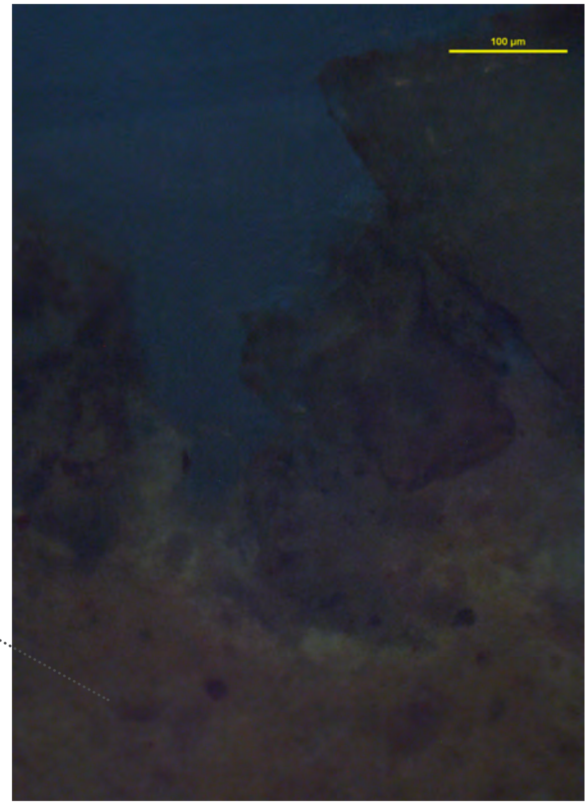
Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Dorm 3. Northwest elevation. Window sash exterior.	Araba Prah	7/14/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Wood			
Layer 1	White primer coating			
Layer 2	Light blue coating			
Layer 3	Brown green coating			
Layer 4	Blue green coating			

Architectural Finishes Analysis of SD1



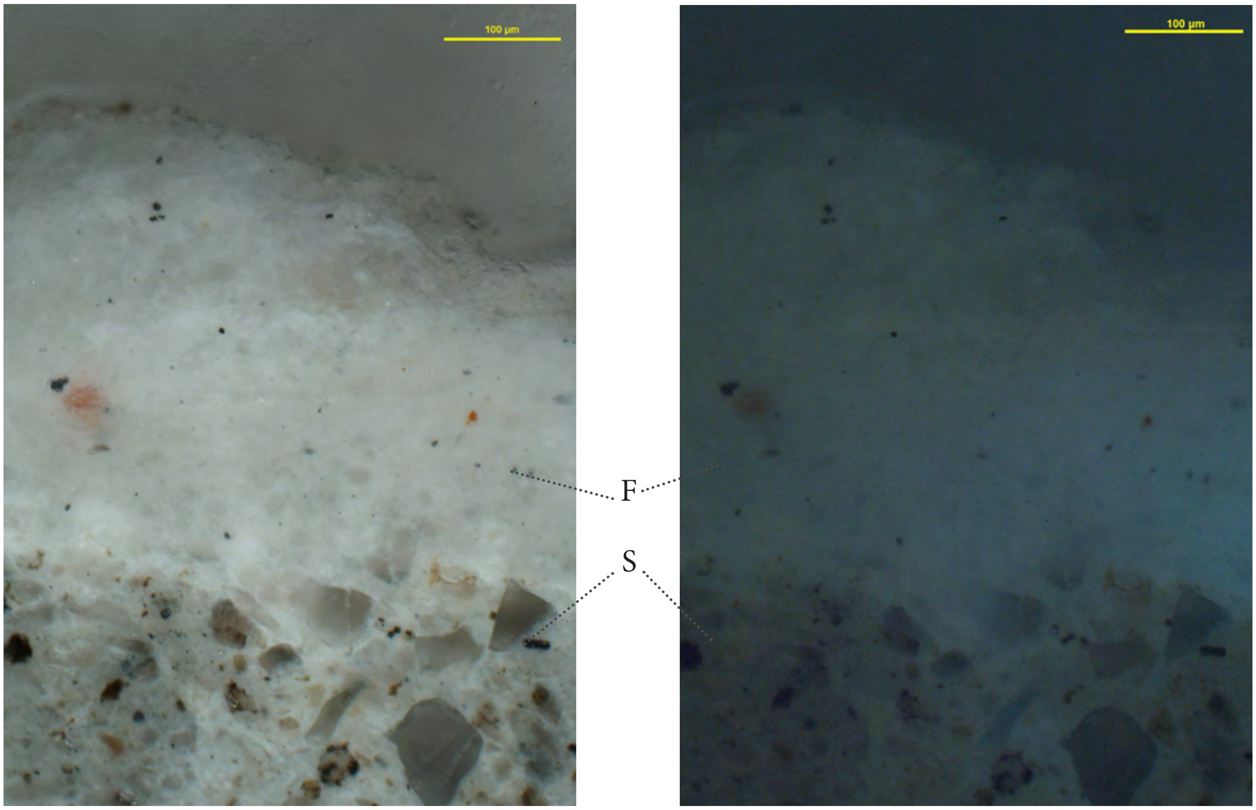
Visible Light



Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
JL-45 Dorm 3. North-west elevation.	Cesar Bargues	7/4/2016	Cesar Bargues Araba Prah	12/16/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate 1	Grey bulk layer (outside of frame) with coarse mineral inclusions			
Finish	Pink grout layer with coarse mineral inclusions-John Manville Autumn Brown Shingle			

Architectural Finishes Analysis of SD2

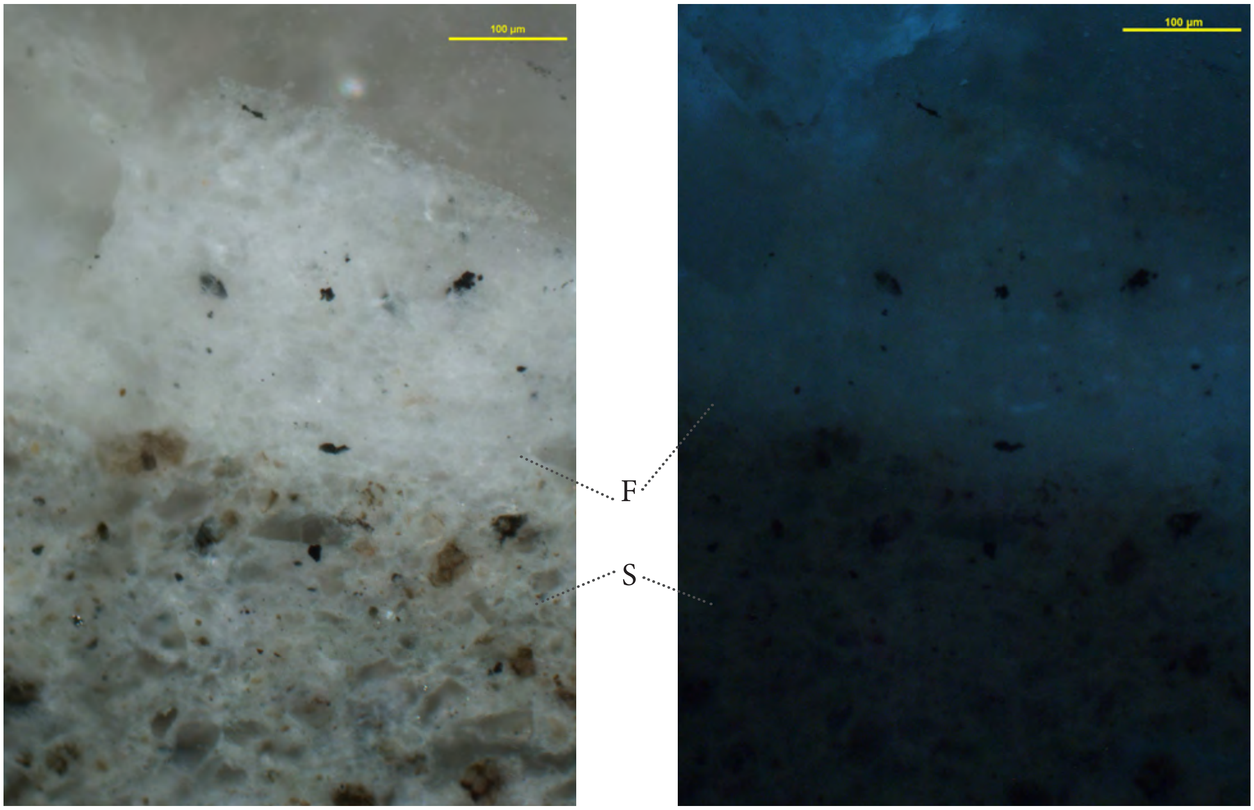


Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
JL-43 Staff 10, 12, 14 & 16. North Elevation.	Cesar Bargues	7/4/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Grey bulk layer with coarse mineral inclusions			
Finish	White grout layer with coarse mineral inclusions-John Manville Silver Grey Shingles			

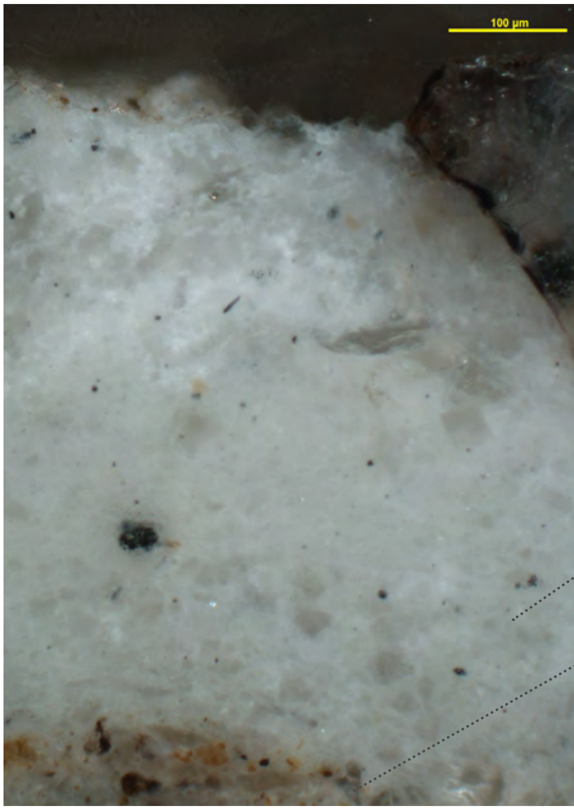
Architectural Finishes Analysis of SD3



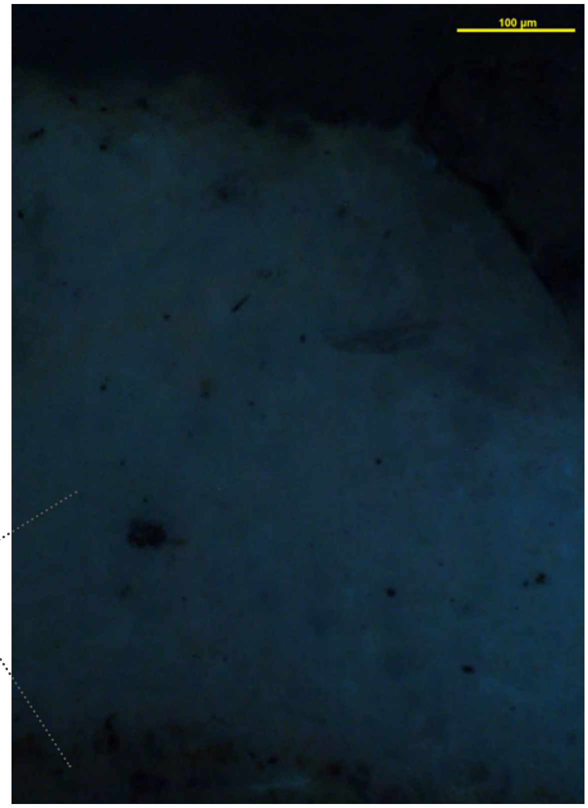
Visible Light   Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-26. East elevation.	Cesar Bargues	7/4/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Grey bulk layer with coarse mineral inclusions			
Finish	White grout layer with coarse mineral inclusions-John Manville Weathered Grey Shingle			

Architectural Finishes Analysis of SD4



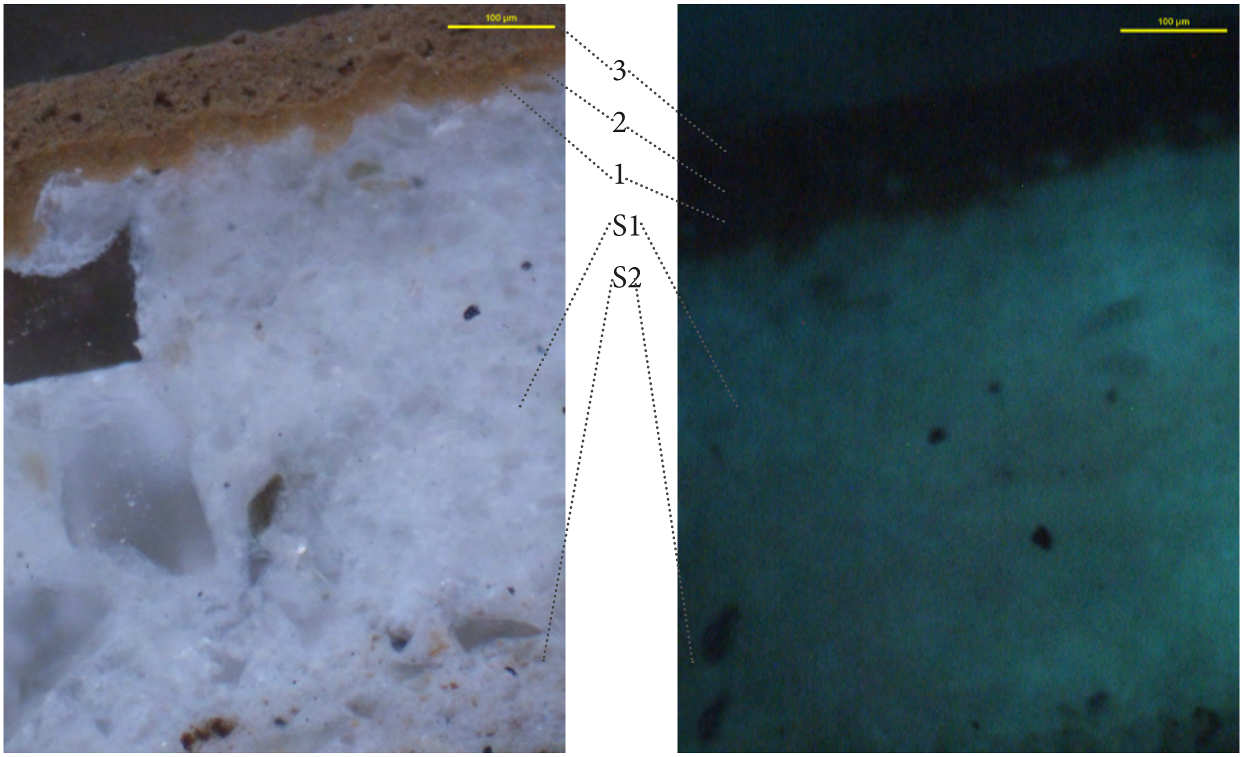
Visible Light



Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
JL-47 Dorm 7.	GTLC Staff	6/30/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate	Grey bulk layer with coarse mineral inclusions			
Finish	White grout layer with coarse mineral inclusions-John Manville Autumn Brown Shingle			

Architectural Finishes Analysis of SD5



Visible Light

Ultraviolet Light UBV

Microscopy Metadata				
Location	Sampled By	Sampling Date	Analyzed By	Date
Guest Lodge JL-28	Cesar Bargues	7/1/2016	Cesar Bargues Araba Prah	11/29/2016
Microscope	Light Source	Filters	Camera	Magnification
Nikon Alphahot YS2	Visible: reflected quart halogen UV: Nikon mercury lamp	Daylight	Nikon DS Fi-1 camera NIS Elements BR software	10x
Notes				
Substrate 1	Grey bulk layer with coarse mineral inclusions			
Substrate 2	White grout layer with coarse mineral inclusions-John Manville Silver Grey Asbestos Shingle			
Layer 1	Light brown coating			
Layer 2	Light brown coating			
Layer 3	Light brown coating			

4.4. Scanning Electron Microscopy (SEM) Datasheets

Quanta 600 FEG ESEM

An FEI Quanta 600 FEG Mark II Environmental Scanning Electron Microscope achieves 1.5 nm resolution in ESEM mode and can be operated under a range of gaseous environments from 6×10^{-4} Pa to ~1000 Pa. It is equipped with a special wet STEM detector that is ideal for the imaging of nanoparticles in biological systems. This system is our platform for in-situ electron microscopy development with heating and cooling stages allowing imaging from 20-1000°C, dual Kleindiek nano-manipulators with a micro-droplet injection system for electrical and mechanical measurements, and gas injection systems for platinum and gold e-beam deposition. The Quanta SEM is equipped with a unique array of accessories to enable the combination of high-resolution imaging and nanoscale manipulation allowing for powerful in-situ experiments involving controlled stimuli and correlated response. In-situ capabilities include: nanoscale manipulation of specimen or probe, access to the large sample volume by fluids, gases, electrical, optical and mechanical probes; detection of sample response to such probes, including the electron beam itself; and the temperature dependences of all these phenomena.

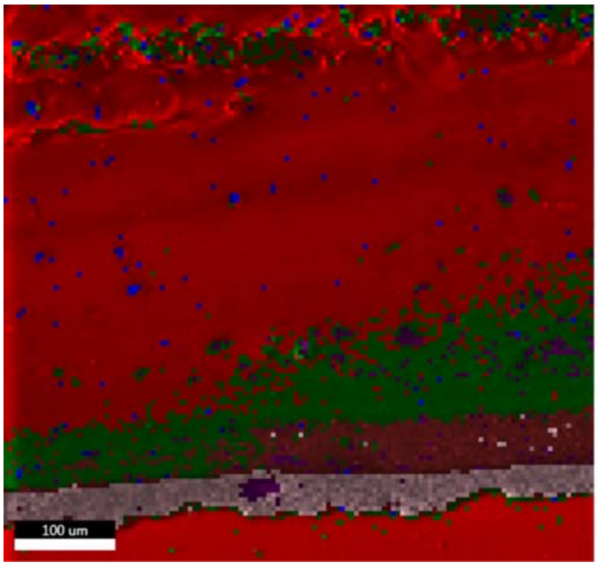
Matero

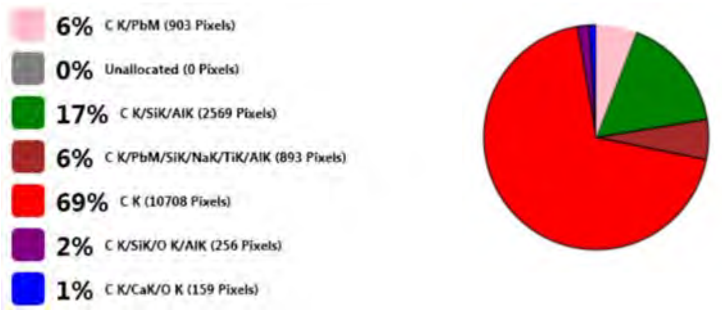
Author: prnuser
Creation: 12/21/2016

Sample Name: CL3

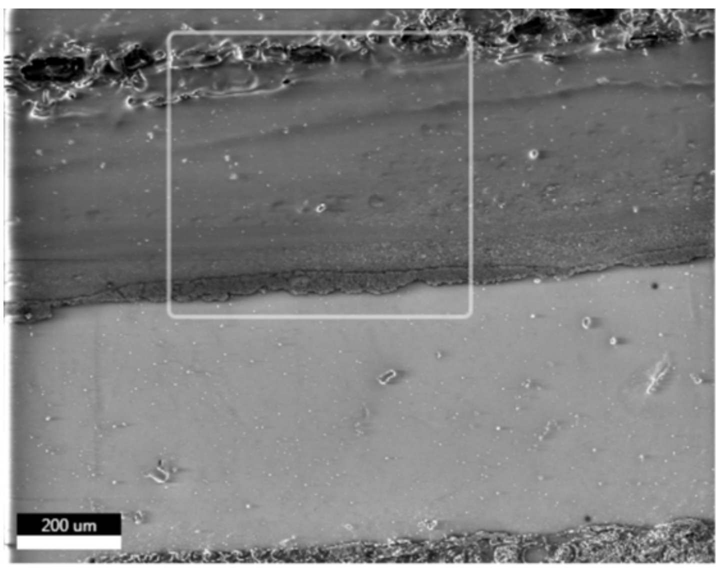
Area 1

PhaseROI 2





Notes:



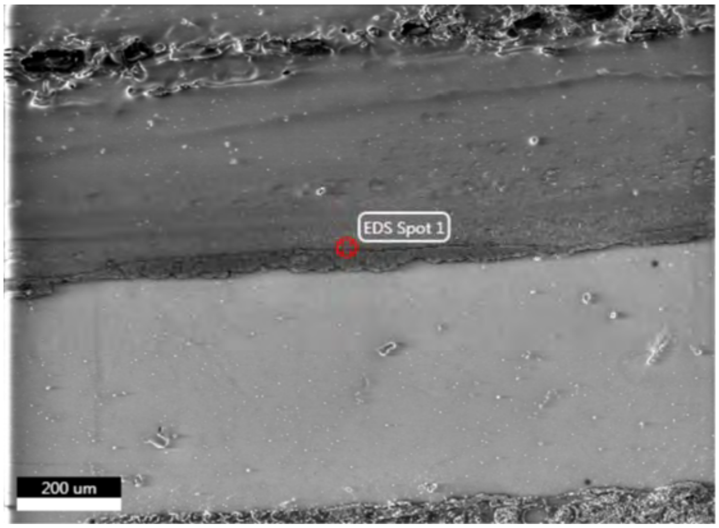
Image

Matero

Author: prnuser
Creation: 12/21/2016

Sample Name: CL3

Area 1



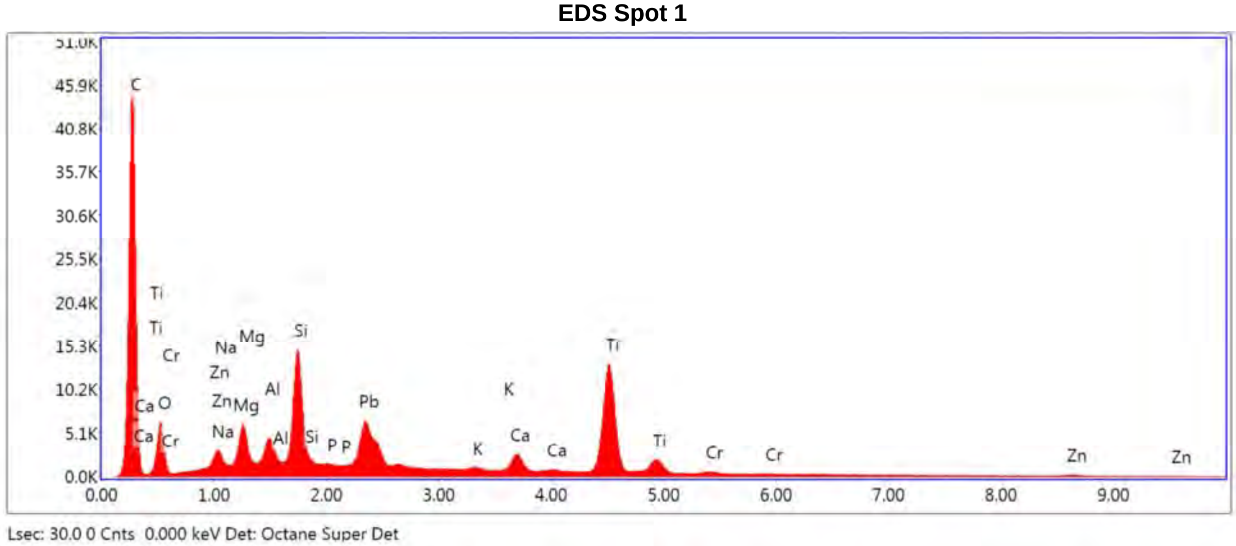
Notes:

EDAX TEAM

EDS Spot 1

kV: 15 Mag: 200 Takeoff: 34 Live Time(s): 30 Amp Time(µs): 1.92 Resolution:(eV)134.

EDS Spot 1



eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	R	A	F
C K	60.93	79.16	11338.96	6.50	0.3200.3207	1.0782	0.9581	0.4881	1.0000
O K	11.51	11.22	1566.13	10.27	0.0180.0183	1.0275	0.9791	0.1549	1.0000
NaK	0.46	0.31	279.81	9.73	0.0020.0023	0.9290	1.0039	0.5217	1.0014
MgK	1.46	0.93	1427.39	5.43	0.0090.0092	0.9437	1.0110	0.6712	1.0023
AlK	1.02	0.59	1105.72	4.55	0.0070.0073	0.9077	1.0176	0.7813	1.0037
SiK	3.83	2.13	4391.17	3.07	0.0300.0307	0.9267	1.0238	0.8619	1.0041
P K	0.21	0.11	195.36	10.75	0.0010.0017	0.8892	1.0295	0.8955	1.0064
PbM	4.74	0.36	1956.95	5.73	0.0380.0389	0.5719	1.4008	1.2596	1.1387
K K	0.19	0.07	122.67	11.94	0.0010.0016	0.8551	1.0484	0.9812	1.0107
CaK	1.41	0.55	772.42	3.82	0.0120.0123	0.8698	1.0521	0.9912	1.0144
TiK	13.02	4.24	5508.09	2.09	0.1030.1036	0.7865	1.0580	1.0005	1.0113
CrK	0.36	0.11	104.14	15.88	0.0020.0029	0.7759	1.0614	0.9891	1.0186
ZnK	0.85	0.20	61.14	20.82	0.0060.0066	0.7213	1.0455	1.0037	1.0694

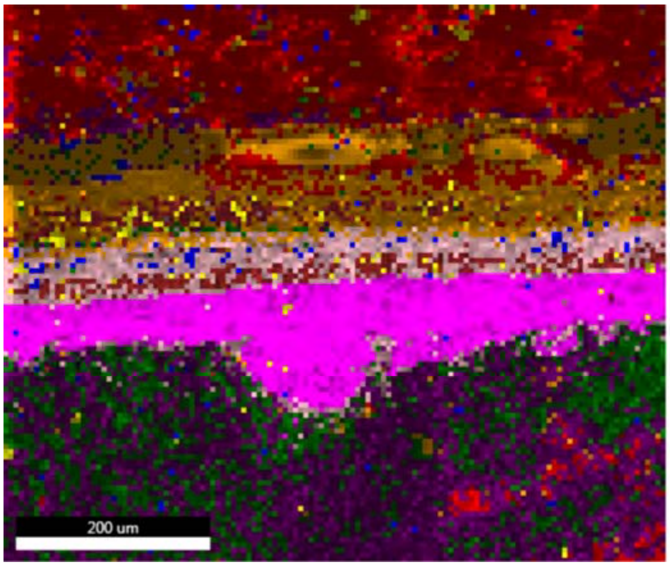
Matero

Author: prnuser
Creation: 12/14/2016

Sample Name: GC3

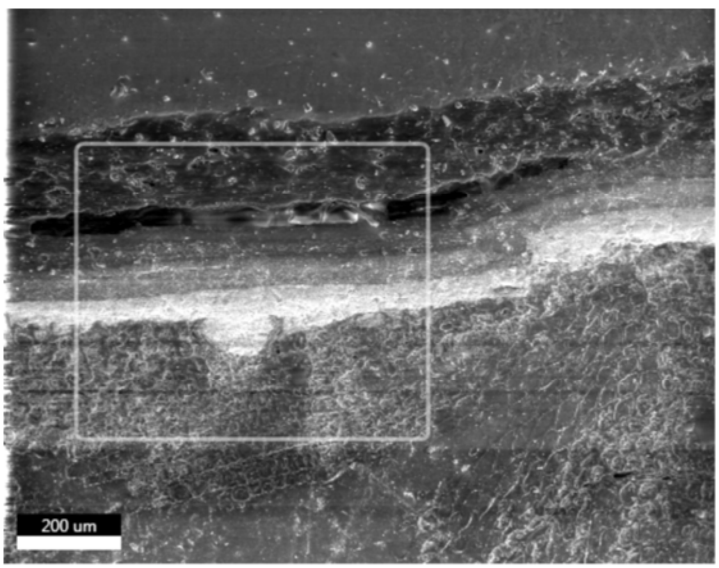
Area 1

PhaseROI 3



- 1% C K/CaK/O K/BrL/PbM (167 Pixels)
- 15% C K/O K/BrL/SiK (2083 Pixels)
- 24% C K/O K/BrL (3337 Pixels)
- 0% Unallocated (0 Pixels)
- 1% SiK/C K/O K/BrL (152 Pixels)
- 22% C K/O K/BrL (3022 Pixels)
- 12% PbM/C K/O K/BrL (1675 Pixels)
- 4% C K/SiK/O K/BrL/PbM/TiK/MgK (502 Pixels)
- 13% C K/O K/BrL/PbM (1846 Pixels)
- 8% C K/O K/PbM/BrL/SiK (1040 Pixels)

Notes:



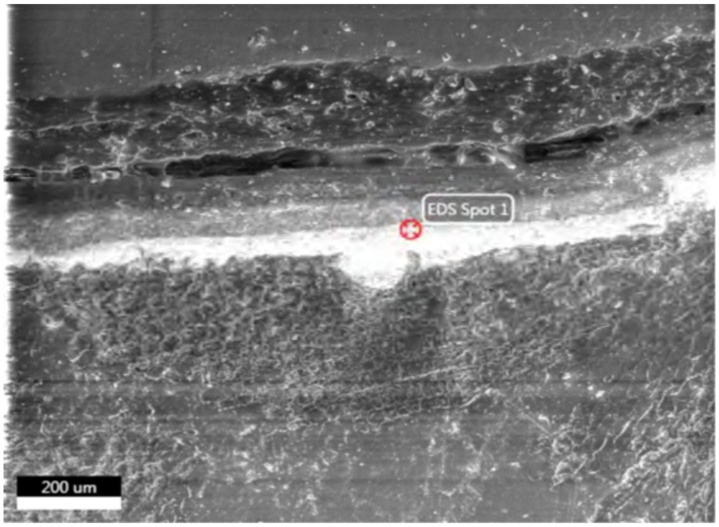
Image

Matero

Author: prnuser
Creation: 12/14/2016

Sample Name: GC3

Area 2

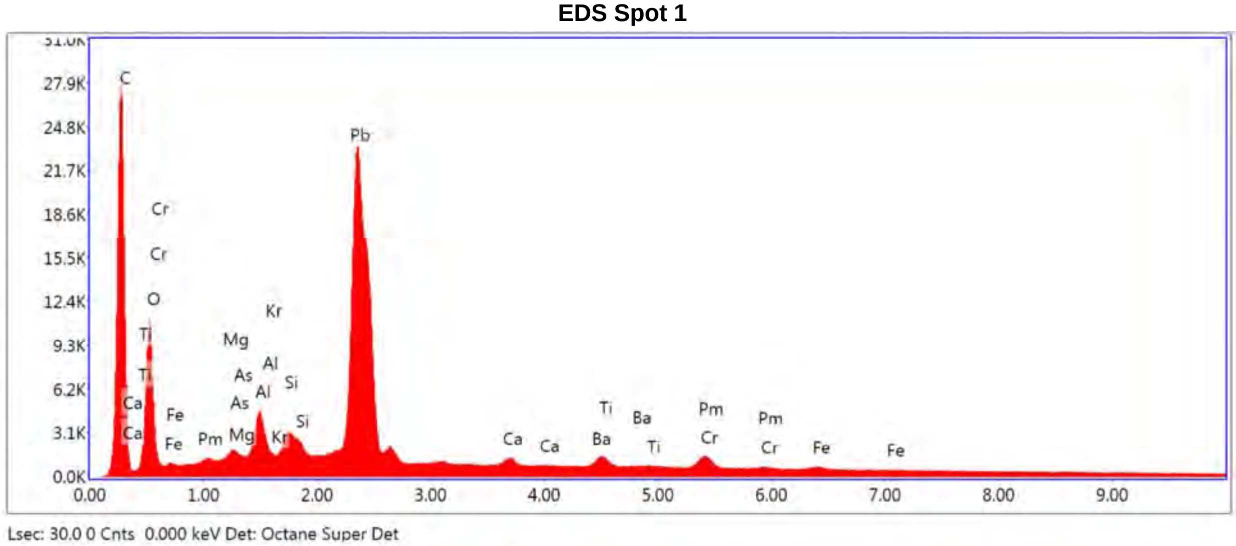


Notes:

EDS Spot 1

kV: 15 Mag: 200 Takeoff: 36 Live Time(s): 30 Amp Time(µs): 1.92 Resolution:(eV)134.

EDS Spot 1



eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	R	A	F
C K	46.62	72.35	6905.23	6.00	0.2960.2964	1.1673	0.9002	0.5447	1.0000
O K	19.31	22.50	2729.47	9.44	0.0479.0479	1.1163	0.9242	0.2224	1.0000
MgK	0.01	0.01	8.72	69.53	0.0001.0001	1.0306	0.9620	0.6207	1.0010
AsL	0.00	0.00	0.03	99.99	0.0000.0000	0.7885	1.1165	0.8221	1.0014
AlK	1.16	0.80	867.31	5.12	0.0085.0085	0.9924	0.9701	0.7354	1.0016
KrL	0.00	0.00	0.03	99.99	0.0000.0000	0.7607	1.1335	0.9511	1.0034
SiK	0.50	0.33	396.37	6.03	0.0041.0041	1.0142	0.9777	0.8161	1.0024
PbM	27.71	2.49	7366.00	3.96	0.2157.2157	0.6275	1.3436	1.2055	1.0287
CaK	0.59	0.27	218.00	10.41	0.0052.0052	0.9575	1.0152	0.9129	1.0032
BaL	0.43	0.06	45.61	40.83	0.0030.0030	0.6679	1.1881	1.0250	1.0055
TiK	0.91	0.36	270.64	10.87	0.0076.0076	0.8676	1.0245	0.9508	1.0060
CrK	1.55	0.56	319.77	9.05	0.0131.0131	0.8580	1.0316	0.9731	1.0095
PmL	0.63	0.08	52.17	37.48	0.0044.0044	0.6679	1.1768	1.0319	1.0105
FeK	0.57	0.19	80.10	20.87	0.0048.0048	0.8512	1.0358	0.9854	1.0149

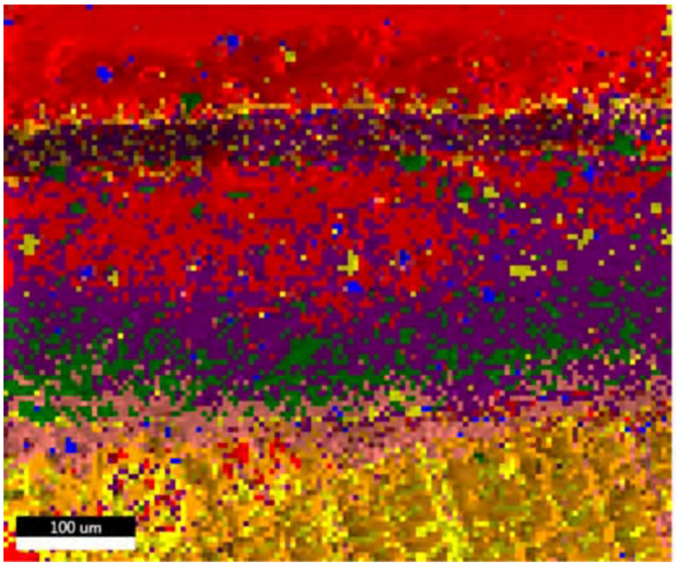
Matero

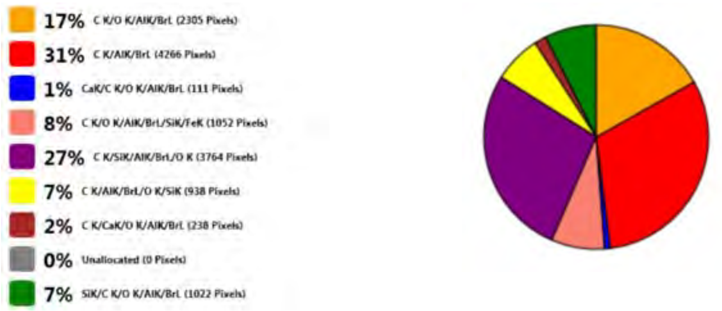
Author: prnuser
Creation: 12/21/2016

Sample Name: GC4

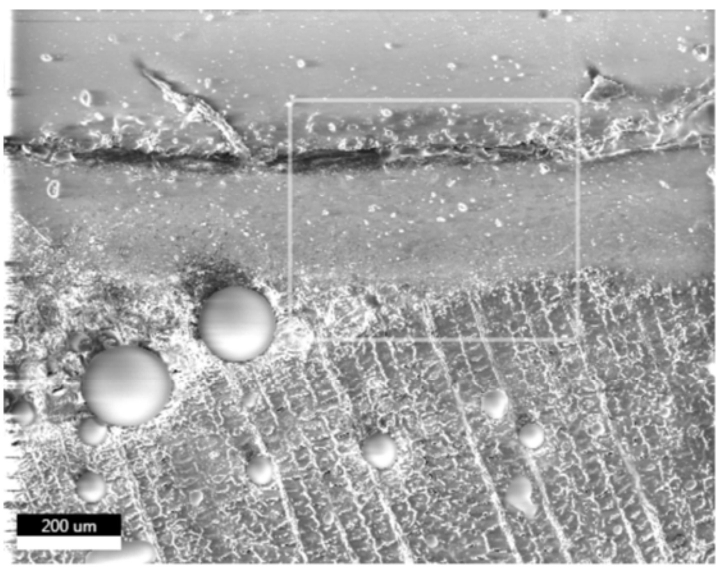
Area 1

PhaseROI 3





Notes:



Image

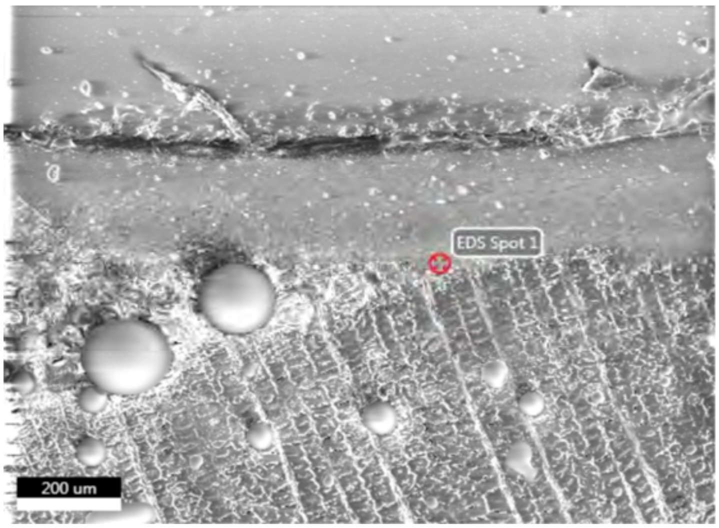
EDAX TEAM

Matero

Author: prnuser
Creation: 12/21/2016

Sample Name: GC4

Area 1

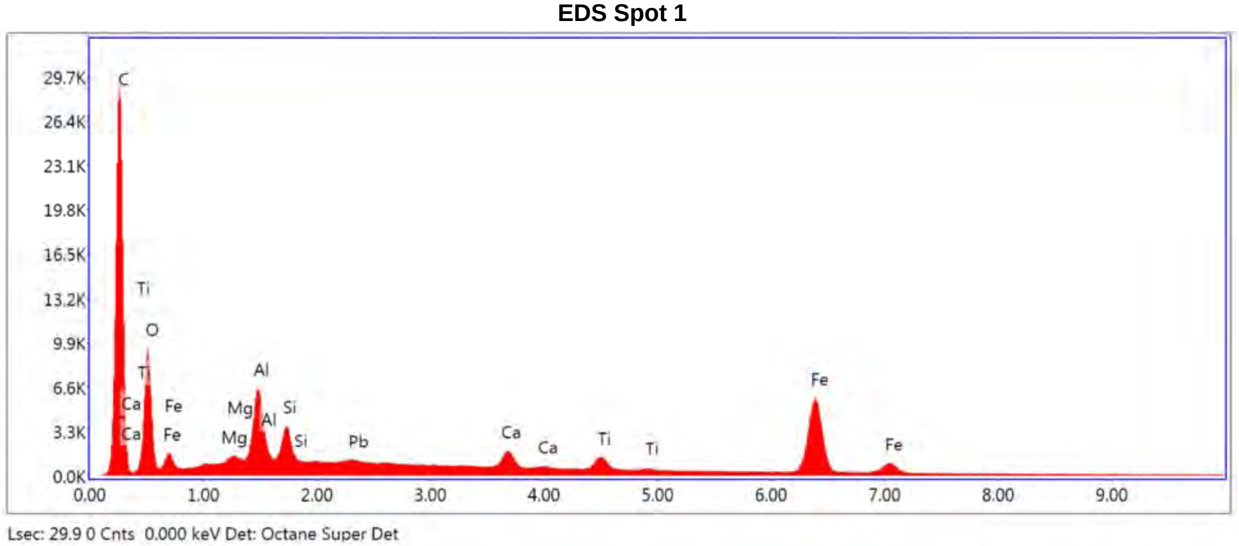


Notes:

EDS Spot 1

kV: 15 Mag: 200 Takeoff: 34 Live Time(s): 29.9 Amp Time(µs): 1.92 Resolution:(eV)134.

EDS Spot 1



eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	R	A	F
C K	57.20	74.82	7187.96	6.79	0.285 0.2855	1.0732	0.9609	0.4651	1.0000
O K	16.90	16.60	2275.18	9.50	0.037 0.0374	1.0224	0.9816	0.2163	1.0000
MgK	0.19	0.13	119.77	11.20	0.001 0.0011	0.9386	1.0132	0.5966	1.0033
AlK	2.58	1.50	1844.19	4.68	0.017 0.0171	0.9028	1.0197	0.7300	1.0045
SiK	1.08	0.60	825.89	4.56	0.008 0.0081	0.9215	1.0258	0.8128	1.0065
PbM	0.26	0.02	107.36	22.87	0.003 0.0030	0.5686	1.4033	1.2527	1.6161
CaK	1.31	0.51	539.51	4.22	0.012 0.0121	0.8646	1.0536	1.0044	1.0599
TiK	1.33	0.43	441.15	4.95	0.011 0.0117	0.7817	1.0594	1.0091	1.1143
FeK	19.15	5.39	2716.63	2.97	0.153 0.1539	0.7627	1.0621	1.0104	1.0430

Matero

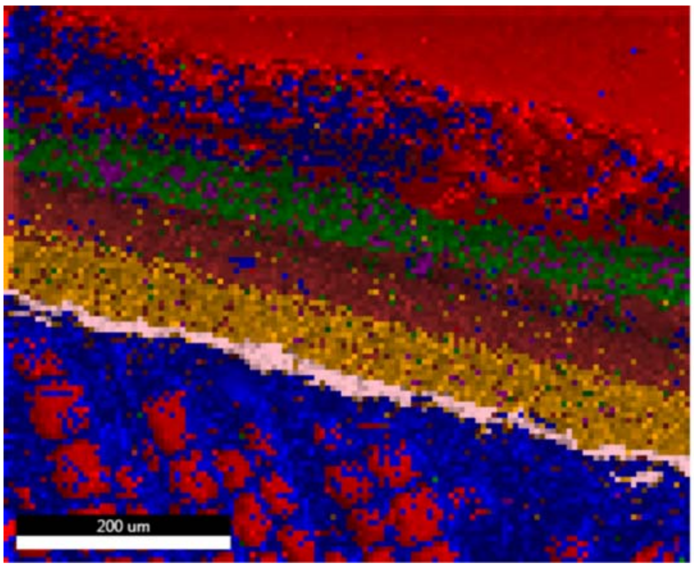
Author: prnuser

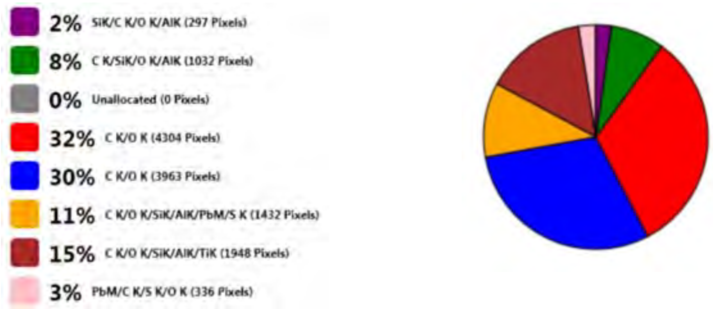
Creation: 12/14/2016

Sample Name: GC6

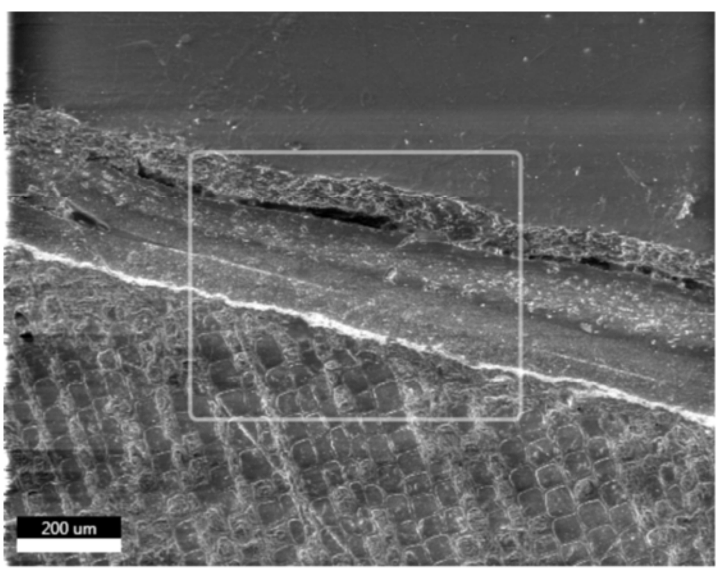
Area 1

PhaseROI 4





Notes:



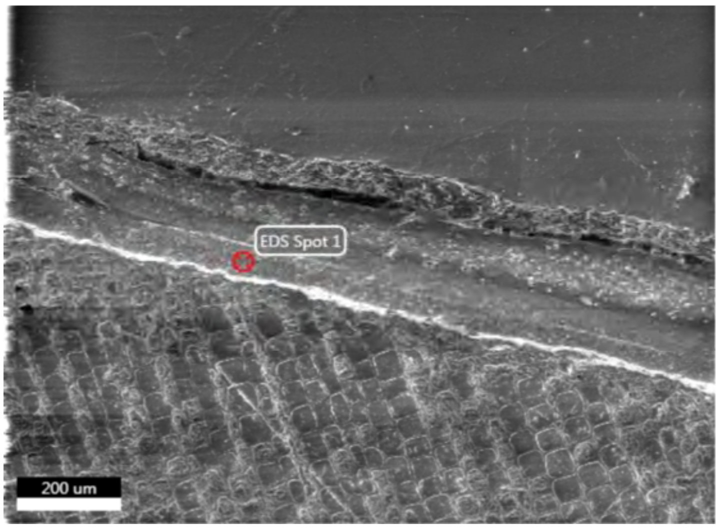
Image

Matero

Author: prnuser
Creation: 12/14/2016

Sample Name: GC6

Area 2

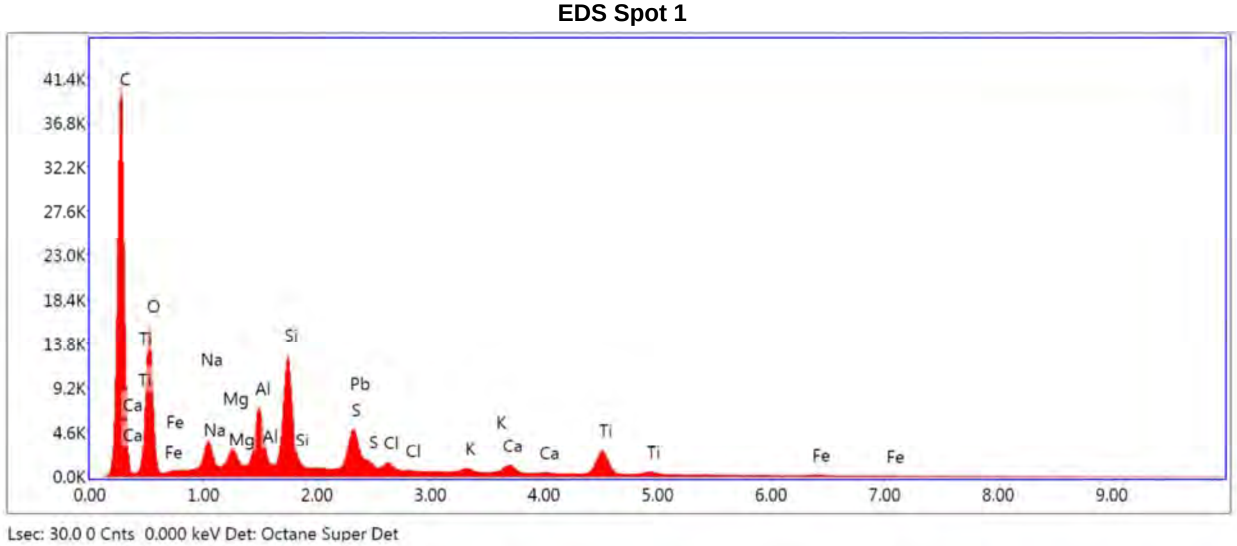


Notes:

EDS Spot 1

kV: 15 Mag: 200 Takeoff: 35.8 Live Time(s): 30 Amp Time(μs): 1.92 Resolution:(eV)134.

EDS Spot 1



<u>eZAF Smart Quant Results</u>

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	R	A	F
C K	61.90	72.71	10050.24	6.75	0.2988 0.2988	1.0389	0.9813	0.4645	1.0000
O K	24.35	21.47	4000.44	9.53	0.0487 0.0487	0.9882	1.0004	0.2025	1.0000
NaK	1.42	0.87	857.21	6.69	0.0071 0.0071	0.8917	1.0229	0.5623	1.0023
MgK	0.65	0.38	625.97	5.82	0.0042 0.0042	0.9054	1.0292	0.7105	1.0039
AlK	1.87	0.98	1988.32	3.69	0.0135 0.0135	0.8705	1.0350	0.8233	1.0057
SiK	3.38	1.70	3707.72	2.83	0.0268 0.0268	0.8882	1.0404	0.8893	1.0058
S K	1.25	0.55	1108.96	2.74	0.0105 0.0105	0.8675	1.0500	0.9595	1.0111
PbM	1.13	0.08	471.96	10.51	0.0096 0.0096	0.5477	1.4210	1.2724	1.2175
ClK	0.34	0.13	260.82	8.68	0.0027 0.0027	0.8242	1.0543	0.9731	1.0074
K K	0.25	0.09	154.18	10.79	0.0021 0.0021	0.8181	1.0616	1.0000	1.0151
CaK	0.65	0.23	336.46	5.71	0.0055 0.0055	0.8319	1.0646	1.0062	1.0192
TiK	2.56	0.76	1026.35	3.09	0.0200 0.0200	0.7517	1.0691	1.0111	1.0251
FeK	0.26	0.06	48.48	22.41	0.0020 0.0020	0.7326	1.0692	1.0099	1.0661

Matero

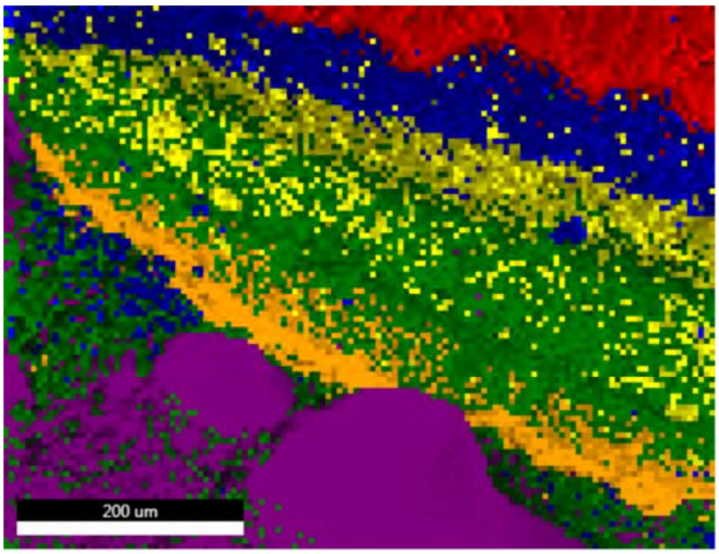
Author: prnuser

Creation: 12/14/2016

Sample Name: GC7

Area 1

PhaseROI 2



14% C K/AlK/BrL/O K/SiK (1766 Pixels)

22% AlK/BrL/C K (2729 Pixels)

7% C K/O K/AlK/BrL (935 Pixels)

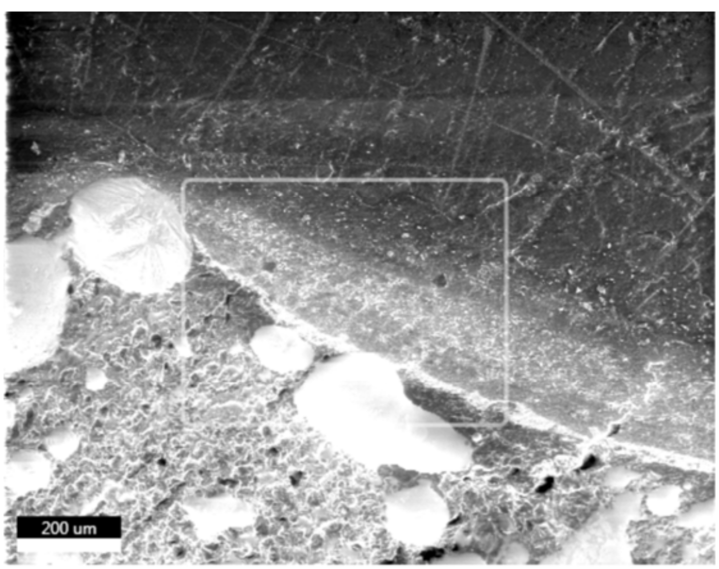
35% AlK/BrL/C K/O K/SiK (4394 Pixels)

8% AlK/BrL/C K/PbM/S K/O K (1039 Pixels)

13% C K/AlK/BrL/SiK/O K (1681 Pixels)

0% Unallocated (0 Pixels)

Notes:



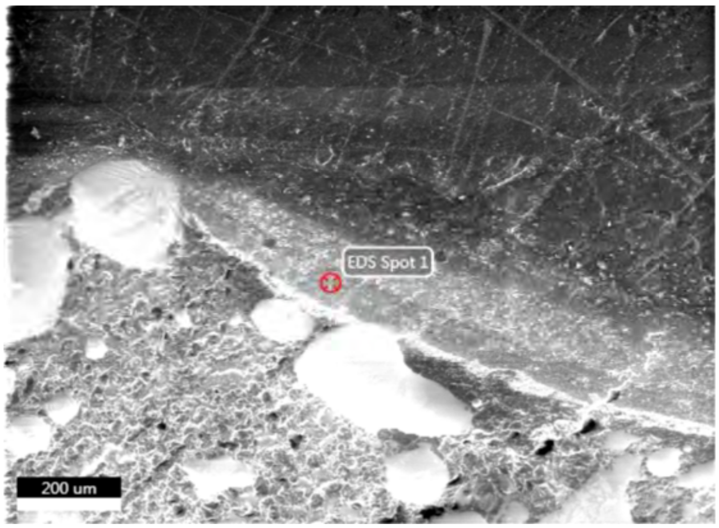
Image

Matero

Author: prnuser
Creation: 12/14/2016

Sample Name: GC7

Area 2

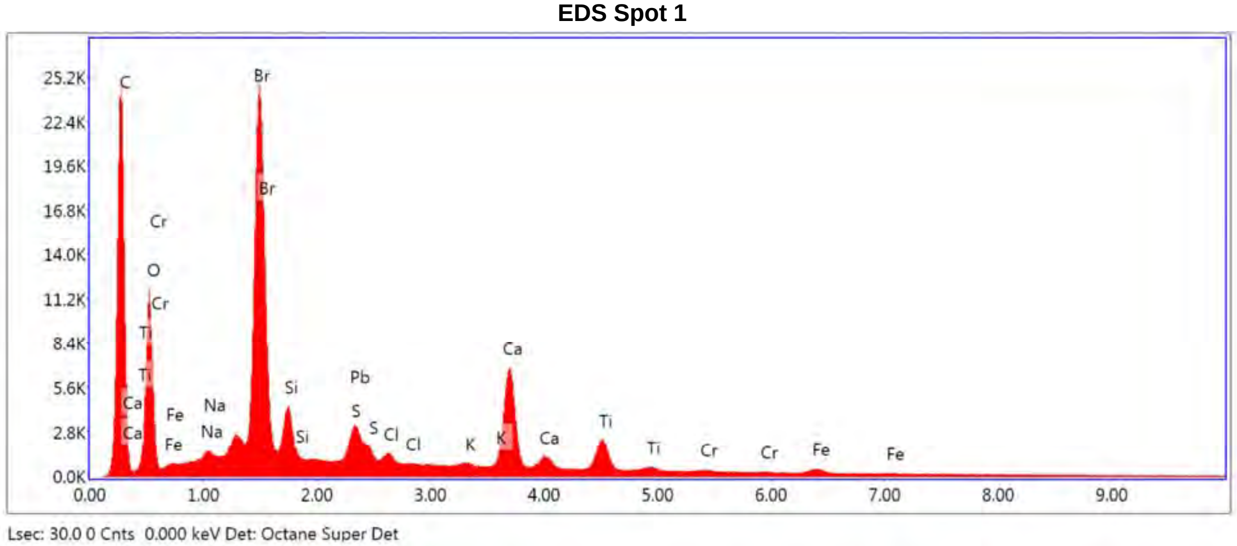


Notes:

EDS Spot 1

kV: 15 Mag: 200 Takeoff: 34.9 Live Time(s): 30 Amp Time(µs): 1.92 Resolution:(eV)134.

EDS Spot 1



eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	R	A	F
C K	53.85	71.30	5922.07	7.83	0.2113	1.0795	0.9555	0.3634	1.0000
O K	21.92	21.79	2841.69	9.77	0.0418	1.0289	0.9766	0.1851	1.0000
NaK	0.11	0.08	54.07	23.58	0.0005	0.9304	1.0018	0.5307	1.0025
BrL	11.29	2.25	5641.60	1.68	0.0818	0.7131	1.1809	1.0118	1.0048
SiK	1.21	0.69	1023.46	4.73	0.0090	0.9282	1.0218	0.7922	1.0040
S K	0.42	0.21	305.58	8.53	0.0035	0.9074	1.0330	0.9066	1.0092
PbM	1.58	0.12	552.55	8.91	0.0137	0.5729	1.3984	1.2162	1.2389
ClK	0.29	0.13	190.42	10.15	0.0024	0.8624	1.0380	0.9348	1.0081
K K	0.16	0.07	85.75	15.22	0.0014	0.8566	1.0468	0.9777	1.0177
CaK	5.75	2.28	2522.46	2.30	0.0504	0.8714	1.0506	0.9895	1.0147
TiK	2.43	0.81	824.96	3.41	0.0194	0.7880	1.0567	0.9920	1.0224
CrK	0.24	0.07	55.83	24.01	0.0019	0.7775	1.0602	0.9981	1.0375
FeK	0.73	0.21	116.93	12.56	0.0059	0.7693	1.0601	1.0033	1.0558

Matero

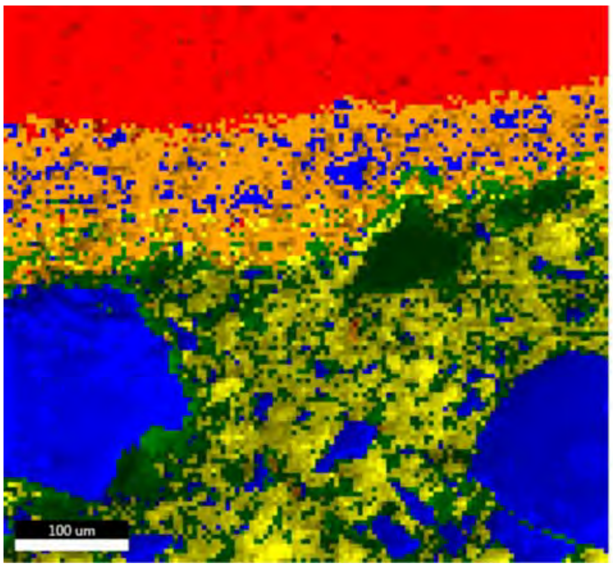
Author: prnuser

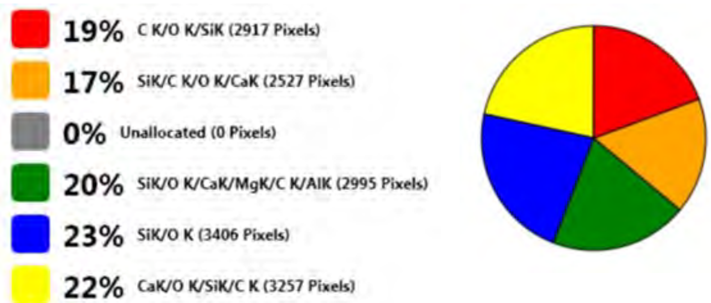
Creation: 12/21/2016

Sample Name: SD5

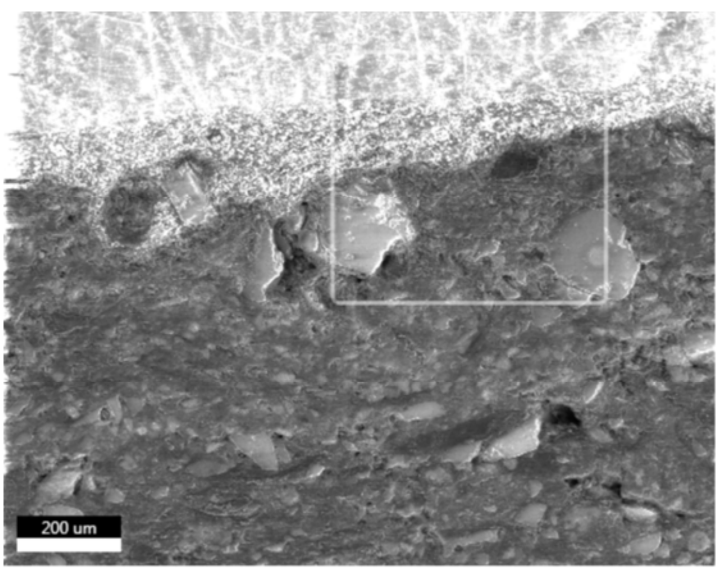
Area 2

Live Map 1





Notes:



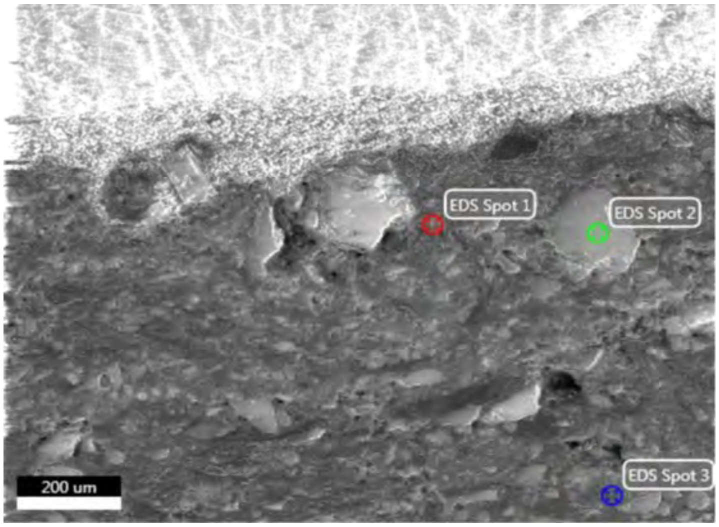
Image

Matero

Author: prnuser
Creation: 12/21/2016

Sample Name: SD5

Area 1

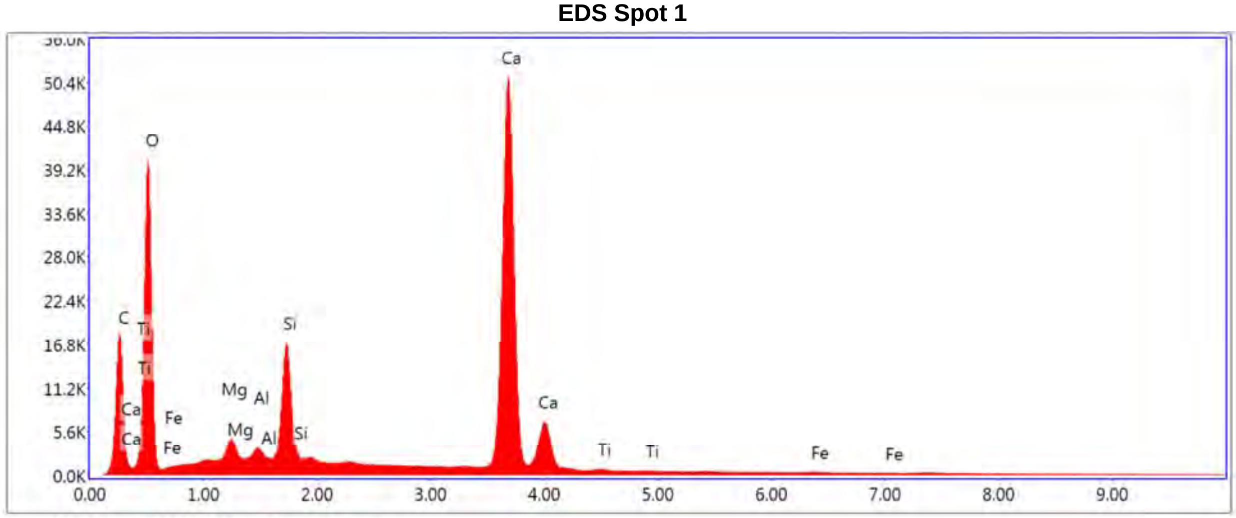


Notes:

EDS Spot 1

kV: 15 Mag: 200 Takeoff: 35 Live Time(s): 30 Amp Time(µs): 1.92 Resolution:(eV)134.

EDS Spot 1



Lsec: 30.0 0 Cnts 0.000 keV Det: Octane Super Det

eZAF Smart Quant Results

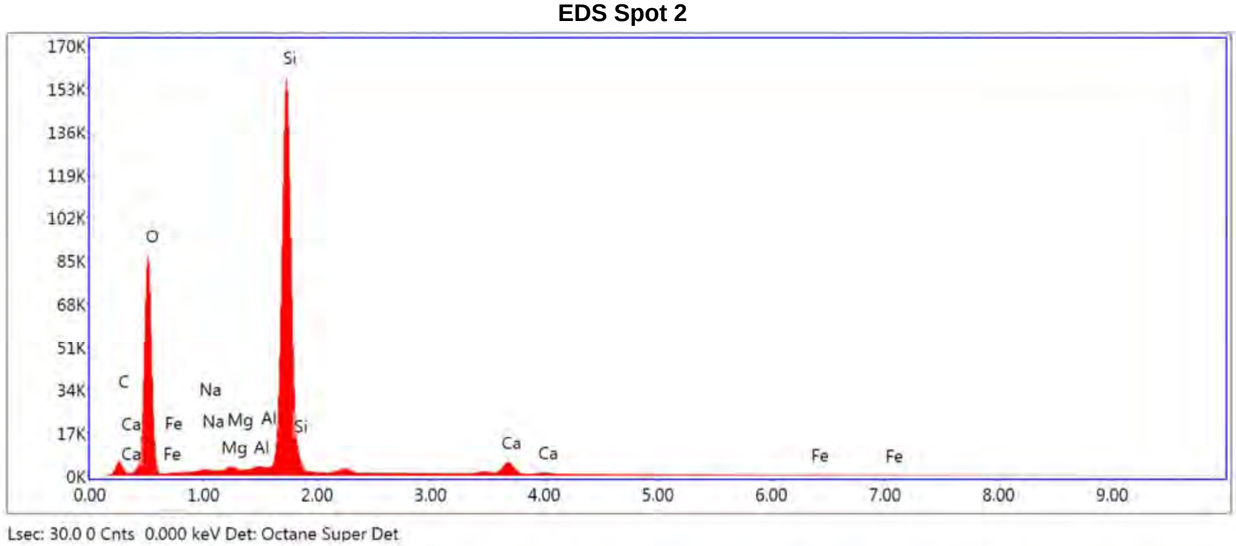
Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	R	A	F
C K	16.42	25.71	3317.50	7.16	0.0788 0.0788	1.0932	0.9517	0.4391	1.0000
O K	48.27	56.74	10554.59	9.33	0.1031 0.1031	1.0419	0.9731	0.2052	1.0000
MgK	0.77	0.60	823.49	6.86	0.0044 0.0044	0.9567	1.0059	0.5984	1.0061
AlK	0.40	0.28	494.46	6.16	0.0027 0.0027	0.9201	1.0126	0.7292	1.0108
SiK	3.55	2.38	4810.56	3.48	0.0280 0.0280	0.9392	1.0190	0.8280	1.0150
CaK	30.13	14.14	20344.42	1.80	0.2699 0.2699	0.8809	1.0484	1.0042	1.0130
TiK	0.21	0.08	104.73	17.65	0.0016 0.0016	0.7963	1.0547	0.9573	1.0248
FeK	0.26	0.09	62.40	18.77	0.0021 0.0021	0.7770	1.0587	0.9928	1.0660

EDAX TEAM

EDS Spot 2

kV: 15 Mag: 200 Takeoff: 35 Live Time(s): 30 Amp Time(µs): 1.92 Resolution:(eV)134.

EDS Spot 2



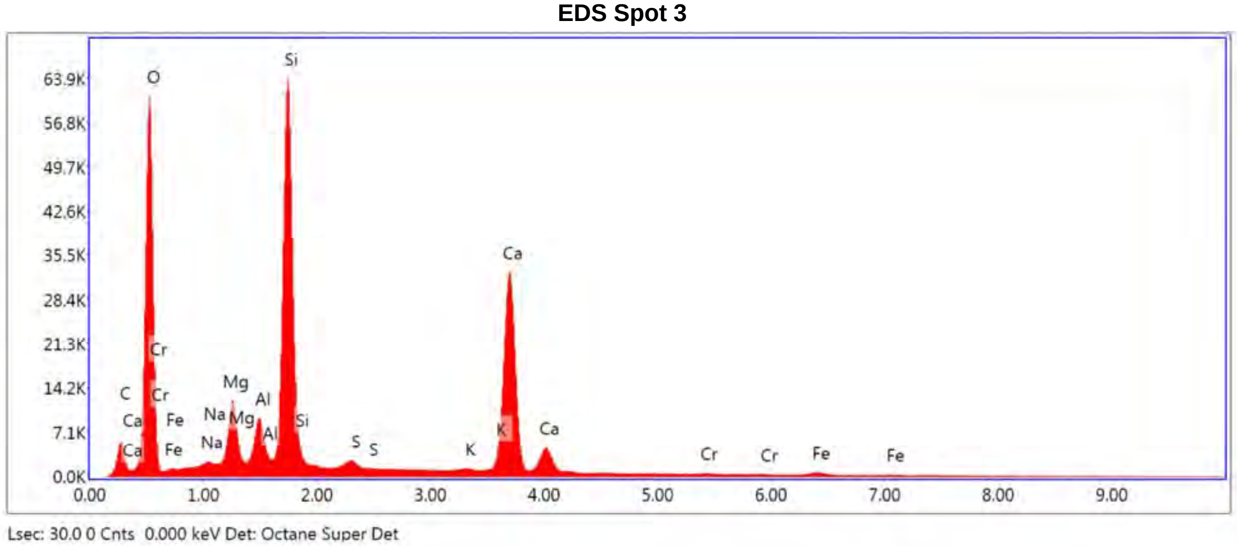
eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	R	A	F
C K	13.14	19.76	1203.09	10.23	0.0257 0.0257	1.0813	0.9634	0.1806	1.0000
O K	51.28	57.89	22646.08	7.57	0.1987 0.1987	1.0296	0.9840	0.3764	1.0000
NaK	0.21	0.16	164.94	12.32	0.0010 0.0010	0.9299	1.0084	0.5123	1.0068
MgK	0.29	0.21	383.80	7.54	0.0019 0.0019	0.9443	1.0153	0.6735	1.0130
AlK	0.40	0.26	595.72	5.44	0.0029 0.0029	0.9080	1.0217	0.7965	1.0238
SiK	31.64	20.35	49542.21	2.62	0.2590 0.2590	0.9267	1.0277	0.8803	1.0034
CaK	2.91	1.31	2105.25	2.71	0.0251 0.0251	0.8682	1.0551	0.9722	1.0220
FeK	0.15	0.05	41.62	30.77	0.0013 0.0013	0.7648	1.0631	1.0046	1.1145

EDS Spot 3

kV: 15 Mag: 200 Takeoff: 35 Live Time(s): 30 Amp Time(µs): 1.92 Resolution:(eV)134.

EDS Spot 3



eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	R	A	F
C K	6.78	11.11	800.73	9.90	0.0189 0.0189	1.1006	0.9515	0.2536	1.0000
O K	52.49	64.52	15903.49	8.55	0.1548 0.1548	1.0489	0.9730	0.2810	1.0000
NaK	0.21	0.18	138.16	13.09	0.0009 0.0009	0.9481	0.9984	0.4552	1.0044
MgK	2.66	2.15	2972.50	5.60	0.0159 0.0159	0.9630	1.0057	0.6173	1.0074
AlK	1.96	1.43	2461.50	4.64	0.0134 0.0134	0.9262	1.0125	0.7299	1.0124
SiK	14.78	10.35	19864.04	3.33	0.1152 0.1152	0.9454	1.0188	0.8172	1.0083
S K	0.44	0.27	479.36	5.40	0.0036 0.0036	0.9237	1.0303	0.8657	1.0217
K K	0.20	0.10	173.62	15.08	0.0019 0.0019	0.8716	1.0444	0.9703	1.0813
CaK	19.30	9.47	12949.95	1.97	0.1711 0.1711	0.8864	1.0483	0.9846	1.0157
CrK	0.25	0.09	90.44	11.98	0.0021 0.0021	0.7903	1.0584	0.9858	1.0519
FeK	0.91	0.32	228.55	7.59	0.0076 0.0076	0.7817	1.0586	0.9960	1.0739

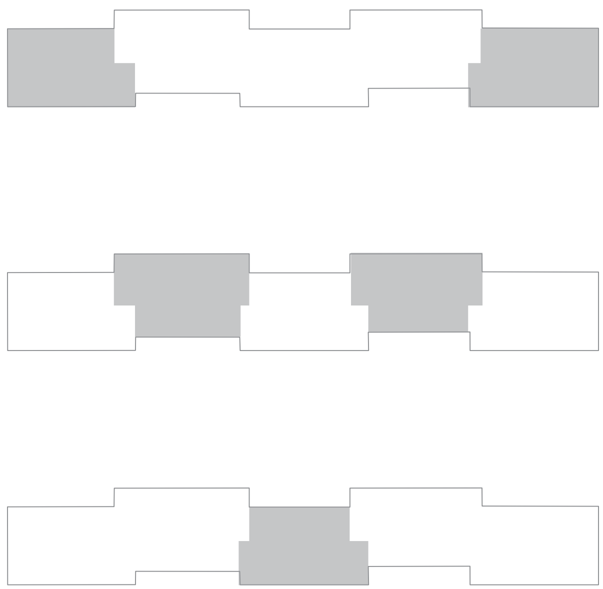
4.4. Color Palette Investigation

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-3 GUEST LODGE ROOMS 101-119

West



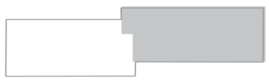
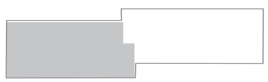
East

Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-4 GUEST LODGE ROOMS 121-127

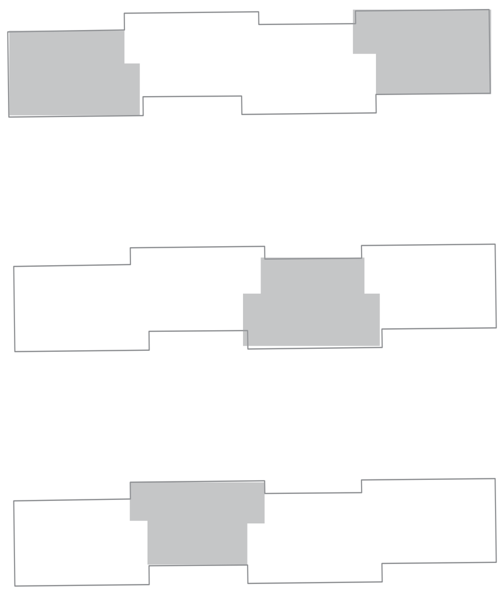
	Ra ers	Shingle	Door	Window	Carpentry
West 	7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
East 	7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-5 GUEST LODGE ROOMS 129-143

West



East

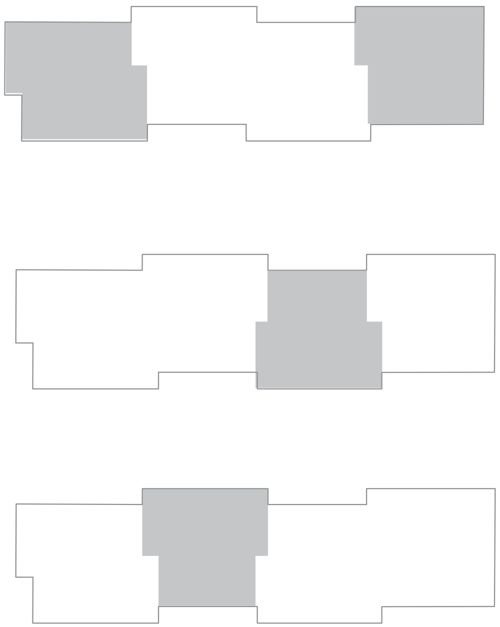
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-6 GUEST LODGE ROOMS 100-114 AND 301-305

West



East

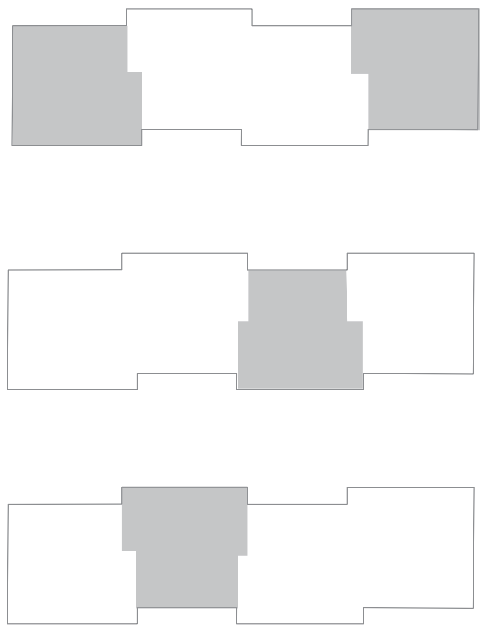
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-7 GUEST LODGE ROOMS 116-130 AND 317-331

West



East

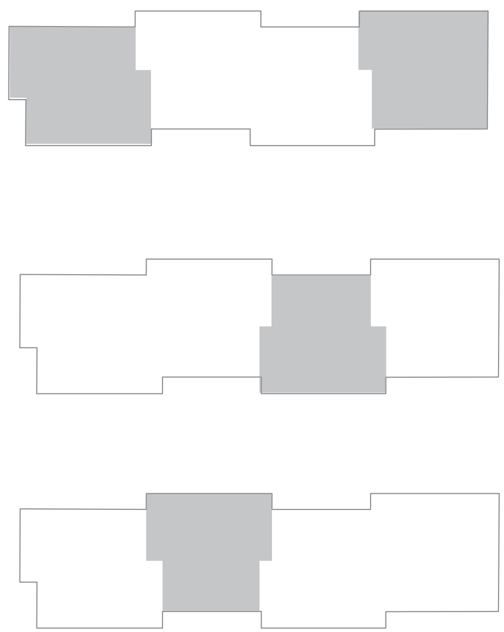
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

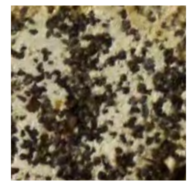
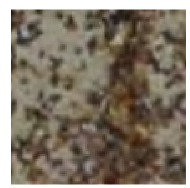
COLOR PALETTE INVESTIGATION

JL-8 GUEST LODGE ROOMS 132-146 AND 333-347

West



East

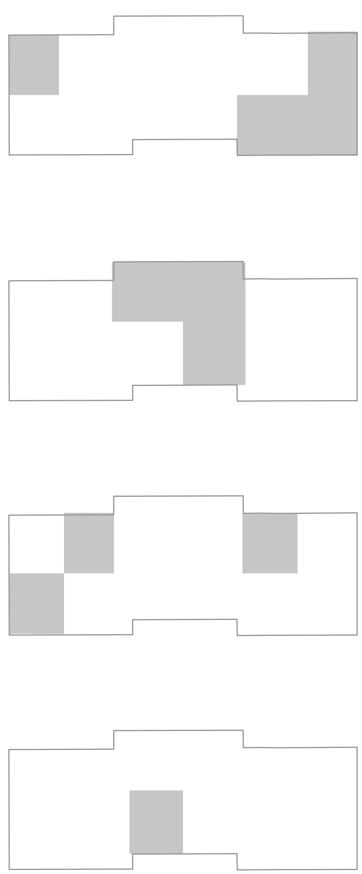
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-9 GUEST LODGE ROOMS 300-310 AND 501-511

West



East

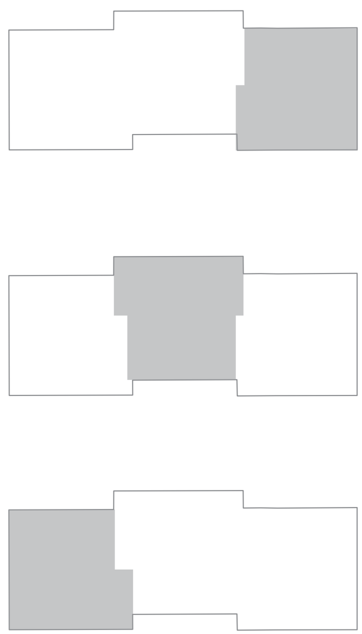
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-10 GUEST LODGE ROOMS 312-322 AND 513-523

West



East

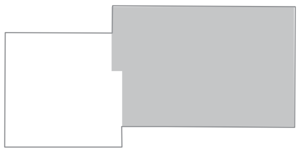
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2

JACKSON LAKE LODGE

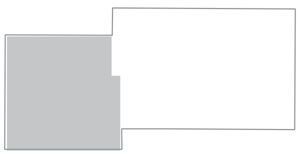
COLOR PALETTE INVESTIGATION

JL-11 GUEST LODGE ROOMS 324-330 AND 525-531

West



East



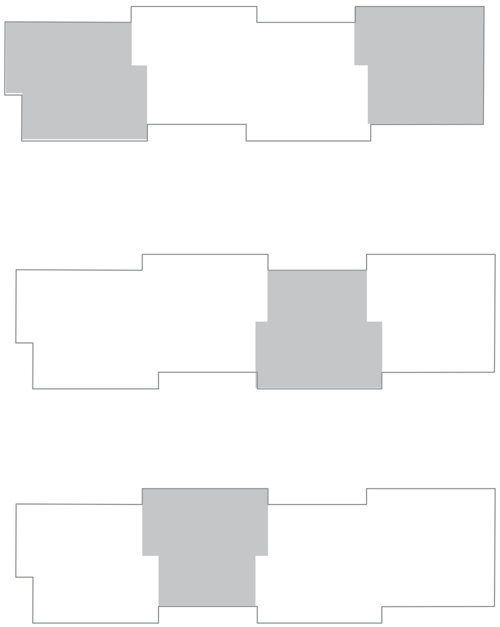
	Ra ers	Shingle	Door	Window	Carpentry
West	7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
East	7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-12 GUEST LODGE ROOMS 332-346 AND 533-547

West



East

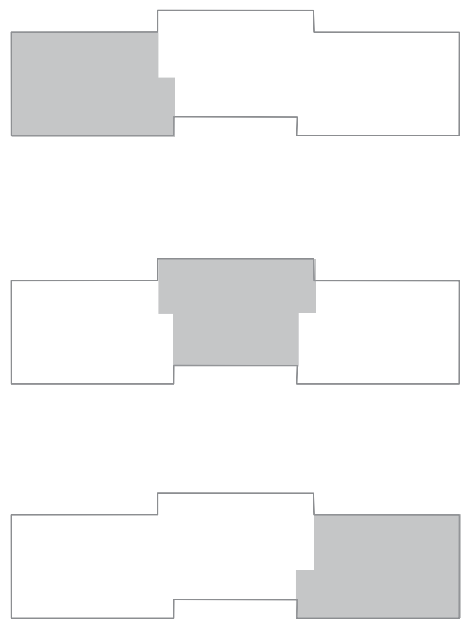
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2

JACKSON LAKE LODGE

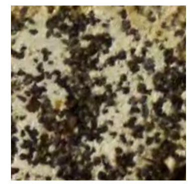
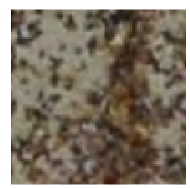
COLOR PALETTE INVESTIGATION

JL-21 GUEST LODGE ROOMS 201-211

West



East

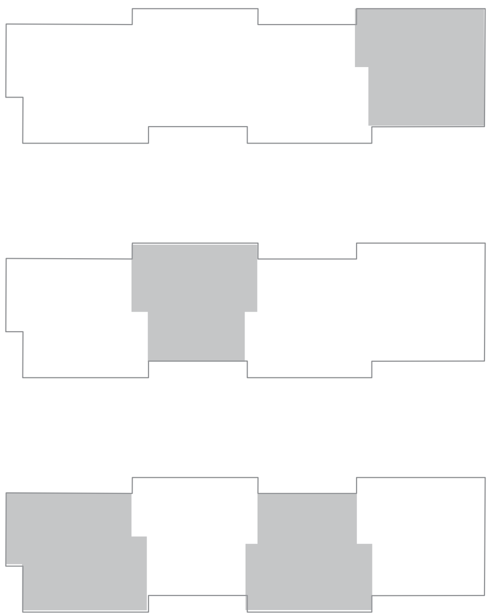
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2

JACKSON LAKE LODGE

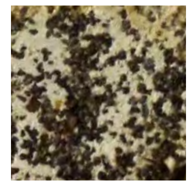
COLOR PALETTE INVESTIGATION

JL-22 GUEST LODGE ROOMS 200-214 AND 401-415

West



East

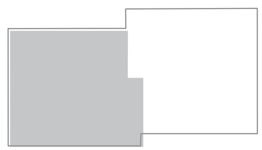
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2

JACKSON LAKE LODGE

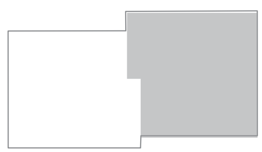
COLOR PALETTE INVESTIGATION

JL-23 GUEST LODGE ROOMS 216-222 AND 417-423

West



East



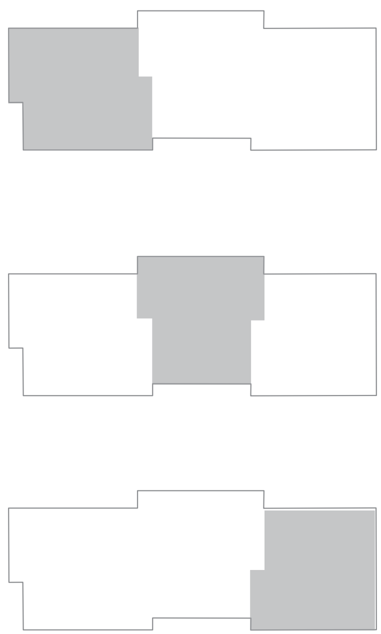
	Ra ers	Shingle	Door	Window	Carpentry
West	7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
East	7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-24 GUEST LODGE ROOMS 224-234 AND 425-435

West



East

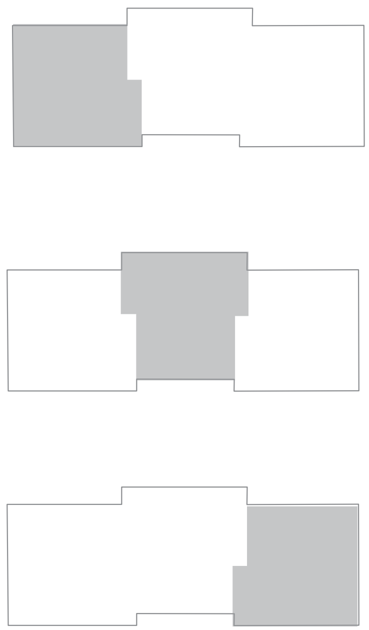
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-25 GUEST LODGE ROOMS 236-246 AND 437-447

West



East

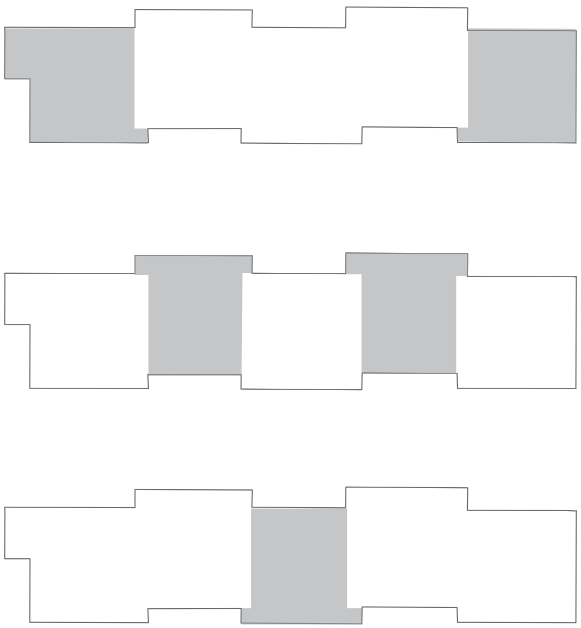
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-26 GUEST LODGE ROOMS 400-418 AND 601-619

West



East

Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2

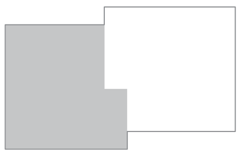
JACKSON LAKE LODGE

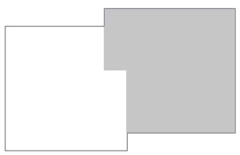
COLOR PALETTE INVESTIGATION

JL-27 GUEST LODGE ROOMS 420-426 AND 621-627

	Ra ers	Shingle	Door	Window	Carpentry
West	7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
East	7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

West





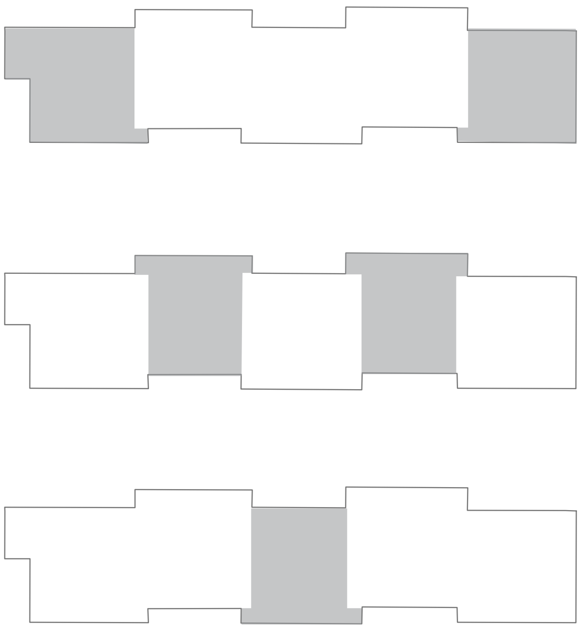
East

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-28 GUEST LODGE ROOMS 428-446 AND 629-647

West



East

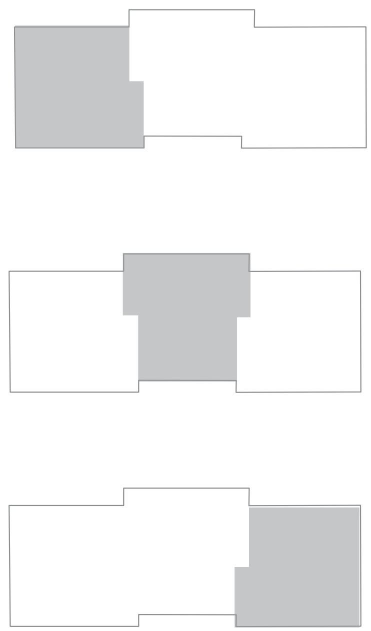
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-29 GUEST LODGE ROOMS 600-610 AND 801-811

West



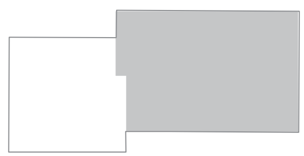
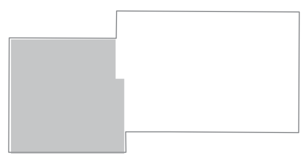
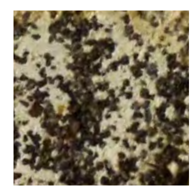
East

Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-30 GUEST LODGE ROOMS 612-618 AND 813-819

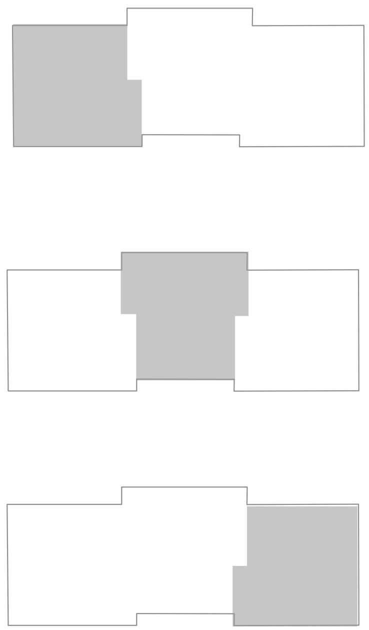
	Ra ers	Shingle	Door	Window	Carpentry
West 	7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
East 	7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

JACKSON LAKE LODGE

COLOR PALETTE INVESTIGATION

JL-31 GUEST LODGE ROOMS 620-630 AND 825-835

West

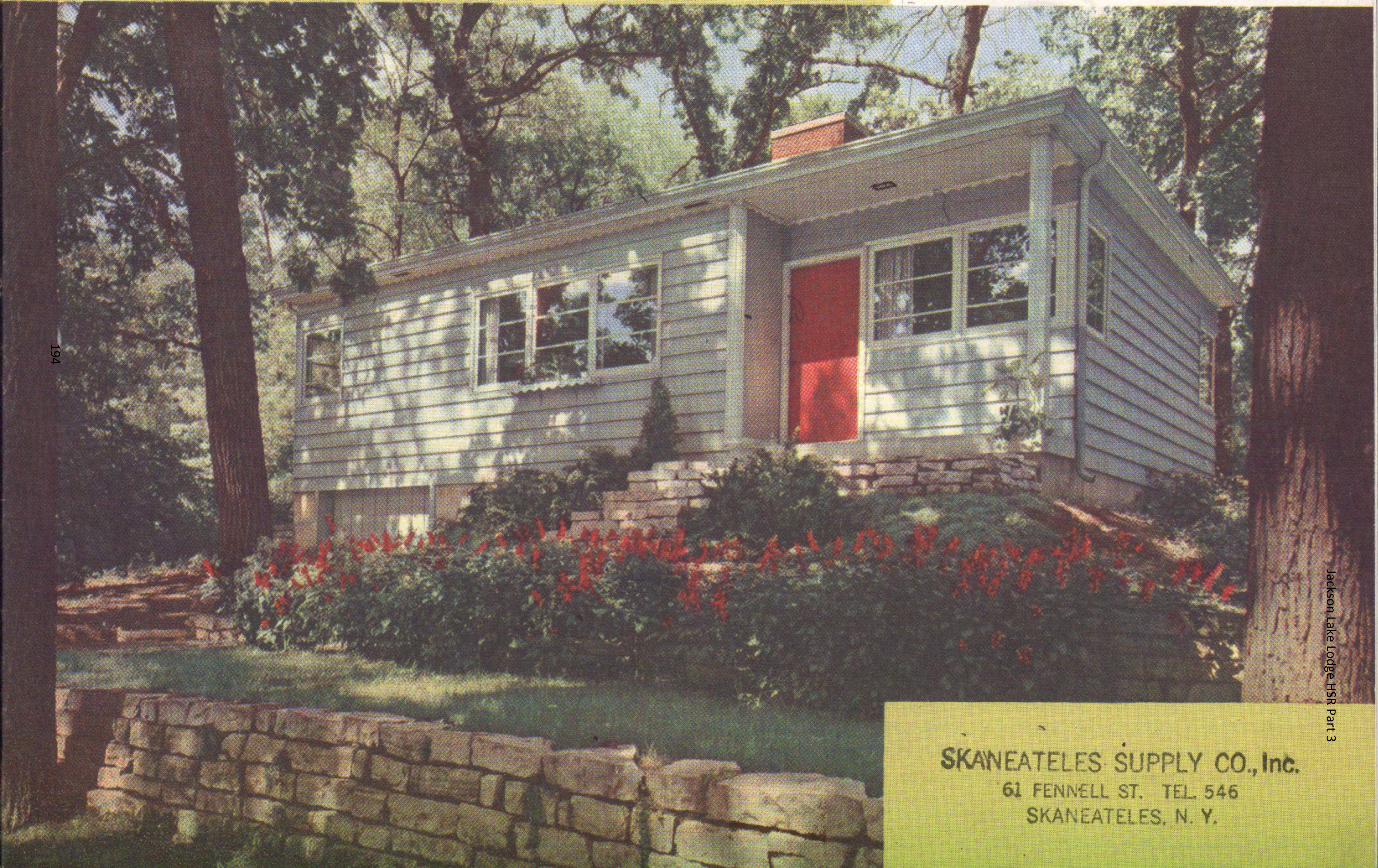


East

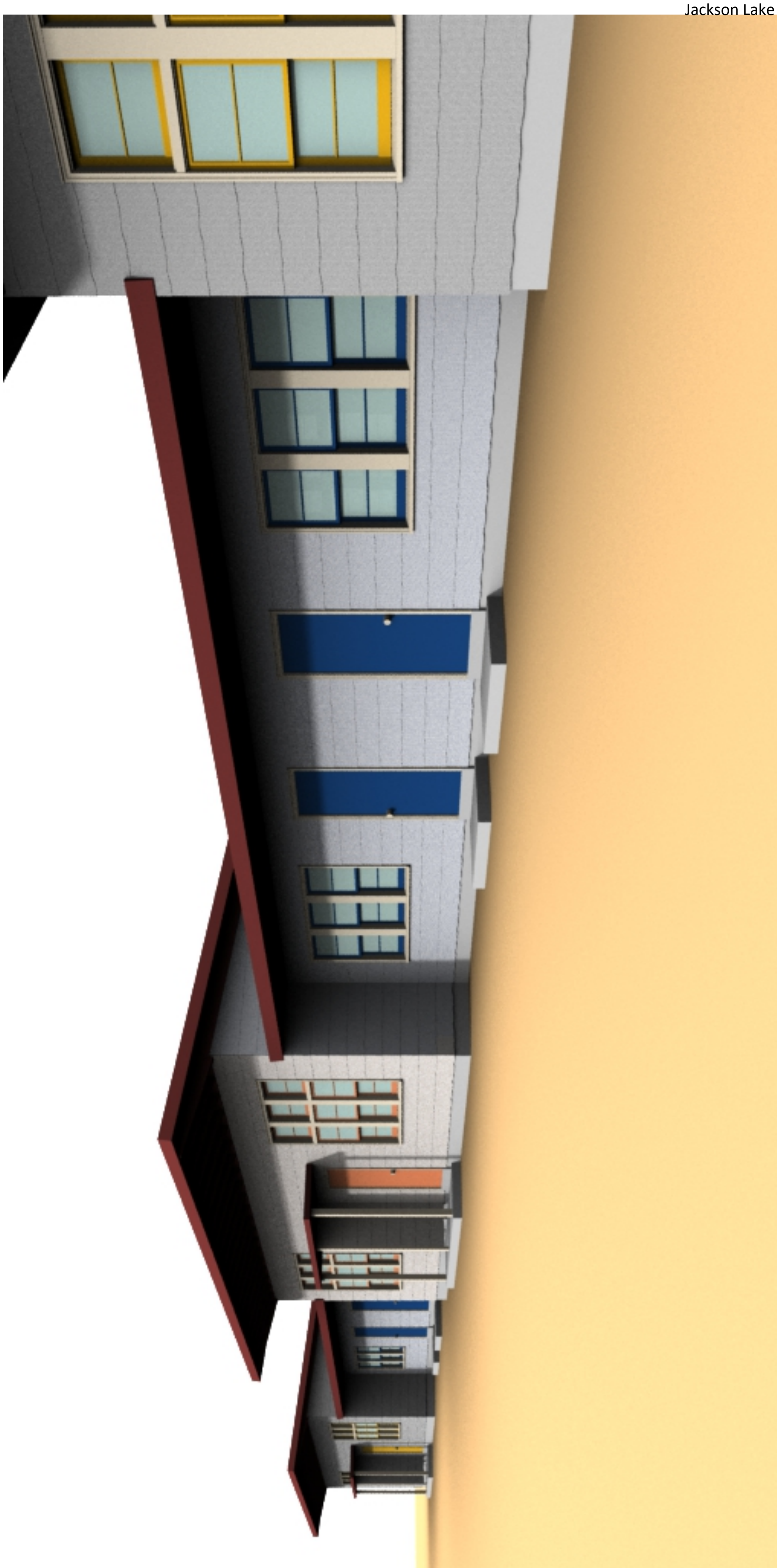
Ra ers	Shingle	Door	Window	Carpentry
7.5R 3/6		10 R 7/10	10 R 7/10	2.5 Y 8/2
7.5R 3/6		5 PB 3/8	5 PB 3/8	2.5 Y 8/2
7.5R 3/6		2.5 Y8/12	2.5 Y8/12	2.5 Y 8/2

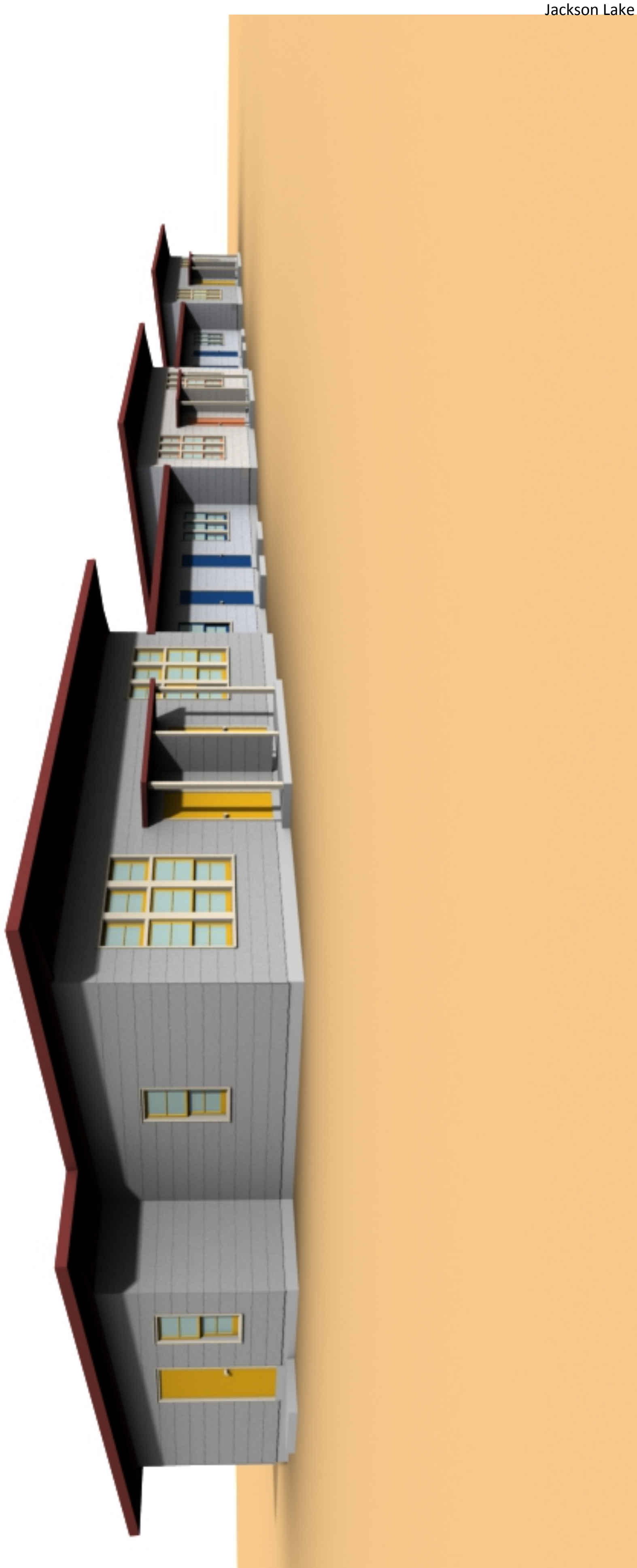
4.6. Guest Lodge Digital Model

Paint Right with COLOR DYNAMICS...Paint Best with PITTSBURGH PAINTS



SKANEATELES SUPPLY CO., Inc.
61 FENNELL ST. TEL. 546
SKANEATELES, N. Y.





4.T. Paint Removal Summer 2016

A. Central Lodge

After a meeting with Lori Spano, on Thursday June 30th, 2016, a GTLC preferred contractor, Color Quest, was contacted to proceed to remove the current coating on the concrete surfaces of the Central Lodge. The scope of this removal was to expose and assess the condition of original acid stains specified by Underwood, and to create an area feasible to test stains and mineral silicates as a previous step to prepare a final treatment recommendation. This effort paralleled GTLC interest on removing and creating a mock up area.

On Tuesday, July 12th, 2016, the contractor, with Lori Spano's approval, used a vapor abrasive blasting technique to remove the different types of coatings on the concrete on three locations at the north and south elevations. On the north elevation, the removal involved an area where original fabric meets the convention hall addition. On the south elevation, coating removal was performed on two locations at the side of the fire escape. Both areas hidden from the guest activity. Vapor Abrasive blasting is similar to dry blasting, except that the blast media is moistened prior to impacting the surface. This technique uses less abrasive media and does not produce dust.

Different blast pressures and abrasive media were tested: garnet at 30 psi, glass beads at 45 psi, and glass beads at 30 psi. Efficiency of the removal was visually evaluated. The team concluded that glass beads at 30psi removed the coating while at the same time fully retaining the Shadowood texture and revealing the original stains. Concrete substrate on the addition showed a different color and wood grain texture. Paint removal allowed better evaluation of the previous repairs as well as shrinkage cracks.

In addition, taking into account the possible health and safety risks to the applicator and to the environment, it is recommended the use of alternative methods such as the Sponge-Jet removal technique.

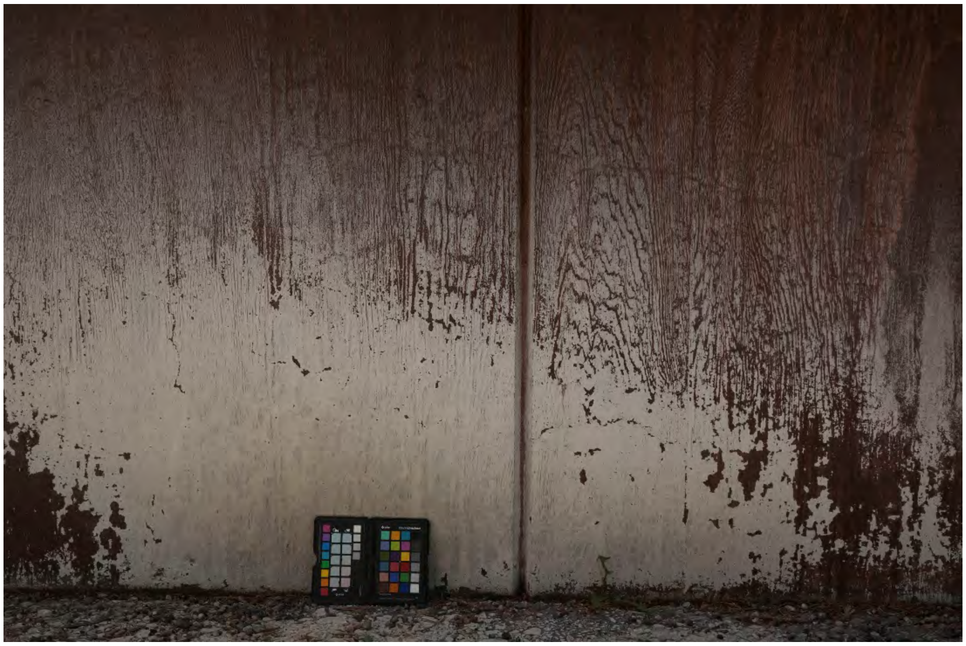


Fig. 23. Area prior to paint removal.

Fig. 24. Area after paint removal. Note the cementitious repair on the right.

Fig. 25. Close up view of the surface after paint removal.

Fig. 62. Contractor performing the removal with EcoQuip® EQm

B. Cement Shingles

Through Keim Mineral Silicates, a third party, Pete Stella from Star General, tested four paint removal techniques on a cement shingle sample provided by the Architectural Conservation Laboratory. The methods included microblasting removal with garnet (A) and sodium bicarbonate (B), and chemical stripping, including Fiberlock Piranha Nexstrip Pro (C) and acetone (D).

After a visual assessment, it appears that the sodium bicarbonate is gentler with the substrate. However, although it would seem to be a possible solution, the volume of soda required and the amount of time needed to accomplish the results you may desire are more than likely cost prohibitive. Also, this material is hazardous for the vegetation. Total fallout asbestos residue as a result of using microblasting techniques was not assessed. Total, negative air containment would be required initially to perform a mock up for blasting at least until a negative exposure assessment is obtained, if possible. Further testing to assess the potential hazards and fine-tune the methodology needs to be done.

Fig. 63. The photo on the right shows the blast areas by garnet (red arrows) and soda (white arrows). The black arrow shows the original finish of the shingle protected from paint by the overlapping of the upper shingle.

Fig. 64. This photo shows the area where a chemical stripper was used (blue arrows). A total of 4 application procedures were required to obtain the final finish. The yellow arrow shows the slightly cloudy area where acetone was used to further cleaning an area where the chemical stripper was used. The acetone seemed to have no effect on the final results other than giving a cloudy finish to an otherwise clean appearance.

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4.y. Tr ade Literature

VERDURA TRIM & SHUTTER FINISH

Modern exterior decoration calls for trim colors of unusual brilliance and permanence. The bright, permanent colors of Verdura Trim & Shutter Finish will greatly improve the appearance of the modest cottage or the more expensive residence. They are equally suitable for trimming larger structures, such as apartment and office buildings, hotels, schools, hospitals and industrial plants.

These exceptionally durable colors are intended for shutters, doors, sash, trim and similar exterior surfaces. While somewhat higher in price than house paint, their greater spreading capacity and unusual durability make them a very economical finish. Made with the very finest of pure pigments and specially treated linseed oil, Verdura Trim & Shutter Finish has unusual hiding and retains its color and gloss for a long time.

On new wood apply a first coat of P&L House Paint Exterior Primer in accordance with directions on the can. This should be followed by a coat of Verdura Trim & Shutter Finish, each gallon thinned with one pint of turpentine. Then apply a finish coat of Verdura Trim & Shutter Finish in the consistency supplied. On old work apply a coat of P&L House Paint Exterior Primer followed by a coat of Verdura Trim & Shutter Finish in the consistency supplied. If the surface is in good condition and only one coat is required, omit Primer and apply Verdura Trim & Shutter Finish in the consistency supplied.

The U. S. standard gallon covers approximately 1200 square feet; one Imperial gallon covers approximately 1450 square feet.

380 — NEPTUNE GREEN

381 — SPRING GREEN

382 — HUNTER GREEN

384 — SPRUCE GREEN

373 CRANBERRY RED

375 SPANISH BLUE

374 BEAVER BROWN

FOR BODY COLORS AND OTHER TRIM COLORS, REFER TO THE PRATT & LAMBERT HOUSE PAINT COLOR CARD

DO NOT GAMBLE WITH CHEAP PAINTS OR VARNISHES THEY ARE COSTLY AT ANY PRICE

REGISTERED

PL

TRADE MARK

REMEMBER THIS TRADE MARK

This trade mark represents honest paint and varnish, made on a quality basis, to provide most economical results to the home owner.

When considering comparative costs of paint and varnish, remember that the expense of applying an inferior product is the same as the expense of applying a paint or varnish that will last two, and in some cases three times as long.

Real economy in paint and varnish is not based on the price per gallon but on the amount of surface each gallon will cover and on the number of years of satisfactory service.

Paint and varnish quality becomes evident only after it is applied and subjected to a long period of exposure. Thus, real economy and satisfaction in paint and varnish can be obtained only by using dependable products of a recognized standard of quality.

For the outside of the house, for the interior walls, floors and furniture — for everything in and about your home, there is a Pratt & Lambert paint, varnish or enamel especially designed to do that particular job better — to insure the utmost in beauty, durability and economy.

Whatever your paint, varnish or enamel job may be, let the name Pratt & Lambert and the trade mark shown above be your assurance that you will receive the **maximum** in beauty and protection at the **minimum ultimate cost.**

PRATT & LAMBERT-INC.
Paint & Varnish Makers
NEW YORK BUFFALO CHICAGO
FORT ERIE, ONTARIO

Pratt & Lambert Press — U S A PGC448

JOHNS-MANVILLE

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CLEVELAND 45 Prospect Ave., N. W.

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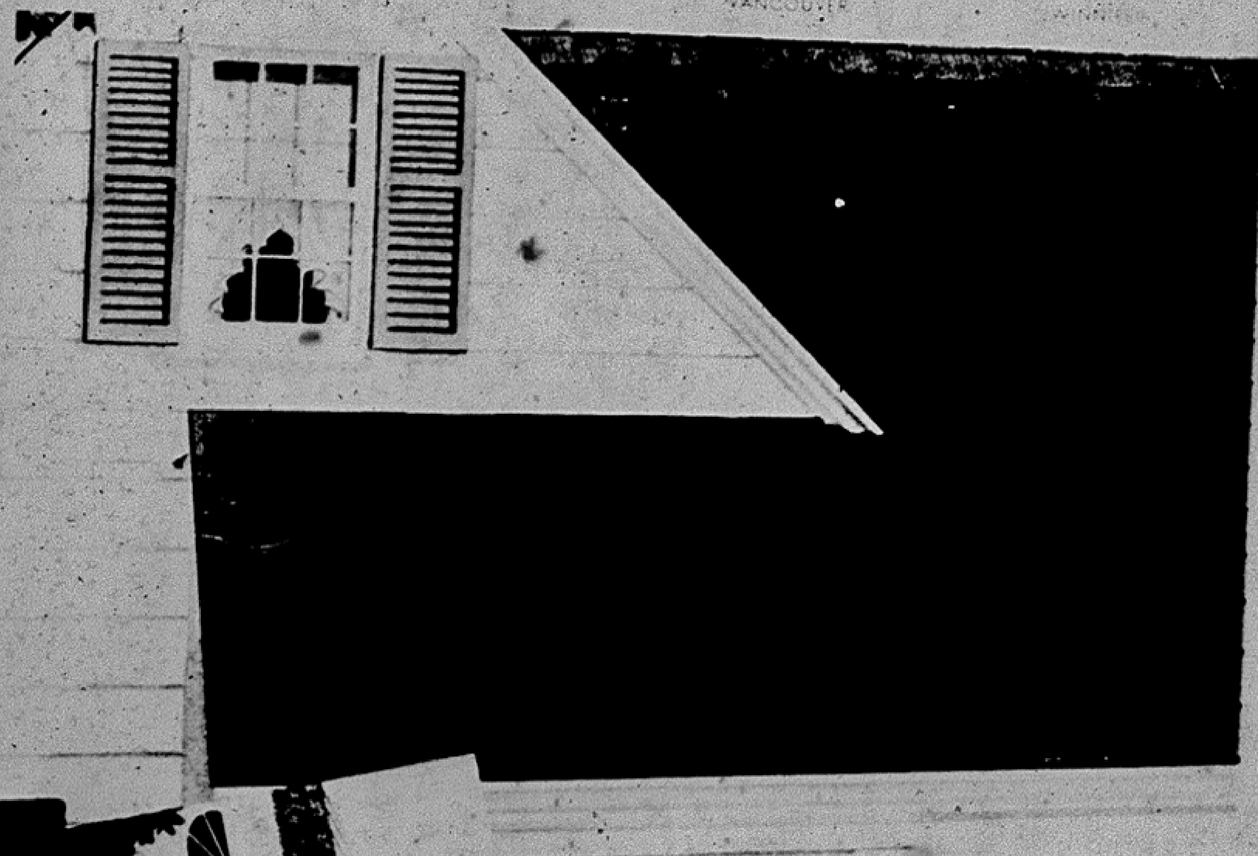
LOS ANGELES 816 West 5th St.
MILWAUKEE 757 North Broadway
NEW ORLEANS 200 Carondelet

NEW YORK [illegible]
PHILADELPHIA [illegible]
ST. LOUIS [illegible]
SAN FRANCISCO [illegible]
SEATTLE [illegible]

IN CANADA
MONTREAL TORONTO VANCOUVER WINNIPEG



J-M American Colonial Shingles in Red Blend. Above Green Blend

JOHNS-MANVILLE AMERICAN COLONIAL ASBESTOS ROOFING SHINGLES

For many years, all the skill and ingenuity of the J-M Research Laboratories have been focussed on the objective of a roof that was more durable and more attractive, yet priced so low that it would be within the budget of any home owner. This objective has been reached with Johns-Manville American Colonial Asbestos Shingles. Thousands of squares now in service all over the country on all types of buildings testify to their ready acceptance by architects and owners.

These shingles, made of two minerals — asbestos and cement — have the mellow beauty of graining and texture of fine old weathered wood, yet freedom from fire risk — from rot — from expensive maintenance. Theirs is the clean-cut shadow lines, the simplicity and dignity of form invariably associated with their name "Colonial."

To beauty of design has been added beauty of color. American Colonial Shingles are offered in a soft green blend which harmonizes with natural surroundings, a warm red blend which gives that distinctive contrasting touch and a blended black that is new and modern. There is also a white that is most suitable for southern homes and a natural gray.

The answer to the problem of lower application cost is found in the size and shape of the American Colonial Shingle. It is an asbestos strip shingle which, on the roof, covers as much area as the five ordinary shingles it appears to be. Yet it is applied in one operation, self-aligned. In actual tests, American Colonial Shingles required only slightly more time to apply than the fastest-laying asphalt strip shingle and far less than any other asbestos shingle which could afford equal protection.

Black Blend, a great favorite among the American Colonial Shingles

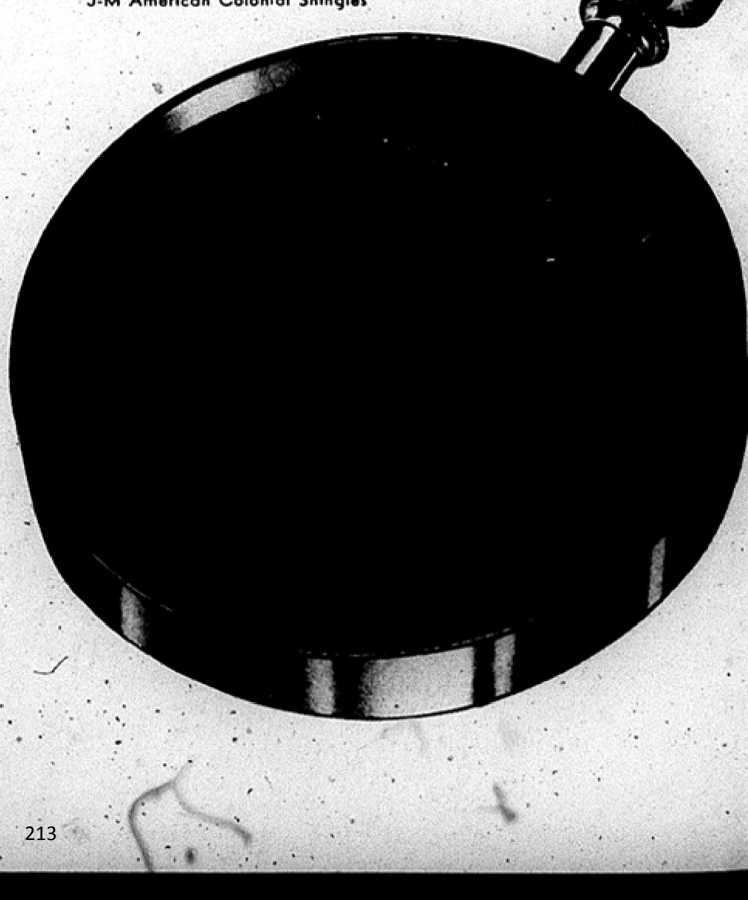
J-M American Colonial Asbestos Shingles are laid with a 6" exposure and carry the Underwriters' Class B label. Eaves starters and hip and ridge shingles are available in matching colors.

Only 4 nails are required in each American Colonial Shingle. In this view, the starter course has been applied, the felt has been laid and the first course started . . . right over the old roof.

The pre-fabricated "strip" can be applied in a fraction of the time it would take to lay the 5 individual shingles it resembles. The corner of each strip lines up with the center point of the previous shingle. Alignment is simple and accurate.

Where it is necessary to cut shingles to fit along valleys; at the ridge; around dormers, etc., a shingle cutter, as shown, available from your dealer, cuts these American Colonial Shingles in a clean, quick and efficient manner.

Close-up showing texture and graining of J-M American Colonial Shingles



JOHNS-MANVILLE ASBESTOS SIDING SHINGLES PROVIDE A BEAUTIFUL EXTERIOR

Johns-Manville Asbestos Siding Shingles have all the beauty of texture found in the graining of weathered wood shingles and have made this charm available in a lasting, fireproof material — as permanent as stone.

J-M Asbestos shingles will not rot, corrode, split or burn. They do not need periodic painting to preserve them. Yet, with all their advantages of beauty, fire protection and durability, these shingles cost no more applied than most other types of siding of comparable durability. When used for re-siding, they can be applied directly over the old wood siding. When combined with a roof of J-M American Colonial Shingles, they complete the protection of the exterior of the building from fire and weather.

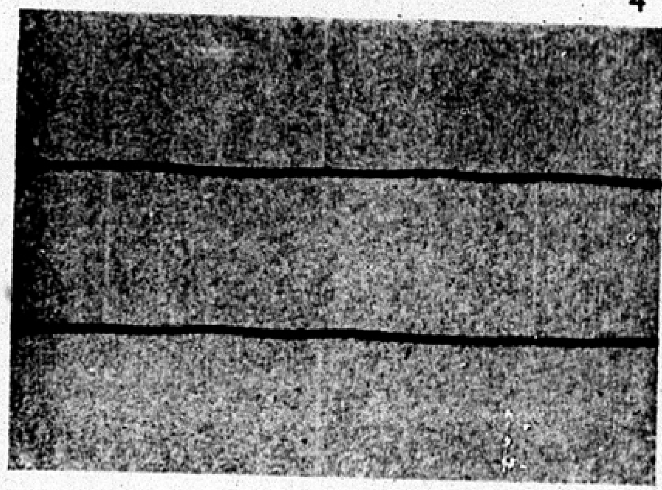
Permatone Colors

The Permatone Shingles have a textured surface that has all the charm and interest of fine weathered wood. And this pleasing texture, combined with soft pastel colors, provides a shingle for exterior walls that is completely distinctive in appearance. In addition these shingles are highly resistant to soiling in spite of long years of exposure to the weather. Especially recommended for industrial cities where smoke and soot are prevalent. Colors available are light green, light buff, and silver grey.

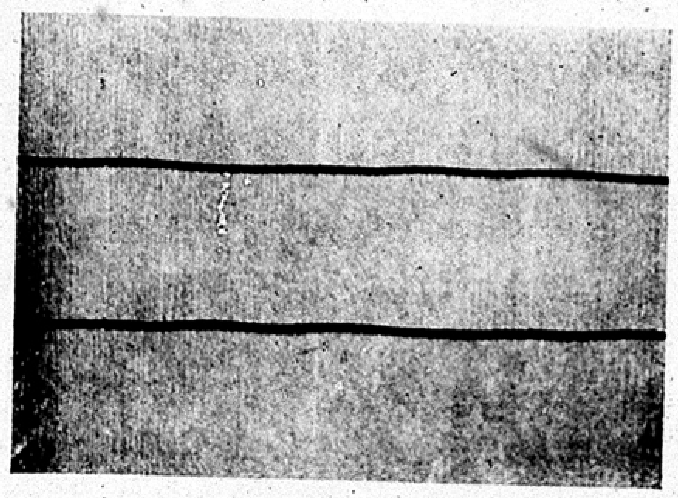
Dover White

The Dover White Shingle is an attractive clear white with the cedargrain texture of weathered wood.

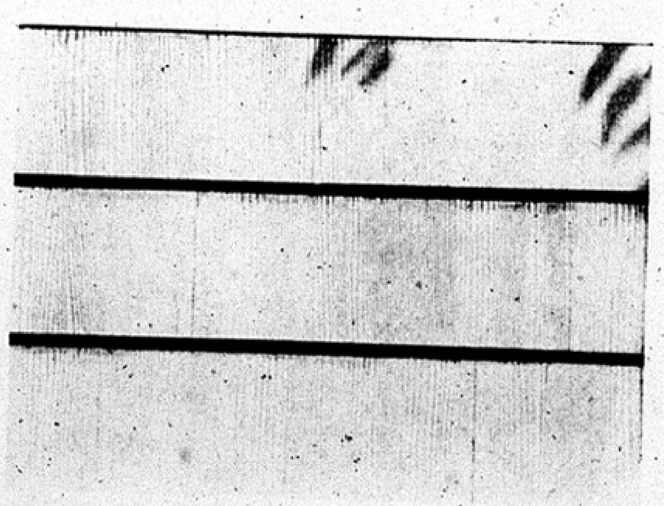
Both *Permatone* and *Dover White* Shingles are furnished with a wavy edge, a straight edge, or a staggered edge.



Permatone Light Green Asbestos Siding Shingles (Also available in Silver Gray)



Permatone Light Buff Asbestos Siding Shingles



Dover White Asbestos Siding Shingles

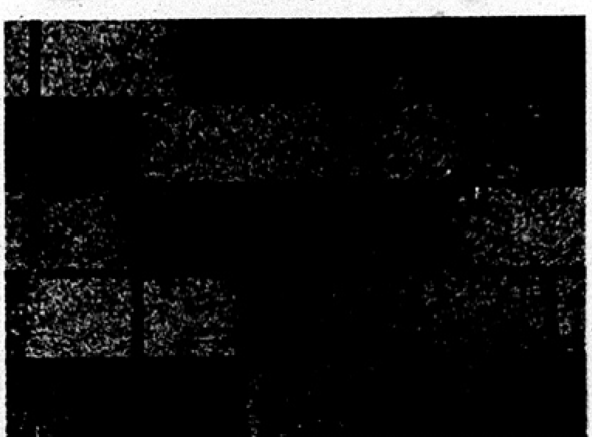
JOHNS-MANVILLE ASPHALT ROOFING AND SIDING SHINGLES

Johns-Manville Asphalt Shingles are made of heavy felts saturated with the finest asphalt and surfaced with crushed mineral. They are made as strip shingles, both American and Hexagonal styles, and as individual shingles, Dutch Lap and Hexagonal styles. These shingles are made in a variety of colors, including monotones and blends. We particularly recommend the new Giant Asphalt Strip Shingle because of the extra protection.

All J-M Asphalt Roofing Shingles listed in the J-M Building Material catalog carry the Underwriters' Class C label.

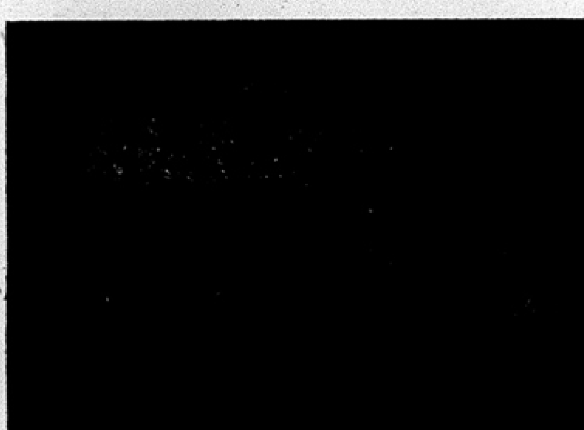
Complete data on colors, sizes, weights, exposure, etc., may be had on request at any Johns-Manville office.

J-M Asphalt Shingles give a colorful, long-lived roof at low cost

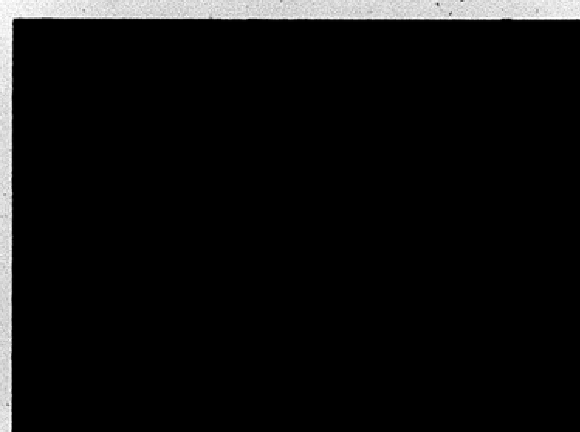


Slate Blend

Blue Blend



Green Blend



Red Blend

Aug. 10, 1948. H. J. OTIS ET AL 2,446,782

MANUFACTURE OF CEMENTITIOUS SHEETS

Filed Jan. 26, 1946

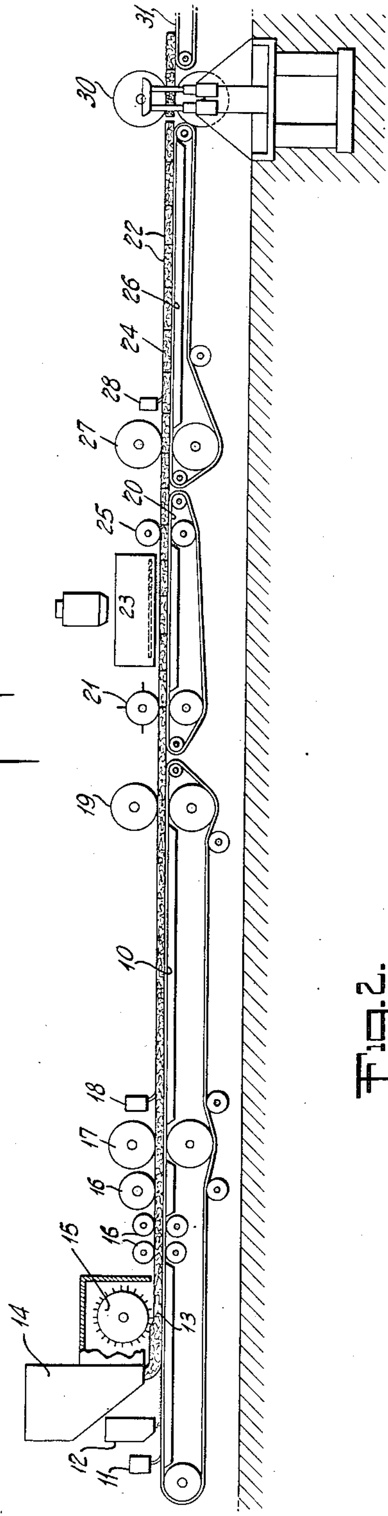


Fig. 1.

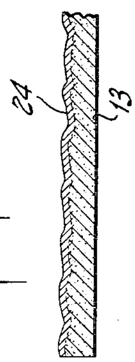


Fig. 3.

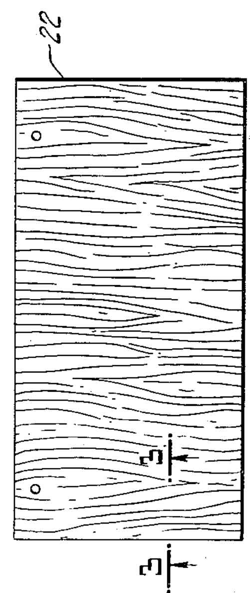


Fig. 2.

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JACK HESSE.
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ATTORNEY

Patented Aug. 10, 1948 2,446,782

UNITED STATES PATENT OFFICE

2,446,782

MANUFACTURE OF CEMENTITIOUS SHEETS

Harold J. Otis, New Orleans, and Jack Hesse, Gretna, La., assignors to Johns-Manville Corporation, New York, N. Y., a corporation of New York

Application January 26, 1946, Serial No. 643,798

5 Claims. (Cl. 18—60)

1

This invention relates to the manufacture of hard and dense fibro-cementitious sheets, and is particularly concerned with an improved method of developing a tough decorative smoothly textured veneer coating for asbestos-cement shingles and siding units.

One method heretofore employed for imparting a decorative finish to the weather-exposed surface of an asbestos-cement shingle or siding unit has involved the steps of forming a thin coating including clean short asbestos fibers, finely divided mineral pigment and hydraulic cement binder, on the top surface of a moist compressible asbestos-cement base sheet, sprinkling coarse granular material as a parting layer over the surface of the thus applied veneer coating, strongly compressing the composite uncured sheet so formed and simultaneously embossing a pattern on the veneer surface, and finally trimming the composite sheet and curing it to develop a hardening set of the cement binder.

Use of coarse sand, slate particles or other coarse granular material as a parting and surfacing medium performs the desirable function of preventing blistering of the veneer surface caused by sticking of the moist veneer to the embossing plates or grain rolls. The granular parting agent also prevents the development of cracks in the veneer under the high pressures applied by the embossing plates or grain rolls during the densifying and embossing operations. However, the presence of coarse granular material at the veneer surface of the finished shingle or siding sheet imparts to said surface a comparatively rough and coarse texture and undesirable non-uniformity of color, since the color of such coarse granular material is not uniform and does not match that of the veneer. Moreover, the rough texture of a granular surface increases the susceptibility of such surface to collection of dust and soil and to undesirable staining and rapid deterioration of color on exposure to moisture or weather.

A principal object of the present invention is to provide a method of developing a tough decorative veneer coating of smooth texture for a structural fibro-cementitious sheet while avoiding difficulties with formation of surface blisters or cracks in the veneer during high pressure densifying and embossing operations on the composite sheet product. Another object is to provide an efficient and economical method of manufacturing hard and dense veneer coated asbestos-cement sheets of improved color stability and

2

surface texture while avoiding use of coarse granular coating and surfacing material.

With the above objects in view, the invention consists in the improved method of manufacturing hard and dense composite fibro-cementitious sheets which is hereinafter described and more particularly defined by the accompanying claims.

In the following description reference will be made to the attached drawings, in which:

Fig. 1 is a diagrammatic assembly view of apparatus adapted for manufacturing fibro-cementitious sheets in accordance with the present invention;

Fig. 2 is a face view of an embossed composite sheet of the type produced by the process; and

Fig. 3 is an enlarged sectional view taken on the line **3—3** of Fig. 2.

Important features of the present invention include the steps taken to effect preliminary consolidation and uniform moistening of originally dry base layer and veneer coating layer compositions so as to produce a dense composite veneer surfaced and embossed asbestos-cement sheet having a soil resistant surface of smooth texture, while avoiding use of coarse granular parting material at the veneer surface and also avoiding difficulties with formation of surface blisters or cracks in the veneer under the high pressure densifying and embossing operations performed on the composite sheet product.

A satisfactory method of manufacturing hard and dense asbestos-cement shingles or siding units in accordance with the present invention involves the following steps:

The top surface of an endless travelling belt **10** of canvas or the like is uniformly wetted with water, which may be supplied from a box **11** by a depending apron. The amount of water fed to the belt at **11** is only sufficient to wet the surface and material immediately in contact therewith. The water is distributed in such a way as to spread it evenly across the width of the belt. The top surface of the belt should be smooth. A small amount of finely divided sand may be spread over the surface of the belt by an applicator **12**. Such sand is used at this point to facilitate easy stripping of the asbestos-cement base layer from the belt beyond the initial press roll consolidation stage.

A dry base mixture including clean asbestos fibers and finely divided hydraulic cement is next distributed over the top surface of the belt in a layer **13** of sufficient thickness to yield a final product of between ⅛″ and ⅜″ thickness. The base mixture layer preferably includes finely divided silica. The dry mixture is deposited on the belt by means of a fluff box 14 in a layer 13 of as nearly uniform thickness as possible, and a picker roll 15 is operated to effect approximate levelling of the layer material.

Belt 10 is preferably operated to continuously advance the layer material at a speed of at least about 50 feet per minute. The layer is initially consolidated by the action of a number of perforate hollow press rolls 16, which rest on the layer material and effect removal of air therefrom by application of suction within the rolls. Further consolidation of the dry layer material is effected by passing it through the bite of a pair of press rolls 17 having smooth surfaces. After passing the press rolls 17, water is distributed over the layer material by an apron spreader 18 in amount approximately limited to that necessary to hydrate the cement in the base layer 13 and to impart to the base layer suitable plasticity for cutting under a cutter roll at a later stage of the operation.

After passing water spreader 18 the consolidated layer material 13 is carried for some distance along the upper surface of belt 10 before it is further compressed and consolidated by passing through the bite of a second set of smoothface press rolls 19. The spacing between water spreader 18 and press rolls 19 is preferably such as to afford a period of at least 30 seconds of elapsed time between application of the water to the surface of the layer material and its further consolidation under the press rolls 19, for thorough absorption and penetration of the water throughout the full thickness of the layer 13.

After passing press rolls 19 the consolidated layer material is transferred from belt 10 to a second short conveyor belt 20, which carries the layer material under a cutter roll 21. Cutter 21 divides the layer material into sheet segments or panels 22 which are of slightly larger area than the finished shingles or siding units into which the segments 22 are finally trimmed. After passing the cutter 21 and while still supported by the belt 20, the segments 22 advance beneath a vibrating screen feeder 23. Screen 23 is operated to distribute evenly over the top surfaces of the moistened base layer segments 22 a dry veneer coating mixture layer 24 comprising very short asbestos fibers or fiberized magnesium silicate, finely divided mineral pigment, and finely divided white Portland cement. The veneer mixture also preferably includes finely divided silica. The veneer is applied in a thoroughly mixed substantially dry state in an amount calculated to develop a thin veneer coating for the shingles, such coating to have a thickness of .015"–.022". Following the spreading of the dry coating layer 24 over the base layer 13, conveyor 20 advances the veneer-coated segments 22 beneath a perforate hollow roll 25 which operates to liberate air from the dry veneer coating and to uniformly spread and consolidate the layer material.

After passing the perforate roll 25, the composite segments 22 are transferred from the surface of conveyor 20 to the surface of a third conveyor belt 26. Belt 26 is operated at a somewhat increased rate of speed as compared with the speeds of belts 10 and 20, in order to take care of increases in the areas of the segments 22 which result from their consolidation to final dimensions under the pressures imposed thereon by the high pressure densifying and embossing operations. Conveyor 26 advances each segment 22 in turn through the bite of a pair of press rolls 27 which operate to substantially densify the dry veneer layer 24 and to develop an initial bond between the veneer layer and the moist base layer of each segment.

On its discharge from the press rolls 27, each segment 22 passes beneath a water spreader 28, which delivers to the consolidated veneer surface sufficient water to effect hydration of the cement component of the veneer layer. Conveyor 26 then delivers the moistened veneer coated segments 22 to a set of hydraulically actuated grain rolls 30, by means of which the consolidated segments are placed under pressures of the order of 5000–10,000 lbs. per square inch to effect final densification of the segments to suitable shingle thickness. The distance separating water spreader 28 from the bite of grain rolls 30 is preferably such as to afford a time period of at least approximately 20 seconds to secure penetration and absorption of the water applied at 28 through the full thickness of the dry veneer layer material.

The upper one of the pair of grain rolls 30 is preferably an embossing roll having on its surface a pattern of projections which operate to emboss a corresponding pattern of indentations on the veneer faces of the composite sheet segments. During the compressing and embossing operation the top grain roll 30 develops a negative of its pattern as irregularities in the face of the veneer 24 and also in the face of the base sheet 13. In other words, the embossing operation develops alternate elevations and depressions in the top surface of the base layer to match conforming irregularities on the lower surface of the veneer, as shown in Fig. 3. Thus by this embossing operation the veneer coating is keyed in with and locked to the base sheet over the complete area of the composite sheet.

The final cure of the consolidated sheets may be carried out by normal air curing methods. Such air curing is initiated after the segments have passed the bite of the grain rolls 30 and have been accepted by a takeoff conveyor 31. In the event that the sheet segments incorporate in their structure a substantial proportion of finely divided silica as well as Portland cement, the final cure is preferably effected by confining the segments 22 in a closed autoclave in the presence of saturated steam at pressures of 75–150 lbs. per square inch. Complete cure may be effected under these steam-curing conditions in periods of less than 24-hour length. The curing operation develops a strongly bonded composite sheet in which the veneer adheres strongly to the base 13.

When the sheet segments do not incorporate silica in their composition, they are preferably cured by prolonged exposure to moist air at substantially normal temperature. Even though the segments 22 are finally subjected to a steam cure, they are preferably given an initial air cure to develop a preliminary air set before being trimmed to precise dimensions. Thus the segments leaving the bite of the grain rolls 30 are allowed to stand at normal atmospheric temperature for a period of two to five days, after which they are trimmed and punched to final dimensions and form. This trimming and punching is carried out at this stage prior to the final heat-hardening stage, without encountering substantial difficulties with cracking or chipping of the veneer layer or with separation of the veneer from the base.

The composition of the base layer 13 may include Portland cement and asbestos fibers in approximately the proportions normally used in the manufacture of asbestos and cement shingles, say 60–120 parts asbestos fibers to 100 parts of the cement. The base sheet composition may also include 30–70 parts of finely divided silica to 100 parts of cement. A suitable size classification of asbestos fibers for the base layer 13 is aproximately 50% retained on a 10 mesh screen and 50% through a 10 mesh screen by the standard Quebec wet screen test.

The proportion of short asbestos fibers in the veneer coating preferably lies in the range 10–20% of the dry weight of the veneer. The fibers in the veneer coating are preferably much shorter than those in the base. Such fibers may classify at least 90% through a 10 mesh screen. A preferred dry veneer formula for a white shingle includes approximately 10% by weight of highly refined and short asbestos fibers, 20% white Portland cement, 25% white silica flour, 17% hydrated lime, 25% finely divided white fibrous magnesium silicate (Asbestine), and 2–5% titanium oxide. The cement, silica, lime and pigment should all have particle sizes finer than 200 mesh. For colored shingles, pigments such as chrome oxide or iron oxide may be substituted in the above formula for titanium oxide.

Maximum production of shingles or sheets of satisfactory durability is obtained when the relative weight of the veneer represents a definite small fraction of the total weight of the shingle. In other words, the most durable shingle is one with a thin veneer coating (approximately .025–.05 inch thick for shingles of ⅛–⅜ inch thickness and 350 square inches surface area).

The embossing operation is best practiced when employing a grain roll which applies full pressure evenly over the width of the shingle segment and on which the projections forming the pattern are of rounded rather than sharp contour and are so dimensioned as to develop indentations in the sheet surfaces of not to exceed .020″–.025″ depth. In embossing indentation patterns having a maximum depth in the indicated range, it has been found that segments 22 having veneer coatings which have been strongly compressed and lightly moistened throughout before reaching the grain roll, can be suitably densified and embossed under the high pressure of the grain roll without sticking to the grain roll. Application of fairly high pressure to the dry veneer under rolls 27 actually facilitates penetration of moisture applied by spreader 28 through the veneer, and thereby insures suitable grain roll densification without developing cracks in the veneer or blisters at the veneer surface. The press rolls 27 which consolidate the dry veneer layer just prior to its being wetted by spreader 28, should be operated to apply pressures as high as 700–800 lbs. or more per inch of width to the sheet segments, in order to promote substantial uniform penetration of water from the underlying base layer and from the spreader 28 into the dry veneer.

The amount of water applied to the base layer by spreader 18, and to the veneer by spreader 28, is limited to that necessary to satisfy the cement in the composite shingle, without providing any substantial excess. If too much water is added at either of points 18 or 28, difficulty is encountered with sticking respectively at the press rolls 19 and at the grain rolls 30. If not enough water is added at either of these points, a weak cementitious bond is developed and poor adherence is secured between the veneer coating and the base layer. The water spreaders 18 and 28 should be spaced respectively as far in advance of the press rolls 19 and grain rolls 30 as is practicable with a continuous equipment layout of the type pictured in Fig. 1, in order to allow adequate time for the water to penetrate by absorption throughout the layers of dry material before such layers are subjected to the high compression of the press and grain rolls.

Since many variations may be made from the illustrative details given, without departing from the scope of the invention, it is intended that the invention should be limited only by the terms of the claims interpreted as broadly as consistent with novelty over the prior art.

What we claim is:

1. In manufacturing asbestos-cement shingles the steps comprising, forming a base layer including a dry mixture of asbestos fibers and hydraulic cement, deaerating and compressing the layer material, moistening the material with sufficient water to hydrate the cement, continuously advancing the layer while allowing the water to penetrate uniformly therethrough, applying to said moistened base layer a veneer coating including an intimate dry mixture of short asbestos fibers, finely divided mineral pigment and finely divided hydraulic cement, deaerating and strongly compressing said veneer coating and moistening the same while advancing the veneer coated sheet at a rate of at least 50 ft. per minute and allowing a period of at least 20 seconds for the moisture to penetrate throughout the veneer coating, highly compressing the composite shingle, and developing a hardening set of the cement binder.

2. The method of manufacturing a composite dense and hard structural sheet which comprises, forming a base layer including an intimate dry mixture of asbestos fibers, finely divided silica and Portland cement, compressing the base layer material and wetting it with sufficient water to hydrate the cement, continuously advancing said base layer material while allowing a period of at least 30 seconds for moisture penetration therethrough, further consolidating the moist base layer material, distributing over the face of said moist base layer a veneer coating including an intimate dry mixture of particles most of which are finer than 200 mesh comprising silica, Portland cement, mineral pigment and fibrous magnesium silicate, strongly compressing the dry veneer coating and moistening it with sufficient water to hydrate the cement component thereof, advancing the veneer coated sheet while allowing a period of at least 20 seconds for the moisture to penetrate throughout the coating layer, highly compressing the composite sheet while forming a pattern of impressions in the veneer coating which extends into the base layer, and curing the densified sheet by heating it in an atmosphere of saturated steam under superatmospheric pressure.

3. The method of manufacturing hard and dense veneer coated shingles while inhibiting development of surface blisters and cracks in the veneer which comprises, uniformly distributing over the moist face of a compressible uncured fiber-cement base sheet a thin coating layer comprising a dry mixture of finely divided mineral pigment and finely divided hydraulic cement, moistening said coating layer with sufficient water to hydrate the cement, allowing a period of at least 20 seconds for the moisture to penetrate

throughout the coating layer material, highly compressing the composite sheet thus formed, and curing the composite sheet to develop a hardening set of the cement binder.

4. In manufacturing a hard and dense shingle the steps comprising, forming a base sheet of moist compressible fiber-cement composition, distributing on said sheet a veneer coating including a dry mixture of finely divided mineral pigment, fibers and finely divided hydraulic cement, strongly compressing said veneer material and moistening it with sufficient water to hydrate the cement component thereof, continuously advancing the veneer coated green sheet while allowing a period of at least 20 seconds for the moisture to penetrate throughout the veneer coating, subjecting the moist compressible composite sheet to compression of the order of at least 5000 lbs. per square inch and simultaneously impressing on the surface of the sheet a pattern of indentations which extend into the base sheet, and finally trimming the sheet and curing it to develop a hardening set.

5. The method of manufacturing a composite dense and hard structural sheet which comprises, forming a base layer including an intimate, dry mixture of asbestos fibers, finely divided silica and Portland cement, uniformly wetting the base layer with sufficient water to hydrate the cement, applying to a face of said layer a veneer coating including a dry mixture of finely divided silica, fibrous magnesium silicate, mineral pigment and hydraulic cement, compressing the veneer coated composite sheet and moistening the veneer coating with sufficient water to hydrate the cement, allowing a period of at least 20 seconds for the water to penetrate throughout the veneer coating, compressing said composite sheet and embossing the veneer surface, and developing a hardening set of the cement binder.

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