National Park Service
U.S. Department of the Interior

George Washington Memorial Parkway
Arlington, Virginia

Arlington House, The Robert E. Lee Memorial

South Slave Quarters
Historic Structure Report Part 3 and Preservation Maintenance Plan

US Department of the Interior • National Park Service • Park Planning, Facilities, and Lands • Historic Preservation Training Center

The historic structure report presented here exists in two formats. Traditional, printed versions are available for study at George Washington Memorial Parkway and the Historic Preservation Training Center of the NPS. For more widespread access, the historic structure report also exists in a web-based format through the National Park Service Electronic Technical Information Center (eTIC). Please visit https://pubs.nps.gov for more information.

Cover: South Slave Quarters, south elevation. Photo: HPTC.

Arlington House, The Robert E. Lee Memorial

South Slave Quarters
Historic Structure Report Part 3 and Preservation Maintenance Plan
May 3, 2024

Prepared By:

Historic Preservation Training Center

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TABLE OF CONTENTS

LIST OF FIGURES

PREFACE
Introduction
Scope and Objectives
Methodology
Project Participants

HISTORIC STRUCTURE REPORT PART 3: South Slave Quarters, Arlington House, The Robert E. Lee Memorial, 1985 – 2021
Introduction
Chronology of Treatments
Bibliography

APPENDICES
Appendix A Project Treatment Records
Rehabilitate Arlington House, Outbuildings and Grounds, 2006 – 2012
Arlington House, The Robert E. Lee Memorial Rehabilitation, 2017 – 2020
Treatment Record Template Forms

Appendix B Preservation Maintenance Plan and Inspection Forms
Including Comprehensive Inspection & Maintenance Form, Periodic Inspection and Maintenance Task Forms, Door and Window Schedules

Appendix C Referenced and Supplemental Information

Appendix D LiDAR Documentation Drawings Produced by Tulane University, New Orleans, LA

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LIST OF FIGURES

HSR Part 3
Introduction

Figure 1. South Slave Quarters, north (front) elevation (HPTC, 10/2023) *3*
Figure 2. South Slave Quarters, line drawing of north elevation *4*
Figure 3. South Slave Quarters, south (rear) elevation (HPTC, 10/2023) *5*
Figure 4. South Slave Quarters, west elevation (HPTC, 01/2023) *6*
Figure 5. South Slave Quarters, east elevation (HPTC, 10/2023) *6*
Figure 6. South Slave Quarters, first floor plan (Tulane University, 2024) *7*
Figure 7. South Slave Quarters, longitudinal section (Tulane University, 2024) *7*
Figure 8. South Slave Quarters, east room, "Experiences after Emancipation" exhibit (HPTC, 10/2023) *8*
Figure 9: South Slave Quarters, center Smokehouse space, "Interviews with Descendants of Enslaved Families" exhibit (HPTC, 10/2023) *9*
Figure 10. South Slave Quarters, west room, "The Gray Family Quarters" exhibit (HPTC, 10/2023) *10*

HSR Part 3
Appendices
Appendix A Project Treatment Records: Rehabilitate Arlington House, Outbuildings and Grounds

Figure 1. South Slave Quarters, north/east oblique elevation (NPS, 07/2001 *13*
Figure 2. South Slave Quarters, east elevation (NPS, 07/2001) *13*
Figure 3. South Slave Quarters, south elevation (NPS, 07/2001) *14*
Figure 4. South Slave Quarters, south elevation detail (NPS, 07/2001 *14*
Figure 5. South Slave Quarters, north elevation (CRIS, 2017) *15*
Figure 6. South Slave Quarters, detail of fresco (CRIS, 10/2006) *16*
Figure 7. South Slave Quarters, south elevation (CRIS, 2017) *17*
Figure 8. South Slave Quarters, south elevation, detail (CRIS, 2017) *17*
Figure 9. South Slave Quarters, west elevation (CRIS, 2017) *18*
Figure 10. South Slave Quarters, damaged flashing (NPS, 02/2011) *18*

Figure 11. South Slave Quarters, roof conditions (NPS, 02/2011) *19*
Figure 12. South Slave Quarters, roof conditions (NPS, 02/2011) *19*
Figure 13. South Slave Quarters, roof repair (NPS, 02/2011) *20*
Figure 14. South Slave Quarters, roof and flashing repair (NPS, 02/2011) *20*
Figure 15. South Slave Quarters, roof repair (NPS, 01/2011) *21*
Figure 16. South Slave Quarters, roof repair (NPS, 01/2011) *21*
Figure 17. South Slave Quarters, roof repair (NPS, 01/2011) *22*
Figure 18. South Slave Quarters, roof repair (NPS, 01/2011) *22*
Figure 19. South Slave Quarters, roof repair (NPS, 01/2011) *23*
Figure 20. South Slave Quarters, roof repair (NPS, 01/2011) *23*
Figure 21. South Slave Quarters, east elevation (CRIS, 02/2012) *24*
Figure 22. South Slave Quarters, west elevation (CRIS, 02/2012) *24*
Figure 23. South Slave Quarters, north oblique elevation (CRIS, 02/2012) *25*
Figure 24. South Slave Quarters, south elevation (CRIS, 02/2012) *25*

HSR Part 3
Appendices
Appendix A Project Treatment Records: HSR Part 3 Treatment Record: Arlington House, The Robert E. Lee Memorial Rehabilitation

Figure 1. South Slave Quarters, north elevation (CRIS, 1/2017) *37*
Figure 2. South Slave Quarters, north elevation (CRIS, 02/2012) *37*
Figure 3. South Slave Quarters, north elevation (NPS, 06/2015) *38*
Figure 4. South Slave Quarters, north elevation, detail of fresco (CRIS, 10/2006) *38*
Figure 5. South Slave Quarters, east elevation (CRIS, 02/2012) *39*
Figure 6. South Slave Quarters, east elevation (CRIS, 01/2017) *39*
Figure 7. South Slave Quarters, south elevation (CRIS, 01/2017) *40*
Figure 8. South Slave Quarters, south elevation (NPS, 06/2015) *40*
Figure 9. South Slave Quarters, detail of south elevation (CRIS, 01/2017) *41*
Figure 10. South Slave Quarters, south elevation, soffit (HPTC, 2019) *41*
Figure 11. South Slave Quarters, west elevation (CRIS, 01/2017) *42*
Figure 12. South Slave Quarters, west elevation (CRIS, 02/2012) *42*

Figure 13. South Slave Quarters, north elevation, looking west, drainage issues and erosion control (NPS, 07/2015) 43
Figure 14. South Slave Quarters, north elevation and work yard, looking west (NPS, 04/2016) 43
Figure 15. South Slave Quarters and Work Yard from Sherman Drive (NPS, 04/2016) 44
Figure 16. South Slave Quarters, west elevation, from Arlington Woods Interpretive Plaza on Sherman Drive (NPS, 04/2016) 44
Figure 17. South Slave Quarters, south elevation, walkway from tram stop (NPS, 04/2016) 45
Figure 18. South Slave Quarters, south elevation, walkway from tram stop (NPS, 04/2016) 45
Figure 19. South Slave Quarters, south elevation, from flower garden (NPS, 04/2016) 46
Figure 20. South Slave Quarters, south elevation, from flower garden (NPS, 04/2016) 46
Figure 21. South Slave Quarters, exhibit plans 47
Figure 22. South Slave Quarters, exhibit plans (09/2017) 48
Figure 23. South Slave Quarters, Selina Gray's Quarters, southeast corner, floor installation and plaster repair (HPTC, 2019) 49
Figure 24. South Slave Quarters, Selina Gray's Quarters, north wall and doorway, floor installation and plaster repair (HPTC, 2019) 49
Figure 25. South Slave Quarters, Selina Gray's Quarters, south wall, floor installation and plaster repair (HPTC, 2019) 50
Figure 26. South Slave Quarters, Smokehouse, southwest corner, beam installation and plaster repair (HPTC, 12/2018) 51
Figure 27. South Slave Quarters, Smokehouse, southwest corner, plaster repair (HPTC, 03/2019) 51
Figure 28. South Slave Quarters, Smokehouse, southwest corner, installation of meat hooks on beams and plaster repair (HPTC, 05/2019) 52
Figure 29. South Slave Quarters, Smokehouse, paint test strip (HPTC, 06/2019) 52
Figure 30. South Slave Quarters, South Slave Quarters Museum Exhibit, east wall, chimney rehabilitation (HPTC, 11/2018) 53
Figure 31. South Slave Quarters, ceiling removed, HVAC installation (HPTC, 11/2018) 53
Figure 32. South Slave Quarters, east elevation, trenching for electrical conduit (HPTC, 10/2018) 54
Figure 33. South Slave Quarters, storm water drainage installation (HPTC, 10/2018) 54
Figure 34. South Slave Quarters, northeast corner, installation of cleanout, drain, and downspout connection (HPTC, 11/2018) 55
Figure 35. South Slave Quarters, south elevation, window frame restoration (HPTC, 09/2018) 55
Figure 36. South Slave Quarters, west elevation, paint removal (HPTC, 12/2018) 56
Figure 37. South Slave Quarters, oblique of south/west elevation, non-historic stucco removal (HPTC, 06/2019) 56

Figure 38. South Slave Quarters, south elevation, stucco repair (HPTC, 06/2019) 57
Figure 39. South Slave Quarters, detail of south elevation, stucco repair (HPTC, 06/2019) 57
Figure 40. South Slave Quarters, Selina Gray's Quarters, exterior of door (HPTC, 04/2022) 58
Figure 41. South Slave Quarters, Selina Gray's Quarters, north wall interior of door (HPTC, 04/2022) 58
Figure 42. South Slave Quarters, Selina Gray's Quarters, north wall, updated fire and security systems (HPTC, 04/2022) 59
Figure 43. South Slave Quarters, Selina Gray's Quarters, west wall, Selina Gray exhibits, updated lighting and detection system (HPTC, 04/2022) 59
Figure 44. South Slave Quarters, Selina Gray's Quarters, west wall, fireplace (HPTC, 04/2022) 60
Figure 45. South Slave Quarters, Selina Gray's Quarters, west wall, Selina Gray exhibits (HPTC, 04/2022) 60
Figure 46. South Slave Quarters, Selina Gray's Quarters, south wall, Selina Gray exhibit (HPTC, 04/2022) 61
Figure 47. South Slave Quarters, Selina Gray's Quarters, southeast corner, Selina Gray exhibits (HPTC, 04/2022) 61
Figure 48. South Slave Quarters, Smokehouse, exterior of door (HPTC, 10/2023) 62
Figure 49. South Slave Quarters, Smokehouse, north wall, interior of door, exposed ceiling, updated fire and security systems (NPS, 01/2020) 62
Figure 50. South Slave Quarters, Smokehouse, detail of paint and meat hooks (NPS, 01/2020) 63
Figure 51. South Slave Quarters, Smokehouse, detail of paint and meat hooks (NPS, 01/2020) 63
Figure 52. South Slave Quarters, Smokehouse, facing north, exhibit space (ARHO Website, 11/2023) 64
Figure 53. South Slave Quarters, Smokehouse, facing south, exhibit space (ARHO Website, 11/2023) 64
Figure 54. South Slave Quarters, South Slave Quarters Museum Exhibit, exterior of door (HPTC, 10/2023) 65
Figure 55. South Slave Quarters, South Slave Quarters Museum Exhibit, north wall, interior of door, new stairway to attic, updated fire and security systems (NPS, 01/2020) 65
Figure 56. South Slave Quarters, South Slave Quarters Museum Exhibit, south wall (NPS, 01/2020) 66
Figure 57. South Slave Quarters, South Slave Quarters Museum Exhibit, south wall (ARHO Website, 01/2024) 66
Figure 58. South Slave Quarters, South Slave Quarters Museum Exhibit, east wall, fireplace and exhibit space (ARHO Website, 11/2023) 67
Figure 59. South Slave Quarters, South Slave Quarters Museum Exhibit, west wall, updated fire and security systems (ARHO Website, 11/2023) 67
Figure 60. South Slave Quarters, east elevation, new bonded aggregate walkway (NPS, 2022) 68
Figure 61. South Slave Quarters, east elevation, new bonded aggregate walkway (NPS, 01/2020) 68
Figure 62. South Slave Quarters, east elevation oblique, looking north into work yard, new bonded aggregate

walkway (NPS, 2022) 69
Figure 63. South Slave Quarters, east elevation (HPTC, 10/2023) 69
Figure 64. South Slave Quarters, north elevation looking south from work yard (HPTC, 10/2023) 70
Figure 65. South Slave Quarters, north elevation (CRIS, 11/2022) 70
Figure 66. South Slave Quarters, north elevation (HPTC, 10/2023) 71
Figure 67. South Slave Quarters, north elevation, new bonded aggregate walkway (HPTC, 10/2023) 71
Figure 68. South Slave Quarters, looking south from new vehicle pullout (NPS, 01/2020) 72
Figure 69. South Slave Quarters, west elevation (HPTC, 10/2023) 72
Figure 70. South Slave Quarters, west elevation (CRIS, 11/2022) 73
Figure 71. South Slave Quarters, west elevation (CRIS, 11/2022) 73
Figure 72. South Slave Quarters, oblique of south/east elevation (NPS, 2022) 74
Figure 73. South Slave Quarters, oblique of south/east elevation (HPTC, 04/2022) 74
Figure 74. South Slave Quarters, south elevation (HPTC, 10/2023) 75
Figure 75. South Slave Quarters, south elevation (HPTC, 10/2023) 75
Figure 76. South Slave Quarters, south elevation, window and stucco detail (HPTC, 10/2023) 76
Figure 77. South Slave Quarters, rehabilitated chimney (HPTC, 01/2023) 76

HSR Part 3 Appendices

Appendix B Preservation Maintenance Plan

Figure 1. South elevation 4
Figure 2. South Slave Quarters chimney detail 4
Figure 3. Details of composite roof (HPTC, 04/2022) 8
Figure 4. Metal roof on door hood (HPTC, 04/2022) 8
Figure 5. Detail of east chimney (HPTC, 10/2023) 10
Figure 6. Detail of west chimney (HPTC, 10/2023) 10
Figure 7. Detail of downspout and boot (HPTC, 04/2022) 12
Figure 8. Gutter along south elevation with southeast downspout (HPTC, 04/2022) 12
Figure 9. East elevation depicting two stucco finishes (HPTC, 04/2022) 15
Figure 10. South elevation stone foundation (HPTC, 04/2022) 18

Figure 11. West elevation highlighting wood trim and soffit (HPTC, 01/2023) 21
Figure 12. Windows on south elevation (HPTC, 10/2023) 25
Figure 13. Reconstructed doors and contemporary hardware (HPTC, 10/2023) 29
Figure 14. North elevation doors (HPTC, 04/2022) 29
Figure 15. Detail of bonded aggregate pedestrian pavement (HPTC, 10/2023) 31
Figure 16. Pedestrian pavement to east of South Slave Quarters (HPTC, 04/2022) 31
Figure 17. Typical foundation landscape along south elevation (HPTC, 04/2022) 33
Figure 18. Foundation landscape at southwest corner (HPTC, 04/2022) 33
Figure 19. North elevation foundation conditions (HPTC, 10/2023) 34
Figure 20. Interpretive panel at east elevation (HPTC, 04/2022) 37
Figure 21. Ceiling conditions in west room and Smokehouse (HPTC, 04/2022 and ARHO website, 05/2024) 40
Figure 22. Plaster walls with a faux finish in center Smokehouse room (HPTC, 10/2023) 42
Figure 23. Plaster wall conditions in west room (HPTC, 04/2022) 42
Figure 24. Glass wall with built-in door in "The Gray Family Quarters" interpretive space (HPTC, 04/2022) 44
Figure 25. Wood ladders in east and west rooms (HPTC, 10/2023) 46
Figure 26. Two fireplaces in South Slave Quarters (HPTC/10/2023) 47
Figure 27. Typical concrete floor conditions ((HPTC, 04/2022) 48
Figure 28. Insect trap and monitor in South Slave 49
Figure 29. Interpretive panels and media (HPTC, 04/2022 and 10/2023) 50
Figure 30. Example of ceiling diffuser, west room (HPTC, 04/2022) 52
Figure 31. Track lights in west room (HPTC, 04/2022) 53
Figure 32. Fire detection and security system devices including pull station, concealed sprinkler head, and motion detector in west room (HPTC, 04/2022) 57

PREFACE

Introduction

The National Park Service (NPS) Historic Preservation Training Center (HPTC) was engaged by George Washington Memorial Parkway (GWMP) to prepare a Historic Structure Report (HSR) Part 3 and Preservation Maintenance Plan (PMP) for the South Slave Quarters, Arlington House, The Robert E. Lee Memorial.

Part 3 of a Historic Structure Report is also known as *Supplemental Record of Work Performed*. It documents planning studies, technical studies, and other investigatory work that was not part the original historic structure report scope. It also records physical work performed on the building. Part 3 is typically added later to update the report, as most historic structure reports are issued prior to implementation of recommended treatments.[1]

The intention of this Preservation Maintenance Plan is to provide guidelines and tools to predict, initiate, and execute scheduled inspections, regular maintenance activities, and cyclical preservation activities to ensure the longevity and integrity of historic resources. It is meant to organize related work into a "written set of procedures to help eliminate duplication, make it easier to coordinate work effort, and create a system for prioritizing maintenance tasks that consider the most vulnerable and character-defining elements."[2]

Scope and Objectives

Per the above-referenced Final Project Agreement between GWMP and HPTC, this HSR Part 3 has been prepared to capture research efforts and present the Chronology of Treatments for the South Slave Quarters for the period between 1985-2021. It also serves to satisfy requirements of the 2017 Programmatic Agreement between the NPS and the Virginia Department of Historic Resources, Package No. 506. The Preservation Maintenance Plan for the South Slave Quarters is included in Appendix B and presents recommended cyclical preventative maintenance tasks and inspections in an effort to maintain the structure in good condition.

Please note that the terminology used in this HSR Part 3 and the Preservation Maintenance Plan to discuss the South Slave Quarters is inconsistent; this report references historical documents that use nomenclature reflecting the period during which they were written. This report has been written to reflect terminology currently used at the Arlington House, The Robert

[1] Deborah Slaton, *Preservation Brief 43*: *The Preparation and Use of Historic Structure Reports,* (Washington D.C: National Park Service), 15.

[2] Sharon Park, *Preservation Brief 47: Maintaining The Exteriors of Small and Medium Size Historic Buildings,* (Washington D.C: National Park Service), 3.

E. Lee Memorial, but since the language of enslavement continues to change the language in this report is also expected to become outdated. To learn more, please visit the "Visitor Expectations and Language Resource Guide" on the NPS, Arlington House website.[3]

Included in Appendix D are documentation drawings developed through the use of LiDAR (laser scanning). These were produced by Tulane University, New Orleans, LA, in fulfilment of its 2022 project agreement with the National Capital Regional Preservation Services Office.

Methodology

The HSR team visited the South Slave Quarters in March and April 2022 and January and October 2023. During the March visits, the team met with GWMP and National Capital Regional staff to hear their interests, concerns, and goals of the project and to gather information from recent conditions and activities. In addition to meeting with NPS staff, the HSR team reviewed the building and site for materials, details, and conditions that would be useful in developing the Preservation Maintenance Plan. Logistical assistance was provided by GWMP staff. In March, the HSR team also had the opportunity to review Arlington House archives held in the Curatorial Building.
In addition to the review of on-site documentation, the HSR team reviewed GWMP and National Capital Regional Office files at GWMP Turkey Run Headquarters and the GWMP Maintenance Building. NPS online sources were also reviewed, including Project Management Information System (PMIS), Electronic Technical Information Center (eTIC2), Integrated Resource Management Applications (IRMA), Cultural Resources Inventory System (CRIS), and Planning, Environment and Public Comment (PEPC).

All photographs included in this report were taken by HPTC in 2022 and 2023, unless otherwise noted.

Project Participants (HSR Team)

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[3] "Arlington House, The Robert E. Lee Memorial, Reopens Following Major Rehabilitation," National Park Service, Accessed 1/11/2024, https://www.nps.gov/arho/learn/news/arlington-house-the-robert-e-lee-memorial-reopens-following-major-rehabilitation.htm.

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South Slave Quarters
Arlington House, The Robert E. Lee Memorial
Historic Structure Report Part 3 and Preservation Maintenance Plan
1985 - 2021

HISTORIC STRUCTURE REPORT Part 3

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HSR Part 3 Introduction

The history and evolution of the South Slave Quarters has been documented in a Historic Structure Report:

Fisher, Charles, Chad Randl and Kaaren Staveteig. "Arlington House, the Robert E. Lee Memorial, South Dependency Historic Structure Report." U.S. Department of the Interior, National Park Service, Technical Preservation Service, Washington DC, 2009.

The intent of this Historic Structure Report Part 3 is to add to the information presented in the previous report by documenting preservation and maintenance events from 1985-2021. These events are presented as Chronology of Treatment entries.

The Chronology of Treatment is presented as a summary followed by a more detailed table. The summary provides an overview of the details included in the table and discusses recurring conditions as well as maintenance and treatment trends. The table includes information revealed during research and documents the source of the information - whether it was revealed through on-site observation, review of photographs, or review of documentary evidence. Most of the table entries were revealed through review of written documents but conducting on-site observation might validate the written documentation claims. Limited photographs were available during the development of this HSR and, as a result, few noted treatments are identified as being revealed through photographic evidence. Some of the treatments revealed through documentary research might be confirmed through review of additional photographs.

This HSR Part 3 is a working document and should be updated as additional evidence is revealed, new research is performed, and future treatments are implemented. See Appendix B for a future treatment documentation template.

A Brief History of the Arlington House,
The Robert E. Lee Memorial

The Arlington House was designed by George Hadfield, second architect of the U.S. Capitol, for George Washington Parke Custis, the adopted grandson of President George Washington. It was constructed by enslaved people between the years of 1802 and 1818 and served not only as the seat of the Custis family plantation but also the nation's first memorial to President Washington. Two slave quarters were constructed behind the Arlington House and were occupied by enslaved people serving domestic needs. The South Slave Quarters was constructed after the North Slave Quarters.
In June 1831, Robert E. Lee, a well-regarded Officer in the United States Army, married Mary Anna Randolph Custis, the only surviving child of G.W.P. and Mary Lee Fitzhugh Custis.

The Lees raised their seven children on the plantation, and in the years between 1855 and 1857, the time between Mr. Custis making his will and his death, Mr. Lee became increasingly involved in managing the family's business affairs and the property. In the spring of 1861, after Mr. Lee resigned from the United States Army to lead Virginia's troops at the start of the U.S. Civil War, the family packed all that they could take and left the property. What remained was under the care of Mrs. Selina Norris Gray, an enslaved maid of Mrs. Mary Anna Randolph Custis Lee. Shortly thereafter, the U.S. Army assumed and held occupation of the plantation for the entirety of the war. In the spring of 1864, Union Quartermaster General Montgomery C. Meigs decided to utilize the land surrounding Arlington House as a national cemetery. This was both a means to address the overcrowding at cemeteries in and around Washington, DC, as well as an attempt to deter the Lees from returning to the plantation. The area now known as Arlington National Cemetery is the result of this action.

The Arlington House was utilized as the headquarters for the Arlington National Cemetery until the late 1920s and was transferred to the National Park Service in 1933. Today, Arlington House, the Robert E. Lee Memorial, is still part of the National Park System and interprets the history of the Custis and Lee families, the stories of those enslaved by them, including the Syphax, Norris, Burke, Parks, Gray, Branham, and Henry families, and Robert E. Lee's role in promoting peace and reunion after the Civil War.[1] The memorial site includes the Arlington House, the North and South Slave Quarters, and the historic gardens. A museum, comfort station, and bookstore have been established for the benefit of the visiting public.

South Slave Quarters, Brief History of Use

Historically, the south quarters included a living quarters for Mrs. Selina Gray, her husband Mr. Thornton Gray, and their eight children, a smoke house, and the estate store house.[2] During the Department of the Army's management, and prior to the start of their restoration efforts in 1928, the building was most likely used for storage of tools and other equipment.

Under the National Park Service's oversight, the South Slave Quarters has served as interpretive, exhibit, and storage spaces.

[1] "Telling the Story of the Enslaved People at Arlington House," National Park Service, Accessed 10/09/2023. https://www.nps.gov/arho/learn/management/telling-the-story-of-the-enslaved-people-at-arlington-house.htm. ***The NPS continues to learn more information about the enslaved people as depicted in images from the site, some known some still unknown. "Uncle Joe's" real identity is still unknown.***

[2] Charles Fisher, Chad Randl and Kaaren Staveteig, "Historic Structure Report: South Dependency, Arlington House, The Robert E. Lee Memorial." Historic Structure Report. U.S. Department of the Interior, National Park Service, Technical Preservation Service. (Washington, D.C. National Park Service: 2009). Available on IRMA.

South Slave Quarters, Location

The South Slave Quarters is perpendicularly placed to the rear (west) of the Arlington House. It is located on the south side of the historic Work Yard opposite the North Slave Quarters. A flower garden lies to the south, at its rear.

Figure 1. *South Slave Quarters, north (front) elevation (HPTC, 10/2023)*

South Slave Quarters, Brief Physical Description

Exterior

The South Slave Quarters measures approximately 40 feet long and 20 feet wide and is one and a half stories. The building is constructed of solid-brick masonry walls that rest on exposed, 18-inch-thick stone foundations. Above the foundation, the masonry has both pebble dash and smooth stucco finishes, currently painted a gold color.

The north (front) elevation has three doors that serve the three, interior bays. Above each door is a decorative hood and a rectangular, framed, recessed panel, which contains a fresco. The east and west frescoes are of eagles with their wings extended. The center fresco is of a man riding a horse. All three frescoes are in a deteriorated state and are difficult to decipher.

The south (rear) elevation consists of three bays. The central bay includes two pilasters and two engaged columns supporting an entablature. Centered above the columns are ornamental balusters flanked by louvered vents. The east and west bays consist of pairs of recessed arches with bands of windows spanning the width of each arch. A segmented, wood water table spans each of the three bays.

The east gable elevation includes a central blind arch with an intersecting, wood water table. Centered above the arch is a pediment containing ornamental balusters flanked by louvered vents.

The west gable elevation includes a set of pilasters and engaged columns resting on a wood sill just above the exposed masonry foundation. The columns and pilasters support a wood lintel. Centered in the pediment are ornamental balusters set within a lunette-shaped vent. Located between the lintel and the gable vent is a decorative, wood molding that spans the length of the west elevation.

The South Slave Quarters is capped with a low-pitched, side-gable roof with wide eaves and soffits and exposed rafter tails. Stucco finished chimneys penetrate the roof at either end.

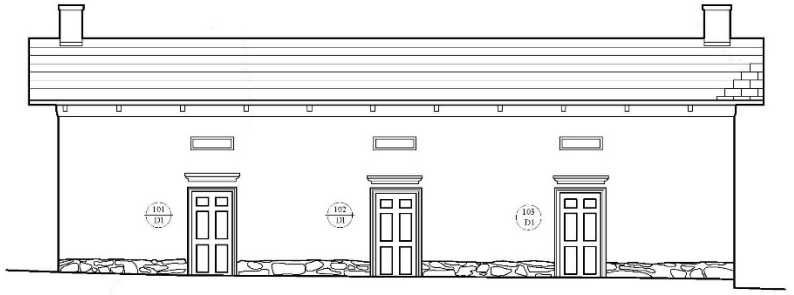

Figure 2. *South Slave Quarters, line drawing of north elevation (Tulane University, 2024)*

Figure 3. *South Slave Quarters, south (rear) elevation (HPTC, 10/2023)*

Figure 4. *South Slave Quarters, west elevation (HPTC, 01/2023)*

Figure 5. *South Slave Quarters, east elevation (HPTC, 10/2023)*

Interior

The South Slave Quarters consists of three rooms. Each room is accessed from an exterior door on the building's north elevation. The west room was the home of the enslaved Gray Family. Selina and Thornton Gray raised eight children in this small room and the upstairs loft. Miss Selina was head housekeeper and Mr. Thornton cared for the horses. During the Civil War, the Grays cut doors into the other two rooms to expand their home into the entire structure. Today the small room is an encased exhibit used to interpret the Gray Family's life, shown with a ladder to access the upstairs loft. The east room was once a storeroom. Today it is a single room with a restored fireplace and a ladder accessing the attic space. This room includes a museum exhibit that tells the story of the enslaved families of the plantation. The center room was historically a smokehouse. Today it sits empty except for a chair and short interpretation video for visitors. Its walls and rafters interpret its history as smokehouse.

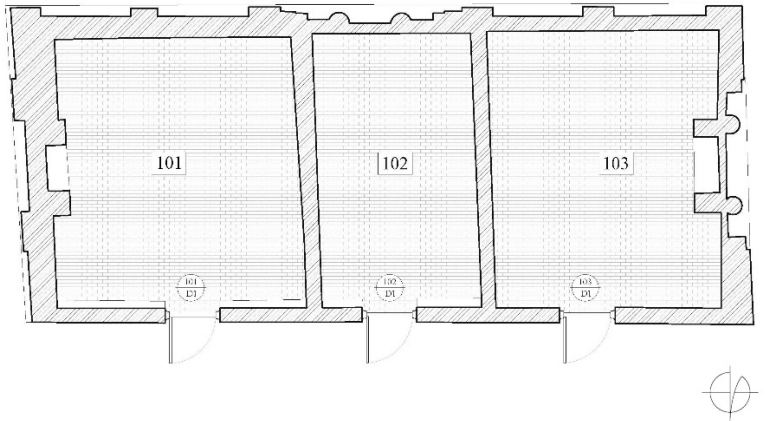

Figure 6. *South Slave Quarters, first floor plan (Tulane University, 2024)*

Figure 7*. South Slave Quarters, longitudinal section (Tulane University, 2024)*

Figure 8. *South Slave Quarters, east room, "Experiences after Emancipation" exhibit (HPTC, 10/2023)*

Figure 9: *South Slave Quarters, center Smokehouse space, "Interviews with Descendants of Enslaved Families" exhibit (HPTC, 10/2023)*

Figure 10. *South Slave Quarters, west room, "The Gray Family Quarters" exhibit (HPTC, 10/2023)*

Chronology of Treatments

Between 1965 and the 1980s documentation stays silent on any preservation or rehabilitation treatments at the South Slave Quarters. The first acknowledgement of a treatment is in the 1980s and it is limited to documentation of walkway material changes.[1] In 1983 an archeology report revealed that the elevation of the yard between the two slave quarters was approximately two feet higher than its historical level. The next piece of information available returned to discussion of walkway material documenting that, in the 1990s, the brick walks were replaced with pea gravel which, in turn, were replaced with bank run gravel. As noted in the updated National Register Nomination, referencing the 2011 update to the George Washington Memorial Parkway Administrative History, the limited maintenance, preservation, and development of the South Slave Quarters was most likely the result of the site's varied jurisdiction.[2]

In the late 1990s and early 2000s things began to change; the NPS started developing plans to address Arlington House cellar drainage issues, utility upgrades, construction of new restrooms, accessibility improvements, and restoration of the North and South Slave Quarters. At the same time Arlington County was celebrating its bicentennial, which brought increased interest to the site and Virginia Congressmen secured an appropriation under Save

America's Treasures Grant Program for planning and staffing. In 2003, the National Park Service received Congressional funding and the "Rehabilitate Arlington House, Outbuildings and Grounds" project was underway. [3]

Multiple planning, documentation and compliance reports were developed to support this effort. These included: a Cultural Landscape Report, a [draft] slave quarters Historic Structure Report, an archeological compliance investigation, Historic American Buildings Survey (HABS) documentation of the slave quarters and proposed draft revisions for the 1966 Master Plan. [4]

The work associated with the South Slave Quarters included but was not limited to interior plaster and exterior stucco restoration, restoration of doors and windows, replication of a historic chimney, installation of a new composite shingle roof and new gutters and downspouts, and new electrical and mechanical systems (including connection to a new mechanical bunker).

[1] Saylor Moss, "Arlington House: The Robert E. Lee Memorial: Cultural Landscape Inventory," (National Park Service, National Capital Region, 2009), 49-50. Available on IRMA.
[2] Katheryn G. Smith, "Arlington House Historic District [2013 Boundary Increase & Additional Documentation]," National Register of Historic Places Inventory Nomination Form [Listed March 17, 2014], (National Park Service, National Capital Region, History Program Office, December 31, 2013), 8.
[3] Moss, "Cultural Landscape Inventory," 50.
[4] Moss, "Cultural Landscape Inventory," 49.

Very shortly after this work was complete, a second rehabilitation project began to complete what was begun. This included restoration of exterior finishes, renewal of interior finishes, improvements to systems to support new uses and services, creation of a more universally accessible site, and installation of new interpretive and wayfinding signage. This project was complete in 2021.

Project and preservation maintenance treatment documentation shows that, over the years, the NPS has performed typical exterior painting and reroofing preservation maintenance tasks at the South Slave Quarters.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
1950s-1960s				HSR[1]	Never content with the QMC restoration of 1927-32, the NPS undertook their own program of restoration beginning in 1957. Starting in August of that year, they began to compile historical information on the South Dependency and draw up a list of tasks that would be included in the project. Work in 1959 included: March 12: Taking up old brick floors and stacking outside. March 13: Taking up old brick floors. Taking off old fascia for sample. March 16: Removing old plaster from walls and some old woodwork from outside. March 17: Removing soffit and outriggers from south side. March 18: Removing old roof along edges for mill company. Took old slate off and stacked up on job. March 19: Exposing rafters, joists for inspection, taking off old plaster. March 20: Remove old plaster from rooms. March 22: Making trim for inside of doors, wiring up inside. Putting gutters on buildings. Finishing 2nd coat of paint outside. Patching outside plaster. March 24: Taking down chimney at east end of building. March 25: Repairing ditch line from manhole. Wiring controls for heat and cooling. Matching outside plaster stucco. Installing large air ducts in ceiling. March 25: Removing old fireplace. March 26: Putting outriggers on side of building. March 27: Extended hangers on roof rafters, replacing old ones. March 30: Priming new wood for job.

[1] Charles Fisher, Chad Randl and Kaaren Staveteig, "Historic Structure Report: South Dependency, Arlington House, The Robert E. Lee Memorial." Historic Structure Report. U.S. Department of the Interior, National Park Service, Technical Preservation Service. (Washington, D.C. National Park Service: 2009), 18 and 49-53. Available on IRMA.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
				Cultural Landscapes Inventory[2]	March 31: Putting new soffit on west side of building. Cleaning old plaster off wall in east room. April 1: Starting to put fascia on. April 2: Putting up fascia board on north side. April 3: Putting mould around outriggers. Put three sheathing boards on roof. Tearing plaster off of rooms on east end. Wood preservatives on all roof boards. April 6: Cutting mould around the outriggers. Cutting plaster off inside wall. April 7: Putting soffit on south side. Built chimney on east end of building. April 8: Putting outriggers and soffit on also fascia board. April 9: Finished fascia soffit on south side. Dug for manhole for new electric service. April 10: Working on west end of building, furring lower poured concrete base for electric manhole. April 13: Putting fascia around louver on west end. Dig ditch for electric pipe from manhole to building. By 1963, all three rooms in the South Dependency were on public display: Selina's room, the center meat curing room, and the storeroom. Few changes have been made to the two dependency buildings since their restoration in the late 1950s and 1960s. There have been some upgrades to the building systems and the grade on the front of the South dependency has been slightly raised for improved public accessibility. Sometime during this, interpretation of the east and center rooms of the South dependency was discontinued. At present, the east room is used for exhibit space and extra room for storage.

[2] Saylor Moss, "Arlington House: The Robert E. Lee Memorial: Cultural Landscape Inventory," (National Park Service, National Capital Region, 2009), 49. Available on IRMA.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					Partially encouraged by the Historic Preservation Act of 1966, the NPS creates a master plan for the Custis-Lee Mansion. One goal of the plan is to recreate the historic scene of April 1861, and to re-emphasize the place of Robert E. Lee in the landscape.
January 1980	Nomination to the National Register			Nomination Form[3]	January 17, 1980, National register form, maps and photographs documenting the listing of Arlington House, The Robert E. Lee Memorial, in the National Register of Historic Places
February 1980	National Register Confirmation			Nomination Form[4]	Documentation submitted in confirmation of The Arlington House's inclusion in the National Register of Historic Places.
April 1980	Acceptance of Arlington House Inclusion in the National Register			Nomination Form[5]	Acceptance of the confirmation documentation.
1970s-1980s	Removal of brick walks and extension of gravel walks			Nomination Form[6] Report[7]	"Around Arlington House, the graveled area continued to be extended as the brick walks surrounding the slave quarters were removed. National Park Service signs were added."

[3] Anna Seagraves, Ann Fuqua, and Nicholas Veloz (George Washington Memorial Parkway, National Capital Region, National Park Service) "Arlington House: The Robert E. Lee Memorial," (National Register of Historic Places Inventory – Nomination Form, George Washington Memorial Parkway, April 16, 1980).
[4] Ibid.
[5] Ibid.
[6] Katheryn G. Smith, "Arlington House Historic District [2013 Boundary Increase & Additional Documentation]," National Register of Historic Places Inventory Nomination Form [Listed March 17, 2014], (National Park Service, National Capital Region, History Program Office: December 31, 2013).
[7] Kaaren Staveteig and Chad Randl, "Report to Aid in Archeological Research, North and South Dependencies, Arlington House." May 2003. File Location: 1985 and Post 1985 / GWMP Maintenance Shop Hard Files / Used / Report to Aid in Archeological Research NSQ and SSQ 2003.pdf.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
June 1983	Determination of historic yard elevation			Report[8]	Archeologist Ellen M. Seidel monitored excavation for a water line between Arlington House and Fort Myer. Determined the elevation of the yard between the two slave qaurters was historically approximately two feet lower.
1990s	Brick walks removed			Cultural Landscapes Report[9] Cultural Landscapes Inventory Report[10]	By the 1990s, the flower garden again needed rehabilitation. ….. Due to safety concerns, the remaining brick walks near the house, slave quarters, and comfort station, and through the kitchen garden were removed. The remaining brick walks around the house and slave quarters are removed and replaced with gravel.
1998	Restoration project proposed			Nomination Form[11]	
1999	Resurfacing of walks and drives			Cultural Landscape Inventory Report[12]	The pea gravel used for walks and drives surrounding the house replaced with bank-run gravel.
2000	Received Save America's Treasures funding			Nomination Form[13]	Virginia congressmen successfully secured a $150,000 appropriation under the Save America's Treasures Fund for renovation planning and staffing.
2001	Cultural Landscape Report			Report[14]	A NPS research report that describes the evolution of the cultural landscape. The report

[8] Ibid, 6.
[9] Jennifer Hanna, "Arlington House, The Robert E. Lee Memorial, Cultural Landscape Report, History, Volume I." (U.S. Department of Interior, National Park Service, 2001), 168. eTIC2 ARHO / 855 / D20.
[10] Moss, "Cultural Landscapes Inventory."
[11] Smith, "Arlington House Historic District," 135.
[12] Moss, "Cultural Landscapes Inventory."
[13] Smith, "Arlington House Historic District," 134.
[14] Hanna, "Cultural Landscape Report," History, Volume I.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					compiles the site history, and documents the changes over time, and establishes what is important to preserve. Detailed Historic Period Plans document the major development periods.
2002	Congress Approved Funding for Rehabilitation Project			Nomination Form[15]	With Arlington County's bicentennial celebrations generating increased interest in the site, NPS requested $2.15 million from Congress for the 2002 fiscal budget to address the drainage issues plaguing the Arlington House cellar. Funds were also planned to be used to restore two slave quarters behind the house in addition to upgrading utilities, constructing new restrooms, and improving handicap accessibility. Only $1.562 million was received.
2002	Stabilization			CRIS[16]	By 2002…the National Park Service raised the grade on the north side of the building eliminating the stone steps in order to improve accessibility to the rooms.
2002	Use of East Room			HSR[17]	By 2002, the east room was used as exhibit space. It had furred out gypsum board walls and a plaster ceiling about 11 feet dash 6 inches above the brick floor. The center room was used for storage and the West room continued as to be interpreted "Salina's Room."
2003	Rehabilitation Project Funded			Nomination Form[18]	Although the rehabilitation/restoration project was initially proposed in 1998, it was not fully funded until 2003.

[15] Smith, "Arlington House Historic District," 134.
[16] CRIS Entry under "Management" Tab.
[17] Fisher, Randl and Staveteig, "South Dependency Historic Structure Assessment Report," 57.
[18] Smith, "Arlington House Historic District," 134.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
2003	Fire Suppression Title I Option Appraisal (Revised) Report			Report[19]	Noted that if a fire started and reached flaming combustion there would be less than two minutes for staff with fire extinguishers to respond and have a chance to achieve extinguishment success. Dry fire sprinklers recommended for South Slave Quarters. Report presents a summary of the key benefits, concerns, and conceptual designs illustrations associated with the fire suppression technology options for the SSQ.
2003	Archeological Investigation			Report[20]	NPS Contract No. C300099063: First phase concentrated on the interiors and exteriors of the two dependencies, the south wing basement, and west exterior of the Arlington House.
2003	Report to Aid in Archeological Research			Report[21]	North and South Dependencies
2004	Archeological Investigation			Report[22]	NPS Contract No. C300099063: Second phase concentrated on the courtyard, west rooms of the dependencies, the vegetable garden, and the proposed footprints of a comfort station, underground utility bunker, and utility corridor.
2004	Draft Historic Structures Report for the Slave Quarters			Nomination Form[23]	Several reports were produced in conjunction with the restoration effort, including a … [draft] 2004 Historic Structures Report for the slave quarters; a 2004 Historic American Buildings Survey (HABS) documentation of Arlington

[19] "Robert E. Lee Memorial (Arlington House), Virginia, Fire Suppression Title I Option Appraisal (Revised)," (Heritage Protection Group, Fire Safety Network, October 2003), 3-4 and 11-12. File Location: 1985 and Post 1985 / GWMP Maintenance Shop Hard Files / Used / GWMP ARHO Fire Suppression Title I Option Appraisal Revised Oct 2003.pdf.

[20] "Archeological Investigations at Arlington House (44AR17), The Robert E. Lee Memorial Repair and Rehabilitation of the Mansion and Slave Quarters, George Washington Memorial Parkway, Final Report" (The Louis Berger Group, Inc. Washington, D.C., 2005). eTIC2 ARHO / 855 / 178476.

[21] Staveteig and Randl, "Report to Aid in Archeological Research," May 2003. File Location: 1985 and Post 1985 / GWMP Maintenance Shop Hard Files / Used / Report to Aid in Archeological Research NSQ and SSQ 2003.pdf.

[22] "Archeological Investigations at Arlington House (44AR17)."

[23] Smith, "Arlington House Historic District," 134.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					House, the slave quarters, and grounds; proposed draft revisions for the 1966 Master Plan.
2005	Archeological Investigation			Report[24]	Archeological Investigations at Arlington House (44AR17), the Robert E. Lee Memorial Repair and Rehabilitation of the Mansion and Slave Quarters
2006	Assessment of Effect for Rehabilitate Arlington House, Outbuildings and Grounds Project			Assessment of Action Having Potential Effect on Cultural Resources[25]	The undertaking proposes to rehabilitate and provide upgraded services to Arlington House, the Robert E. Lee Memorial (ARHO) in order to ensure preservation of the historic structures and grounds. The project proposes to replace an aging and unsafe physical plant infrastructure with a new climate control system for the ARHO Mansion House and slave quarters, provide fire detection and suppression in the historic structures, and undertake rehabilitation efforts on the buildings and grounds to protect and preserve the property and better reflect the legislatively mandated mid-nineteenth century period of interpretation. Specific elements of the project are as follows: • rehabilitate the North and South slave quarters for appropriate interpretation of African American history circa 1861 • install a new fire detection and suppression system within Arlington house and its outbuildings install a new climate management system within Arlington house and its outbuildings • provide a new remote mechanical bunker outside the historic kitchen garden to support the new Fire Protection and mechanical systems • remove the existing circa 1921 comfort station from the kitchen garden and

[24] "Archeological Investigations at Arlington House (44AR17)."

[25] "Assessment of Action Having Potential Effect on Cultural Resources, GWMP 06-02."

Park: Arlington House, The Robert E. Lee Memorial. Project Title: Rehabilitation of Arlington House, Outbuildings and Grounds

Project Compliance number: 2005-28 Affected Resources: Arlington House, North Slave Quarters, South Slave Quarters, Comfort Station, North (Kitchen) Gardens.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					replace it with a modern facility at the North End of site • rehabilitate the kitchen garden and provide for site accessibility and dust abatement • and stabilize the brick masonry foundation of Arlington house Due to budget limitations, the work for the entire project was divided into two Phases. Phase 1 includes mechanical and Fire Protection work on the mansion, north slave quarters, new mechanical bunker, new comfort station, and site utilities. Phase 2 includes the South slave quarters, the kitchen garden and work yard, additional mechanical work in the new bunker and basement of the mansion, and foundation work in the mansion. This work is expected to take place over a period of several years.
February 2006	Environmental Assessment			Report[26]	This Environmental Assessment (EA) was prepared to address the need to rehabilitate Arlington House, its Outbuildings, and the Historic Grounds in a manner that protects and maintains the Cultural Resources and values for which the Robert E. Lee Memorial was established; and to provide sufficient analysis on a range of alternatives and their environmental impacts.
April 2006	Briefing to Representative Moran re: Rehabilitate Arlington House,			FY2007 Briefing Statement[27]	**Key Points:** • Need for action: Rectify the long-standing inaccurate interpretation of the slave quarters and return pubic access to the north slave quarters; Prevent catastrophic loss of critical,

[26] "Rehabilitation Of Arlington House, Outbuildings And Grounds - Environmental Assessment" (National Park Service, George Washington Memorial Parkway, February 2006). eTIC2 GWMP / 850 / 118291.

[27] Andrew Wenchel and Kendell Thompson, "FY2007 Briefing Statement to Member Representative Moran," Arlington House, the Robert E. Lee Memorial (George Washington Memorial Parkway April 10, 2006). File Location: GWMP Internal Share Drive/2004 Rehab Line Item/10 DOCUMENTS/2007 GWMP Arlington House Rehab-draft kt&aw.doc.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
	Outbuildings and Grounds				cultural resources (mansion and collections) to fire; Protect the museum collection from humidity induced damage; Restore the core elements of the Cultural Landscape through removal of non-contributing structures, re-grading/re-landscaping, and rehabilitating the historic kitchen garden; Provide comfort station facilities for visitor use and satisfaction; Protect the mansion from structural failure caused by cumulative water damage to the foundation; Increase visitor understanding through improved interpretation and restoration of cultural resources • Rehabilitation includes: a) installation of fire detection and suppression system in historic buildings; b) installation of climate management mechanical system to protect historic buildings and artifacts; c) rehabilitation of historic slave quarters; d) relocate restroom facility to location outside the core historic zone; e) construction of remote bunker for mechanical/electrical and fire protection systems; f) correction of drainage and foundation problems; and g) rehabilitation of historic kitchen, and improvement of ADA accessibility to buildings and grounds h) rehabilitation of the historic kitchen garden. • Project funding: $2.1 million was requested in FY02; however, $1.562 million was received. In FY2003, $616,000 was requested and received, bringing total to $2,164,700. Some funds were reprogrammed in FY03 and FY 04for fire assessment, reducing total to $984,000. In FY2006, line item budget request for $1,251,000 will restore project funds (escalated to 2006 dollars) to $2,236,000.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					• The preliminary Class A cost estimates (based on 75% construction documents for all the mechanical system, new underground utilities and remote bunker) have increased the costs of the overall project to $2,918,000, leaving a shortfall of $1,085,000. The construction work was divided into the current funded project (phase 1) of $1,833,000, and future work [phase 2 to be requested for funding in the future for $1,085,000]. • Construction: Contract is expected in July 2006 on the first phase of the work. (Note: Project was delayed, work began in May 2008) • Comfort station facilities would be supplied through use of existing, temporary mobile units placed outside the Core Historic Zone. **Background:** • Based on the concerns raised by the constituents in April 2000 about the poor condition and critical deficiencies at the site, the NPS requested program funding as stated above. Further design of the project created better cost estimates and it was found that there was a shortfall in the original cost estimate and additional funds are required to complete the scope of the project, as detailed above. • A Save America Treasures grant of $150,000 was secured by site in FY2001, however no partner has been found to match the grant. Only $38,000 has been raised thus far and the NPS is seeking organizations to match the grant. **Current Status:**

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					• Title II services (Class A cost estimates) indicated that the total $2.1 million funded in FY02/03 will be sufficient only to fund a portion of phase one (of two) in FY 2006. Note: The Environmental Assessment and Title II Design work in progress both address phase 1 and 2 components to allow work on phase 2 to continue if more funding becomes available in the near future. • Phase 1 (costs not to exceed $1,833,000) will include: a) all the fire suppression system and attic level of mechanical ductwork for Arlington House; b) construction of all underground water and electric utilities, and remote mechanical bunker,(and salvage/ relocation of existing gas-fired boiler for continued operation of antiquated heating system in basement); and c) demolition of existing non-contributing comfort station in historic kitchen area, and construction of new comfort station outside the historic area. Note: existing fire detection remains, but new electrical panels are provided in bunker. • Phase II (cost estimate $1,085,000) will include: a) rehabilitation of both the North and South Slave Quarters to include fire suppression system and mechanical ductwork; b) 3-phase transformer upgrade; c) new mechanical equipment for Climate Management system in mechanical bunker; and d) rehabilitation of historic Kitchen Garden. • Completed work to date includes: a) Cultural Landscape Report of Historic Area including Kitchen Garden; b) Archeological studies; c) HABS documentation of Arlington House,

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					Outbuildings and Grounds; d) Historic Structures Reports for North and South Slave Quarters; and e) Title II services has produced 75% drawings and Class A cost estimates. • Title II Design for final construction drawings / specifications as well as an Environmental Assessment for all phase 1 and phase 2 work, are underway, and should both be complete by April-May 2006. • Construction of phase 1 to start in September 2006. (Note: Project was delayed, work began in May 2008)
2007	Finding of No Significant Impact			850 / 118665[28]	PEPC Project ID: 14952 Rehabilitate Arlington House, Outbuildings and Grounds Rehabilitate Arlington House, Outbuildings and Grounds – Additional Work [PMIS150123]
2007	Design Complete: Rehabilitate Arlington House, Outbuildings and Grounds			PMIS 016018 Construction Drawings[29]	Design included: DESIGNING AND PROVIDING A NEW, COMPLETE, ANALOG ADDRESSABLE BUILDING FIRE ALARM SYSTEM AS MANUFACTURED BY SILENT KNIGHT, MODEL SK5820XL AND AS DESCRIBED HEREIN AND ON THE CONTRACT DRAWINGS FOR THE ARLINGTON HOUSE, NORTH SLAVE QUARTERS AND MECHANICAL BUNKER, ARLINGTON, VIRGINIA. THE SYSTEM SHALL INCLUDE ALL WIRING, RACEWAYS, PULL BOXES, TERMINAL CABINETS, OUTLET AND MOUNTING BOXES, CONTROL EQUIPMENT, ALARM AND SUPERVISORY SIGNALS, INITIATING DEVICES, ALARM NOTIFICATION APPLIANCES, NOTIFICATION ALARM PANELS, INTERFACE EQUIPMENT, AND ALL OTHER ACCESSORIES AND MISCELLANEOUS ITEMS INCLUDING

[28] "Finding of No Significant Impact, Rehabilitation of Arlington House, Outbuildings & Grounds, Arlington House, The Robert E. Lee Memorial," (National Park Service, George Washington Memorial Parkway, August 2007). eTIC2 GWMP / 850 / 118665.
[29] "Rehabilitate Arlington House, Outbuildings and Grounds," (HNTB Architecture, Washington, DC, 4/9/2007), Sheet 1 – 129. File Location: 1985 and Post 1985 / GWMP Maintenance Shop Hard Files / HNTB 100% Construction Drawings ARHO 16018 2007 / PDF Drawings /.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					SOFTWARE, SYSTEM PROGRAMMING, TESTING AND CONSTRUCTION PERMITS REQUIRED FOR A COMPLETE OPERATING SYSTEM EVEN THOUGH EACH ITEM IS NOT SPECIFICALLY MENTIONED OR DESCRIBED. THE SYSTEM SHALL COMPLY WITH THE VIRGINIA UNIFORM STATEWIDE BUILDING CODE (VUSBC), INCLUDING AMMENDMENTS, WHICH ADOPTS THE INTERNATIONAL BUILDING CODE, 2003 Edition BY REFERENCE AND NFPA STANDARDS 70 AND 72. THE EQUIPMENT PROVIDED BY THE CONTRACTOR SHALL BE NEW AND LISTED FOR THE INTENDED PURPOSE BY A NATIONAL RECOGNIZED TESTING LABORATORY.
2007	Design Complete: Rehabilitate Arlington House, Outbuildings and Grounds, Phase 1			PMIS 016018 Construction Drawings[30]	Design included: Demolition or Obliteration Plans, Electrical System, Communication System/Telephone/Radio/Radar/Fire Alarm/Security Alarm/Cable(TV), Planning Documents and Drawings-Existing Conditions, Site and Development Plans, Utility Systems, Erosion Control/River Floodwalls/Riverbank Stabilization, Roofs/Gables/Eaves/Gutters, and Doors/Windows
2008	Briefing to Representative Jim Moran re: Rehabilitate Arlington House, Outbuildings and Grounds			Briefing Paper[31]	**Key Points:** • Phase 1 (construction costs not to exceed $1,833,000) will include: a) operational fire suppression and detection system for Arlington House and North Slave Quarters, b) climate management mechanical system ductwork for Arlington House and North Slave Quarters, c) underground water and electric utilities, d) limited sitework for dust abatement and ADA accessibility, and e) a bid option for rehabilitation of North Slave Quarters.

[30] "Rehabilitate Arlington House, Outbuildings and Grounds, (Phase 1)," (HNTB Architecture, Washington, DC, 6/18/2007), Sheets 1 – 104. eTIC2 GWMP / 850 / 84293A.

[31] David Vela (National Park Service, George Washington Memorial Parkway, Superintendent), "FY2008 Briefing Statement to Member Representative Moran," (George Washington Memorial Parkway, 2008) .File Location: GWMP Internal Share Drive/2004 Rehab Line Item/10 DOCUMENTS/GWMP.NPS.Briefing Paper 2008 ARHO.doc.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					• The combination of budget shortfalls and escalating costs have delayed the project to date and necessitated a phased construction. • Construction contract is expected by May 2008 on the first phase of the work. **Background:** • Based on the concerns raised by the constituents in April 2000 about the poor condition and critical deficiencies at the site, the NPS requested program funding (see 2006 program funding). Detailed design of the project resulted in better cost estimates and identified a shortfall in the original cost estimate and additional funds necessary to complete the scope of the project, as detailed in 2006. • Title II services (Class A cost estimates) dictated that the project would be carried out in phases, as detailed in 2006. • Completed work to date includes: a) Cultural Landscape Report of Historic Area including Kitchen Garden; b) Archeological studies; c) HABS documentation of Arlington House, Outbuildings and Grounds; d) Historic Structures Reports for North and South Slave Quarters; e) Environmental Assessment for all work; and e) complete construction drawings, specifications and current Class A cost estimates. **Current Status:** • Project has been reviewed and approved by Development Advisory Board and has the Directors Approval for construction. • To prepare for construction, museum collections have been removed from the house and lead-based paint is

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					currently being removed from closets and other work areas. • Line-item Construction of Phase 1 is scheduled to begin in May 2008.
2009	Design Complete: Rehabilitate Arlington House, Outbuildings and Grounds, Phase 2A			Specifications[32] Product Data[33] Submittal Log[34] Construction Drawings[35] PMIS 150123	Design Scope: 1. Relocation of the fire protection, mechanical and electrical equipment from the existing Comfort Station to the new Mechanical Bunker. 2. Demolition of the existing Comfort Station and mechanical basement, fire protection for Arlington House and North Slave Quarters. 3. A new Mechanical Bunker, plus the rehabilitation of the North Slave Quarters. 4. A new climate management system for Arlington House, and the North Slave Quarters. 5. Underground mechanical, electrical and plumbing service for Arlington House and the North Slave Quarters. Associated underground utilities to support the work stated above.
2008 - 2009	Cultural Landscapes Inventory			Cultural Landscapes Inventory Report[36]	Original Plan: Arlington House is undergoing a three-phase rehabilitation project to preserve the site's historic structures and furnishings, and to improve visitor experience. Phase I includes installation of a fire detection and suppression system in the house and

[32] "Rehabilitate Arlington House, Outbuildings and Grounds (Phase 2A)," (National Park Service, George Washington Memorial Parkway, 2009). Project Specifications. ARHO – PMIS No. 150123, eTIC2 ARHO / 855 / 110089 / 0002. Also 964652, eTIC2 ARHO / 855 / 114951 / 0001 of 0665.
[33] "Rehabilitate Arlington House, Outbuildings and Grounds (Phase 2A)," (National Park Service, George Washington Memorial Parkway, 2009). Product Data. ARHO – PMIS No. 150123 and 119754, eTIC2 ARHO / 855 / 110089 / 0005. Also 842169, eTIC2 ARHO / 855 / 110089 / 0001.
[34] "Rehabilitate Arlington House, Outbuildings and Grounds (Phase 2A)," (National Park Service, George Washington Memorial Parkway, 2009). Submittal Log. ARHO – PMIS No. 150123 and 119753, eTIC2 ARHO / 855 / 110089 / 0006.
[35] "Rehabilitate Arlington House, Outbuildings and Grounds, (Phase 2A)," (National Park Service, George Washington Memorial Parkway, December 2009). Final Submission, Sheets 1-102. ARHO – PMIS No. 218611, eTIC2 ARHO / 855 / 84293.
[36] Moss, "Cultural Landscapes Inventory."

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					ductwork for climate management to protect the house and historic furnishings. Phase II will focus on a climate management system which includes construction of a below grade mechanical bunker on the western edge of the access road west of the vegetable garden, installation of HVAC and demolition and installation of underground ductwork. Phase III focuses on preservation and visitor services. During this phase, the interior of the house will be repaired and refurbished, the furniture will be returned to the home, the South Slave Quarters will undergo rehabilitation, the kitchen garden will be restored to its 1861 appearance, stabilization of soils and the house foundation will occur, and the comfort station will be replaced.
2009	South Dependency Historic Structure Report			Report[37] Environmental Assessment[38]	The purpose of this Historic Structures Report is to function as a central repository of information, analysis and conclusion resulting from the investigation of the South Dependency (South Servant's Quarters) at Arlington House, The Robert E. Lee Memorial, by National Park Service (NPS) historians and their associated consultants in 2002 and 2003. Based on a resulting understanding of the history, appearance and use of the structure over time (with particular emphasis on the period around 1860), this document will also propose an appropriate restoration program that will enable the NPS to better interpret the building, its occupants and functions during the period of significance. *Arlington House, The Robert E. Lee Memorial South Dependency Historic Structures Report (NPS 2009a).* The historic structures report for

[37] Fisher, Randl and Staveteig, "South Dependency Historic Structure Assessment Report," 57. Available on IRMA.
[38] National Park Service, Department of the Interior, "Arlington House, The Robert E. Lee Memorial Rehabilitation Environmental Assessment," (George Washington Memorial Parkway, August 2016). eTIC2 GWMP / 850 / 147553.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					the south slave quarters reports the information, analysis, and conclusion resulting from investigation of the historic structure. The document also proposed an appropriate restoration program to enable the National Park Service to better interpret the building, its occupants, and its functions during the period of significance. This historic structure report provided background information on the project area and the south slave quarters, which informed some of the rehabilitation efforts proposed in this environmental assessment.
2009	General status / use			Cultural Landscapes Inventory[39]	North and South Slave Quarters: The South Slave Quarters currently exhibits a Freedman's Village diorama and an exhibit on Arlington House slaves as well as Selena Gray's quarters furnished with 19th century furnishings. The North Slave Quarters currently hosts a rehabilitation exhibit and will soon reflect the time period in which George Clark [sic], a cook, was living and working there.
2011	Update to GWMP Administrative History			Nomination Form[40]	The 2011 update to the George Washington Memorial Parkway Administrative History prepared by Robinson and Associates.
January 2011	South Slave Quarters roof		Photographs[41]	PMIS 159977	Emergency repair of the roof involves: Removed existing roof covering. Selective repairs/replacement of roof sheathing. Installation of Lamarite Shake Composite Shingles.

[39] Moss, "Cultural Landscapes Inventory."
[40] Smith, "Arlington House Historic District."
[41] File Location: GWMP Internal Share Drive/2011 NSQ SSQ Roofs/New Folder/south slave quarters roof deck/P1200005-P1210019.JPG.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
2008-2012	Construction Complete: Rehabilitate Arlington House, Outbuildings and Grounds Project		Photos[42,43]	PEPC 14952 PMIS 16018	• Install fire suppression system (Arlington House, Museum, Dependencies, Annex) • Demolition of the existing Comfort Station and mechanical basement. • Partial completion of underground site utilities (mechanical, electrical, and plumbing) in work yard west of mansion, and service under foundations of Mansion and North Slave Quarters. • Construct new Comfort Station, Underground Utilities, Amenities • Construct new Mechanical Bunker • Relocation of fire protection, mechanical and electrical equipment from the existing Comfort Station to the new Mechanical Bunker. • Rehabilitation of historic structures (2 dependencies/ outbuildings) • Grounds and Site Access Stabilization. • All fire suppression, fire alarm, mechanical, electrical, and utilities work basically completed by mid-January 2010. A final inspection of fire suppression, fire alarm, mechanical, electrical, and utilities work was conducted on January 15, 2010. A letter of substantial completion was issued February 19, 2010, subject to satisfactory completion of a list of work items by no later than February 26, 2010. • The only outstanding work was site paving using NaturalPave, a special natural colored paving with a temperature-dependent epoxy resin and aggregate mix from a California plant and was delayed by winter weather and was not completed until June 2010. Site paving using NaturalPave, a special epoxy resin and aggregate mix from California plant was delayed by winter weather, and wet spring site conditions. A paving attempt with NaturalPave in April 2010 was unsatisfactory and rejected by Park (with concurrence by manufacturer's representative and installer) due to problems

[42] File Location: GWMP Internal Share Drive / 2010 Phase II rehab stimulus / As-Builts from DSC / Photos during construction / P1040651.jpg.
[43] File Location: GWMP Internal Share Drive / 2010 Phase II rehab stimulus / construction photos / New Folder / New Folder.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					with aggregate weather. The aggregate was changed, and a new mix was shipped and installed in early June under ideal weather conditions. This NaturalPave work accepted by Park and NCR contracts on June 16, 2010. • A new climate management system for Arlington House, and the North Slave Quarters. • Underground mechanical, electrical and plumbing service for Arlington House and the North Slave Quarters. • Associated underground utilities to support the above. July 2009 – November 2012 Total Component Account Cost: $3,623,806.00 Work included: 1) construction of new bunker with green roof for Climate Management (CM) equipment and Fire Pump & Alarm, 2) underground site utilities including water, sewer, electric, and mechanical air supply/return, 3) demolition of old comfort station within historic Kitchen Garden with new site utilities and sewer connection. As Built Drawing or Report Number: 831/84293 Title: Rehabilitate Arlington House, Outbuildings and Grounds Location: DSC Author: DSC July 2010 – November 2012 Construction of new Comfort Station House outside historic area.
				PMIS 150123 Specifications[44] PMIS 150123A 855 / 84293[45]	

[44] "Rehabilitate Arlington House, Outbuildings and Grounds (Phase 2A)," (National Park Service, George Washington Memorial Parkway, 2009), Project Specifications. PMIS No. 150123, eTIC2 ARHO / 855 / 110089 and PMIS No. 964652, eTIC2 ARHO / 855 / 114951.

[45] "Rehabilitate Arlington House, Outbuildings and Grounds, (Phase 2A)," (National Park Service, George Washington Memorial Parkway, December 23, 2009), Final Submission. PMIS No. 218611, eTIC2 ARHO / 855 / 84293.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
				PMIS 150123B Drawings[46]	Component Created by Splitting component 150123A: Rehabilitate Arlington House, Outbuildings & Grounds Component Start Date: July 15, 2010 Component Completion Date: November 30, 2012 Total Component Account Cost: $340,629.00 After an October 2012 meeting, the contractor finally completed the final 5 items on the punch list and ongoing warranty items by November 30, 2012. The Park was not satisfied with the operation of the new climate management system and will have to follow up with another contract to properly balance the system, improve ventilation to North Wing and seasonally program humidity.
March 2014	General Status/Use			National Register Nomination[47]	Currently, the east room (originally the storehouse) contains a display on the slaves of the Arlington Estate; the center room (formerly the smokehouse) is closed to the public and used for storage; and the west room is furnished as the room of Selina Gray, the matriarch of the most prominent of the slave families at Arlington.
March 2014	Accepted Additional Documentation and Boundary Increase			Nomination Form[48]	National register listing modified by increase in boundary. "The boundary increase area is limited to 3.1 acres located adjacent to the north, south, east, and southwest boundaries of the Arlington House NPS boundary, as well as the small discontiguous Custis Burial Plot (1 site) that stand approximately 1,100 feet southwest of the NPS boundary." The accepted/approved revision to the original Arlington House Historic District National

[46] "Rehabilitate Arlington House, Outbuildings and Grounds (Phase 2B)" (George Washington Memorial Parkway, 3/4/2010). Comfort Station. eTIC2 ARHO / 855 / 80148.
[47] Smith, "Arlington House Historic District."
[48] Ibid, 159.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					Register Nomination considers the Museum Building (Potting Shed) as contributing. This is a change from the original nomination.[49]
2016	Environmental Assessment			Environmental Assessment[50]	*Rehabilitation of Arlington House, Outbuildings & Grounds Environmental Assessment (NPS 2006).* … The 2016 environmental assessment continues and builds upon the preservation and rehabilitation of the mansion, slave quarters and grounds that was called for in the 2006 environmental assessment. Preservation and rehabilitation activities that were completed are considered in this 2016 environmental as cumulative actions. A few items that were proposed under the 2006 environmental assessment were not completed during the resulting 2009-2011 rehabilitation campaign [2008-2012] and are included within the scope of the currently proposed rehabilitation. These actions are the stabilization of the foundation, rehabilitation and preservation of the south slave quarters, and rehabilitation of the kitchen garden with historical plantings including fruit trees. Because the proposed improvements may be slightly more specific than previously discussed, their impacts are disclosed in this 2016 environmental assessment.
2016	Arlington House Site Rehabilitation			850 / 147553[51]	PEPC Project ID: 58878 Arlington House and Site Rehabilitation 2016
2017	Finding of No Significant Impact			850 / 147552[52]	PEPC Project ID: 58878 Arlington House and Site Rehabilitation 2016

[49] Smith, "Arlington House Historic District."
[50] "Arlington House, The Robert E. Lee Memorial Rehabilitation Environmental Assessment," (National Park Service, George Washington Memorial Parkway, August 2016). eTIC2 GWMP / 850 / 147553.
[51] "Arlington House, The Robert E. Lee Memorial Rehabilitation Environmental Assessment," (National Park Service, George Washington Memorial Parkway, August 2016). eTIC2 GWMP / 850 / 147553.
[52] "The Robert E. Lee Memorial Finding of No Significant Impact," (National Park Service, George Washington Memorial Parkway, Executed July 10, 2017). eTIC2 GWMP / 850 / 147552.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
2017	"Rehabilitate Arlington House Mansion & Grounds, Arlington House and Grounds" design complete			855 / 138878[53] 850 / 128171[54]	This rehabilitation design continues on with the designs of Phase I, Phase 2A, and Phase 2b.
2018	Non-Destructive Moisture Tests in Summer Kitchen, North Slave Quarters and Storeroom, South Slave Quarters			Memorandum[55]	Testing performed by National Capital Region Architectural Conservator on October 25, 2018, and November 7, 2018. Testing performed to inform plaster failure mitigation recommendations.
2019	Archeology Report			Report[56]	Supplementary Section 106 Archeological Investigations Related to the 2006-2012 Rehabilitation Program
2019	Discovery of Subfloor Storage Pit Shrine at South Slave Quarters			Archeological Report[57]	During the latest rehabilitation project, workmen were in the 40 ft x 20 ft South Dependency performing a floor leveling task in the 18 ft x 16 ft west room that served as slave quarters and uncovered an interesting find. The workmen shovel-skimming modem fill away dug too deeply in a spot and uncovered four glass bottles clustered in the historic period soils below and

[53] "Rehabilitate Arlington House Mansion and Grounds - Final Construction Documents: Drawings, Specifications, Cost Estimate, Price Schedule, Constructability Checklist, Sustainability Checklist, Calculations," (National Park Service, George Washington Memorial Parkway, June 16, 2017). eTIC2 ARHO / 855 / 138878.

[54] "Rehabilitate Arlington House Mansion and Grounds," Construction Drawings (GWWO Architects, Baltimore, MD, January 31, 2018). eTIC2 ARHO / 855 / 128171.

[55] Lindy Gulick, NCR Architectural Conservator "RE: Memo on the Moisture testing at the North and South Slave Quarters, Arlington House, Arlington National Cemetery," November 30, 2018. File Location: HPTC 2020 ARHO Rehab / 7.0 Construction / CONSTRUCTION MANAGEMENT / outstanding issues / NSQ Plaster Separation / Moisture issues_NSQ SSQ_ARLO.docx.

[56] Matthew Virta, "Rehabilitation of Arlington House, the Robert E. Lee Memorial: North Dependency/Slave Quarters Supplementary Section 106 Archeological Investigations, Related to the 2006-2012 Rehabilitation Program, George Washington Memorial Parkway, Arlington House, the Robert E. Lee Memorial," (National Park Service, George Washington Memorial Parkway, 2019). File Location: 1985 and Post 1985 / Used / ARHO N Dependency Slave Qtrs Report Assembled.pdf.

[57] Matthew R. Virta, "Rehabilitation of Arlington House, the Robert E. Lee Memorial South Dependency/Slave Quarters – Discovery of a Subfloor Storage Pit Shrine, Supplementary Section 106 Archeological Investigations Related to the 2017-2020 Rehabilitation Program," (National Park Service, George Washington Memorial Parkway, 2021). eTIC2 ARHO / 855 / 179782.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					immediately reported it to the archeological monitor on site who joined the discovery scenario. Following notification of the find and inspection of the site, GWMP Cultural Resources Program Manager and Archeologist Matthew Virta requested a work stoppage so that a 3 ft x 3 ft archeological excavation unit could be placed at the site of the discovery for further exploration. The resulting archeological investigations by GWMP archeologists of the unanticipated discovery have identified that there were four northward-pointing bottles in what was a subfloor storage pit adjacent to and northeast of the fireplace hearth that was most likely a feature associated with the enslaved Selina and Thornton Gray family occupying the west room quarters in the mid-nineteenth century. Analysis of the findings indicate that the pit functioned as a type of shrine and had contained what may be an enslaved people's "spirit bundle" with "conjuring bottles"; exhibiting West African religious connections (Haq 2016, Samford 2007) and creolized Hoodoo Rootwork religious/folk magic practices (Chireau 2003, Kraus etal 2010, Leone 1999, Unger 2009) that demonstrate resistance to their state of bondage and their perseverance for freedom. Placement of a spirit bundle and/or conjure bottles by an enslaved individual as part of a ritualistic religious/magical shrine served variously to ward off evil, promote self-preservation, cast spells to harm others, and host a protective Nkisi spirit or entrap malevolent entities (Haq 2016, Hoggard 2019, Lane 2008, Manning 2012), functioning as a talisman to combat the harsh and de-humanizing realities of slavery and to safeguard the future.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
2017 - 2021	Construction Complete: Arlington House, The Robert E. Lee Memorial Rehabilitation			PMIS 216010 PMIS 245580 Programmatic Agreement Yearly Update dated April 22, 2019[58]	• Restore South Slave Quarters Interior Rooms • Restore Kitchen Garden and Historic Grounds • Install New Electrical, Lighting and Security Systems • Provide space conditioning at Slave Quarters • Provide accessible route entry/egress to Mansion, Slave Quarters, and Site area • Correct drainage deficiencies at doors and other improvements at Mechanical Bunker Restoration of the South Slave Quarters: Although the South Slave Quarters did receive a new roof and drainage system in 2011, the interior requires complete rehabilitation into exhibit space. The exterior requires repairs to the historic structure, replacement of all doors and windows, and installation of a fire suppression system. *June – July 2017 Construction mobilization and fencing; Utilities and drainage work began; Archeological monitoring and additional testing began.* *Summer/Fall 2018: Site utility and drainage work underway. Interior/exterior historic structure rehabilitation started. Demolition/expansion of comfort station/bookstore began. Archeological testing/monitoring continued.* *Winter 2018/2019: Interior plaster restoration in Mansion and Dependencies. Post and chain in front of Mansion.* *Spring 2019: Scaffolding erected around mansion; exterior stucco restoration began; Archeological monitoring continued, and additional data recovery began at North Depending prior to foundation waterproofing.*

[58] File Location: GWMP Internal Share Drive/2014-2019 Rehab Donation Project/1.0 Project Planning and Compliance/Compliance/ARHO Rehab PA Yearly Update 2019.pdf.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
				2017 Programmatic Agreement[59] Construction Drawings[60] Specifications[61]	*Spring and Summer 2019: Construction continued on Arlington House grounds and within the historic structures. Grading for accessible walks, creating of improved tram stop and road emergency pull off, installation of signage, providing waterproofing of northern dependency, making foundation repairs to the mansion, making improvements to potting shed/museum building, and completing the bookstore/comfort station renovation are among the remaining tasks.* *The National Park Service (NPS) proposes to preserve and rehabilitate the historic Arlington House mansion, slave quarters, and surrounding grounds. The purpose of this project is to expand upon preservation and rehabilitation efforts to the Arlington House mansion and its surrounding grounds in order to protect and maintain the historic integrity of the site, while expanding and improving visitor orientation, wayfinding, and interpretation, and improving universal access throughout the mansion and grounds. It will also move the bookstore out of the North Slave Quarters and upgrade the climate, fire, and security systems.* *Restoration and/or rehabilitation of four historic buildings including the Mansion, South Slave Quarters, North Slave Quarters, and Museum; extensive renovation and addition to the non-historic Comfort Station; minor alterations to the Mechanical Bunker; site accessibility and circulation improvement; landscape rehabilitation, and mechanical, electrical,*

[59] File Location: GWMP Internal Share Drive/2014-2019 Rehab Donation Project/1.0 Project Planning and Compliance/Arlington House PA, with SHPO signature.pdf
[60] "Rehabilitate Arlington House Mansion and Grounds," *Construction Drawings* (GWWO Architects, Baltimore, MD, January 31, 2018), 1-148 and 149-269. eTIC2 ARHO / 855 / 128171.
[61] "Rehabilitate Arlington House Mansion and Grounds - Final Construction Documents: Drawings, Specifications, Cost Estimate, Price Schedule, Constructability Checklist, Sustainability Checklist, Calculations" (National Park Service, George Washington Memorial Parkway, June 16, 2017), 1-1,046. eTIC2 ARHO / 855 / 138878.

Date	Event	Physical Evidence	Photographic Evidence	Documentary Evidence	Notes
					plumbing and security systems improvements to support the work.
2021	Reopening of Arlington House, the Robert E. Lee Memorial			NPS Website[62]	

[62] "Arlington House, The Robert E. Lee Memorial, Reopens Following Major Rehabilitation," National Park Service, Accessed 1/11/2024, https://www.nps.gov/arho/learn/news/arlington-house-the-robert-e-lee-memorial-reopens-following-major-rehabilitation.htm.

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South Slave Quarters
Arlington House, The Robert E. Lee Memorial
Historic Structure Report Part 3 and Preservation Maintenance Plan
1985 - 2021

APPENDICES

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South Slave Quarters
Arlington House, The Robert E. Lee Memorial
Historic Structure Report Part 3 and Preservation Maintenance Plan
1985 - 2021

Appendix A:
Project Treatment Records

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TREATMENT RECORD

Project Title:	**Rehabilitate Arlington House, Outbuildings and Grounds**
Project Description:	The Rehabilitate Arlington House, Outbuildings and Grounds project was the first of two, large, rehabilitation projects completed between 2006 and 2021. The goal of the initial project, 2006 to 2012, was to improve upon the safety and security of the historic buildings and collections for employees and visitors at Arlington House, The Robert E. Lee Memorial and lay the foundation for future projects to build upon this success. The project also provided for improvements to the accessibility, interpretation and historical accuracy of Arlington House and surrounding buildings, to include the North and South Slave Quarters and the 1861 Work Yard and Kitchen Garden. Rehabilitation of the grounds included the Kitchen Garden being restored to pre-Civil War conditions and the removal of non-contributing buildings, including the demolition and removal of the 1921 Comfort Station and its' mechanical basement. The gas fired boiler and water pumps housed in the basement were salvaged for temporary use in a newly constructed Mechanical Bunker outside of the historic area. This mechanical structure was constructed partially underground and includes a green roof. A new Comfort Station, including a First Aid Station, was also constructed outside of the historic area. Within the historic area, a new epoxy consolidated aggregate walking surface was installed to facilitate travel. The South Slave Quarters (SSQ) restoration and rehabilitation was based upon the 2009 Historic Structure Report. The exterior work included removal of the existing roof covering, selective roof sheathing repairs/replacement, and installation of a new composite shingle roof. Additional exterior work included a finished grade for improved accessibility. Interior work for the SSQ included replacement of the existing heating system with a new, remote, climate management system to temper ventilation and improve seasonal conditions. The new system included the installation of new mechanical equipment and electrical service in the new Mechanical Bunker. A new dry automatic sprinkler system was installed as well as a new fire detection and addressable fire alarm system. These new devices (smoke detectors, horn strobes, and manual pull stations) were tied into the central system, which was housed in the new Mechanical Bunker. Underground work included new underground mechanical, electrical and plumbing service for the SSQ. Where applicable, the existing utilities trench was reused.

TREATMENT RECORD

Associated Buildings:	Arlington House North Slave Quarters South Slave Quarters 1921 Comfort Station New Mechanical Bunker Surrounding Grounds
Goal of Project / Justifications:	Goal: Provide a safe environment for the visiting public where the history and significance of the site can be interpreted through a more accurate representation of the circa 1861 conditions. Justifications: • Previous reconstruction of the North and South Slave Quarters was revealed to be inaccurate, based on recent research. • The 1861 Work Yard and Kitchen Garden were inaccurately recreated and were inappropriately interpreted. • The 1921 Comfort Station in the historic Kitchen Garden was non-contributing and could not be made accessible. • No fire protection system existed to safeguard the historic buildings and the museum collections housed within those structures. • The extant mechanical system was deficient and not capable of preserving the historic buildings and collections. • Tracking of dust/dirt into Arlington House interior from gravel paths of Historic Area was a problem. Loose gravel, especially on slopes, was also an accessibility problem for persons with disabilities. • The project also focused on improving access to the buildings and grounds pursuant to the Americans with Disabilities Act. • Improve site accessibility and stabilize soils within the historic area.
Goals Met?	Secondary rehabilitation project (Arlington House, The Robert E. Lee Memorial Rehabilitation) followed closely to complete the desired goals.
Discoveries?	None identified.

TREATMENT RECORD

PMIS Number(s):	016018 (old) Conduct archeological investigation and monitoring; stabilize foundation drainage, repoint foundation wall, reconstruct basement entries, stabilize pedestrian/vehicular access A: Rehabilitation of Arlington House, The Outbuildings and Grounds B: Component Created by splitting Component 16018A: Rehabilitation of Arlington House, The Outbuildings	150123 Rehabilitate Arlington House, Outbuildings & Grounds, Phase II – Complete Climate Management System A. Rehabilitate Arlington House, Outbuildings & Grounds, Phase II – Complete Climate Management B. Component created by splitting component 150123A: Rehabilitate Arlington House, Outbuildings & Grounds [for funding reasons]
Project Accounting:	Component A: Line-Item Construction[1]	Component A – 2009 Economic Recovery-Construction[3]
	Component B: Line-Item Construction[2]	Component B – Recreation Fee Nationwide 20%[4]
Funding:	Component A: $901,000[5]	Component A - $3,623,806[7]
	Component B: $1,139,000[6]	Component B - $340,629[8]
Purchase Order / Contract Information:	**Purchase Order / Contract With:**	**Purchase Order / Contract Number:**

[1] PMIS Component 016018A Status Report 02/07/2012.
[2] PMIS Component 016018B Status Report 02/07/2012.
[3] PMIS Component 150123A Last Reported Status Date 10/31/2013.
[4] PMIS Component 150123B Last Reported Status Date 10/31/2013.
[5] PMIS Component 016018A Status Report 02/07/2012.
[6] PMIS Component 016018B Status Report 02/07/2012.
[7] PMIS Component150123A Last Reported Status Date 10/31/2013.
[8] PMIS Component 150123B Last Reported Status Date 10/31/2013.

TREATMENT RECORD

Architect/Engineer:	HNTB Architecture, Washington, DC	AE IDIQ Contract C3000030047 PMIS 016018
	HNTB Architecture	C2000040800 PMIS 016018
	Beyer Blinder Belle, Washington, DC	AE IDIQ Contract C3000060016 TO NO: 10
Construction:	Federal Contractors, Inc.	NCR Contract #C3000080027
	Bell/Biscayne JV, LLC.	1442C2011100130

Project Milestones:	
Design Award:	March 2004. PMIS 016018. Value Analysis Study for Rehabilitation of Arlington House, the Outbuildings and Grounds.[9]
Design Complete:	Arlington House Rehabilitation. PMIS 016018. 129 Sheets. April 9, 2007. Drawing Number: 831 / 84293
	Rehabilitate Arlington House, Outbuildings and Grounds, Phase 1. PMIS 016018. 100% Submission. 104 Sheets. June 18, 2007. Drawing Number: 855 / 84293
	Rehabilitate Arlington House, Outbuildings and Grounds, Phase 2A. PMIS 150123 (NEW). PMIS 016018 (OLD). Final Submission. 102 Sheets. December 23, 2009. Drawing Number: 855 / 84293
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[9] File Location: GWMP Internal Share Drive / 2004 Rehab Line Item / DAB Submittal 10 12 04 / ARHO VA Report 6 21 04.pdf.

TREATMENT RECORD

Substantial Completion:	February 19, 2010 December 16, 2011 Substantial completion defined as the new Comate Management System being operational, related fire alarm panel and fire pump approved by NPS Authority Having Jurisdiction, and NPS taking beneficial occupancy of new Comfort Station.
Final Acceptance:	June 16, 2010 (NaturalPave installation) November 30, 2012 (Completion of final 5 items on the punch list and ongoing warranty items)

Project Team:	
Park Staff:	Dottie Marshall, GWMP Superintendent Brandon Bies, Site Manager Matthew Virta, GWMP Cultural Resources Program Manager Andrew Wenchel, Historical Architect
Design Professionals:	HNTB Architecture, Washington, DC Mechanical: Henry Adams, LLC., Baltimore, MD Fire/Security: Tyco / Fire & Security / SimplexGrinnell
	Beyer Blinder Belle, Architects & Planners LLP Structural: Silman Associates, Washington, DC Civil: Wiles Mensch Corporation, Reston, VA Landscape: Rhodeside & Harwell, Inc., Alexandria, VA Mech/Elect: GHT Limited, Arlington, VA Cost Estimator: U.S. Cost, Arlington, VA
General Contractor:	Federal Contractors, Inc. Washington, DC Worcester Eisenbrandt Inc., Baltimore, MD

TREATMENT RECORD

Project Documentation:	Description / Date:	Document Number:	Repository:
Construction Specifications:	Rehabilitate Arlington House, Outbuildings and Grounds Phase 2A ARHO – PMIS NO.150123 Final Submission Project Specifications December 23, 2009	855 / 110089 (_0006) Also: 855 / 114951 File Name: 842171 – ARHO_855_110089_ 0002	eTIC2
	GWMP Rehabilitate Arlington House, Outbuildings and Grounds, Arlington House, The Robert E. Lee Memorial, Arlington, VA Specifications, Phase 2b Comfort Station, Final CD Submission, March 3, 2010 PMIS No. 150123	855 / 110071 Also: 850 / 106322	eTIC2
Construction Drawings:	Rehabilitate Arlington House, Outbuildings and Grounds, Phase 2b: Comfort Station, PMIS 150123. Final CD Submission, Beyer Blinder Belle, Washington, DC, dated 03/03/10. 49 Sheets.	855 / 80148	eTIC2
	GWMP Rehabilitate Arlington House, Outbuildings and Grounds, Arlington House, The Robert E. Lee Memorial, Arlington, VA Specifications, Phase 2b Comfort Station, Final CD Submission, March 3, 2010 PMIS No. 150123	855 / 110071 Also: 850 / 106322	eTIC2

95% Construction Drawings Rehabilitate Arlington House, Outbuildings and Grounds (sheets 1 – 127) PMIS 016018 C2000040800 HNTB Architecture, Washington, DC 05/26/2006	855 / 80146	
HNTB Phase I Dated 04/09/2007 PMIS 016018	831 / 84293	Park Files[10]
Arlington House Rehabilitation, George Washington Memorial Parkway, Arlington, VA. PMIS 016018. 100% Construction Drawings dated 07/28/2006.	831 / 84293	eTIC2
Rehabilitate Arlington House, Outbuildings and Grounds, Phase 1, George Washington Memorial Parkway, Arlington, VA, 100% Submission, dated 6/18/07. Recommended 06/10/2008. HNTB Architecture, Washington, DC (PMIS 016018) (modified 95% drawings for a specific smaller "project")	850 / 84293-A	eTIC2
Rehabilitate Arlington House, Outbuildings and Grounds, Phase 2A, George Washington Memorial Parkway, Arlington, VA, Final Submission, December 23, 2009, Revised 3/10. PMIS 150123 [016018 Old PMIS Number] HNTB Architecture, Washington, DC	855 / 80148	eTIC2
Rehabilitate Arlington House, Outbuildings and Grounds – Phase 2B: Comfort Station dated PMIS 150123	855 / 84293	eTIC2

[10] File Location: 1985 and Post 1985 / GWMP Maintenance Shop Hard Files / HNTB 100% Construction Drawings ARHO 16018 2007 / PDF Drawings /

	Rehabilitate Arlington House, Outbuildings and Grounds Phase 2b: Comfort Station, George Washington Memorial Parkway, Arlington VA PMIS 150123 Final CD Submission	855 / 80148 File Name: 218622 – ARHO_855_80148	eTIC2
	Rehabilitate Arlington House, Outbuildings & Grounds, Phase 2A- Complete Climate Management System – Final Construction Documents: Drawings, Specifications, Class A Cost Estimate, Constructability Checklist, Contract Price Schedule, Product File, Material Submittal List, Product Data	ARHO-855-110089 See Drawing 855/84293 Document Names: ARHO_855_110089_ 0001 - 0006	
As-Built Drawings:	Rehabilitate Arlington House, Outbuildings and Grounds As-Constructed Drawings Revision Code: A 06/18/2007 [016018]	850 / 84293-A	eTIC2
	Rehabilitate Arlington House, Outbuildings and Grounds, Arlington National Cemetery, George Washington Memorial Parkway, As Built.	As-Builts PH2A.pdf	Park files[11]
	Arlington House Phase I, As Builts – Sprinkler. Tyco / Fire & Security / SimplexGrinnell. Original design 01/23/09. As Built undated.	855 / 147956-A	eTIC2
	Arlington House and Outbuildings Rehabilitation, Arlington National Cemetery – Fire Alarm System As-Builts. Tyco / Fire & Security / SimplexGrinnell. Dated 05/19/09.	855 / 147535	eTIC2

[11] File Location: GWMP Internal Share Drive / 14-19 Rehab Donation Projects / Coordination / Plaster – int and ext / NSQ Pages from As-Builts Ph2A.pdf.

	Arlington House, Arlington National Cemetery As-Builts – HVAC. Welch and Rushe, Upper Marlboro, MD Stromberg Sheet Metal Works, Inc., Beltsville, MD. Dated 04/13/2010.	855 / 147538	eTIC2
	Rehabilitation of Arlington House, 08/31/2010.	855/80148	eTIC2
	Rehabilitate Arlington House, Outbuildings and Grounds, February 3, 2014[12]	855 / 84293	eTIC2
O&M Manual:	Rehabilitate Arlington House, Outbuildings & Grounds, Phase 2A, O & M Manual – Complete Climate Management System	850 / 128379	eTIC2
	O&M Manual Phase 2B Dated 12/15/2011	850 / 128380	eTIC2
Other Relevant Documentation / Correspondence:	Environmental Assessment for the Arlington House, The Robert E. Lee Memorial, Arlington, Virginia	850 / 118291	eTIC2
	Finding of No Significant Impact, Rehabilitation of Arlington House, Outbuildings & Grounds, Arlington House, The Robert E. Lee Memorial, August 2007.	850 / 118665	eTIC2
	Rehabilitate Arlington House, Outbuildings and Grounds Phase 2A, ARHO – PMIS NO. 150123, Final Submission Class A Estimate, December 23, 2009	842080-ARHO_855_110071_0937pg File Name: 842170 – ARHO_855_110089_0004	eTIC2

[12] 07/30/2018 PMIS update.

Rehabilitate Arlington House, Outbuildings and Grounds Phase 2A, ARHO – PMIS NO. 150123, Final Submission Product Data, December 23, 2009	842170-ARHO_855_110089_0004 119751-ARHO_855_110089_0005 855 / 110089 – 0005 File Name: 842169 – ARHO_855_110089_0001	eTIC2
Rehabilitate Arlington House, Outbuildings and Grounds Phase 2A, ARHO-PMIS No. 150123, Final Submission Submittal Log, December 23, 2009	842168-ARHO_855_110089_0003	eTIC2
Rehabilitate Arlington House, Outbuildings and Grounds Phase 2b Class A Estimate, George Washington Memorial Parkway, Arlington, Virginia, 100% CD Submission, February 05, 2010	850/118665 842086-ARHO_855_110071_0937	eTIC2
GWMP Rehabilitate Arlington House, Outbuildings and Grounds, Arlington House, The Robert E. Lee Memorial, Arlington, VA Product Literature and Data Sheets, Phase 2b Comfort Station, Final CD Submission, March 3, 2010	842081-ARHO_855_110071_0937pg	eTIC2
"Arlington House Comfort Station, 100% Construction Schedule" Rehabilitate Arlington House, Outbuildings and Grounds Phase 2b	842080-ARHO_855_110071_0937pg	eTIC2

"Arlington House – Comfort Station, Roof Joist Calculation" Rehabilitate Arlington House, Outbuildings and Grounds Phase 2b	ARHO_855_110071_0937pg	eTIC2
Arlington House- Comfort Station, Ridge Beam Calculation	842084-ARHO_855_110071_0937pg	eTIC2
GWMP Rehabilitate Arlington House, Outbuildings and Grounds, Material Submittal List and Review Estimate	842083-ARHO_855_110071_0937	eTIC2
GWMP Rehabilitate Arlington House, Outbuildings and Grounds, Arlington House, The Robert E. Lee Memorial, Arlington, VA Product Literature and Data Sheets, Phase 2b Comfort Station, Final CD Submission, March 3, 2010	842081-ARHO_855_110071_0937pg	eTIC2
Rehabilitate Arlington House, Outbuildings and Grounds, Phase 2A, Contract Price Schedule, Solicitation Number N5000082808, Park – PMIS ARHO - 150123. No Date.	842169-ARHO_855_110089_0001 File Name: 842 – ARHO_855_110089_0003	eTIC2

Additional Information:	All fire suppression, fire alarm, mechanical, electrical, and utilities work was completed by mid-January 2010. The only outstanding work was site paving using NaturalPave, a special natural colored paving with a temperature-dependent epoxy resin and aggregate. The installation was delayed by winter weather. A paving attempt made in April 2010 was unsatisfactory and rejected by the Park (with concurrence by manufacturer's representative and installer) due to problems with aggregate

and weather. The aggregate was changed, and a new mix was shipped and installed in early June under ideal weather conditions. This NaturalPave work accepted by Park and NCR contracts on June 16, 2010.[13]

Completion date extended to August 23, 2011, due to weather delays, after which Contractor continued work under liquidated damages. Substantial Completion by 12/16/2011 with Punchlist. Contractor continued work on punchlist and warranty items. CO issued Warranty of Construction letter 06/05/2012. Final Completion of Project and Closeout by 11/30/2012. Substantial completion defined as the new Comate Management System being operational, related fire alarm panel and fire pump approved by NPS Authority Having Jurisdiction, and NPS taking beneficial occupancy of new Comfort Station. Contract work was substantially completed by 12/16/2012. Remaining punch list items and unresolved warranty issues included: Climate Management System, Electrical Service Upgrade, and Resin Pavement. After an October 2012 meeting, the contractor finally completed the final 5 items on the punch list and ongoing warranty items by 11/30/2012. At project completion, the Park was not satisfied with the operation of the new climate management system and planned to follow up with another contract to properly balance the system, improve ventilation to North Wing and seasonally program humidity. [14]

Form Completed by:	NPS Historic Preservation Training Center
Date:	October 2023

[13] PMIS 016018 Component Status Report: 06/16/2010.
[14] PMIS 150123A Last Reported Status Date: 10/31/2013.

TREATMENT RECORD

South Slave Quarters Before:

Figure 1. *South Slave Quarters, north/east oblique elevation (NPS, 07/2001)*

Figure 2. *South Slave Quarters, east elevation (NPS, 07/2001)*

Figure 3. *South Slave Quarters, south elevation (NPS, 07/2001)*

Figure 4. *South Slave Quarters, south elevation detail (NPS, 07/2001)*

Figure 5. *South Slave Quarters, north elevation (CRIS, 2017)*

Figure 6. *South Slave Quarters, detail of fresco (CRIS, 10/2006)*

Figure 7. *South Slave Quarters, south elevation (CRIS, 2017)*

Figure 8. *South Slave Quarters, south elevation, detail (CRIS, 2017)*

Figure 9. *South Slave Quarters, west elevation (CRIS, 2017)*

Figure 10. *South Slave Quarters, damaged flashing (NPS, 02/2011)*

Figure 11. *South Slave Quarters, roof conditions (NPS, 02/2011)*

Figure 12. *South Slave Quarters, roof conditions (NPS, 02/2011)*

TREATMENT RECORD

South Slave Quarters During:

Figure 13. *South Slave Quarters, roof repair (NPS, 02/2011)*

Figure 14. *South Slave Quarters, roof and flashing repair (NPS, 02/2011)*

Figure 15. *South Slave Quarters, roof repair (NPS, 01/2011)*

Figure 16. *South Slave Quarters, roof repair (NPS, 01/2011)*

Figure 17. *South Slave Quarters, roof repair (NPS, 01/2011)*

Figure 18. *South Slave Quarters, roof repair (NPS, 01/2011)*

Figure 19. *South Slave Quarters, roof repair (NPS, 01/2011)*

Figure 20. *South Slave Quarters, roof repair (NPS, 01/2011)*

TREATMENT RECORD

South Slave Quarters After:

Figure 21. *South Slave Quarters, east elevation (CRIS, 02/2012)*

Figure 22. *South Slave Quarters, west elevation (CRIS, 02/2012)*

Figure 23. *South Slave Quarters, north oblique elevation (CRIS, 02/2012)*

Figure 24. *South Slave Quarters, south elevation (CRIS, 02/2012)*

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TREATMENT RECORD

Project Title:	**Arlington House, The Robert E. Lee Memorial Rehabilitation**
Project Description:	This project is an expansion of the 2006–2012 preservation and rehabilitation project. The Work included restoration and/or rehabilitation of four historic buildings including the Arlington House, South Slave Quarters, North Slave Quarters, and Museum; minor alterations to the Mechanical Bunker; site accessibility and circulation improvements; landscape rehabilitation; site signage and wayfinding installation; and mechanical, electrical, plumbing, and security systems improvements to support the Work. The exterior of the South Slave Quarters was preserved. This included replacing non-original, extant stucco with historically appropriate stucco and repairing or replacing in-kind and refinishing exterior wood features. All doors were replaced with replica wood stile and rail doors. In the interior, the missing fireplace and chimney were reconstructed, and preservation work included repair or replacement and refinishing of plaster walls and ceilings and repair of the brick flooring in the west room. This work allowed for continued interpretive programming use. All existing climate management, fire suppression systems, security systems, and lighting systems, including those installed in the 2006-2012 campaign, were improved and upgraded. The project also provided for the development of an overall strategy for interpreting the site, new interpretive media, exhibits and wayfinding; an accessible interpretive wayside overlooking the Arlington Woodlands – the last stand of old growth forest inside the beltway – was constructed, historically compatible plantings, gates, and fencing were installed in the planting and garden areas, gravel walks that previously led visitors around the site were upgraded to bonded aggregate walks that meet ADA standards for accessible design, and significant museum objects, reproductions and historic furnishings were acquired.

TREATMENT RECORD

Associated Buildings:	Arlington House North Slave Quarters South Slave Quarters Museum Building Comfort Station Surrounding Grounds
Goal of Project / Justifications:	Expand upon preservation and rehabilitation efforts to the Arlington House, The Robert E. Lee Memorial and its surrounding grounds to protect and maintain the historic integrity of the site, while expanding and improving visitor orientation, wayfinding, and interpretation, and improving universal access throughout the mansion and grounds. Move the bookstore out of the North Slave Quarters and upgrade the climate, fire, and security systems.
Goals Met?	Yes
Discoveries?	Discovery of a subfloor storage pit shrine at the South Dependency/Slave Quarters.[1]

[1] Matthew R. Virta, "Rehabilitation of Arlington House, the Robert E. Lee Memorial South Dependency/Slave Quarters – Discovery of a Subfloor Storage Pit Shrine, Supplementary Section 106 Archeological Investigations Related to the 2017-2020 Rehabilitation Program," National Park Service (GWMP: 2021).

TREATMENT RECORD

PMIS Number(s):	216010 Arlington House Project A: Stabilize foundation, rehabilitate portico and entrance, Restore exterior finishes and hardware B: Collections C: Interpretation D: Repair Arlington House Roof E: Update Systems [not pursued]	245580 Restore Arlington House – Centennial Project A. Restore Arlington House Construction – Centennial B. Restore Arlington House Construction – Donation C. Restore Arlington House Exhibitory – Centennial D. Restore Arlington House Exhibitory - Donations

Project Accounting:		
Funding Source(s):	FY 2015 Donations	FY 2017 and FY 2018 Centennial Challenge / Donations - Centennial Challenge
Funding:	A: $1,400,474.00[2] B: $986,511.05[3] C: $2,493,842.16[4]	A: $4,396,496.55[6] B: $5,872,447.03[7]

[2] PMIS Component 216010A FBMS Funding Details as of: 02/23/2022
[3] PMIS Component 216010B FBMS Funding Details as of: 02/23/2022
[4] PMIS Component 216010C FBMS Funding Details as of: 02/23/2022
[6] PMIS Component 245580A FMBS Funding Details as of: 02/18/2022
[7] PMIS Component 245580B FBMS Funding Details as of: 02/18/2022

	D: $40,356.39[5]	C: $1,117,496.91[8] D: $95,790.00[9]

Purchase Order / Contract Information:	**Purchase Order / Contract Number:**	**Purchase Order / Contract Amount:**
Project Management:	NPS Denver Service Center	$66,734.00[10] $243,074.00[11] $42,759.00[12]
Architect/Engineer:	P15PC00037 / P16PD00948	$571,764.00[13]
Construction:	140P2018C0008	$9,664,229.00[14]
Construction Management:	NPS Historic Preservation Training Center	$238,256.35[15] $76,250.00[16]

[5] PMIS Component 216010D FBMS Funding Details as of: 02/23/2022
[8] PMIS Component 245580C FBMS Funding Details as of: 02/18/2022
[9] PMIS Component 245580D FBMS Funding Details as of: 02/18/2022
[10] Denver Service Center Project Management and Contracting Service for 02/02/2015 – 09/30/2015.
[11] Project Management Plan, GWMP 216010 – Rehabilitate Arlington House Mansion and Grounds. Fully executed 02/04/16.
[12] Denver Service Center Project Management and Contracting Services Direct Charge Authorization for 10/01/2019 – 09/30/2020.
[13] Contractor Performance Assessment Report (CPARS), 06/01/2017.
[14] Contract Number: 140P2018C0008 Contractor Performance Assessment Report (CPAR), dated February 3, 2020.
[15] Denver Service Center/Historic Preservation Training Center Project Agreement, 02/19/2018.
[16] Historic Preservation Training Center Direct Charge Authorization for 10/01/2019 – 03/27/2020.

TREATMENT RECORD

Project Milestones:	
Design Award:	January 14, 2012 April 20, 2015
Design Complete:	May 4, 2017[17] June 16, 2017[18] August 7, 2017[19]
Construction Award:	March 19, 2018
Construction NTP:	Partial: May 15, 2018 Full: June 26, 2018
Substantial Completion:	February 18, 2020[20]
Construction Completion:	April 30, 2020[21]
Final Close-out, Commissioning & Inspections	June 12, 2020[22]

[17] Date on construction contract documents.
[18] Drawing Number 850 / 128171 (GWWO)
[19] Date of NPS final review of documents. (E39 SubstantialCompletion Ltr.pdf)
[20] Letter of Substantial Completion, 02/18/2020.
[21] GWMP 216010-245580 ARHO NCA Worksession June 2020.pdf
[22] Ibid.

TREATMENT RECORD

Project Team:	
Park Staff:	Charles Cuvelier, GWMP Superintendent Blanca Stansky, Deputy Superintendent Ming-Yi Wong, GWMP Historical Architect Kimberly Robinson, GWMP Museum Curator Benjamin Stinnett, GWMP Landscape Architect Matthew Virta, GWMP Cultural Resources Program Manager
Project Manager:	Denver Service Center, National Park Service Michael, Morelli, Project Manager, NPS DSC Jack Hagen, Project Specialist, NPS DSC
Contracting:	Victoria Nosal, Contracting Officer, NPS DSC Heather Vogt, Contract Specialist, NPS DSC
Design Professionals:	AE Prime: GWWO, Inc., Baltimore, MD Structural: Faisant, Baltimore, MD Civil: VHB, Williamsburg, VA Landscape: WRT, Inc., Philadelphia, PA Mech/Elect: Henry Adams, Baltimore, MD Fire/Security: GHD, Inc., Baltimore, MD
General Contractor:	W.M. Schlosser Co, Inc., Hyattsville, MD
Specialty Contractors:	Hayles and Howe, Inc., Baltimore, MD: Interior and exterior finishes, including stucco repair, plaster repairs, stone restoration, interior paint and faux painting treatments. Worcester Eisenbrandt, Baltimore, MD: Interior and exterior wood repairs and restoration at historic mansion, including maple floor replacement and finish, stairs, doors, and door hardware installation. Capitol Solutions: Hardscape paving installation, including bonded aggregate pavement and stone fine paths at Flower Garden.

TREATMENT RECORD

Construction Manager:	Project Management Section, Historic Preservation Training Center, National Park Service Todd Ravesloot, Exhibits Specialist, NPS HPTC Fritz Rushlow, Supervisory Exhibits Specialist, NPS HPTC Jerome Kirkland, Exhibits Specialist, NPS, HPTC Mark Slater, Historical Architect, NPS, HPTC Rene' Laya, Exhibits Specialist, NPS, HPTC

Project Documentation:	**Description / Date:**	**Document Number:**	**Repository:**
Project Correspondence:	Project Management Plan: April 15, 2015 Letter of Substantial Completion: January 3, 2020	GWMP-216010 ARHO Signed PMP_2-4-16.pdf WMS LTR 37 Substantial Completion Nosal 12-2-2020.pdf	Park Files[23] Park Files[24]
Construction Specifications:	George Washington Memorial Parkway, Arlington House, The Robert E. Lee Memorial, Repair / Rehabilitation and Preservation Work, GWMP PMIS No. 216010, Project Specifications, June 16, 2017.	855 / 138878	eTIC2
Construction Drawings:	Rehabilitate Arlington House Mansion & Grounds, Arlington House and Grounds, George Washington Memorial Parkway, Construction Drawings, Volume 1 of 2, Code & Accessibility, Civil, Landscape, Architectural, Structural, June 16, 2017. PMIS 216010	855 / 138878 850 / 128171	eTIC2

[23] File Location: HPTC ARHO 2020 Rehab / Project Administration / Project Agreement / PMP / Final Signed PMP / GWMP-216010 ARHO Signed PMP_2-4-16.pdf.
[24] File Location: HPTC ARHO 2020 Rehab / Construction / Construction Management / Correspondence / Request for Substantial Completion / WMS LTR 37 Substantial Completion Nosal 12-2-2020.pdf.

	Rehabilitate Arlington House Mansion & Grounds, Construction Drawings, Vol 1 of 2. 06/16/2017. PMIS 216010 GWWO Inc, Baltimore, MD Faisant (structural) Baltimore, MD WRT, Inc. (Landscape) Philadelphia, PA Henry Adams (Mech/Elec) Baltimore, MD Fire/Security: GHD, Inc. Baltimore, MD Civil: VHB, Williamsburg, VA	850 / 128171	eTIC2
	Rehabilitate Arlington House Mansion & Grounds, Arlington House and Grounds, George Washington Memorial Parkway, Construction Drawings, Volume 2 of 2, Mechanical, Electrical, Security, Fire Alarm, Sprinkler, June 16, 2017	850 / 128171	eTIC2
	Repair/Rehabilitation and Preservation Work at Historic Arlington House, George Washington Memorial Parkway, Virginia. GWWO Inc, Baltimore, MD. 269 Sheets. Dated 01/31/2018.	850 / 128171	eTIC2
As-Built Drawings:	Rehab Arlington House, Mansion & Grounds As-Constructed Drawings 140P2018C0008 GWMP 216010 / 245580A Volume 1 of 2 W.M Schlosser Company, Inc. October 16, 2020	850 / 128171A	eTIC2
	Rehabilitate Arlington House Mansion & Grounds, Construction Drawings, Vol 1 of 2. 06/16/2017. PMIS 216010 GWWO Inc, Baltimore, MD Faisant (structural) Baltimore, MD	850 / 128171	eTIC2

	WRT, Inc. (Landscape) Philadelphia, PA Henry Adams (Mech/Elec) Baltimore, MD Fire/Security: GHD, Inc. Baltimore, MD Civil: VHB, Williamsburg, VA		
	Rehabilitate Arlington House Mansion and Grounds, dated 01/31/2018.	850 / 128171	eTIC2
O&M Manual:	Arlington House Project - Operation and Maintenance Manual	850 / 180133	eTIC2
Other Relevant Documentation / Correspondence:	Environmental Assessment, August 2016	850 / 147553	eTIC2
	Finding of No Significant Impact (FONSI), Arlington House, The Robert E. Lee Memorial Rehabilitation, George Washington Memorial Parkway, March 2017.	850 / 147552	eTIC2
	Rehabilitation of Arlington House, The Robert E. Lee Memorial, South Dependency/Slave Quarters – Discovery of a Subfloor Storage Shrine, Supplementary Section 106 Archeological Investigations Related to the 2017-2020 Rehabilitation Program. Dated 04/17/2021.	850 / 179782 1190753-ARHO_855_110089_0006	eTIC2

Additional Information:	Some project complications: NCR Historic Architect on-site 12/06/2019 to look at developing leaks at the Mansion's northwest corner. She noted pre-existing leaks in the area and new gutters and down spouts did not seem to be correcting the issue. She believed the leaks were significant based on visible damage since completion of wall repairs. She suggested notifying the Project Architect, since the existing conditions were not acceptable. Per email message dated: 12/06/2019. (Meeting Agenda Dec 11, 2019 (Meeting #82)

	Fire Alarm/Suppression System – CMR assembled list of items for correction resulting from 4/21 site visit by AJH; items to complete for contractor and with previous existing system required GWMP correction before Final FA system inspection could be completed by AJH. Security Alarm System – Was installed with new Telguard Communications and tested; some issues remained between reporting to both USPP Primary and NCACC Secondary receivers. Contractor had to trouble-shoot with NCA. HVAC System Commissioning – Some corrections in Bunker were existing and required GWMP service vendor (JCI) to complete before CxA could come back and complete the testing process.

Form Completed by:	NPS Historic Preservation Training Center
Date:	October 2023

TREATMENT RECORD

Photographic Documentation:

South Slave Quarters Before:

Figure 1. *South Slave Quarters, north elevation (CRIS, 1/2017)*

Figure 2. *South Slave Quarters, north elevation (CRIS, 02/2012)*

TREATMENT RECORD

Figure 3. *South Slave Quarters, north elevation (NPS, 06/2015)*

Figure 4. *South Slave Quarters, north elevation, detail of fresco (CRIS, 10/2006)*

Figure 5. *South Slave Quarters, east elevation (CRIS, 02/2012)*

Figure 6. *South Slave Quarters, east elevation (CRIS, 01/2017)*

Figure 7. *South Slave Quarters, south elevation (CRIS, 01/2017)*

Figure 8. *South Slave Quarters, south elevation (NPS, 06/2015)*

Figure 9. *South Slave Quarters, detail of south elevation (CRIS, 01/2017)*

Figure 10. *South Slave Quarters, south elevation, soffit (HPTC, 2019)*

Figure 11. *South Slave Quarters, west elevation (CRIS, 01/2017)*

Figure 12. *South Slave Quarters, west elevation (CRIS, 02/2012)*

Figure 13. *South Slave Quarters, north elevation, looking west, drainage issues and erosion control (NPS, 07/2015)*

Figure 14. *South Slave Quarters, north elevation and work yard, looking west (NPS, 04/2016)*

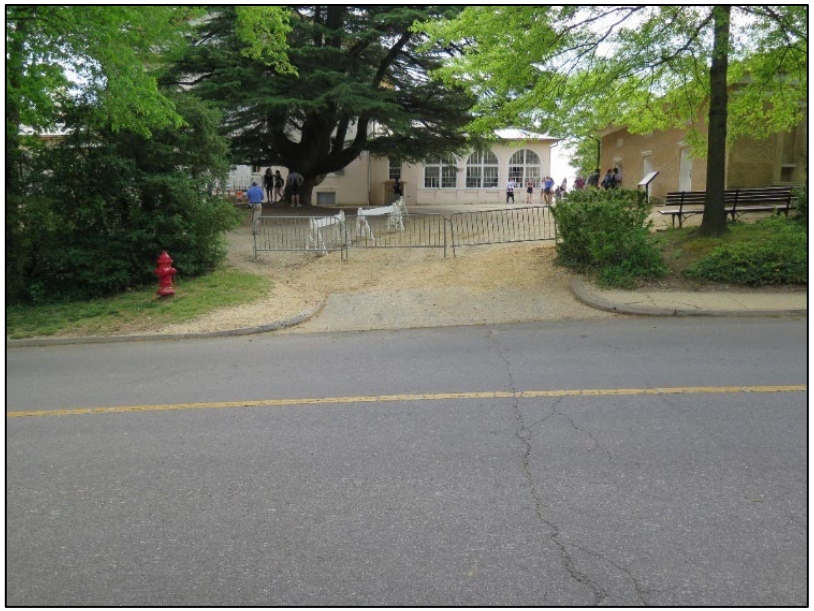


Figure 15. *South Slave Quarters and Work Yard from Sherman Drive (NPS, 04/2016)*

Figure 16. *South Slave Quarters, west elevation, from Arlington Woods Interpretive Plaza on Sherman Drive (NPS, 04/2016)*

Figure 17. *South Slave Quarters, south elevation, walkway from tram stop (NPS, 04/2016)*

Figure 18. *South Slave Quarters, south elevation, walkway from tram stop (NPS, 04/2016)*

Figure 19. *South Slave Quarters, south elevation, from flower garden (NPS, 04/2016)*

Figure 20. *South Slave Quarters, south elevation, from flower garden (NPS, 04/2016)*

South Slave Quarters During (Interior):

Figure 21. *South Slave Quarters, exhibit plans*

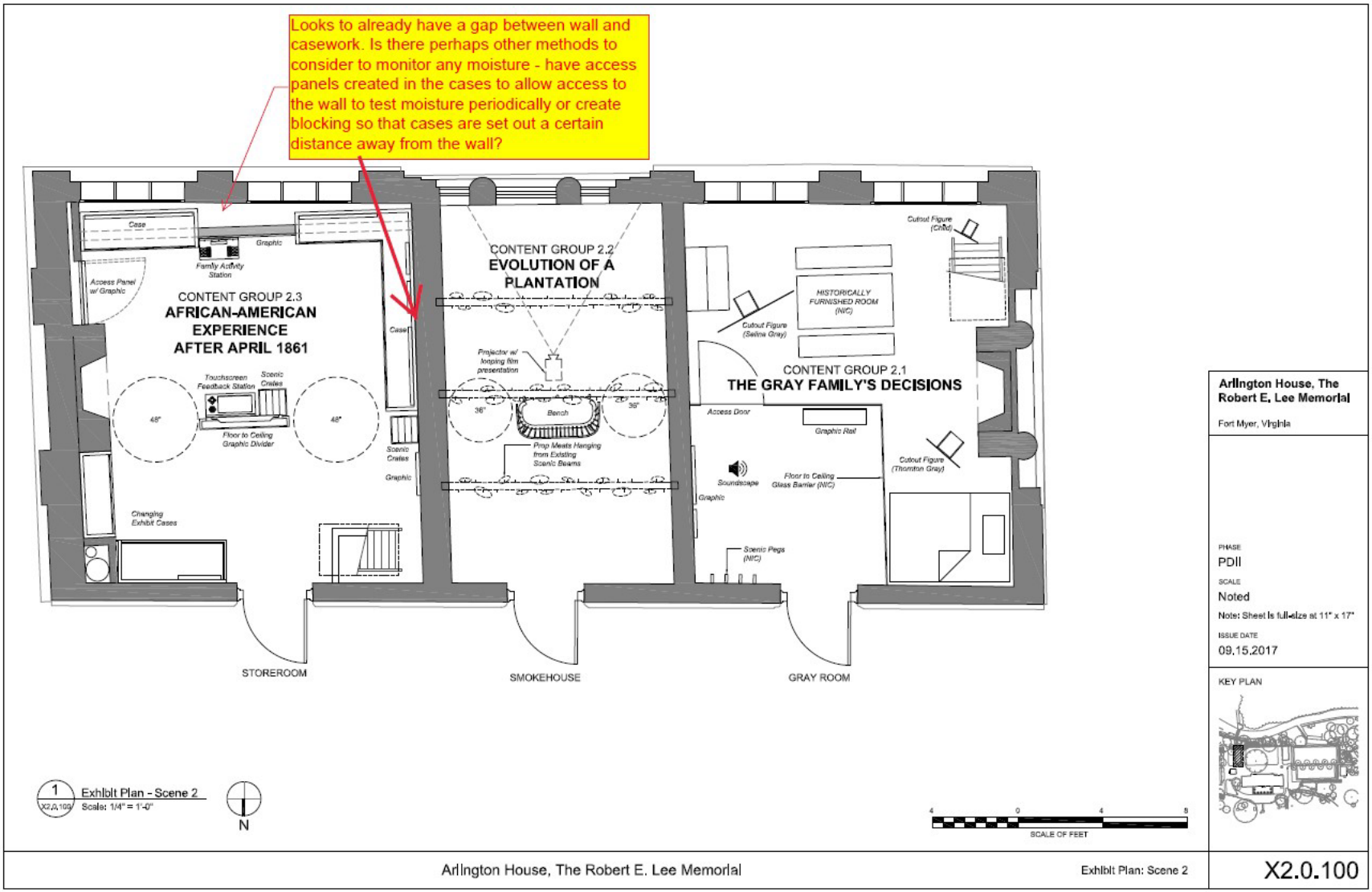


Figure 22. *South Slave Quarters, exhibit plans (09/2017)*

Figure 23. *South Slave Quarters, Selina Gray's Quarters, southeast corner, floor installation and plaster repair (HPTC, 2019)*

Figure 24. *South Slave Quarters, Selina Gray's Quarters, north wall and doorway, floor installation and plaster repair (HPTC, 2019)*

Figure 25. *South Slave Quarters, Selina Gray's Quarters, south wall, floor installation and plaster repair (HPTC, 2019)*

Figure 26. *South Slave Quarters, Smokehouse, southwest corner, beam installation and plaster repair (HPTC, 12/2018)*

Figure 27. *South Slave Quarters, Smokehouse, southwest corner, plaster repair (HPTC, 03/2019)*

Figure 28. *South Slave Quarters, Smokehouse, southwest corner, installation of meat hooks on beams and plaster repair (HPTC, 05/2019)*

Figure 29. *South Slave Quarters, Smokehouse, paint test strip (HPTC, 06/2019)*

Figure 30. *South Slave Quarters, South Slave Quarters Museum Exhibit, east wall, chimney rehabilitation (HPTC, 11/2018)*

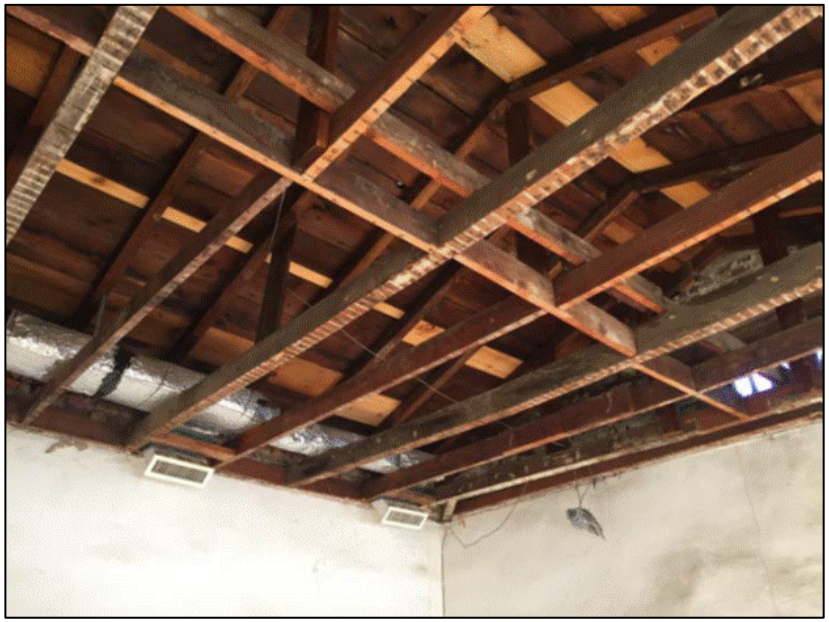


Figure 31. *South Slave Quarters, ceiling removed, HVAC installation (HPTC, 11/2018)*

South Slave Quarters During (Exterior):

Figure 32. *South Slave Quarters, east elevation, trenching for electrical conduit (HPTC, 10/2018)*

Figure 33. *South Slave Quarters, storm water drainage installation (HPTC, 10/2018)*

Figure 34. *South Slave Quarters, northeast corner, installation of cleanout, drain, and downspout connection (HPTC, 11/2018)*

Figure 35. *South Slave Quarters, south elevation, window frame restoration (HPTC, 09/2018)*

Figure 36. *South Slave Quarters, west elevation, paint removal (HPTC, 12/2018)*

Figure 37. *South Slave Quarters, oblique of south/west elevation, non-historic stucco removal (HPTC, 06/2019)*

Figure 38. *South Slave Quarters, south elevation, stucco repair (HPTC, 06/2019)*

Figure 39. *South Slave Quarters, detail of south elevation, stucco repair (HPTC, 06/2019)*

South Slave Quarters After (Interior):

Figure 40. *South Slave Quarters, Selina Gray's Quarters, exterior of door (HPTC, 04/2022)*

Figure 41. *South Slave Quarters, Selina Gray's Quarters, north wall interior of door (HPTC, 04/2022)*

Figure 42. *South Slave Quarters, Selina Gray's Quarters, north wall, updated fire and security systems (HPTC, 04/2022)*

Figure 43. *South Slave Quarters, Selina Gray's Quarters, west wall, Selina Gray exhibits, updated lighting and detection system (HPTC, 04/2022)*

Figure 44. *South Slave Quarters, Selina Gray's Quarters, west wall, fireplace (HPTC, 04/2022)*

Figure 45. *South Slave Quarters, Selina Gray's Quarters, west wall, Selina Gray exhibits (HPTC, 04/2022)*

Figure 46. *South Slave Quarters, Selina Gray's Quarters, south wall, Selina Gray exhibit (HPTC, 04/2022)*

Figure 47. *South Slave Quarters, Selina Gray's Quarters, southeast corner, Selina Gray exhibits (HPTC, 04/2022)*

Figure 48. *South Slave Quarters, Smokehouse, exterior of door (HPTC, 10/2023)*

Figure 49. *South Slave Quarters, Smokehouse, north wall, interior of door, exposed ceiling, updated fire and security systems (NPS, 01/2020)*

Figure 50. *South Slave Quarters, Smokehouse, detail of paint and meat hooks (NPS, 01/2020)*

Figure 51. *South Slave Quarters, Smokehouse, detail of paint and meat hooks (NPS, 01/2020)*

Figure 52. *South Slave Quarters, Smokehouse, facing north, exhibit space (ARHO Website, 11/2023)*

Figure 53. *South Slave Quarters, Smokehouse, facing south, exhibit space (ARHO Website, 11/2023)*

Figure 54. *South Slave Quarters, South Slave Quarters Museum Exhibit, exterior of door (HPTC, 10/2023)*

Figure 55. *South Slave Quarters, South Slave Quarters Museum Exhibit, north wall, interior of door, new stairway to attic, updated fire and security systems (NPS, 01/2020)*

Figure 56. *South Slave Quarters, South Slave Quarters Museum Exhibit, south wall (NPS, 01/2020)*

Figure 57. *South Slave Quarters, South Slave Quarters Museum Exhibit, south wall (ARHO Website, 01/2024)*

Figure 58. *South Slave Quarters, South Slave Quarters Museum Exhibit, east wall, fireplace and exhibit space (ARHO Website, 11/2023)*

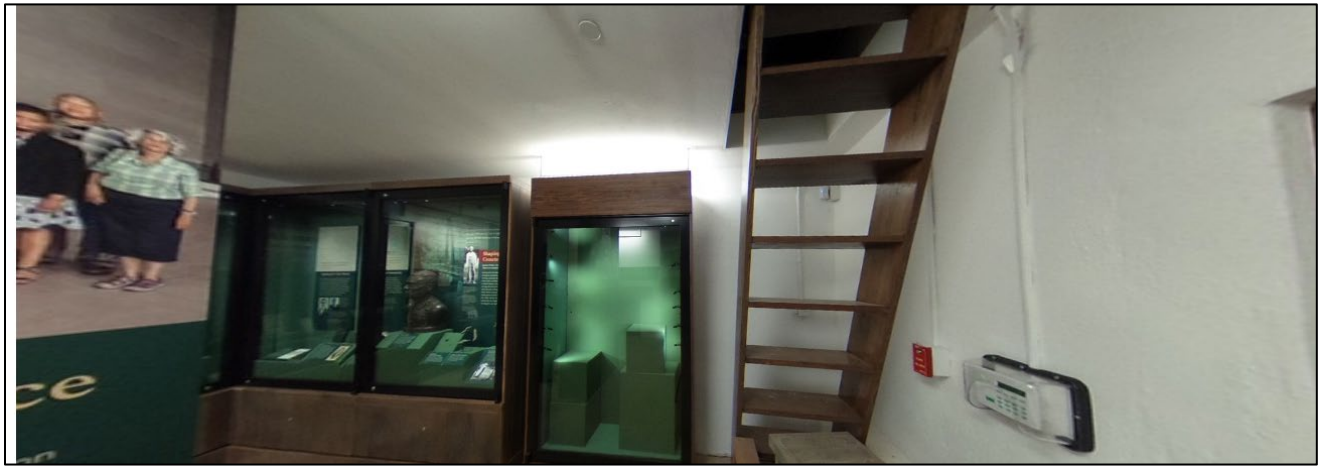


Figure 59. *South Slave Quarters, South Slave Quarters Museum Exhibit, west wall, updated fire and security systems (ARHO Website, 11/2023)*

South Slave Quarters After (Interior):

Figure 60. *South Slave Quarters, east elevation, new bonded aggregate walkway (NPS, 2022)*

Figure 61. *South Slave Quarters, east elevation, new bonded aggregate walkway (NPS, 01/2020)*

Figure 62. *South Slave Quarters, east elevation oblique, looking north into work yard, new bonded aggregate walkway (NPS, 2022)*

Figure 63. *South Slave Quarters, east elevation (HPTC, 10/2023)*

Figure 64. *South Slave Quarters, north elevation looking south from work yard (HPTC, 10/2023)*

Figure 65. *South Slave Quarters, north elevation (CRIS, 11/2022)*

Figure 66. *South Slave Quarters, north elevation (HPTC, 10/2023)*

Figure 67. *South Slave Quarters, north elevation, new bonded aggregate walkway (HPTC, 10/2023)*

Figure 68. *South Slave Quarters, looking south from new vehicle pullout (NPS, 01/2020)*

Figure 69. *South Slave Quarters, west elevation (HPTC, 10/2023)*

Figure 70. *South Slave Quarters, west elevation (CRIS, 11/2022)*

Figure 71. *South Slave Quarters, west elevation (CRIS, 11/2022)*

Figure 72. *South Slave Quarters, oblique of south/east elevation (NPS, 2022)*

Figure 73. *South Slave Quarters, oblique of south/east elevation (HPTC, 04/2022)*

Figure 74. *South Slave Quarters, south elevation (HPTC, 10/2023)*

Figure 75. *South Slave Quarters, south elevation (HPTC, 10/2023)*

Figure 76. *South Slave Quarters, south elevation, window and stucco detail (HPTC, 10/2023)*

Figure 77. *South Slave Quarters, rehabilitated chimney (HPTC, 01/2023)*

TREATMENT RECORD

Project Title:	
Project Description:	
Associated Buildings:	

TREATMENT RECORD

Goal of Project / Justifications:	
Goals Met?	
Discoveries?	

PMIS Number(s):		

TREATMENT RECORD

Project Accounting:		
Funding Source(s):		
Funding:		

Purchase Order / Contract Information:	**Purchase Order / Contract With:**	**Purchase Order / Contract Number:**
Architect/Engineer:		
Construction:		

TREATMENT RECORD

Project Milestones:	
Design Award:	
Design Complete:	
Substantial Completion:	
Final Acceptance:	

TREATMENT RECORD

Project Team:	
Park Staff:	
Design Professionals:	
General Contractor:	

Project Documentation:	**Description / Date:**	**Document Number:**	**Repository:**
Construction Specifications:			

TREATMENT RECORD

Construction Drawings:			
As-Built Drawings:			
O&M Manual:			

TREATMENT RECORD

Other Relevant Documentation / Correspondence:			

Additional Information:	

Form Completed by:	
Date:	

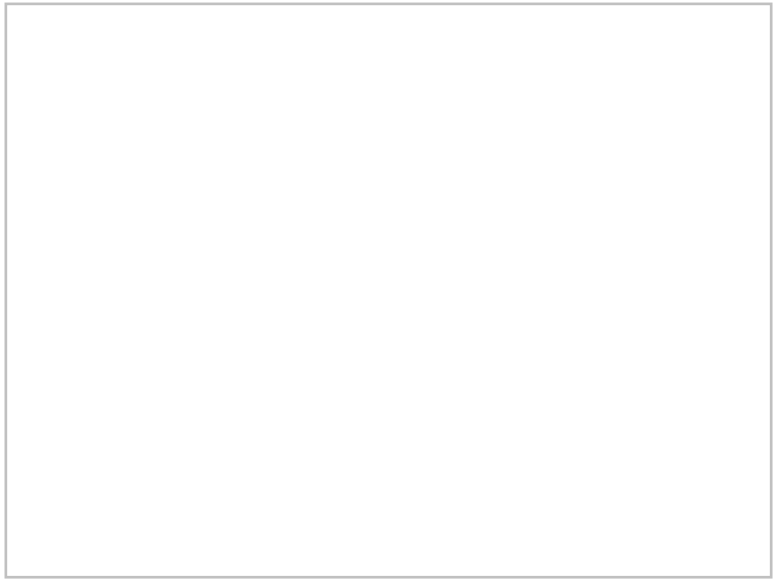
TREATMENT RECORD

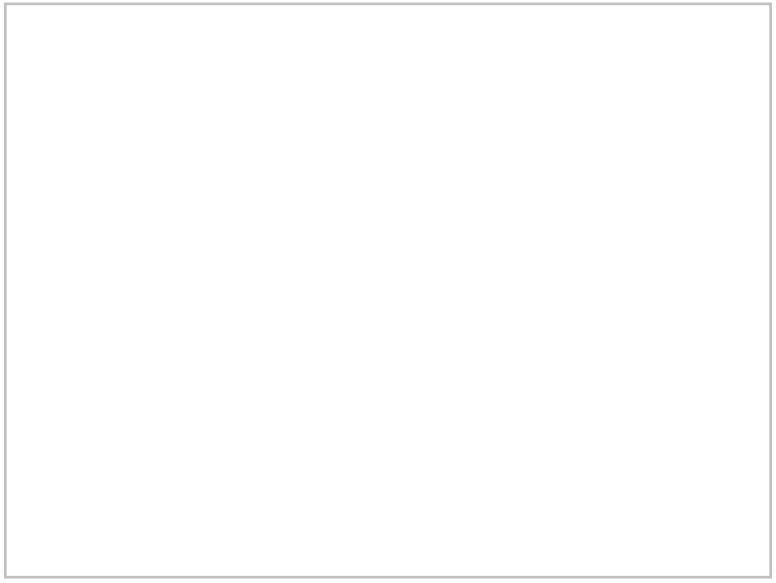
Photographic Documentation:

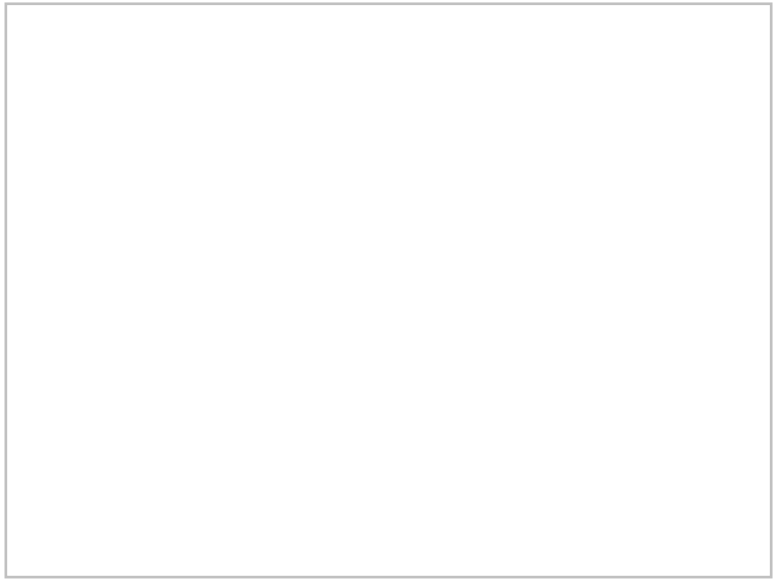
Before:

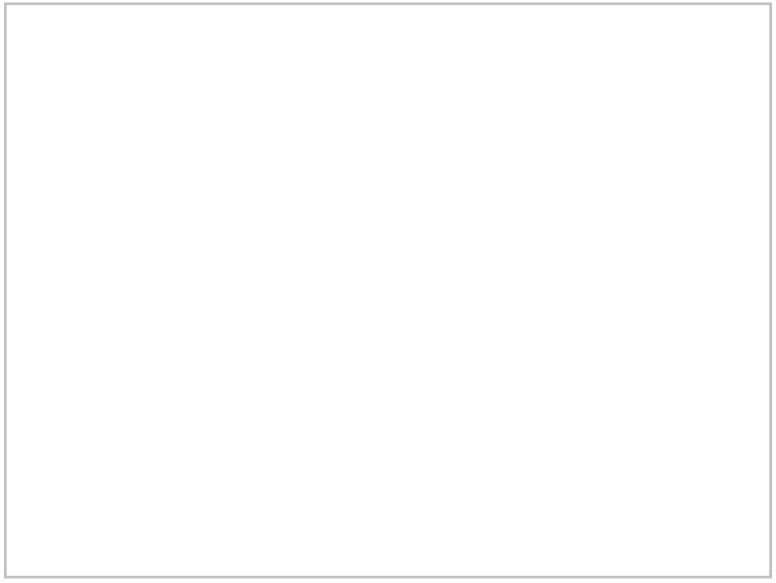
TREATMENT RECORD

Before continued:









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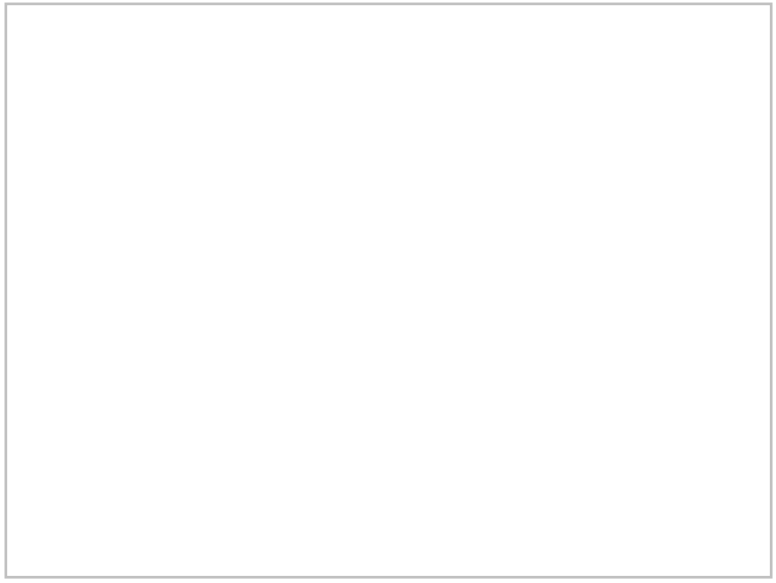

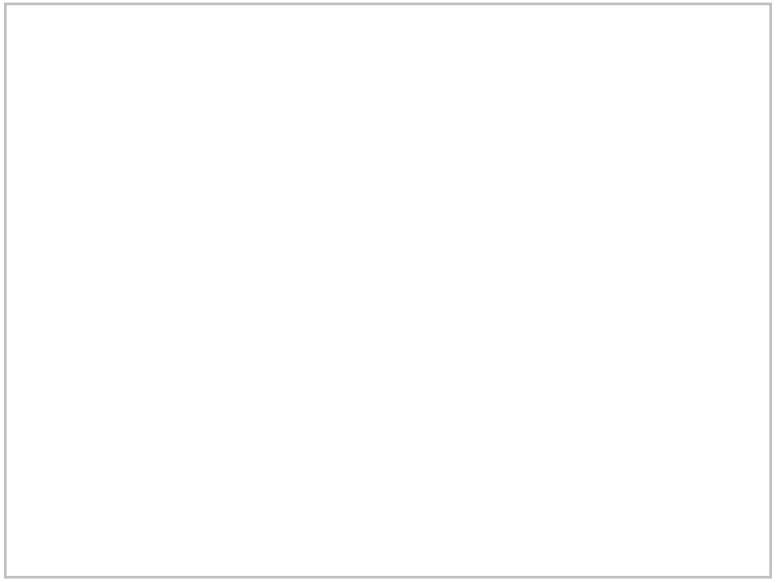

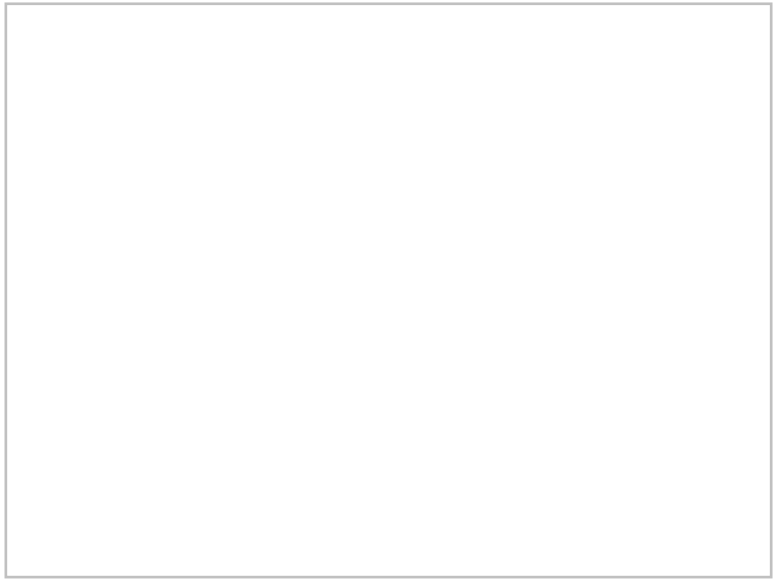

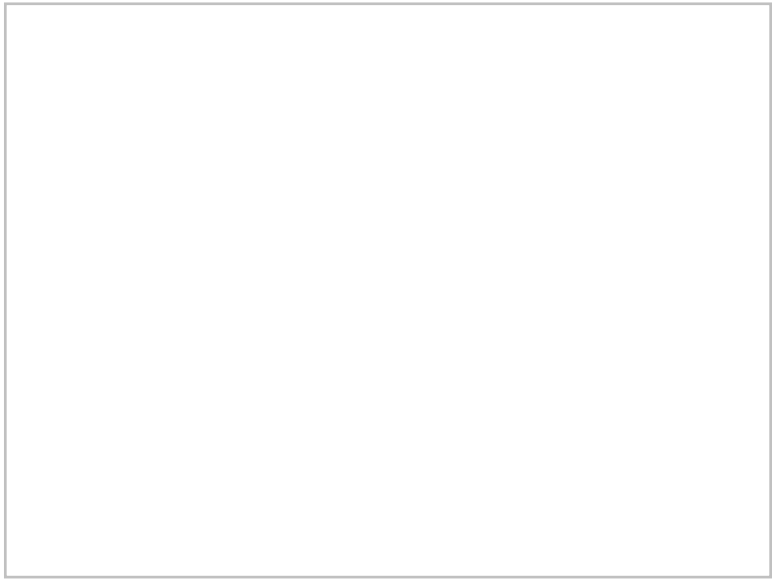

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TREATMENT RECORD

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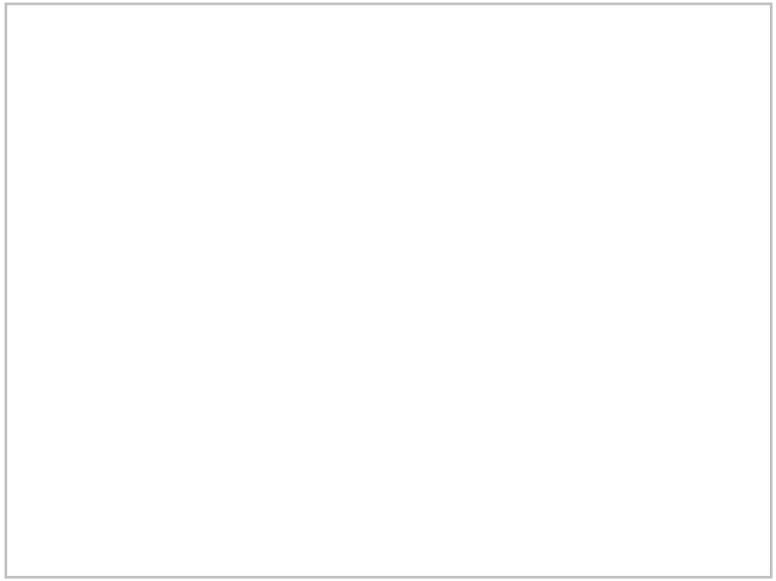

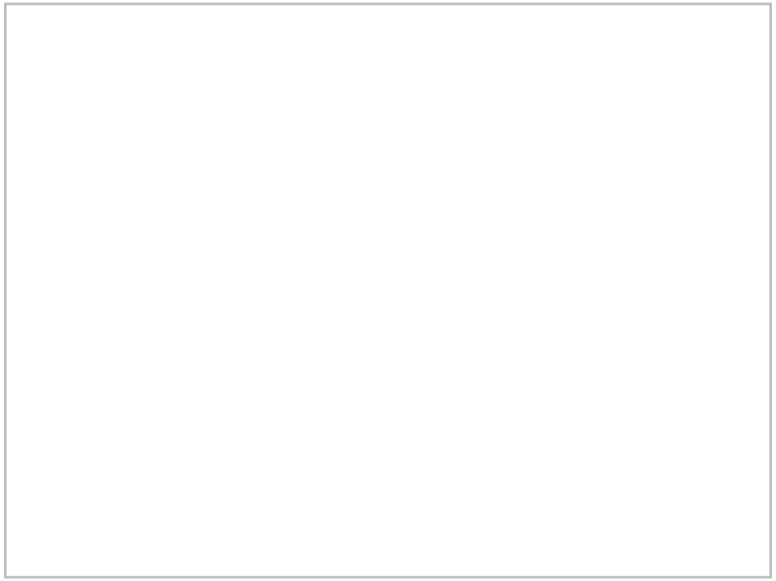

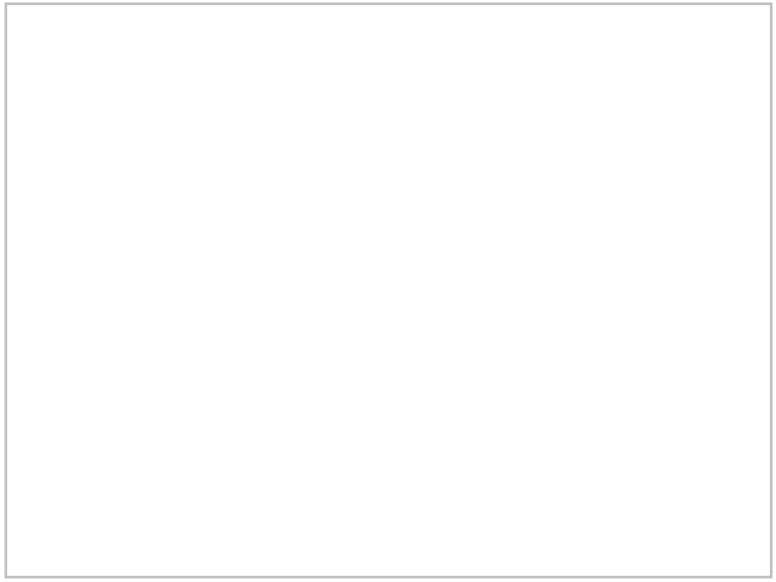

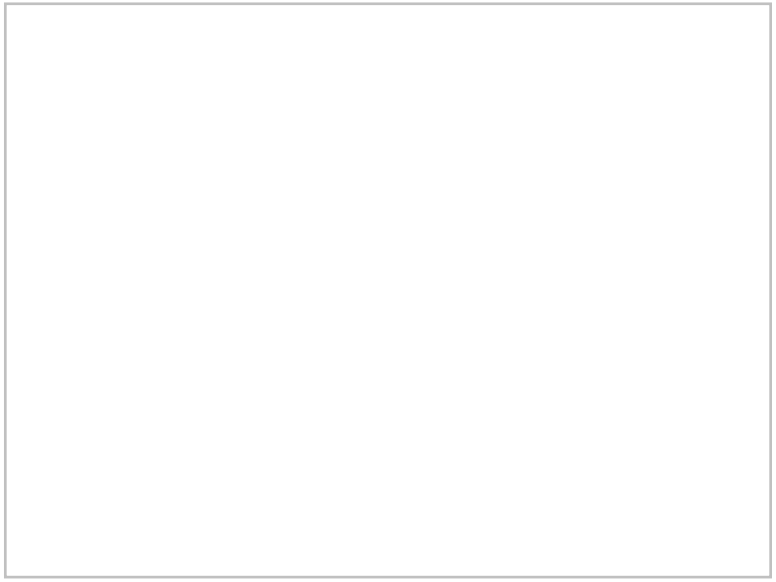

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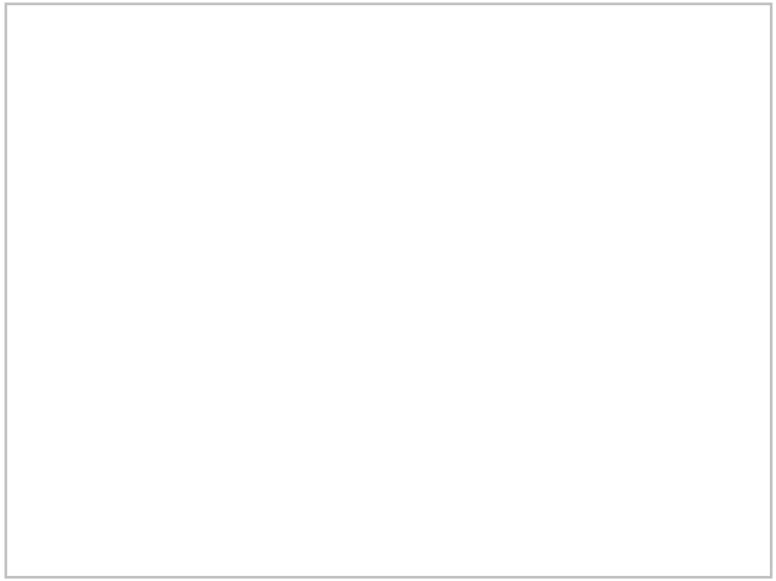

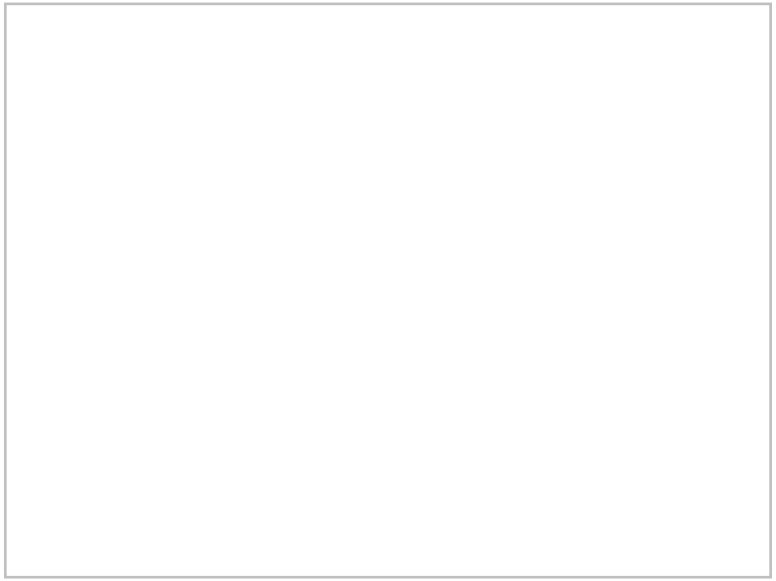

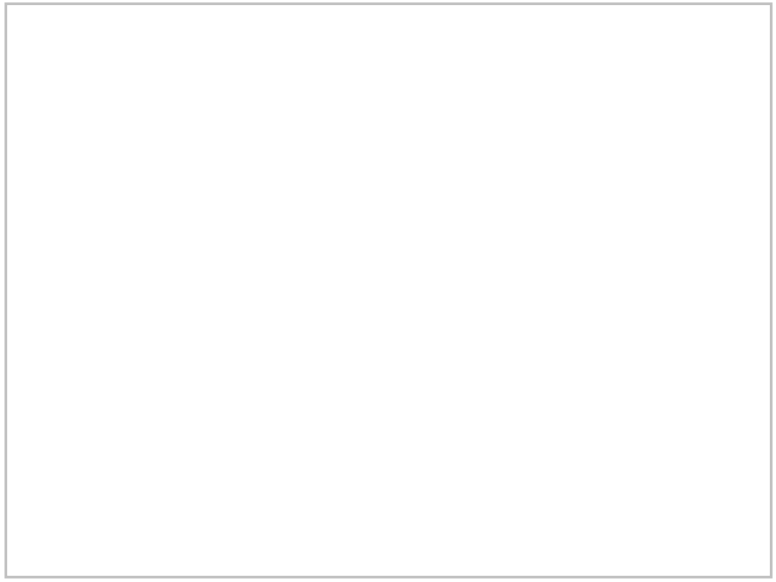

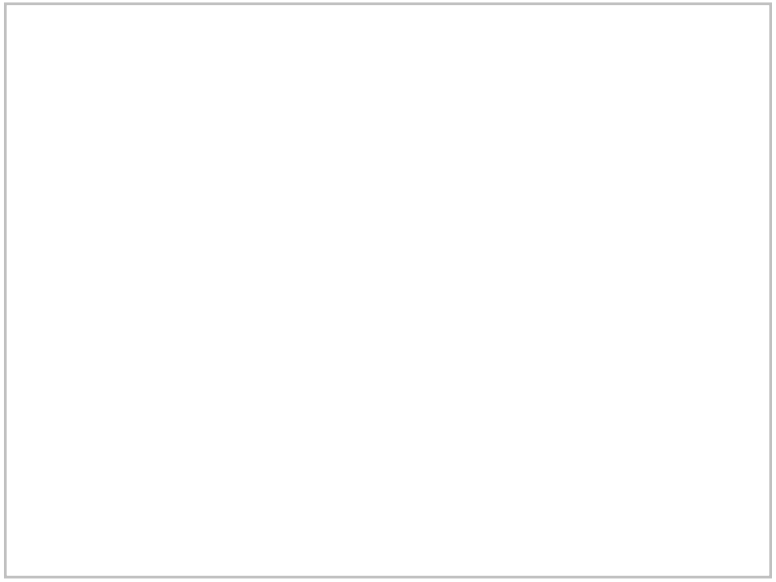

South Slave Quarters
Arlington House, The Robert E. Lee Memorial
Historic Structure Report Part 3 and Preservation Maintenance Plan
1985 - 2021

Appendix B:
Preservation Maintenance Plan and Inspection Forms

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Preservation Maintenance Plan

The following Preservation Maintenance Plan has been developed to reflect existing conditions, materials, and construction details of the South Slave Quarters. Its principal goal is to maintain the building in good condition and minimize repairs that will lead to loss of historic fabric. It should assist in monitoring and controlling conditions to slow deterioration and delay the need for replacement and repair, as well as predicting future problems.[1]

The plan is presented as a table and is organized by Uniformat's functional elements.[2] It makes recommendations for inspections, including frequency, and then presents maintenance and treatment recommendations. It is recommended that these tasks be performed by individuals skilled in preservation crafts and in consultation with historical architects, preservation engineers, and architectural conservators. Please make safety a priority in executing the recommendations within this maintenance plan. This includes considering the hazards of task execution as well as material hazards.

Following the plan are documents to assist with inspections and documentation of future treatment. These include recommended inspection and repair lists organized by month (or other interval), inspection forms based on door and window schedules, baseline drawings for condition documentation, and templates for documentation of future treatment. All are in Appendix B. The need for documentation can never be overstated; documentation informs future repairs and can assist in the planning and development of future projects. This plan should also help coordinate work effort and assist in prioritization of maintenance tasks.

This Preservation Maintenance Plan and its associated documents are considered working documents. They should be modified as experience suggests and as conditions change.

[1] Babor, Dan and Diana Plian, page 2.

[2] UniFormat®, a publication of CSI and CSC, is a method of arranging construction information based on functional elements, or parts of a facility characterized by their functions, without regard to the materials and methods used to accomplish them. These elements are often referred to as systems or assemblies. UniFormat is utilized in performance specifications, preliminary project descriptions, and cost estimating. https://www.csiresources.org/standards/uniformat/about-uniformat Accessed 08/19/2022.

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B201099 CHIMNEYS	**Inspect chimneys**	Annually from grade: end of SEP	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Plant/biological growth o Cracked stucco parging or loss of aggregate o Failing paint o Dislodged chimney caps o Dislodged flashing NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles
	Inspect chimneys	Every five years at roof level	**5-Year Inspection to be performed by: Preservation Masonry Contractor**
	Repair Chimneys and Caps	Immediately, when noted	**Use professional services to make repairs.** Guidelines for repair work: o Remove plant growth. o Correct condition allowing moisture penetration. o Repoint eroded, cracked, or missing joints. Mortar should be lime-based and match historic mortar in color, texture, width, and tooling. Ideally the new mortar should match existing mortar in strength but, at minimum, be slightly weaker than the adjacent masonry. A mortar analysis is suggested. Weaker mortar allows trapped moisture to migrate through the mortar joint instead of through the masonry. Spalled masonry is often evidence of joints that have been pointed with a mortar mix that is too hard for the surrounding masonry. o Stucco parging should be repaired with a stucco mix that matches the existing parging in materials, strength, and tooling. o Reference: Preservation Brief 22: The Preservation and Repair of Historic Stucco (Appendix C)
	Repair flashing	Immediately, when noted	o Re-secure loose flashing. Clean out old mortar, lead, lead wool, or fastening materials. Make sure flashing is properly inserted into reglet (slot) joints, taking care not to damage substrate. o If flashing is no longer intact, replace with flashing matching existing in material, size, shape, and finish. Because cap and step flashings each have specific overlap and extension requirements, replacement flashing should match the existing material and installation unless there has been a proven deficiency. Avoid attaching step flashing with mastic or sealant. Properly re-bed all step flashing. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. NOTE: **Work with Certified Roofing Contractors**

B201099 CHIMNEYS continued	Renew paint system	As needed (anticipate every 5 years)	**Use professional services to renew paint system.** o Scrape and repaint selected areas as needed. o Wash and properly prepare the area before application to obtain good adhesion. o Apply the coating system in accordance with manufacturer's recommendations. o Environmental regulations may restrict the use of certain types of paints. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.

Figure 1. *South elevation*

Figure 2. *South Slave Quarters chimney detail*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B301001 ROOF FINISHES (Composite)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Slipped, missing, cracked, buckling, abraded, deformed, or broken roof materials o Standing water o Evidence of water infiltration on interior surfaces o Deflection, splitting, evidence of stress within roof framing NOTE: During semi-annual inspections, inspect from the ground using binoculars and access interior framing spaces, if able. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles
	Inspect roof	Every five years at roof level	**5-Year Inspection to be performed by: Certified Roofing Contractor**
	Inspect ridges	Semi-Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Lifted, slipped, missing, or damaged ridge material o Loose or raised fasteners NOTE: During semi-annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.
	Inspect ridges	Every five years at roof level	**5-year Inspection to be performed by: Certified Roofing Contractor**

B301001 ROOF FINISHES continued (Composite)	**Inspect adjacent interior spaces**	Quarterly: JAN, APR, JUL & OCT	**Quarterly Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Staining or other evidence of water infiltration o Water leaks, especially after major storms. o Work with a professional roofing contractor to identify source of water infiltration and to develop a repair plan.
	Clean roof surfaces	Annually: Fall (OCT)	o Remove excessive debris and biological growth from roof surfaces. Use low-pressure garden hose water and a natural or nylon scrubbing brush, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Avoid using diluted chlorine bleach. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. o Remove overhanging tree branches to minimize abrasion/damage. **NOTE: Tree work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**
	Repair roof coverings and finishes	Immediately, when noted	o Repair and replace missing composite materials according to manufacturer's instructions from PMIS 150123 project o Reinstall lifted or slipped ridge materials. If unable to reuse or material missing, replace in-kind NOTE: When accessing a roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. **NOTE: Work with Certified Roofing Contractors**

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B301001 ROOF FINISHES (Metal)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by:** **Park Historical Architect and Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Missing, cracked, buckling, abraded, or deformed roof materials o Open seams o Standing water o Deterioration, splitting, evidence of stress within roof framing o NOTE: During semi-annual inspections, inspect from the ground using binoculars, if needed.
	Inspect roof	Every five years at roof level	**5-Year Inspection to be performed by: Certified Roofing Contractor**
	Clean roof surfaces	Annually: Fall (OCT)	o Remove excessive debris and biological growth from roof surfaces. Use low-pressure garden hose water and a natural or nylon scrubbing brush, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Avoid using diluted chlorine bleach. o Remove overhanging tree branches to minimize abrasion/damage. NOTE: **Tree work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**
	Repair roof coverings and finishes	Immediately, when noted	o Solder patches on sheet metal roofs/hoods NOTE: **Work with Certified Roofing Contractors**

Figure 3*. Details of composite roof (HPTC, 04/2022)*

Figure 4. *Metal roof on door hood (HPTC, 04/2022)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B301004 FLASHING	**Inspect flashing and adjacent interior spaces**	Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Debris accumulating in valleys o Deteriorated and damaged flashing, including cracks, dents, and dissimilar materials o Failing connections at any intersection of roof areas, of roof and adjacent wall, of roof and chimney, or any flashed projections o Raised edges o Failing paint systems o Staining or other evidence of water infiltration o Water leaks, especially after major storms. NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. NOTE: **Work with a professional roofing contractor** to identify source of water infiltration and to develop a repair plan.
	Inspect flashing	Every 5 years at roof level	**5-year Inspection to be performed by: Certified Roofing Contractor**
	Clean flashing	Annually: OCT	o Broom sweep branch and leaf debris away from valleys NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.
	Repair flashing	Immediately, when noted	o Re-secure loose flashing. Clean out old mortar, lead, lead wool, or fastening materials. Make sure flashing is properly inserted into reglet (slot) joints, taking care not to damage substrate. o If flashing is no longer intact, replace with flashing matching existing in material, size, shape, and finish. Because cap, step, valley, cricket, and apron flashings each have specific overlap and extension requirements, replacement flashing should match the existing material and installation unless there has been a proven deficiency. Avoid attaching step flashing with mastic or sealant. Properly re-bed all step flashing. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. NOTE: **Work with Certified Roofing Contractors.**

Figure 6. *Detail of west chimney (HPTC, 10/2023)*

Figure 5. *Detail of east chimney (HPTC, 10/2023)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B301005 GUTTERS & DOWNSPOUTS	**Inspect roof drainage system**	Quarterly: JAN, late APR, mid-JUL, late-OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Sagging and misaligned gutters, downspouts, and boots o Damaged, failing gutter hangers and downspout brackets o Crushed or split gutters and downspouts o Open seams o Dissimilar materials o Damaged boots o Debris accumulating in gutters and at juncture of downspout and boots o Overflowing gutters o Failure or slow to drain at boots o Ice damming and icicles hanging from gutters and downspouts in winter months o Overhanging branches impacting gutters o Growth, moss, and stains NOTE: During quarterly inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.
	Inspect roof drainage system	Every 5 years from roof level	**5-year Inspections to be performed by: Certified Roofing Contractor**
	Inspect/scope underground drain lines	Every 3 years; more frequently as needed	**Use professional services to scope underground drain lines** to ensure lines are open and free of debris and clogs. Clean lines if debris is noted.
	Clean roof drainage system	Semi-Annually: late APR & late OCT	o Remove leaves and other debris from gutters, downspouts, and boots. o Use a garden hose to flush out troughs and downspouts. NOTE: If using a ladder to access gutter, utilize a ladder with a brace device to keep ladder from crushing gutter.
	Repair gutters and downspouts	Immediately, when noted	**Use professional services to make repairs.** o Correct alignment of gutters, downspouts, and boots as necessary so water flows to drains without ponding. o Repair or replace split gutters, downspouts, and damaged boots. o If patching or repairing holes in metal gutters, use traditional brazing techniques. Patching with asphalt compounds (an acidic material) can cause further deterioration of metal gutters.

B301005 GUTTERS & DOWNSPOUTS continued	Correct ice dam condition	Immediately, when noted	**Use professional services to determine cause.** o Consider: ▪ Warm air leak or indoor heat loss ▪ Insufficient insulation ▪ Insufficient air circulation o Make improvements as needed.

Figure 8*. Gutter along south elevation with southeast downspout (HPTC, 04/2022)*

Figure 7. *Detail of downspout and boot (HPTC, 04/2022)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B201001 EXTERIOR WALLS (Stucco)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. With a ladder or binoculars, look for: o Moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any pattern o Excessive damp spots, often accompanied by staining, peeling paint, moss, or mold. o Evidence of rising damp o Cracks within stucco finish/rendering o Loss of aggregate in pebble dash stucco o Surface salts o Active cracks in joints and around windows and doors. Determine whether movement is seasonal or sign of ongoing problem. o Areas significantly misaligned or where there are bulging wall sections or cracks could be indicative of potential structural problems (**seek professional guidance).** o Failed sealant o Deterioration of mineral finish coat on stucco rendering, including signs of checking, flaking, and chalking o Deterioration of faux finishes o Evidence of insect infestation and vegetative growth o Surface stains o Openings from prior utilities or service pipes
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls NOTE: **Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**
	Clean exterior wall surfaces	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. o Follow guidance per KEIM Mineral Coatings of America, Inc. when cleaning exterior wall surfaces finished with a KEIM product **NOTE: When graffiti or stains are present, consult a with a conservator for professional removal.**

B201001 EXTERIOR WALLS continued (Stucco)	Repair stucco parging	As needed, during summer months	o **Under consultation with a preservation architect and mason,** determine cause of and solution to stucco damage. o Stucco **repairs should be made by a stucco mason or journeyman plasterer.** Guidelines for repair work: o Stucco parging should be repaired with a stucco mix that matches the existing parging in materials, strength, and tooling. Reference: Preservation Brief 22: The Preservation and Repair of Historic Stucco (Appendix C)
	Paint exterior wall components	As needed, during summer months	o It is ideal to allow exterior paints to wear away before recoating and only paint deteriorated areas, as unnecessary painting slowly obliterates detail and thick coatings can impact moisture migration. Although there may be a slight difference in color and texture between new and old paint, this contrast will be reduced by weathering. Guidelines: o Follow guidance per KEIM Mineral Coatings of America, Inc. when painting exterior wall surfaces finished with a KEIM product o Remove deteriorated caulks and sealants, clean, and reapply appropriate caulks and sealants using backer rods as needed. Follow manufacturer's instructions regarding preparation and installation. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building.
	Faux finish and fresco painting repair	Immediately, when noted	o **Under consultation with a preservation architect and conservator,** determine cause of and solution to finish deterioration or damage. o Faux finish and fresco work should be executed by an **experienced decorative painter or conservator.**

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*

Figure 9. *East elevation depicting two stucco finishes (HPTC, 04/2022)*

B201001 EXTERIOR WALLS (Stone)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. Look for: o Moisture patterns that may appear after a heavy or sustained rainfall or snow, recording any pattern o Excessive damp spots, often accompanied by moss, or mold o Evidence of rising damp o Cracked or failing mortar o Cracks through masonry o Deteriorating or delaminating masonry o Surface salts o Active cracks in joints and around windows and doors. Determine whether movement is seasonal or sign of ongoing problem. o Areas significantly misaligned or where there are bulging wall sections or cracks could be indicative of potential structural problems (**seek professional guidance).** o Failed sealant o Openings from prior utilities or service pipes
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls. **NOTE: Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**
	Clean exterior wall surfaces	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. Guidelines: o When cleaning, use the gentlest means possible. Begin treatment with hose-pressure water. If this does not remove soiling, introduce agitation via natural bristle brushes. o Avoid abrasive methods, such as mechanical scrapers and high-pressure water or air and additives such as sand, natural soda, ice crystals, or water products, as all abrasive blasting removes some portion of the surface. Avoid power-washing as it drives excessive moisture into wall materials, wall cavities, and interior walls. If required maximum pressure should be 400 psi and a fan tip should be used at a minimum working distance of 12". **NOTE: When graffiti or stains are present, consult a with a conservator for professional removal.**

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B201001 EXTERIOR WALLS continued (Stone)	Repoint masonry	As needed, during summer months	**Use professional services to make repairs.** o Repoint eroded, cracked, or missing joints. o Rake out joints by hand, generally avoiding rotary saws or drills, to a depth of 2½ times the width of the joint (or until sound mortar is encountered), to ensure new mortar will stay adhered between the masonry units. o Repoint joints using a lime-based mortar and match historic mortar in color, texture, width, and tooling. Ideally the new mortar should match the existing mortar in strength but, at minimum, it must be slightly weaker than the adjacent masonry. A mortar analysis is suggested. Weaker mortar allows trapped moisture to migrate through the mortar joint instead of through the masonry. Spalled masonry is often evidence of joints that have been pointed with a mortar mix that is too hard for the surrounding masonry. o Avoid off-the-shelf, pre-mixed cement mortars as they are inappropriate for most historic buildings. o Avoid use of joint sealants in place of mortar on vertical masonry surfaces as they are not breathable and can lead to moisture-related damage of the adjacent masonry. o Correct areas which trap unwanted moisture. o Damaged stone units may be able to be removed, turned around, and reset; or replaced to match. NOTE: It is important to resolve the cause of cracks or failure before resetting masonry units and repointing.

Figure 10. *South elevation stone foundation (HPTC, 04/2022)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B201001 EXTERIOR WALLS (Wood, Wood Details, Exterior Soffits)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. Look for: o Moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any pattern o Damp spots, often accompanied by staining, peeling paint, moss, or mold o Evidence of wicking moisture o Failed sealant o Deterioration of paint finish coat on decorative wood elements and wall details, including peeling, checking, flaking, and chalking o Evidence of wood rot, insect infestation, and vegetative growth o Surface stains
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls NOTE: **Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**
	Clean exterior wall surfaces	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. Guidelines: o When cleaning, use the gentlest means possible. Begin treatment with hose-pressure water. If this does not remove soiling, introduce agitation via natural bristle brushes. o A mild detergent may be used. It is recommended that two people work together when using mild detergent – one to brush, and one to pre-wet and rinse. Avoid strong soap solutions as they may leave streaks. It is also recommended to begin cleaning at the bottom and move up the wall. o Avoid abrasive methods, such as mechanical scrapers and high-pressure water or air and additives such as sand, natural soda, ice crystals, or water products, as all abrasive blasting removes some portion of the surface. o Avoid power-washing as it drives excessive moisture into wall materials, wall cavities, and interior walls. NOTE: **When graffiti or stains are present, consult a with a conservator for professional removal.**

B201001 EXTERIOR WALLS Continued (Wood, Wood Details, Exterior Soffits)	Repair wood features	As needed	**Repairs to structure/architectural features should be made by a preservation carpenter. Consultation from a preservation architect or engineer may also be necessary.** o Make repairs using wood that matches species of existing feature, if possible. Ensure match of texture, dimension, and tooling. o When temporarily removing wood components, make every effort to reuse the removed component after underlying repair work is needed. o Consider using stainless steel or high strength aluminum nails as appropriate. Putty or fill nail holes flush with wood prior to repainting. o Backprime any installed wood with one coat of primer and coat end grain that might be exposed with two coats of primer. NOTE: Durable hardwoods should be considered for replacement material where beading, chamfering, or other decorative work is required to match historic details. Although appropriate for certain applications, pressure treated lumber is difficult to tool and may inhibit paint adherence if not allowed to weather prior to coating application.
	General repair	As needed	**Consult or use professional services to execute repairs.** o When using traditional or contemporary materials for patching wood ensure that the materials are compatible with the substrate—evaluate strength, vapor permeability, thermal expansion, and appearance.

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*

Figure 11. *West elevation highlighting wood trim and soffit (HPTC, 01/2023)*

B2020 EXTERIOR WINDOWS	**Inspect windows**	Semi-Annually: May & OCT	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a window schedule (see sample to follow), according to window number, which includes condition and description of each opening component. Review interior and exterior components. Look for: o Overall material condition, including paint o Unwanted water penetration and surface condensation o Insect infiltration (especially termite and carpenter ant damage), or animal entry o Window sash and shutters that do not open and close properly o Rubbing points/abrasion due to ill-fit or alignment o Loose, open, or decayed joints in frames, sash o Slipped sills and tipped or cupped stools o Loose, damaged, or missing hardware o Broken sash cords/chains, sash pulleys o Missing or damaged sash o Locking difficulties o Deteriorated weatherstripping and flashing o Gaps between sash and sill or window opening o Broken/cracked glass, loose or missing glazing and putty o Loose/damaged moldings, architraves, decayed stiles at sill level o Accumulation of dirt or collection of leaves and debris NOTE: Pay particular attention to exposed horizontal surfaces of window components as they tend to deteriorate faster than vertical surfaces.
	Clean glass components	Semi-Annually: MAY & OCT	o Dust sash with a brush or whisk broom. o Wash glass, beginning with top sash, working from top to bottom. o Use mild vinegar and water mixture or a non-alkaline commercial window cleaner. Be cautious with compounds that contain ammonia as they may stain brass or bronze hardware elements. Vinegar, in a one-to-one combo with distilled water, works as an excellent degreaser and is also great at breaking down dirt and grime. Dry windows with a squeegee or a clean cloth. Can spot treat with full-strength vinegar. o When using a squeegee blade or sponge, wipe wet corners with a soft dry cloth. o Avoid high-pressure washes. NOTE: Do NOT wash outside windows when the temperature is below freezing.
	Repair and maintain weatherstripping	As needed	Use durable weatherstripping, such as spring metal or a high-quality synthetic material, avoiding common brush and bulb or pile weatherstripping that requires more frequent replacement.

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B2020 EXTERIOR WINDOWS continued	Replace broken or missing glass	Immediately, when noted	For historic glass, a conservation approach should be considered to repair limited cracks. Where panes with a distinct appearance are missing, specialty glass should be obtained to match. An inventory should be kept for future needs. NOTE: Take appropriate safety precautions when working with components finished in lead paint.
	Repair window glazing	As needed	o Repair where deteriorated or missing. o Use care when removing putty so as not to crack or break old glass or damage muntins and sash frames. o Avoid using mechanical devices to remove old putty and match historic putty bevels or details when undertaking work. o Re-glaze with either traditionally formulated oil or modern synthetic putties, making sure to properly bed the glass and secure with glazing points. NOTE: Take appropriate safety precautions when working with components finished in lead paint.
	Repair and repaint windows, frames, and sills	As needed (anticipate every 5 years)	o Clean out paint chips from window openings using a wet paper towel and dispose of debris prior to repair or repainting. o Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture. Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. o Correct perimeter cracks around windows to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. o Reduce excess air infiltration through windows by repairing, aligning sash frames, and lubricating sash locks so that windows close tightly. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o After a major painting operation sash should be daily opened and closed for the first few days to break the paint film and preventing the windows from becoming "painted in" and inoperative. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.

B2020 EXTERIOR WINDOWS continued	Clean, repair, and maintain sills	As needed	o Replace deteriorated or failing individual elements with in-kind materials. o Sand and prepare surfaces and use material-specific patching compounds to fill cracks, holes or areas collecting moisture. Follow manufacturer's instructions for preparation and installation. Do not cover a wood sill with metal panning; this may trap moisture and promote decay. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for preparation and application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.
	Repair and maintain sash as operable	As needed	o Adjust wood sash which bind when operated. o Sash runs were traditionally unpainted between the stop and parting bead. Removing subsequent paint applications will often help improve sash operation. Apply beeswax, paraffin, or similar material to tracks or sash runs for ease of movement. o If sash are loose, replace worn parting beads. o Lubricate sash chains and pulleys using a graphite- or silicone-type lubricant.
	Clean, repair, maintain sash locks/hardware	As needed	o Use a soft, damp cloth. o Use mineral spirits or commercial cleaners very sparingly, as repeated use may remove original finishes. Most metal cleaners include ammonia that can streak and stain metal, so it is important to remove all cleaning residue. Polished hardware subject to tarnishing or oxidation often benefit from a thin coat of paste wax (carnauba), hand buffed to remove extra residue. NOTE: Avoid lacquer finishes for high-use areas, as they require more extensive maintenance. NOTE: Patinated finishes should not be cleaned with any chemicals, since subtle aged appearances contribute to the building's character.

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*

Figure 12. *Windows on south elevation (HPTC, 10/2023)*

B2030 EXTERIOR DOORS	**Inspect doors**	Semi-Annually: MAY & OCT	**Semi-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a door schedule (see sample to follow), according to door number, which includes condition and description of each opening component. Look for: o Overall material condition, including finish o Fit and operation of door o Loose, open, or decayed joints in frames, doors, transoms, and sidelights o Gaps between threshold, door frame, and door opening. o Tipped or cupped thresholds o Drag marks on thresholds o Loose hardware, locking difficulties o Deteriorated weatherstripping and flashing o Wear at the knuckles, loosening of screws, or poor fit of hinges o Functionality of power-assisted doors o Condensation or evidence of water infiltration o Evidence of insect infiltration or animal entry NOTE: Heavily used doors may merit greater inspection frequency.
	Repair and maintain weatherstripping	As needed	o Reduce excess air infiltration by repairing and maintaining weatherstripping. o Use durable weatherstripping, such as spring metal or high-quality synthetic material. Avoid common brush and bulb or pile weather stripping that require more frequent replacement.

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
B2030 EXTERIOR DOORS continued	Repair and repaint doors, frames, thresholds	As needed (anticipate every 5 years)	o Remove insect residue. o Clean out paint chips from doorways using a wet paper towel and dispose of debris prior to repair or repainting. o Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture. Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. o Correct perimeter cracks around doors to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. o Reduce excess air infiltration through doors by repairing, aligning door frames, and lubricating locks so doors close tightly. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.
	Clean, repair, and maintain thresholds	As needed	o Remove insect residue. o Replace deteriorated or failing areas with in-kind materials. o Sand and prepare surfaces and use material-specific patching compounds to fill cracks, holes or areas collecting moisture. Follow manufacturer's instructions for preparation and installation. Do not cover a wood threshold with metal panning; this may trap moisture and promote decay. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.

B2030 EXTERIOR DOORS continued	Repair and maintain door as operable	As needed	○ It is best to resolve binding doors via fastener and hardware adjustment/corrections. Last resort is to shave historic wood door. ○ **Contract with a vendor to improve operation of power-assisted doors.**
	Repair damaged door	As needed	○ **Under consultation with a preservation architect and preservation woodworker, determine** solution to repair damage. ○ Repair should be performed by an **experienced preservation woodworker.**
	Clean, repair, and maintain locks/hardware	As needed	○ Use a soft, damp cloth. ○ If the desired level of clean requires is not achieved with a soft, damp cloth, contact a professional conservator for guidance and treatment – particularly if the hardware has an applied, patinated finish. ○ Microcrystalline wax might prove beneficial in protecting polished hardware from to tarnishing or oxidation, but this should be applied under the supervision of a professional conservator. ○ Tighten screws in doorframes and lubricate door hinges using a graphite- or silicone-type lubricant. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried.

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*

Figure 14. *North elevation doors (HPTC, 04/2022)*

Figure 13. *Reconstructed doors and contemporary hardware (HPTC, 10/2023)*

G2030 PEDESTRIAN PAVING	**Inspect pedestrian paving**	Daily	**Daily Inspections to be performed by: Park Interpretive Staff** Inspect daily to ensure public's safe circulation of the site. Look for: o Depressions o Loss of aggregate material o Standing water after a rain event o Cracks o Vegetation o Deteriorated or damaged curb/edging conditions o Debris collection at man/hand holes o Damage to man/hand holes
	Inspect pedestrian paving	Annually	**Annual Inspections to be performed by: Park Preservation Architect & Park Maintenance Staff** Look for: o Depressions o Loss of aggregate material o Cracks o Deteriorated or damaged curb/edging conditions o Damage to man/hand holes
	Maintain pedestrian paving	Immediately, when noted	o Keep paving free from loose aggregate, soil, leaf debris, and snow. Remove as it accumulates using a broom or plastic blade shovel. o Flush clean as needed. o Remove standing water. NOTE: Fixed or revolving brushes may be successful in getting into crevices and sweeping down to the wearing surface. Test for success and potential damage prior to full-scale use. NOTE: Do NOT use snow throwers or snow blades. NOTE: Do NOT apply ice melting chemicals. This can be tracked into buildings and cause damage to interior finishes and materials. It is harmful to many plants and shrubs and causes spalling of brick and stone.
	Bonded aggregate pavement repair	Immediately, when noted	o **Contact vendor** to make warranty repairs. o After warranty expiration, contract with vendor to make repairs.

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*

Figure 16. *Pedestrian pavement to east of South Slave Quarters (HPTC, 04/2022)*

Figure 15. *Detail of bonded aggregate pedestrian pavement (HPTC, 10/2023)*

G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Eliminate grass from around foundations; maintain a 3' mow strip o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry. NOTE: Reference "Arlington House, The Robert E. Lee Memorial, George Washington Memorial Parkway Landscape Management Plan" by Suzanne Bouchard. This is included in Appendix C.
	Maintain trees	Annually: DEC	Trim branches to 12'-0" away from building. NOTE: If tree roots appear to be damaging a foundation wall, **consult with a preservation engineer.** NOTE: Tree work shall be **performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.** NOTE: Reference "Arlington House, The Robert E. Lee Memorial, George Washington Memorial Parkway Landscape Management Plan" by Suzanne Bouchard. This is included in Appendix C.

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*

Figure 17. *Typical foundation landscape along south elevation (HPTC, 04/2022)*

Figure 18. *Foundation landscape at southwest corner (HPTC, 04/2022)*

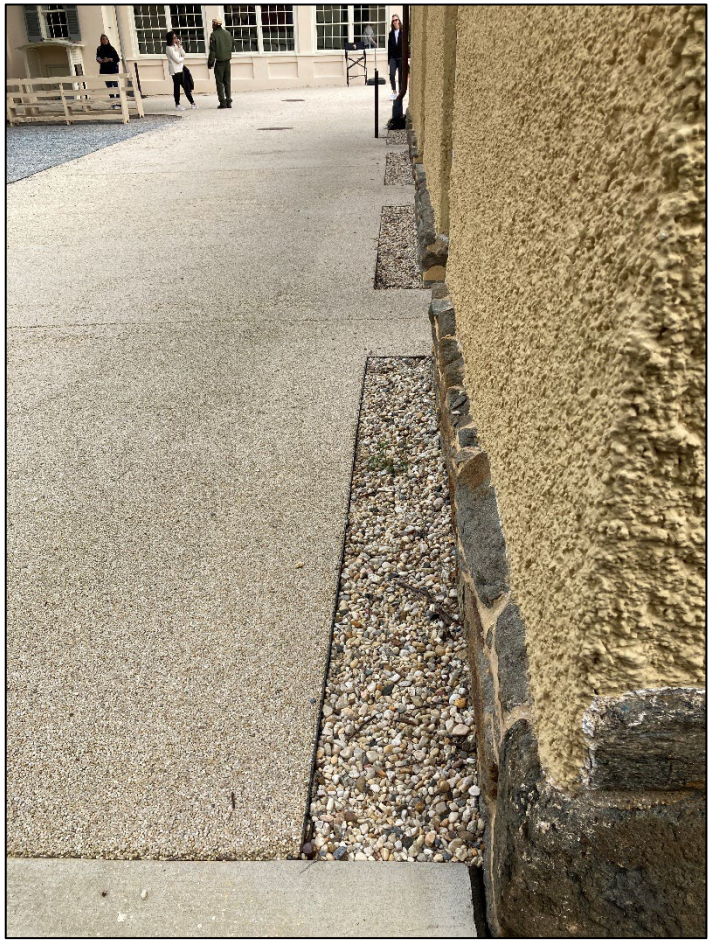

Figure 19. *North elevation foundation conditions (HPTC, 10/2023)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
G9087 SITE DRAINAGE	**Inspect foundation at grade**	Quarterly: JAN, APR, JUL, OCT	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect in conjunction with the inspection of downspouts to ensure water is being discharged a sufficient distance from the building perimeter to avoid being source of dampness in basement. Also look for: o Depressions or grade sloping toward the foundation (negative drainage) o Standing water o Vegetation growing close to the foundation o Evidence of moisture damage o Evidence of moss or mold from damp conditions related to roof drainage system leaks o Blocked downspout drainage boots o Poorly positioned splash blocks o Foundation gravel that has collected or migrated o Debris and leaves collecting at foundation, handholes, manholes, or drain grates
	Inspect basement	Quarterly: JAN, APR, JUL & OCT And after heavy rains	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Especially after major storms, look for: o Water infiltration through basement walls o Material deterioration at or near the foundation, including loss of mortar in masonry and rotting wood o Evidence of mold from damp conditions
	Improve foundation drainage	As needed	o Regrade to ensure positive drainage. o Add soil to fill depressions o Redistribute gravel if it has collected or migrated. o Remove collection of debris and leaves NOTE: Ensure soil does not come too close to wood or metal elements; a 6" separation is usually recommended. NOTE: Avoid use of mulching material at foundations as it may change grade slope.

G204090 OTHER SITE IMPROVEMENTS - INTERPRETIVE PANELS	**Inspect Interpretive Panels**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage, including evidence of moisture penetration o Integrity of frame, including stable connection at grade o Appearance and condition of surrounding grade
	Inspect Wayfinding Panels	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage, including evidence of moisture penetration o Integrity of frame, including stable connection at grade o Appearance and condition of surrounding grade
	Repair panels and frame	Per recommendation of NPS Media Services	**Consult with Harpers Ferry Media Services for treatment options.**
	Correct grade issues	Immediately, when noted	**Park Maintenance Staff to make corrections at grade (in consultation with Park Cultural Resource Manager)**

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*

Figure 20. *Interpretive panel at east elevation (HPTC, 04/2022)*

C3030 **CEILING FINISHES** (Plaster)	**Inspect**	4 times/year JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, checking, chalking, and delamination o Cracks, blisters, fading colors o Evidence of moisture/staining o Efflorescence/salt o Evidence of pests o Biological growth o Damage
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a wide dusting brush. o Remove superficial soiling and cobwebs.
	Wet clean	As needed	o Dust first. o Determine/identify finish type. Finishes such as calcimine and whitewash can be damaged by water. o Determine finish coverage. If inconsistent or incomplete, identify substrate to implement an appropriate wet cleaning plan. o Use the gentlest means possible. Begin by gently rubbing with a clean damp sponge and immediately drying with a clean wiping cloth. o A non-ionic detergent solution may be used, followed by damp rinsing and drying with a clean wiping cloth. May require double rinsing and then drying. o **When graffiti or stains are present, consult with a conservator for professional removal.**
	Paint	As needed (assume every 5 years)	o Be thoughtful in the decision to paint; unnecessary painting slowly obliterates detail of historic moldings and thick paint film can become inflexible and be subject to cracking and peeling. o Use high-quality materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. Reference: Preservation Brief 28: Painting Historic Interiors (Appendix C)
	Repair plaster	As needed	**Consult with a preservation architect and architectural conservator** to determine conditions and appropriate repairs. Repairs to flat or decorative plaster **should be made by a journeyman plasterer.**

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
C3030 CEILING FINISHES (Wood)	**Inspect**	4 times/year JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Evidence of moisture/staining o Evidence of pests o Biological growth o Failing fasteners o Damage
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a wide dusting brush. o Remove superficial soiling and cobwebs.
	Wet clean	As needed	o Dust first. o Use the gentlest means possible. Begin by gently rubbing with a clean damp sponge and immediately drying with a clean wiping cloth. o A non-ionic detergent solution may be used, followed by damp rinsing and drying with a clean wiping cloth. May require double rinsing and then drying. o **When graffiti or stains are present, consult with a conservator for professional removal.**
	Repair wood	As needed	**Consult with a preservation architect** to determine conditions and appropriate repairs. Repairs **should be made by a preservation woodworker.**

Figure 21. *Ceiling conditions in west room and Smokehouse (HPTC, 04/2022 and ARHO website, 05/2024)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
C3010 WALL FINISHES (Plaster)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, chalking, delamination, blisters, and fading colors o Cracks o Evidence of moisture/rising damp o Efflorescence/salt o Staining and/or soiling o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. Dusting should start in a corner at the floor and move upward to the cornice. o Remove superficial soiling and cobwebs. o Dust routinely all ledge-type horizontal surfaces.
	Wet clean	As needed	o Dust first. o Determine/identify finish type. Finishes such as calcimine and whitewash can be damaged by water. o Determine finish coverage. If inconsistent or incomplete, identify substrate to implement an appropriate wet cleaning plan. o Use the gentlest means possible. Begin by gently rubbing with a clean damp sponge and immediately drying with a clean wiping cloth. o A non-ionic detergent solution may be used, followed by damp rinsing, and drying with a clean wiping cloth. May require double rinsing and then drying. o **When graffiti or stains are present, consult with a conservator for professional removal.**
	Paint	As needed (assume every 5 years)	o Be thoughtful in the decision to paint; unnecessary painting slowly obliterates detail of historic moldings and thick paint film can become inflexible and be subject to cracking and peeling. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for preparation and application of coatings. Use high-quality coating materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. NOTE: Graffiti "windows" isolate better than with blue tape o Reference: Preservation Brief 28: Painting Historic Interiors (Appendix C)

Figure 22. *Plaster walls with a faux finish in center Smokehouse room (HPTC, 10/2023)*

Figure 23. *Plaster wall conditions in west room (HPTC, 04/2022)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
C3010 WALL FINISHES (Glass)	**Inspect**	Quarterly: JAN, APR, JUL, OCT	**Quarterly Inspections to be performed by: Park Museum Curation Staff** Look for: o Cracks o Staining and/or soiling o Damage o Condition of finish of metal frame
	Inspect	Semi-Annual: APR & OCT	**Semi-Annual Inspections to be performed by: Park Museum Curation Staff** Glass door is included in glass wall in the west room. Look for: o Doors that are drooping, mis-aligned, or not properly functioning o Evidence of scraping of floor finish in line with door swing o Wear at the knuckles, loosening of screws, or poor fit of hinges o Broken/cracked glass o Abrasion at hardware
	Clean	Weekly	o Remove insect residue using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean brush attachment. o Dust glass with a brush or whisk broom. o Wash glass, working from top to bottom. o Use mild vinegar and water mixture or a non-alkaline commercial window cleaner. Be cautious with compounds that contain ammonia as they may stain brass or bronze hardware elements. Vinegar, in a one-to-one combo with distilled water, works as an excellent degreaser and is also great at breaking down dirt and grime. Dry windows with a squeegee or a clean cloth. Can spot treat with full-strength vinegar. o When using a squeegee blade or sponge, wipe wet corners with a soft dry cloth.
	Refinish	As needed	o Follow manufacturer's instructions on refinishing associated metal components. <u>NOTE:</u> Before refinishing, ensure the compatibility of product with existing conditions to avoid premature paint failure.
	Replace broken or missing glass	As needed	o Review product literature or consult with manufacturer. o **Contract with glass vendor.**

Figure 24. *Glass wall with built-in door in "The Gray Family Quarters" interpretive space (HPTC, 04/2022)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
C201001 INTERIOR STAIR STRUCTURE (Staircases and Handrails)	**Inspection**	Quarterly	**Quarterly Inspection to be performed by: Park Interpretive Staff OR Park Museum Curation Staff** Look for: o Structural integrity including framing, steps, and supplemental wall support o Excessive wear and abrasion o Evidence of moisture o Deteriorated finish
	Clean stairs	As needed	o Keep stairs free from dust, dirt, and debris. Remove as it accumulates using a soft broom or vacuum. o Finished wood surfaces in good condition can be dusted with a dusting product that does not contain silicone or tung, lemon or linseed oils sprayed onto a soft diaper or with an untreated magnetic cleaning cloth.
	Repair stairs and handrails	As needed	**Consult preservation architect and preservation engineer to understand conditions and develop solutions.** o Secure loose connections. Do not modify design to make stronger connections. o Remove cupped, damaged, or deteriorated material and replace with wood to match. o Replace deteriorated or failing individual elements with in-kind materials. **NOTE: Repairs should be made by preservation woodworkers.**
	Refinish stair	As needed	**Consult preservation architect and wood conservator to review conditions and develop a refinishing plan.** Prepare and refinish per product manufacturer's guidelines. NOTE: Before refinishing, ensure compatibility between new and existing finishes.

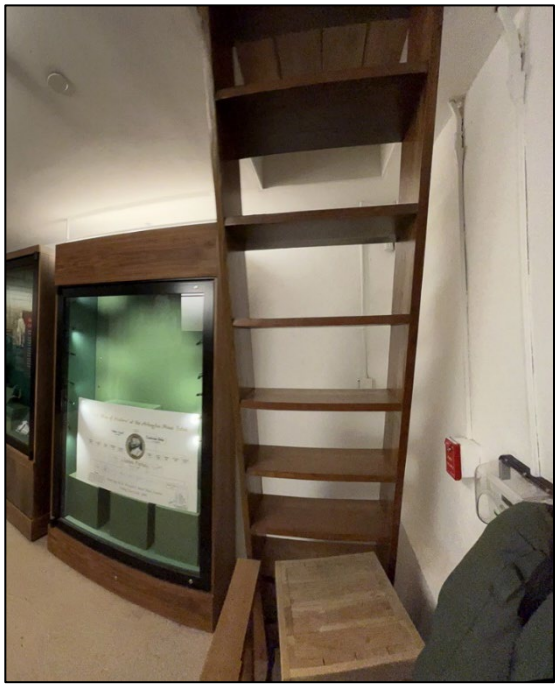

Figure 25. *Wood ladders in east and west rooms (HPTC, 10/2023)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
C302090 FIREPLACE AND FIREPLACE HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner
	Wet Cleaning	As needed	o Damp clean finished wood and masonry fireplace components. o Periodically damp mop masonry hearth before its appearance becomes dull. o Wet mopping and scrubbing masonry hearth are acceptable if required.

Figure 26. *Two fireplaces in South Slave Quarters (HPTC/10/2023)*

C302006 BRICK, PAVER and CONCRETE FLOORING	**Inspect**	Weekly	**Weekly Inspection to be performed by: Park Museum Curation Staff or Park Interpretive Staff** Look for: o Wear o Abrasion o Cracks o Deterioration o Evidence of moisture o Unsafe conditions o Evidence of pest infestation
	Inspect	Annually	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Unstable or excessive wear of walking surfaces o Abrasion o Cracks o Unsafe conditions o Evidence of moisture NOTE: Document moisture conditions for future comparison and development of solutions.
	Dry Cleaning	Daily	Dry clean entire floor with a vacuum cleaner.
	Wet Cleaning	Weekly	Damp mop to keep dirt from building up.

Figure 27. *Typical concrete floor conditions ((HPTC, 04/2022)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
PESTS	**Inspect**	3 times/year: MAR, JUN, OCT	**Inspection to be performed by: Park Museum Curation Staff** Look for evidence of: o Boring insects, including carpenter bees o Insects o Snakes o Animals
	Conduct termite inspections	Throughout Spring	Swarm season for termites is in the spring. Promptly address termite and other insect infestations, as needed. **Use only a licensed company for treatment.**
	Action	Per recommendation of NPS IPM	**Consult with NPS Regional Integrated Pest Management Program for treatment options.**

Figure 28*. Insect trap and monitor in South Slave Quarters (HPTC, 04/2022)*

E201090 OTHER FIXED INTERIOR FURNISHINGS – INTERPRETIVE PANELS	**Inspect Interpretive Panels**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage o Integrity of frame, including stable connection at floor
	Repair panels and frame	Per recommendation of NPS Media Services	**Consult with Harpers Ferry Media Services for treatment options.**

Figure 29. *Interpretive panels and media (HPTC, 04/2022 and 10/2023)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
D30 HVAC	**Heating System Inspection**	Daily during heating season	**Daily inspections to be performed by: Park Museum Curation Staff OR Park Interpretive Staff** Look for: o Changes in humidity levels o Unprogrammed changes in temperature o Condensation in attic and roof spaces o Condensation on interior walls
	Heating System Inspection	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.
	Heating System Inspection	Annually	**Annual inspection of the heating system to be performed by: Certified HVAC Contractor** Inspection to meet requirements of PMIS 150123 project documentation.
	Cooling System Inspection	Daily during cooling season	**Daily inspections to be performed by: Park Museum Curation Staff OR Park Interpretive Staff** Look for: o Changes in humidity levels o Unprogrammed changes in temperature o Condensation in attic and roof spaces o Condensation on interior walls
	Cooling System Inspection	Annually	**Annual inspection of the cooling system to be performed by: Certified HVAC Contractor** Inspection to meet requirements of Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), National Electrical Code 70 (NFPA 70), and PMIS 150123 project documentation.
	Maintenance	Variable	**Maintenance to be performed by: Certified HVAC Contractor** Maintenance to meet requirements of Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), and PMIS 150123 project documentation.

Figure 30. *Example of ceiling diffuser, west room (HPTC, 04/2022)*

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
D50 ELECTRICAL	**System Inspection**	Daily	**Daily Inspection to be performed by: Park Interpretive Staff** Look for: o Light fixtures requiring lamp replacement o Leaves or debris accumulating around light fixtures
	System Inspection	Three times/year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff OR Park Museum Curation Staff** Review: o Condition of conduit, exposed electric wire, electric panels, switches, and outlets o Operation of electric panels, switches, outlets, and fixtures
	System Inspection	Annually: OCT	**Five-year inspections should be performed by a licensed and bonded electrician compliant with the standards outlined in** the National Electrical Code 70 (NFPA 70), NFPA Guide on Electrical Inspections (NFPA 78), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. Review: o Condition of conduits, exposed electric wire, electric panels, switches, and outlets o Operation of electric panels, switches, outlets, and fixtures o Changes, including include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness. Ensure no changes have been made that affect system and fixture performance.
	System Maintenance	Immediately, when identified	**Repairs to be performed by a licensed and bonded electrician**, compliant with the NFPA 70, NFPA 101, and ANSI/IEEE C2.

Figure 31. *Track lights in west room (HPTC, 04/2022)*

D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.
	System Inspection and Maintenance	Three times / year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Perform operational checks and lens focus and cleaning of 25% of the cameras in the system. o Perform operational check of 25% of components of the security system. o Troubleshoot issues identified.
	System Inspection and Maintenance	Annually: October	**Security systems and cameras should be inspected by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Inspection shall ensure no changes have been made that affect equipment performance. Potential changes include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness. o Annual inspection includes operational check of all (100%) components of the security system. o Annual inspection includes 100% of the cameras within the system. o Troubleshoot issues identified.
	Repair	Immediately, when identified	**Use a Certified Security and Camera System Contractor** to troubleshoot and perform repairs.

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*
D40 Fire Protection	**System Inspection**	Quarterly: JAN, APR, JUL, OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** **Look for:** o Visible signs of damage or surrounding conditions that might impact operation of fire detection and suppression system devices (heat detectors, smoke detectors, pull alarm stations, strobes) o Damage or changes to original installation of suppression piping, hangers, and heads
	System Inspection	Annual	**Fire alarm systems should be inspected by qualified persons per the requirements of** National Electrical Code 70 (NFPA 70), National Fire Alarm and Signaling Code (NFPA 72), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. Inspection shall ensure no changes have been made that effect equipment performance. Potential changes include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness.
	System Inspection and Testing	Various Intervals	**Fire alarm systems should be inspected and tested by qualified persons per the requirements of** National Electrical Code 70 (NFPA 70), National Fire Alarm and Signaling Code (NFPA 72), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation.
	Fire Extinguisher Inspection	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing)

D40 Fire Protection continued			▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.
	System Maintenance	Various intervals	**Fire alarm systems should be maintained by qualified persons** per the requirements of the National Fire Alarm and Signaling Code 72 (NFPA 72) and as outlined in PMIS 150123 project documentation.
	System Repair	Immediately, when identified	**Use a qualified persons** to troubleshoot and perform repairs.
	Fire Extinguisher Maintenance	Various intervals	**Maintenance must be performed by a certified person** (must pass a test acceptable to AHJ) and must be familiar with the requirements in NFPA 10. Fire extinguishers need to have an external maintenance examination conducted on a yearly basis, at the time of hydrostatic test, or when specifically indicated by an inspection discrepancy. Extinguishers need to have an internal examination conducted at anywhere from 1-6 year intervals depending on the type of extinguisher. Maintenance procedures must include the procedures detailed in the manufacturer's service manual and a thorough examination of the basic elements of the fire extinguisher, including the following: o Mechanical parts of all fire extinguishers o Extinguishing agent o Expelling means o Physical condition

Uniformat Functional Element	*Task*	*Frequency*	*Recommended Inspections and Repair*

Figure 32*. Fire detection and security system devices including pull station, concealed sprinkler head, and motion detector in west room (HPTC, 04/2022)*

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COMPREHENSIVE
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201099 CHIMNEYS	**Inspect chimneys**	Annually from grade: end of SEP	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Plant/biological growth o Cracked stucco parging or loss of aggregate o Failing paint o Dislodged chimney caps o Dislodged flashing NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles	
	Inspect chimneys	Every five years at roof level	**5-Year Inspection to be performed by: Preservation Masonry Contractor**	
	Repair Chimneys and Caps	Immediately, when noted	**Use professional services to make repairs.** Guidelines for repair work: o Remove plant growth. o Correct condition allowing moisture penetration. o Repoint eroded, cracked, or missing joints. Mortar should be lime-based and match historic mortar in color, texture, width, and tooling. Ideally the new mortar should match existing mortar in strength but, at minimum, be slightly weaker than the adjacent masonry. A mortar analysis is suggested. Weaker mortar allows trapped moisture to migrate through the mortar joint instead of through the masonry. Spalled masonry is often evidence of joints that have been pointed with a mortar mix that is too hard for the surrounding masonry.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			○ Stucco parging should be repaired with a stucco mix that matches the existing parging in materials, strength, and tooling. Reference: Preservation Brief 22: The Preservation and Repair of Historic Stucco (Appendix C)	
	Repair flashing	Immediately, when noted	○ Re-secure loose flashing. Clean out old mortar, lead, lead wool, or fastening materials. Make sure flashing is properly inserted into reglet (slot) joints, taking care not to damage substrate. ○ If flashing is no longer intact, replace with flashing matching existing in material, size, shape, and finish. Because cap and step flashings each have specific overlap and extension requirements, replacement flashing should match the existing material and installation unless there has been a proven deficiency. Avoid attaching step flashing with mastic or sealant. Properly re-bed all step flashing. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. NOTE: **Work with Certified Roofing Contractors**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Renew paint system	As needed (anticipate every 5 years)	**Use professional services to renew paint system.** o Scrape and repaint selected areas as needed. o Wash and properly prepare the area before application to obtain good adhesion. o Apply the coating system in accordance with manufacturer's recommendations. o Environmental regulations may restrict the use of certain types of paints. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Slipped, missing, cracked, buckling, abraded, deformed, or broken roof materials o Standing water o Evidence of water infiltration on interior surfaces o Deflection, splitting, evidence of stress within roof framing NOTE: During semi-annual inspections, inspect from the ground using binoculars and access interior framing spaces, if able. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles	
	Inspect roof	Every five years at roof level	**5-Year Inspection to be performed by: Certified Roofing Contractor**	
	Inspect ridges	Semi-Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Lifted, slipped, missing, or damaged ridge material o Loose or raised fasteners NOTE: During semi-annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	
	Inspect ridges	Every five years at roof level	**5-year Inspection to be performed by: Certified Roofing Contractor**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Inspect adjacent interior spaces	Quarterly: JAN, APR, JUL & OCT	**Quarterly Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Staining or other evidence of water infiltration o Water leaks, especially after major storms. o Work with a professional roofing contractor to identify source of water infiltration and to develop a repair plan.	
B301001 ROOF FINISHES Continued (Composite)	**Clean roof surfaces**	Annually: Fall (OCT)	o Remove excessive debris and biological growth from roof surfaces. Use low-pressure garden hose water and a natural or nylon scrubbing brush, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Avoid using diluted chlorine bleach. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. o Remove overhanging tree branches to minimize abrasion/damage. NOTE: **Tree work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	
	Repair roof coverings and finishes	Immediately, when noted	o Repair and replace missing composite materials according to manufacturer's instructions from PMIS 150123 project o Reinstall lifted or slipped ridge materials. If unable to reuse or material missing, replace in-kind NOTE: When accessing a roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			NOTE: **Work with Certified Roofing Contractors**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Metal)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect and Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Missing, cracked, buckling, abraded, or deformed roof materials o Open seams o Standing water o Deterioration, splitting, evidence of stress within roof framing o NOTE: During semi-annual inspections, inspect from the ground using binoculars, if needed.	
	Inspect roof	Every five years at roof level	**5-Year Inspection to be performed by: Certified Roofing Contractor**	
	Clean roof surfaces	Annually: Fall (OCT)	o Remove excessive debris and biological growth from roof surfaces. Use low-pressure garden hose water and a natural or nylon scrubbing brush, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Avoid using diluted chlorine bleach. o Remove overhanging tree branches to minimize abrasion/damage. NOTE: **Tree work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	o
	Repair roof coverings and finishes	Immediately, when noted	o Solder patches on sheet metal roofs/hoods NOTE: **Work with Certified Roofing Contractors**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301004 FLASHING	**Inspect flashing and adjacent interior spaces**	Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Debris accumulating in valleys o Deteriorated and damaged flashing, including cracks, dents, and dissimilar materials o Failing connections at any intersection of roof areas, of roof and adjacent wall, of roof and chimney, or any flashed projections o Raised edges o Failing paint systems o Staining or other evidence of water infiltration o Water leaks, especially after major storms. NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. NOTE: **Work with a professional roofing contractor** to identify source of water infiltration and to develop a repair plan.	
	Inspect flashing	Every 5 years at roof level	**5-year Inspection to be performed by: Certified Roofing Contractor**	
	Clean flashing	Annually: OCT	o Broom sweep branch and leaf debris away from valleys NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Repair flashing	Immediately, when noted	○ Re-secure loose flashing. Clean out old mortar, lead, lead wool, or fastening materials. Make sure flashing is properly inserted into reglet (slot) joints, taking care not to damage substrate. ○ If flashing is no longer intact, replace with flashing matching existing in material, size, shape, and finish. Because cap, step, valley, cricket, and apron flashings each have specific overlap and extension requirements, replacement flashing should match the existing material and installation unless there has been a proven deficiency. Avoid attaching step flashing with mastic or sealant. Properly re-bed all step flashing. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. NOTE: **Work with Certified Roofing Contractors.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301005 GUTTERS & DOWNSPOUTS	**Inspect roof drainage system**	Quarterly: JAN, late APR, mid-JUL, late-OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Sagging and misaligned gutters, downspouts, and boots o Damaged, failing gutter hangers and downspout brackets o Crushed or split gutters and downspouts o Open seams o Dissimilar materials o Damaged boots o Debris accumulating in gutters and at juncture of downspout and boots o Overflowing gutters o Failure or slow to drain at boots o Ice damming and icicles hanging from gutters and downspouts in winter months o Overhanging branches impacting gutters o Growth, moss, and stains NOTE: During quarterly inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	
	Inspect roof drainage system	Every 5 years from roof level	**5-year Inspections to be performed by: Certified Roofing Contractor**	
	Inspect/scope underground drain lines	Every 3 years; more frequently as needed	**Use professional services to scope underground drain lines** to ensure lines are open and free of debris and clogs. Clean lines if debris is noted.	
	Clean roof drainage system	Semi-Annually: late APR & late OCT	o Remove leaves and other debris from gutters, downspouts, and boots. o Use a garden hose to flush out troughs and downspouts.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			NOTE: If using a ladder to access gutter, utilize a ladder with a brace device to keep ladder from crushing gutter.	
	Repair gutters and downspouts	Immediately, when noted	**Use professional services to make repairs.** o Correct alignment of gutters, downspouts, and boots as necessary so water flows to drains without ponding. o Repair or replace split gutters, downspouts, and damaged boots. o If patching or repairing holes in metal gutters, use traditional brazing techniques. Patching with asphalt compounds (an acidic material) can cause further deterioration of metal gutters.	
	Correct ice dam condition	Immediately, when noted	**Use professional services to determine cause.** o Consider: ▪ Warm air leak or indoor heat loss ▪ Insufficient insulation ▪ Insufficient air circulation o Make improvements as needed.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stucco)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. With a ladder or binoculars, look for: o Moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any pattern o Excessive damp spots, often accompanied by staining, peeling paint, moss, or mold. o Evidence of rising damp o Cracks within stucco finish/rendering o Loss of aggregate in pebble dash stucco o Surface salts o Active cracks in joints and around windows and doors. Determine whether movement is seasonal or sign of ongoing problem. o Areas significantly misaligned or where there are bulging wall sections or cracks could be indicative of potential structural problems (**seek professional guidance).** o Failed sealant o Deterioration of mineral finish coat on stucco rendering, including signs of checking, flaking, and chalking o Deterioration of faux finishes o Evidence of insect infestation and vegetative growth o Surface stains o Openings from prior utilities or service pipes	
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			NOTE: **Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	
	Clean exterior wall surfaces	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. o Follow guidance per KEIM Mineral Coatings of America, Inc. when cleaning exterior wall surfaces finished with a KEIM product **NOTE: When graffiti or stains are present, consult a with a conservator for professional removal.**	
	Repair stucco parging	As needed, during summer months	o **Under consultation with a preservation architect and mason,** determine cause of and solution to stucco damage. o Stucco **repairs should be made by a stucco mason or journeyman plasterer.** Guidelines for repair work: o Stucco parging should be repaired with a stucco mix that matches the existing parging in materials, strength, and tooling. Reference: Preservation Brief 22: The Preservation and Repair of Historic Stucco (Appendix C)	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Paint exterior wall components	As needed, during summer months	○ It is ideal to allow exterior paints to wear away before recoating and only paint deteriorated areas, as unnecessary painting slowly obliterates detail and thick coatings can impact moisture migration. Although there may be a slight difference in color and texture between new and old paint, this contrast will be reduced by weathering. Guidelines: ○ Follow guidance per KEIM Mineral Coatings of America, Inc. when painting exterior wall surfaces finished with a KEIM product ○ Remove deteriorated caulks and sealants, clean, and reapply appropriate caulks and sealants using backer rods as needed. Follow manufacturer's instructions regarding preparation and installation. ○ Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building.	
	Faux finish and fresco painting repair	Immediately, when noted	○ **Under consultation with a preservation architect and conservator,** determine cause of and solution to finish deterioration or damage. ○ Faux finish and fresco work should be executed by an **experienced decorative painter or conservator.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stone)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. Look for: o Moisture patterns that may appear after a heavy or sustained rainfall or snow, recording any pattern o Excessive damp spots, often accompanied by moss, or mold o Evidence of rising damp o Cracked or failing mortar o Cracks through masonry o Deteriorating or delaminating masonry o Surface salts o Active cracks in joints and around windows and doors. Determine whether movement is seasonal or sign of ongoing problem. o Areas significantly misaligned or where there are bulging wall sections or cracks could be indicative of potential structural problems (**seek professional guidance).** o Failed sealant o Openings from prior utilities or service pipes	
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls. **<u>NOTE:</u> Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	o

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Clean exterior wall surfaces	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. Guidelines: o When cleaning, use the gentlest means possible. Begin treatment with hose-pressure water. If this does not remove soiling, introduce agitation via natural bristle brushes. o Avoid abrasive methods, such as mechanical scrapers and high-pressure water or air and additives such as sand, natural soda, ice crystals, or water products, as all abrasive blasting removes some portion of the surface. Avoid power-washing as it drives excessive moisture into wall materials, wall cavities, and interior walls. If required maximum pressure should be 400 psi and a fan tip should be used at a minimum working distance of 12". **NOTE: When graffiti or stains are present, consult a with a conservator for professional removal.**	
	Repoint masonry	As needed, during summer months	**Use professional services to make repairs.** o Repoint eroded, cracked, or missing joints. o Rake out joints by hand, generally avoiding rotary saws or drills, to a depth of 2½ times the width of the joint (or until sound mortar is encountered), to ensure new mortar will stay adhered between the masonry units. o Repoint joints using a lime-based mortar and match historic mortar in color, texture, width, and tooling. Ideally the	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			new mortar should match the existing mortar in strength but, at minimum, it must be slightly weaker than the adjacent masonry. A mortar analysis is suggested. Weaker mortar allows trapped moisture to migrate through the mortar joint instead of through the masonry. Spalled masonry is often evidence of joints that have been pointed with a mortar mix that is too hard for the surrounding masonry. o Avoid off-the-shelf, pre-mixed cement mortars as they are inappropriate for most historic buildings. o Avoid use of joint sealants in place of mortar on vertical masonry surfaces as they are not breathable and can lead to moisture-related damage of the adjacent masonry. o Correct areas which trap unwanted moisture. o Damaged stone units may be able to be removed, turned around, and reset; or replaced to match. NOTE: It is important to resolve the cause of cracks or failure before resetting masonry units and repointing.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Wood, Wood Details, Exterior Soffits)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. Look for: o Moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any pattern o Damp spots, often accompanied by staining, peeling paint, moss, or mold o Evidence of wicking moisture o Failed sealant o Deterioration of paint finish coat on decorative wood elements and wall details, including peeling, checking, flaking, and chalking o Evidence of wood rot, insect infestation, and vegetative growth o Surface stains	
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls NOTE: **Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Clean exterior wall surfaces	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. Guidelines: o When cleaning, use the gentlest means possible. Begin treatment with hose-pressure water. If this does not remove soiling, introduce agitation via natural bristle brushes. o A mild detergent may be used. It is recommended that two people work together when using mild detergent – one to brush, and one to pre-wet and rinse. Avoid strong soap solutions as they may leave streaks. It is also recommended to begin cleaning at the bottom and move up the wall. o Avoid abrasive methods, such as mechanical scrapers and high-pressure water or air and additives such as sand, natural soda, ice crystals, or water products, as all abrasive blasting removes some portion of the surface. o Avoid power-washing as it drives excessive moisture into wall materials, wall cavities, and interior walls. NOTE: **When graffiti or stains are present, consult a with a conservator for professional removal.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS Continued (Wood, Wood Details, Exterior Soffits)	**Repair wood features**	As needed	**Repairs to structure/architectural features should be made by a preservation carpenter. Consultation from a preservation architect or engineer may also be necessary.** o Make repairs using wood that matches species of existing feature, if possible. Ensure match of texture, dimension, and tooling. o When temporarily removing wood components, make every effort to reuse the removed component after underlying repair work is needed. o Consider using stainless steel or high strength aluminum nails as appropriate. Putty or fill nail holes flush with wood prior to repainting. o Backprime any installed wood with one coat of primer and coat end grain that might be exposed with two coats of primer. NOTE: Durable hardwoods should be considered for replacement material where beading, chamfering, or other decorative work is required to match historic details. Although appropriate for certain applications, pressure treated lumber is difficult to tool and may inhibit paint adherence if not allowed to weather prior to coating application.	
	General repair	As needed	**Consult or use professional services to execute repairs.** o When using traditional or contemporary materials for patching wood ensure that the materials are compatible with the substrate—evaluate strength, vapor permeability, thermal expansion, and appearance.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2020 EXTERIOR WINDOWS	**Inspect windows**	Semi-Annually: May & OCT	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a window schedule (see sample to follow), according to window number, which includes condition and description of each opening component. Review interior and exterior components. Look for: o Overall material condition, including paint o Unwanted water penetration and surface condensation o Insect infiltration (especially termite and carpenter ant damage), or animal entry o Window sash and shutters that do not open and close properly o Rubbing points/abrasion due to ill-fit or alignment o Loose, open, or decayed joints in frames, sash o Slipped sills and tipped or cupped stools o Loose, damaged, or missing hardware o Broken sash cords/chains, sash pulleys o Missing or damaged sash o Locking difficulties o Deteriorated weatherstripping and flashing o Gaps between sash and sill or window opening o Broken/cracked glass, loose or missing glazing and putty o Loose/damaged moldings, architraves, decayed stiles at sill level o Accumulation of dirt or collection of leaves and debris NOTE: Pay particular attention to exposed horizontal surfaces of window components as they tend to deteriorate faster than vertical surfaces.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Clean glass components	Semi-Annually: MAY & OCT	o Dust sash with a brush or whisk broom. o Wash glass, beginning with top sash, working from top to bottom. o Use mild vinegar and water mixture or a non-alkaline commercial window cleaner. Be cautious with compounds that contain ammonia as they may stain brass or bronze hardware elements. o When using a squeegee blade or sponge, wipe wet corners with a soft dry cloth. o Avoid high-pressure washes. NOTE: Do NOT wash outside windows when the temperature is below freezing.	
	Repair and maintain weather-stripping	As needed	Use durable weatherstripping, such as spring metal or a high-quality synthetic material, avoiding common brush and bulb or pile weatherstripping that requires more frequent replacement.	
	Replace broken or missing glass	Immediately, when noted	For historic glass, a conservation approach should be considered to repair limited cracks. Where panes with a distinct appearance are missing, specialty glass should be obtained to match. An inventory should be kept for future needs. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Repair window glazing	As needed	o Repair where deteriorated or missing. o Use care when removing putty so as not to crack or break old glass or damage muntins and sash frames. o Avoid using mechanical devices to remove old putty and match historic putty bevels or details when undertaking work. o Re-glaze with either traditionally formulated oil or modern synthetic putties, making sure to properly bed the glass and secure with glazing points.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Repair and repaint windows, frames, and sills	As needed (anticipate every 5 years)	o Clean out paint chips from window openings using a wet paper towel and dispose of debris prior to repair or repainting. o Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture. Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. o Correct perimeter cracks around windows to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			tool, taking care to avoid damage to adjacent trim. o Reduce excess air infiltration through windows by repairing, aligning sash frames, and lubricating sash locks so that windows close tightly. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o After a major painting operation sash should be daily opened and closed for the first few days to break the paint film and preventing the windows from becoming "painted in" and inoperative. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2020 EXTERIOR WINDOWS continued	**Clean, repair, and maintain sills**	As needed	o Replace deteriorated or failing individual elements with in-kind materials. o Sand and prepare surfaces and use material-specific patching compounds to fill cracks, holes or areas collecting moisture. Follow manufacturer's instructions for preparation and installation. Do not cover a wood sill with metal panning; this may trap moisture and promote decay. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for preparation and application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Repair and maintain sash as operable	As needed	o Adjust wood sash which bind when operated. o Sash runs were traditionally unpainted between the stop and parting bead. Removing subsequent paint applications will often help improve sash operation. Apply beeswax, paraffin, or similar material to tracks or sash runs for ease of movement. o If sash are loose, replace worn parting beads. o Lubricate sash chains and pulleys using a graphite- or silicone-type lubricant.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Clean, repair, maintain sash locks/hardware	As needed	o Use a soft, damp cloth. o Use mineral spirits or commercial cleaners very sparingly, as repeated use may remove original finishes. Most metal cleaners include ammonia that can streak and stain metal, so it is important to remove all cleaning residue. Polished hardware subject to tarnishing or oxidation often benefit from a thin coat of paste wax (carnauba), hand buffed to remove extra residue. NOTE: Avoid lacquer finishes for high-use areas, as they require more extensive maintenance. NOTE: Patinated finishes should not be cleaned with any chemicals, since subtle aged appearances contribute to the building's character.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2030 EXTERIOR DOORS	**Inspect doors**	Semi-Annually: MAY & OCT	**Semi-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a door schedule (see sample to follow), according to door number, which includes condition and description of each opening component. Look for: o Overall material condition, including finish o Fit and operation of door o Loose, open, or decayed joints in frames, doors, transoms, and sidelights o Gaps between threshold, door frame, and door opening. o Tipped or cupped thresholds o Drag marks on thresholds o Loose hardware, locking difficulties o Deteriorated weatherstripping and flashing o Wear at the knuckles, loosening of screws, or poor fit of hinges o Functionality of power-assisted doors o Condensation or evidence of water infiltration o Evidence of insect infiltration or animal entry NOTE: Heavily used doors may merit greater inspection frequency.	
	Repair and maintain weather-stripping	As needed	o Reduce excess air infiltration by repairing and maintaining weatherstripping. o Use durable weatherstripping, such as spring metal or high-quality synthetic material. Avoid common brush and bulb or pile weather stripping that require more frequent replacement.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2030 EXTERIOR DOORS Continued	**Repair and repaint doors, frames, thresholds**	As needed (anticipate every 5 years)	o Remove insect residue. o Clean out paint chips from doorways using a wet paper towel and dispose of debris prior to repair or repainting. o Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture. Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. o Correct perimeter cracks around doors to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. o Reduce excess air infiltration through doors by repairing, aligning door frames, and lubricating locks so doors close tightly. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Clean, repair, and maintain thresholds	As needed	o Remove insect residue. o Replace deteriorated or failing areas with in-kind materials. o Sand and prepare surfaces and use material-specific patching compounds to fill cracks, holes or areas collecting moisture. Follow manufacturer's instructions for preparation and installation. Do not cover a wood threshold with metal panning; this may trap moisture and promote decay. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Repair and maintain door as operable	As needed	o It is best to resolve binding doors via fastener and hardware adjustment/corrections. Last resort is to shave historic wood door. o **Contract with a vendor to improve operation of power-assisted doors.**	
B2030 EXTERIOR DOORS Continued	**Repair damaged door**	As needed	o **Under consultation with a preservation architect and preservation woodworker, determine** solution to repair damage. o Repair should be performed by an **experienced preservation woodworker.**	
	Clean, repair, and maintain locks/hardware	As needed	o Use a soft, damp cloth. o If the desired level of clean requires is not achieved with a soft, damp cloth, contact a professional conservator for guidance and treatment – particularly if the hardware has an applied, patinated finish. o Microcrystalline wax might prove beneficial in protecting polished hardware from to tarnishing or oxidation, but this should be applied under the supervision of a professional conservator. o Tighten screws in doorframes and lubricate door hinges using a graphite- or silicone-type lubricant. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2030 PEDESTRIAN PAVING	**Inspect pedestrian paving**	Daily	**Daily Inspections to be performed by: Park Interpretive Staff** Inspect daily to ensure public's safe circulation of the site. Look for: o Depressions o Loss of aggregate material o Standing water after a rain event o Cracks o Vegetation o Deteriorated or damaged curb/edging conditions o Debris collection at man/hand holes o Damage to man/hand holes	
	Inspect pedestrian paving	Annually	**Annual Inspections to be performed by: Park Preservation Architect & Park Maintenance Staff** Look for: o Depressions o Loss of aggregate material o Cracks o Deteriorated or damaged curb/edging conditions o Damage to man/hand holes	
	Maintain pedestrian paving	Immediately, when noted	o Keep paving free from loose aggregate, soil, leaf debris, and snow. Remove as it accumulates using a broom or plastic blade shovel. o Flush clean as needed. o Remove standing water. NOTE: Fixed or revolving brushes may be successful in getting into crevices and sweeping down to the wearing surface. Test for success and potential damage prior to full-scale use. NOTE: Do NOT use snow throwers or snow blades. NOTE: Do NOT apply ice melting chemicals. This can be tracked into buildings and cause damage to interior finishes and materials. It	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			is harmful to many plants and shrubs and causes spalling of brick and stone.	
	Bonded aggregate pavement repair	Immediately, when noted	o **Contact vendor** to make warranty repairs. o After warranty expiration, contract with vendor to make repairs.	
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			foundations, as these materials can cause salt contamination of masonry.	
	Maintain trees	Annually: DEC	Trim branches to 12'-0" away from building. NOTE: If tree roots appear to be damaging a foundation wall, **consult with a preservation engineer.** NOTE: Tree work shall be **performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G9087 SITE DRAINAGE	**Inspect foundation at grade**	Quarterly: JAN, APR, JUL, OCT	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect in conjunction with the inspection of downspouts to ensure water is being discharged a sufficient distance from the building perimeter to avoid being source of dampness in basement. Also look for: o Depressions or grade sloping toward the foundation (negative drainage) o Standing water o Vegetation growing close to the foundation o Evidence of moisture damage o Evidence of moss or mold from damp conditions related to roof drainage system leaks o Blocked downspout drainage boots o Poorly positioned splash blocks o Foundation gravel that has collected or migrated o Debris and leaves collecting at foundation, handholes, manholes, or drain grates	
	Inspect basement	Quarterly: JAN, APR, JUL & OCT And after heavy rains	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Especially after major storms, look for: o Water infiltration through basement walls o Material deterioration at or near the foundation, including loss of mortar in masonry and rotting wood o Evidence of mold from damp conditions	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Improve foundation drainage	As needed	o Regrade to ensure positive drainage. o Add soil to fill depressions o Redistribute gravel if it has collected or migrated. o Remove collection of debris and leaves NOTE: Ensure soil does not come too close to wood or metal elements; a 6" separation is usually recommended. NOTE: Avoid use of mulching material at foundations as it may change grade slope.	
G204090 OTHER SITE IMPROVEMENTS - INTERPRETIVE PANELS	**Inspect Interpretive Panels**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage, including evidence of moisture penetration o Integrity of frame, including stable connection at grade o Appearance and condition of surrounding grade	
	Inspect Wayfinding Panels	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage, including evidence of moisture penetration o Integrity of frame, including stable connection at grade o Appearance and condition of surrounding grade	
	Repair panels and frame	Per recommendation of NPS Media Services	**Consult with Harpers Ferry Media Services for treatment options.**	
	Correct grade issues	Immediately, when noted	**Park Maintenance Staff to make corrections at grade (in consultation with Park Cultural Resource Manager)**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3030 CEILING FINISHES (Plaster)	**Inspect**	4 times/year JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, checking, chalking, and delamination o Cracks, blisters, fading colors o Evidence of moisture/staining o Efflorescence/salt o Evidence of pests o Biological growth o Damage	
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a wide dusting brush. o Remove superficial soiling and cobwebs.	
	Wet clean	As needed	o Dust first. o Determine/identify finish type. Finishes such as calcimine and whitewash can be damaged by water. o Determine finish coverage. If inconsistent or incomplete, identify substrate to implement an appropriate wet cleaning plan. o Use the gentlest means possible. Begin by gently rubbing with a clean damp sponge and immediately drying with a clean wiping cloth. o A non-ionic detergent solution may be used, followed by damp rinsing and drying with a clean wiping cloth. May require double rinsing and then drying. o **When graffiti or stains are present, consult with a conservator for professional removal.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Paint	As needed (assume every 5 years)	o Be thoughtful in the decision to paint; unnecessary painting slowly obliterates detail of historic moldings and thick paint film can become inflexible and be subject to cracking and peeling. o Use high-quality materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. Reference: Preservation Brief 28: Painting Historic Interiors (Appendix C)	
	Repair plaster	As needed	**Consult with a preservation architect and architectural conservator** to determine conditions and appropriate repairs. Repairs to flat or decorative plaster **should be made by a journeyman plasterer.**	
C3010 WALL FINISHES (Plaster)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, chalking, delamination, blisters, and fading colors o Cracks o Evidence of moisture/rising damp o Efflorescence/salt o Staining and/or soiling	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests	
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. Dusting should start in a corner at the floor and move upward to the cornice. o Remove superficial soiling and cobwebs. o Dust routinely all ledge-type horizontal surfaces.	
	Wet clean	As needed	o Dust first. o Determine/identify finish type. Finishes such as calcimine and whitewash can be damaged by water. o Determine finish coverage. If inconsistent or incomplete, identify substrate to implement an appropriate wet cleaning plan. o Use the gentlest means possible. Begin by gently rubbing with a clean damp sponge and immediately drying with a clean wiping cloth. o A non-ionic detergent solution may be used, followed by damp rinsing, and drying with a clean wiping cloth. May require double rinsing and then drying. o **When graffiti or stains are present, consult with a conservator for professional removal.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Paint	As needed (assume every 5 years)	o Be thoughtful in the decision to paint; unnecessary painting slowly obliterates detail of historic moldings and thick paint film can become inflexible and be subject to cracking and peeling. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for preparation and application of coatings. Use high-quality coating materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. NOTE: Graffiti "windows" isolate better than with blue tape Reference: Preservation Brief 28: Painting Historic Interiors (Appendix C)	
C3010 WALL FINISHES (Glass)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Discoloration o Cracks o Staining and/or soiling o Abrasion o Evidence of pests	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			○ Biological growth	
	Dry clean/dust	Weekly	○ Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. Dusting should start in a corner at the floor and move upward to the ceiling. ○ Remove superficial soiling and cobwebs. ○ Dust routinely all ledge-type horizontal surfaces.	
	Clean	Weekly	○ Remove insect residue using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean brush attachment. ○ Follow manufacturer's instructions on cleaning glass. NOTE: Install/ensure protection of applied lettering. NOTE: Do NOT wash outside glass when the temperature is below freezing.	
	Paint	As needed	○ Follow manufacturer's instructions on refinishing associated metal components. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C201001 INTERIOR STAIR STRUCTURE (Staircases and Handrails)	**Inspection**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff OR Park Museum Curation Staff** Look for: o Misaligned or deteriorating posts, structural framing, anchorage, and fasteners o Safety/stability of stair treads, including wear (i.e., dishing, cupping) o Deteriorated finish o Abrasion	
	Inspection	Quarterly	**Quarterly Inspection to be performed by: Park Historical Architect & Park Maintenance Staff** Look for: o Structural integrity including framing, balustrade, steps, and supplemental wall support o Excessive wear and abrasion o Evidence of moisture o Deteriorated finish	
	Clean handrails and stairs	As needed	o Keep stairs free from dust, dirt, and debris. Remove as it accumulates using a soft broom or vacuum. o Finished wood surfaces in good condition can be dusted with a dusting product that does not contain silicone or tung, lemon or linseed oils sprayed onto a soft diaper or with an untreated magnetic cleaning cloth. o Dusting unfinished wood: Using the variable rheostat on a vacuum cleaner, use the lowest power setting that will do the job. Use the round brush attachment marked "clean." Carefully vacuum without applying pressure to the object. o **If desire is to clean beyond broom-clean, follow the recommendations of a wood conservator**.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Repair stairs and handrails	As needed	**Consult preservation architect and preservation engineer to understand conditions and develop solutions.** o Secure loose connections such as rails and balustrades. Do not modify historic railings or balustrade to make stronger connections. o Carefully remove cupped, damaged, or deteriorated material and replace with wood to match. o Replace deteriorated or failing individual elements with in-kind materials. There may be some instances when repair with wood Dutchman, wood putty, and epoxy filler may be appropriate. NOTE: Take appropriate safety precautions when working with components finished in lead paint and using corrosion-removal products. NOTE: **Repairs should be made by preservation woodworkers.**	
C201001 INTERIOR STAIR STRUCTURE continued	**Refinish stair and handrail components**	As needed	**Consult preservation architect and wood conservator to review conditions and develop a refinishing plan.** Prepare and refinish per product manufacturer's guidelines. NOTE: Before refinishing, ensure compatibility between new and existing finishes. NOTE: **Refinishing should be performed by professional conservator or preservation woodworker.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C101004 INTERIOR GUARDRAILS & SCREENS (Exhibit Barriers)	**Inspect**	Daily	**Daily inspection to be performed by: Park Interpretive Staff** Look for: o Safety/stability of posts, anchorage, and fasteners o Condition of finishes o Abrasion o Cracked/broken glass o Safety hazards	
	Clean	As needed	Clean per housekeeping plan.	
	Repair	Immediately, when identified	Contract with vendor to make repairs.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C1020 INTERIOR DOORS	**Inspect Interior Doors**	Semi-Annual: MAY & OCT	**Semi-Annual Inspections to be performed by: Park Museum Curation Staff** Record findings in a door schedule (see sample to follow), according to door number, which includes condition and description of each opening component. Look for: o Overall material condition, including finish o Doors that are drooping, mis-aligned, or not properly functioning o Tipped or cupped thresholds o Drag marks on thresholds and evidence of scraping of floor finish in line with door swing o Wear at the knuckles, loosening of screws, or poor fit of hinges o Damaged or deteriorating trim o Broken/cracked glass, loose or missing glazing and putty NOTE: Heavily used doors may merit more frequent inspection. Look for: o Abrasion at bottoms of doors. o Abrasion at hardware.	
	Clean glass components	Semi-Annually: MAR & JUL	o Dust glass with a brush or whisk broom. o Wash glass, working from top to bottom. o Use mild vinegar and water mixture or a non-alkaline commercial window cleaner. Be cautious with compounds that contain ammonia as they may stain brass or bronze hardware elements. o When using a squeegee blade or sponge, wipe wet corners with a soft dry cloth.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Clean wood components	Quarterly: MAR, JUN, SEP, DEC	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. o Remove superficial soiling and cobwebs. o Dust all ledge-type horizontal surfaces, including tops of door panel moldings, trim, and tops of doors.	
	Replace broken or missing glass	As needed	For historic glass, a conservation approach should be considered to repair limited cracks. Where panes with a distinct appearance are missing, specialty glass should be obtained to match. An inventory should be kept for future needs. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Repair glazing	As needed	o Repair where deteriorated or missing. o Use care when removing putty so as not to crack or break old glass or damage muntins and frames. o Avoid using mechanical devices to remove old putty and match historic putty bevels or details when undertaking work. o Re-glaze with either traditionally formulated oil or modern synthetic putties, making sure to properly bed the glass and secure with glazing points. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C1020 INTERIOR DOORS continued	**Repair and repaint doors, frames, thresholds**	As needed (anticipate every 5 years)	o Clean out paint chips from doorways using a wet paper towel and dispose of debris prior to repair or repainting. o Sand and prepare surfaces and use material-specific patching compounds to fill any holes. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. NOTE: Physical damage should be corrected **under consultation of a historical/ preservation architect/engineer or a preservation carpenter,** depending on the damage. NOTE: Faux finish repairs should be executed by an **experienced decorative painter.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Clean, repair, and maintain thresholds	As needed	o Fill cracks in wood thresholds with a wood filler and epoxy. Follow manufacturer's instructions for preparation and installation. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. Refer to rehabilitation specifications, if available. NOTE: Take appropriate safety precautions when working with components finished in lead paint. NOTE: Physical damage should be corrected under **consultation of a historical/ preservation architect/engineer or a preservation carpenter**, depending on the damage.	
	Repair and maintain door as operable	As needed	It is preferred to resolve binding doors with hardware adjustments; shaving a historic door is not appropriate. NOTE: Physical damage to structure/architectural features should be corrected under **consultation of a historical/preservation architect/engineer or a preservation carpenter**, depending on the damage. (Main House) (Museum)	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
	Wet Cleaning	As needed	o Damp clean finished wood and masonry fireplace components. o Periodically damp mop masonry hearth before its appearance becomes dull. o Wet mopping and scrubbing masonry hearth are acceptable if required.	
C302006 BRICK, PAVER and CONCRETE FLOORING	**Inspect**	Weekly	**Weekly Inspection to be performed by: Park Museum Curation Staff or Park Interpretive Staff** Look for: o Wear o Abrasion o Cracks o Deterioration o Evidence of moisture o Unsafe conditions o Evidence of pest infestation	
	Inspect	Annually	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Unstable or excessive wear of walking surfaces o Abrasion o Cracks o Unsafe conditions o Evidence of moisture	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			NOTE: Document moisture conditions for future comparison and development of solutions.	
	Dry Cleaning	Daily	Dry clean entire floor with a vacuum cleaner.	
	Wet Cleaning	Weekly	Damp mop to keep dirt from building up.	
PESTS	**Inspect**	3 times/year: MAR, JUN, OCT	**Inspection to be performed by: Park Museum Curation Staff** Look for evidence of: o Insects o Snakes o Animals	
	Conduct termite inspections	Throughout Spring	Swarm season for termites is in the spring. Promptly address termite and other insect infestations, as needed. **Use only a licensed company for treatment.**	
	Action	Per recommendation of NPS IPM	**Consult with NPS Regional Integrated Pest Management Program for treatment options.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
E201090 OTHER FIXED INTERIOR FURNISHINGS – INTERPRETIVE PANELS	**Inspect Interpretive Panels**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage o Integrity of frame, including stable connection at floor	
	Repair panels and frame	Per recommendation of NPS Media Services	**Consult with Harpers Ferry Media Services for treatment options.**	
D30 HVAC	**Heating System Inspection**	Daily during heating season	**Daily inspections to be performed by: Park Museum Curation Staff OR Park Interpretive Staff** Look for: o Changes in humidity levels o Unprogrammed changes in temperature o Condensation in attic and roof spaces o Condensation on interior walls	
	Heating System Inspection	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
	Heating System Inspection	Annually	**Annual inspection of the heating system to be performed by: Certified HVAC Contractor** Inspection to meet requirements of PMIS 150123 project documentation.	
	Cooling System Inspection	Daily during cooling season	**Daily inspections to be performed by: Park Museum Curation Staff OR Park Interpretive Staff** Look for: o Changes in humidity levels o Unprogrammed changes in temperature	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			o Condensation in attic and roof spaces o Condensation on interior walls	
	Cooling System Inspection	Annually	**Annual inspection of the cooling system to be performed by: Certified HVAC Contractor** Inspection to meet requirements of Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), National Electrical Code 70 (NFPA 70), and PMIS 150123 project documentation.	
	Maintenance	Variable	**Maintenance to be performed by: Certified HVAC Contractor** Maintenance to meet requirements of Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), and PMIS 150123 project documentation.	
D50 ELECTRICAL	**System Inspection**	Daily	**Daily Inspection to be performed by: Park Interpretive Staff** Look for: o Light fixtures requiring lamp replacement o Leaves or debris accumulating around light fixtures	
	System Inspection	Three times/year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff OR Park Museum Curation Staff** Review: o Condition of conduit, exposed electric wire, electric panels, switches, and outlets o Operation of electric panels, switches, outlets, and fixtures	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	System Inspection	Annually: OCT	**Five-year inspections should be performed by a licensed and bonded electrician compliant with the standards outlined in** the National Electrical Code 70 (NFPA 70), NFPA Guide on Electrical Inspections (NFPA 78), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. Review: o Condition of conduits, exposed electric wire, electric panels, switches, and outlets o Operation of electric panels, switches, outlets, and fixtures o Changes, including include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness. Ensure no changes have been made that affect system and fixture performance.	
	System Maintenance	Immediately, when identified	**Repairs to be performed by a licensed and bonded electrician**, compliant with the NFPA 70, NFPA 101, and ANSI/IEEE C2.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	
	System Inspection and Maintenance	Three times / year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Perform operational checks and lens focus and cleaning of 25% of the cameras in the system. o Perform operational check of 25% of components of the security system. o Troubleshoot issues identified.	
	System Inspection and Maintenance	Annually: October	**Security systems and cameras should be inspected by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Inspection shall ensure no changes have been made that affect equipment performance. Potential changes include building modifications, occupancy changes, changes in environmental	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness. o Annual inspection includes operational check of all (100%) components of the security system. o Annual inspection includes 100% of the cameras within the system. o Troubleshoot issues identified.	
	Repair	Immediately, when identified	**Use a Certified Security and Camera System Contractor** to troubleshoot and perform repairs.	
D40 Fire Protection	**System Inspection**	Quarterly: JAN, APR, JUL, OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** **Look for:** o Visible signs of damage or surrounding conditions that might impact operation of fire detection and suppression system devices (heat detectors, smoke detectors, pull alarm stations, strobes) o Damage or changes to original installation of suppression piping, hangers, and heads	
	System Inspection	Annual	**Fire alarm systems should be inspected by qualified persons per the requirements of** National Electrical Code 70 (NFPA 70), National Fire Alarm and Signaling Code (NFPA 72), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			Program or Annual Service Contract, and PMIS 150123 project documentation. Inspection shall ensure no changes have been made that effect equipment performance. Potential changes include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness.	
	System Inspection and Testing	Various Intervals	**Fire alarm systems should be inspected and tested by qualified persons per the requirements of** National Electrical Code 70 (NFPA 70), National Fire Alarm and Signaling Code (NFPA 72), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation.	
	Fire Extinguisher Inspection	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing)	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** ○ Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	
	System Maintenance	Various intervals	**Fire alarm systems should be maintained by qualified persons per the requirements** of the National Fire Alarm and Signaling Code 72 (NFPA 72) **and as outlined in PMIS 150123 project documentation.**	
D40 Fire Protection	**System Repair**	Immediately, when identified	**Use a qualified persons** to troubleshoot and perform repairs.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
continued	**Fire Extinguisher Maintenance**	Various intervals	**Maintenance must be performed by a certified person** (must pass a test acceptable to AHJ) and must be familiar with the requirements in NFPA 10. Fire extinguishers need to have an external maintenance examination conducted on a yearly basis, at the time of hydrostatic test, or when specifically indicated by an inspection discrepancy. Extinguishers need to have an internal examination conducted at anywhere from 1-6 year intervals depending on the type of extinguisher. Maintenance procedures must include the procedures detailed in the manufacturer's service manual and a thorough examination of the basic elements of the fire extinguisher, including the following: o Mechanical parts of all fire extinguishers o Extinguishing agent o Expelling means o Physical condition	

JANUARY
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite)	**Inspect adjacent interior spaces**	Quarterly: JAN, APR, JUL & OCT	**Quarterly Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Staining or other evidence of water infiltration o Water leaks, especially after major storms. o Work with a professional roofing contractor to identify source of water infiltration and to develop a repair plan.	
B301005 GUTTERS & DOWNSPOUTS	**Inspect roof drainage system**	Quarterly: JAN, late APR, mid-JUL, late-OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Sagging and misaligned gutters, downspouts, and boots o Damaged, failing gutter hangers and downspout brackets o Crushed or split gutters and downspouts o Open seams o Dissimilar materials o Damaged boots o Debris accumulating in gutters and at juncture of downspout and boots o Overflowing gutters o Failure or slow to drain at boots o Ice damming and icicles hanging from gutters and downspouts in winter months o Overhanging branches impacting gutters o Growth, moss, and stains NOTE: During quarterly inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G9087 SITE DRAINAGE	**Inspect foundation at grade**	Quarterly: JAN, APR, JUL, OCT	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect in conjunction with the inspection of downspouts to ensure water is being discharged a sufficient distance from the building perimeter to avoid being source of dampness in basement. Also look for: o Depressions or grade sloping toward the foundation (negative drainage) o Standing water o Vegetation growing close to the foundation o Evidence of moisture damage o Evidence of moss or mold from damp conditions related to roof drainage system leaks o Blocked downspout drainage boots o Poorly positioned splash blocks o Foundation gravel that has collected or migrated o Debris and leaves collecting at foundation, handholes, manholes, or drain grates	
	Inspect basement	Quarterly: JAN, APR, JUL & OCT And after heavy rains	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Especially after major storms, look for: o Water infiltration through basement walls o Material deterioration at or near the foundation, including loss of mortar in masonry and rotting wood o Evidence of mold from damp conditions	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3030 CEILING FINISHES (Plaster)	**Inspect**	4 times/year JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, checking, chalking, and delamination o Cracks, blisters, fading colors o Evidence of moisture/staining o Efflorescence/salt o Evidence of pests o Biological growth o Damage	
C3010 WALL FINISHES (Plaster)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, chalking, delamination, blisters, and fading colors o Cracks o Evidence of moisture/rising damp o Efflorescence/salt o Staining and/or soiling o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Glass)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Discoloration o Cracks o Staining and/or soiling o Abrasion o Evidence of pests o Biological growth	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
D50 ELECTRICAL	**System Inspection**	Three times/year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff OR Park Museum Curation Staff** Review: o Condition of conduit, exposed electric wire, electric panels, switches, and outlets o Operation of electric panels, switches, outlets, and fixtures	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	
	System Inspection and Maintenance	Three times / year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Perform operational checks and lens focus and cleaning of 25% of the cameras in the system. o Perform operational check of 25% of components of the security system. o Troubleshoot issues identified.	
D40 Fire Protection	**System Inspection**	Quarterly: JAN, APR, JUL, OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** **Look for:** o Visible signs of damage or surrounding conditions that might impact operation of fire detection and suppression system devices (heat detectors, smoke detectors, pull alarm stations, strobes) o Damage or changes to original installation of suppression piping, hangers, and heads	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection continued	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:

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FEBRUARY
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

MARCH
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	

PESTS	**Inspect**	3 times/year: MAR, JUN, OCT	**Inspection to be performed by: Park Museum Curation Staff** Look for evidence of: o Insects o Snakes o Animals	

D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	

D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** ○ NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** ○ Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:

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APRIL
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Slipped, missing, cracked, buckling, abraded, deformed, or broken roof materials o Standing water o Evidence of water infiltration on interior surfaces o Deflection, splitting, evidence of stress within roof framing NOTE: During semi-annual inspections, inspect from the ground using binoculars and access interior framing spaces, if able. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles.	
	Inspect ridges	Semi-Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Lifted, slipped, missing, or damaged ridge material o Loose or raised fasteners NOTE: During semi-annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
	Inspect adjacent interior spaces	Quarterly: JAN, APR, JUL & OCT	**Quarterly Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Staining or other evidence of water infiltration o Water leaks, especially after major storms. o Work with a professional roofing contractor to identify source of water infiltration and to develop a repair plan.	
B301001 ROOF FINISHES (Metal)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect and Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Missing, cracked, buckling, abraded, or deformed roof materials o Open seams o Standing water o Deterioration, splitting, evidence of stress within roof framing o NOTE: During semi-annual inspections, inspect from the ground using binoculars, if needed.	
	Repair roof coverings and finishes	Immediately, when noted	o Solder patches on sheet metal roofs/hoods NOTE: **Work with Certified Roofing Contractors**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301004 FLASHING	**Inspect flashing and adjacent interior spaces**	Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Debris accumulating in valleys o Deteriorated and damaged flashing, including cracks, dents, and dissimilar materials o Failing connections at any intersection of roof areas, of roof and adjacent wall, of roof and chimney, or any flashed projections o Raised edges o Failing paint systems o Staining or other evidence of water infiltration o Water leaks, especially after major storms. NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. NOTE: **Work with a professional roofing contractor** to identify source of water infiltration and to develop a repair plan.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301005 GUTTERS & DOWNSPOUTS	**Inspect roof drainage system**	Quarterly: JAN, late APR, mid-JUL, late-OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Sagging and misaligned gutters, downspouts, and boots o Damaged, failing gutter hangers and downspout brackets o Crushed or split gutters and downspouts o Open seams o Dissimilar materials o Damaged boots o Debris accumulating in gutters and at juncture of downspout and boots o Overflowing gutters o Failure or slow to drain at boots o Ice damming and icicles hanging from gutters and downspouts in winter months o Overhanging branches impacting gutters o Growth, moss, and stains NOTE: During quarterly inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	
	Clean roof drainage system	Semi-Annually: late APR & late OCT	o Remove leaves and other debris from gutters, downspouts, and boots. o Use a garden hose to flush out troughs and downspouts. NOTE: If using a ladder to access gutter, utilize a ladder with a brace device to keep ladder from crushing gutter.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stucco)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. With a ladder or binoculars, look for: o Moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any pattern o Excessive damp spots, often accompanied by staining, peeling paint, moss, or mold. o Evidence of rising damp o Cracks within stucco finish/rendering o Loss of aggregate in pebble dash stucco o Surface salts o Active cracks in joints and around windows and doors. Determine whether movement is seasonal or sign of ongoing problem. o Areas significantly misaligned or where there are bulging wall sections or cracks could be indicative of potential structural problems (**seek professional guidance).** o Failed sealant o Deterioration of mineral finish coat on stucco rendering, including signs of checking, flaking, and chalking o Deterioration of faux finishes o Evidence of insect infestation and vegetative growth o Surface stains o Openings from prior utilities or service pipes	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stone)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. Look for: o Moisture patterns that may appear after a heavy or sustained rainfall or snow, recording any pattern o Excessive damp spots, often accompanied by moss, or mold o Evidence of rising damp o Cracked or failing mortar o Cracks through masonry o Deteriorating or delaminating masonry o Surface salts o Active cracks in joints and around windows and doors. Determine whether movement is seasonal or sign of ongoing problem. o Areas significantly misaligned or where there are bulging wall sections or cracks could be indicative of potential structural problems (**seek professional guidance).** o Failed sealant o Openings from prior utilities or service pipes	
B201001 EXTERIOR WALLS (Wood, Wood Details, Exterior Soffits)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. Look for: o Moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any pattern o Damp spots, often accompanied by staining, peeling paint, moss, or mold o Evidence of wicking moisture o Failed sealant o Deterioration of paint finish coat on decorative wood elements and wall details, including peeling, checking, flaking, and chalking o Evidence of wood rot, insect infestation, and vegetative growth o Surface stains	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G9087 SITE DRAINAGE	**Inspect foundation at grade**	Quarterly: JAN, APR, JUL, OCT	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect in conjunction with the inspection of downspouts to ensure water is being discharged a sufficient distance from the building perimeter to avoid being source of dampness in basement. Also look for: o Depressions or grade sloping toward the foundation (negative drainage) o Standing water o Vegetation growing close to the foundation o Evidence of moisture damage o Evidence of moss or mold from damp conditions related to roof drainage system leaks o Blocked downspout drainage boots o Poorly positioned splash blocks o Foundation gravel that has collected or migrated o Debris and leaves collecting at foundation, handholes, manholes, or drain grates	
	Inspect basement	Quarterly: JAN, APR, JUL & OCT And after heavy rains	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Especially after major storms, look for: o Water infiltration through basement walls o Material deterioration at or near the foundation, including loss of mortar in masonry and rotting wood o Evidence of mold from damp conditions	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3030 CEILING FINISHES (Plaster)	**Inspect**	4 times/year JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, checking, chalking, and delamination o Cracks, blisters, fading colors o Evidence of moisture/staining o Efflorescence/salt o Evidence of pests o Biological growth o Damage	
C3010 WALL FINISHES (Plaster)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, chalking, delamination, blisters, and fading colors o Cracks o Evidence of moisture/rising damp o Efflorescence/salt o Staining and/or soiling o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Glass)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Discoloration o Cracks o Staining and/or soiling o Abrasion o Evidence of pests o Biological growth	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C201001 INTERIOR STAIR STRUCTURE continued	**Refinish stair and handrail components**	As needed	**Consult preservation architect and wood conservator to review conditions and develop a refinishing plan.** Prepare and refinish per product manufacturer's guidelines. NOTE: Before refinishing, ensure compatibility between new and existing finishes. NOTE: **Refinishing should be performed by professional conservator or preservation woodworker.**	
C101004 INTERIOR GUARDRAILS & SCREENS (Exhibit Barriers)	**Inspect**	Daily	**Daily inspection to be performed by: Park Interpretive Staff** Look for: o Safety/stability of posts, anchorage, and fasteners o Condition of finishes o Abrasion o Cracked/broken glass o Safety hazards	
	Clean	As needed	Clean per housekeeping plan.	
	Repair	Immediately, when identified	Contract with vendor to make repairs.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
	Wet Cleaning	As needed	o Damp clean finished wood and masonry fireplace components. o Periodically damp mop masonry hearth before its appearance becomes dull. o Wet mopping and scrubbing masonry hearth are acceptable if required.	
C302006 BRICK, PAVER and CONCRETE FLOORING	**Inspect**	Weekly	**Weekly Inspection to be performed by: Park Museum Curation Staff or Park Interpretive Staff** Look for: o Wear o Abrasion o Cracks o Deterioration o Evidence of moisture o Unsafe conditions o Evidence of pest infestation	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C302006 BRICK, PAVER and CONCRETE FLOORING continued	**Inspect**	Annually	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Unstable or excessive wear of walking surfaces o Abrasion o Cracks o Unsafe conditions o Evidence of moisture NOTE: Document moisture conditions for future comparison and development of solutions.	
	Dry Cleaning	Daily	Dry clean entire floor with a vacuum cleaner.	
	Wet Cleaning	Weekly	Damp mop to keep dirt from building up.	
PESTS	**Inspect**	3 times/year: MAR, JUN, OCT	**Inspection to be performed by: Park Museum Curation Staff** Look for evidence of: o Insects o Snakes o Animals	
	Conduct termite inspections	Throughout Spring	Swarm season for termites is in the spring. Promptly address termite and other insect infestations, as needed. **Use only a licensed company for treatment.**	
	Action	Per recommendation of NPS IPM	**Consult with NPS Regional Integrated Pest Management Program for treatment options.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
E201090 OTHER FIXED INTERIOR FURNISHINGS – INTERPRETIVE PANELS	**Inspect Interpretive Panels**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage o Integrity of frame, including stable connection at floor	
	Repair panels and frame	Per recommendation of NPS Media Services	**Consult with Harpers Ferry Media Services for treatment options.**	
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
D50 ELECTRICAL	**System Inspection**	Three times/year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff OR Park Museum Curation Staff** Review: o Condition of conduit, exposed electric wire, electric panels, switches, and outlets o Operation of electric panels, switches, outlets, and fixtures	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	
	System Inspection and Maintenance	Three times / year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Perform operational checks and lens focus and cleaning of 25% of the cameras in the system. o Perform operational check of 25% of components of the security system. o Troubleshoot issues identified.	
D40 Fire Protection	**System Inspection**	Quarterly: JAN, APR, JUL, OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** **Look for:** o Visible signs of damage or surrounding conditions that might impact operation of fire detection and suppression system devices (heat detectors, smoke detectors, pull alarm stations, strobes) o Damage or changes to original installation of suppression piping, hangers, and heads	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection continued	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

MAY
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2030 EXTERIOR DOORS	**Inspect doors**	Semi-Annually: MAY & OCT	**Semi-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a door schedule (see sample to follow), according to door number, which includes condition and description of each opening component. Look for: o Overall material condition, including finish o Fit and operation of door o Loose, open, or decayed joints in frames, doors, transoms, and sidelights o Gaps between threshold, door frame, and door opening. o Tipped or cupped thresholds o Drag marks on thresholds o Loose hardware, locking difficulties o Deteriorated weatherstripping and flashing o Wear at the knuckles, loosening of screws, or poor fit of hinges o Functionality of power-assisted doors o Condensation or evidence of water infiltration o Evidence of insect infiltration or animal entry NOTE: Heavily used doors may merit greater inspection frequency.	

G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	
	Repair	Immediately, when identified	**Use a Certified Security and Camera System Contractor** to troubleshoot and perform repairs.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

JUNE
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
PESTS	**Inspect**	3 times/year: MAR, JUN, OCT	**Inspection to be performed by: Park Museum Curation Staff** Look for evidence of: o Insects o Snakes o Animals	
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:

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JULY
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite)	**Inspect adjacent interior spaces**	Quarterly: JAN, APR, JUL & OCT	**Quarterly Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Staining or other evidence of water infiltration o Water leaks, especially after major storms. o Work with a professional roofing contractor to identify source of water infiltration and to develop a repair plan.	
B301005 GUTTERS & DOWNSPOUTS	**Inspect roof drainage system**	Quarterly: JAN, late APR, mid-JUL, late-OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Sagging and misaligned gutters, downspouts, and boots o Damaged, failing gutter hangers and downspout brackets o Crushed or split gutters and downspouts o Open seams o Dissimilar materials o Damaged boots o Debris accumulating in gutters and at juncture of downspout and boots o Overflowing gutters o Failure or slow to drain at boots o Ice damming and icicles hanging from gutters and downspouts in winter months o Overhanging branches impacting gutters o Growth, moss, and stains NOTE: During quarterly inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	

G9087 SITE DRAINAGE	**Inspect foundation at grade**	Quarterly: JAN, APR, JUL, OCT	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect in conjunction with the inspection of downspouts to ensure water is being discharged a sufficient distance from the building perimeter to avoid being source of dampness in basement. Also look for: o Depressions or grade sloping toward the foundation (negative drainage) o Standing water o Vegetation growing close to the foundation o Evidence of moisture damage o Evidence of moss or mold from damp conditions related to roof drainage system leaks o Blocked downspout drainage boots o Poorly positioned splash blocks o Foundation gravel that has collected or migrated o Debris and leaves collecting at foundation, handholes, manholes, or drain grates	
	Inspect basement	Quarterly: JAN, APR, JUL & OCT And after heavy rains	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Especially after major storms, look for: o Water infiltration through basement walls o Material deterioration at or near the foundation, including loss of mortar in masonry and rotting wood o Evidence of mold from damp conditions	

C3030 CEILING FINISHES (Plaster)	**Inspect**	4 times/year JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, checking, chalking, and delamination o Cracks, blisters, fading colors o Evidence of moisture/staining o Efflorescence/salt o Evidence of pests o Biological growth o Damage	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Plaster)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, chalking, delamination, blisters, and fading colors o Cracks o Evidence of moisture/rising damp o Effflorescence/salt o Staining and/or soiling o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests	

C3010 WALL FINISHES (Glass)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Discoloration o Cracks o Staining and/or soiling o Abrasion o Evidence of pests o Biological growth	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
D50 ELECTRICAL	**System Inspection**	Three times/year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff OR Park Museum Curation Staff** Review: o Condition of conduit, exposed electric wire, electric panels, switches, and outlets o Operation of electric panels, switches, outlets, and fixtures	
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	
	System Inspection and Maintenance	Three times / year: JAN, APR, JUL	**Tri-Annual Inspections to be performed by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Perform operational checks and lens focus and cleaning of 25% of the cameras in the system. o Perform operational check of 25% of components of the security system. o Troubleshoot issues identified.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection	**System Inspection**	Quarterly: JAN, APR, JUL, OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** **Look for:** o Visible signs of damage or surrounding conditions that might impact operation of fire detection and suppression system devices (heat detectors, smoke detectors, pull alarm stations, strobes) o Damage or changes to original installation of suppression piping, hangers, and heads	
	Fire Extinguisher Inspection	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection continued			**For further reference:** ○ Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

AUGUST
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	

D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	

D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	

D40 Fire Protection	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection continued			▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** ○ Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:

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SEPTEMBER
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201099 CHIMNEYS	**Inspect chimneys**	Annually from grade: end of SEP	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Plant/biological growth o Cracked stucco parging or loss of aggregate o Failing paint o Dislodged chimney caps o Dislodged flashing NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles.	
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE continued			NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	
D40 Fire Protection	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

OCTOBER
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Slipped, missing, cracked, buckling, abraded, deformed, or broken roof materials o Standing water o Evidence of water infiltration on interior surfaces o Deflection, splitting, evidence of stress within roof framing NOTE: During semi-annual inspections, inspect from the ground using binoculars and access interior framing spaces, if able. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles	
	Inspect ridges	Semi-Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Lifted, slipped, missing, or damaged ridge material o Loose or raised fasteners NOTE: During semi-annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite) **continued**	**Inspect adjacent interior spaces**	Quarterly: JAN, APR, JUL & OCT	**Quarterly Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Staining or other evidence of water infiltration o Water leaks, especially after major storms. o Work with a professional roofing contractor to identify source of water infiltration and to develop a repair plan.	
	Clean roof surfaces	Annually: Fall (OCT)	o Remove excessive debris and biological growth from roof surfaces. Use low-pressure garden hose water and a natural or nylon scrubbing brush, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Avoid using diluted chlorine bleach. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. o Remove overhanging tree branches to minimize abrasion/damage. NOTE: **Tree work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Metal)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect and Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Missing, cracked, buckling, abraded, or deformed roof materials o Open seams o Standing water o Deterioration, splitting, evidence of stress within roof framing o NOTE: During semi-annual inspections, inspect from the ground using binoculars, if needed.	
	Clean roof surfaces	Annually: Fall (OCT)	o Remove excessive debris and biological growth from roof surfaces. Use low-pressure garden hose water and a natural or nylon scrubbing brush, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Avoid using diluted chlorine bleach. o Remove overhanging tree branches to minimize abrasion/damage. NOTE: **Tree work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301004 FLASHING	**Inspect flashing and adjacent interior spaces**	Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Debris accumulating in valleys o Deteriorated and damaged flashing, including cracks, dents, and dissimilar materials o Failing connections at any intersection of roof areas, of roof and adjacent wall, of roof and chimney, or any flashed projections o Raised edges o Failing paint systems o Staining or other evidence of water infiltration o Water leaks, especially after major storms. NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. NOTE: **Work with a professional roofing contractor** to identify source of water infiltration and to develop a repair plan.	
	Clean flashing	Annually: OCT	o Broom sweep branch and leaf debris away from valleys NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301005 GUTTERS & DOWNSPOUTS	**Inspect roof drainage system**	Quarterly: JAN, late APR, mid-JUL, late-OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Sagging and misaligned gutters, downspouts, and boots o Damaged, failing gutter hangers and downspout brackets o Crushed or split gutters and downspouts o Open seams o Dissimilar materials o Damaged boots o Debris accumulating in gutters and at juncture of downspout and boots o Overflowing gutters o Failure or slow to drain at boots o Ice damming and icicles hanging from gutters and downspouts in winter months o Overhanging branches impacting gutters o Growth, moss, and stains NOTE: During quarterly inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	
	Clean roof drainage system	Semi-Annually: late APR & late OCT	o Remove leaves and other debris from gutters, downspouts, and boots. o Use a garden hose to flush out troughs and downspouts. NOTE: If using a ladder to access gutter, utilize a ladder with a brace device to keep ladder from crushing gutter.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2020 EXTERIOR WINDOWS	**Inspect windows**	Semi-Annually: May & OCT	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a window schedule (see sample to follow), according to window number, which includes condition and description of each opening component. Review interior and exterior components. Look for: o Overall material condition, including paint o Unwanted water penetration and surface condensation o Insect infiltration (especially termite and carpenter ant damage), or animal entry o Window sash and shutters that do not open and close properly o Rubbing points/abrasion due to ill-fit or alignment o Loose, open, or decayed joints in frames, sash o Slipped sills and tipped or cupped stools o Loose, damaged, or missing hardware o Broken sash cords/chains, sash pulleys o Missing or damaged sash o Locking difficulties o Deteriorated weatherstripping and flashing o Gaps between sash and sill or window opening o Broken/cracked glass, loose or missing glazing and putty o Loose/damaged moldings, architraves, decayed stiles at sill level o Accumulation of dirt or collection of leaves and debris NOTE: Pay particular attention to exposed horizontal surfaces of window components as	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			they tend to deteriorate faster than vertical surfaces.	
	Clean glass components	Semi-Annually: MAY & OCT	o Dust sash with a brush or whisk broom. o Wash glass, beginning with top sash, working from top to bottom. o Use mild vinegar and water mixture or a non-alkaline commercial window cleaner. Be cautious with compounds that contain ammonia as they may stain brass or bronze hardware elements. o When using a squeegee blade or sponge, wipe wet corners with a soft dry cloth. o Avoid high-pressure washes. NOTE: Do NOT wash outside windows when the temperature is below freezing.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2030 EXTERIOR DOORS	**Inspect doors**	Semi-Annually: MAY & OCT	**Semi-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a door schedule (see sample to follow), according to door number, which includes condition and description of each opening component. Look for: o Overall material condition, including finish o Fit and operation of door o Loose, open, or decayed joints in frames, doors, transoms, and sidelights o Gaps between threshold, door frame, and door opening. o Tipped or cupped thresholds o Drag marks on thresholds o Loose hardware, locking difficulties o Deteriorated weatherstripping and flashing o Wear at the knuckles, loosening of screws, or poor fit of hinges o Functionality of power-assisted doors o Condensation or evidence of water infiltration o Evidence of insect infiltration or animal entry NOTE: Heavily used doors may merit greater inspection frequency.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G9087 SITE DRAINAGE	**Inspect foundation at grade**	Quarterly: JAN, APR, JUL, OCT	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect in conjunction with the inspection of downspouts to ensure water is being discharged a sufficient distance from the building perimeter to avoid being source of dampness in basement. Also look for: o Depressions or grade sloping toward the foundation (negative drainage) o Standing water o Vegetation growing close to the foundation o Evidence of moisture damage o Evidence of moss or mold from damp conditions related to roof drainage system leaks o Blocked downspout drainage boots o Poorly positioned splash blocks o Foundation gravel that has collected or migrated o Debris and leaves collecting at foundation, handholes, manholes, or drain grates	
	Inspect basement	Quarterly: JAN, APR, JUL & OCT And after heavy rains	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Especially after major storms, look for: o Water infiltration through basement walls o Material deterioration at or near the foundation, including loss of mortar in masonry and rotting wood o Evidence of mold from damp conditions	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3030 CEILING FINISHES (Plaster)	**Inspect**	4 times/year JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, checking, chalking, and delamination o Cracks, blisters, fading colors o Evidence of moisture/staining o Efflorescence/salt o Evidence of pests o Biological growth o Damage	
C3010 WALL FINISHES (Plaster)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, chalking, delamination, blisters, and fading colors o Cracks o Evidence of moisture/rising damp o Efflorescence/salt o Staining and/or soiling o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Glass)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Discoloration o Cracks o Staining and/or soiling o Abrasion o Evidence of pests o Biological growth	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C1020 INTERIOR DOORS	**Inspect Interior Doors**	Semi-Annual: MAY & OCT	**Semi-Annual Inspections to be performed by: Park Museum Curation Staff** Record findings in a door schedule (see sample to follow), according to door number, which includes condition and description of each opening component. Look for: o Overall material condition, including finish o Doors that are drooping, mis-aligned, or not properly functioning o Tipped or cupped thresholds o Drag marks on thresholds and evidence of scraping of floor finish in line with door swing o Wear at the knuckles, loosening of screws, or poor fit of hinges o Damaged or deteriorating trim o Broken/cracked glass, loose or missing glazing and putty NOTE: Heavily used doors may merit more frequent inspection. Look for: o Abrasion at bottoms of doors. o Abrasion at hardware.	
PESTS	**Inspect**	3 times/year: MAR, JUN, OCT	**Inspection to be performed by: Park Museum Curation Staff** Look for evidence of: o Insects o Snakes o Animals	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
D50 ELECTRICAL	**System Inspection**	Annually: OCT	**Five-year inspections should be performed by a licensed and bonded electrician compliant with the standards outlined in** the National Electrical Code 70 (NFPA 70), NFPA Guide on Electrical Inspections (NFPA 78), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. Review: o Condition of conduits, exposed electric wire, electric panels, switches, and outlets o Operation of electric panels, switches, outlets, and fixtures o Changes, including include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness. Ensure no changes have been made that affect system and fixture performance.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	
	System Inspection and Maintenance	Annually: October	**Security systems and cameras should be inspected by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Inspection shall ensure no changes have been made that affect equipment performance. Potential changes include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness. o Annual inspection includes operational check of all (100%) components of the security system. o Annual inspection includes 100% of the cameras within the system. o Troubleshoot issues identified.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection	**System Inspection**	Quarterly: JAN, APR, JUL, OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** **Look for:** o Visible signs of damage or surrounding conditions that might impact operation of fire detection and suppression system devices (heat detectors, smoke detectors, pull alarm stations, strobes) o Damage or changes to original installation of suppression piping, hangers, and heads	
	Fire Extinguisher Inspection	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:

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NOVEMBER
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Inspect foundation landscape**	Once per month during the following months: MCH, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV	**Monthly inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Vegetation growing close to the foundation o Evidence of damage caused by tree roots o Reseeding of trees and plants	
	Maintain foundation landscape	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	

D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	

D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	

D40 Fire Protection **D40 Fire Protection continued**	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			For further reference: ○ Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:

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DECEMBER
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Maintain trees**	Annually: DEC	Trim branches to 12'-0" away from building. NOTE: If tree roots appear to be damaging a foundation wall, **consult with a preservation engineer.** NOTE: Tree work shall be **performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	
D40 Fire Protection	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

DAILY / WEEKLY
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2030 PEDESTRIAN PAVING	**Inspect pedestrian paving**	Daily	**Daily Inspections to be performed by: Park Interpretive Staff** Inspect daily to ensure public's safe circulation of the site. Look for: o Depressions o Loss of aggregate material o Standing water after a rain event o Cracks o Vegetation o Deteriorated or damaged curb/edging conditions o Debris collection at man/hand holes o Damage to man/hand holes	
G204090 OTHER SITE IMPROVEMENTS - INTERPRETIVE PANELS	**Inspect Interpretive Panels**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage, including evidence of moisture penetration o Integrity of frame, including stable connection at grade o Appearance and condition of surrounding grade	
	Inspect Wayfinding Panels	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage, including evidence of moisture penetration o Integrity of frame, including stable connection at grade o Appearance and condition of surrounding grade	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Glass)	**Dry clean/dust**	Weekly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. Dusting should start in a corner at the floor and move upward to the ceiling. o Remove superficial soiling and cobwebs. o Dust routinely all ledge-type horizontal surfaces.	
	Clean	Weekly	o Remove insect residue using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean brush attachment. o Follow manufacturer's instructions on cleaning glass.	
C201001 INTERIOR STAIR STRUCTURE (Staircases and Handrails)	**Inspection**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff OR Park Museum Curation Staff** Look for: o Misaligned or deteriorating posts, structural framing, anchorage, and fasteners o Safety/stability of stair treads, including wear (i.e., dishing, cupping) o Deteriorated finish o Abrasion	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C101004 INTERIOR GUARDRAILS & SCREENS (Exhibit Barriers)	**Inspect**	Daily	**Daily inspection to be performed by: Park Interpretive Staff** Look for: o Safety/stability of posts, anchorage, and fasteners o Condition of finishes o Abrasion o Cracked/broken glass o Safety hazards	
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
	Wet Cleaning	As needed	o Damp clean finished wood and masonry fireplace components. o Periodically damp mop masonry hearth before its appearance becomes dull. o Wet mopping and scrubbing masonry hearth are acceptable if required.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C302006 BRICK, PAVER and CONCRETE FLOORING	**Inspect**	Weekly	**Weekly Inspection to be performed by: Park Museum Curation Staff or Park Interpretive Staff** Look for: o Wear o Abrasion o Cracks o Deterioration o Evidence of moisture o Unsafe conditions o Evidence of pest infestation	
	Dry Cleaning	Daily	Dry clean entire floor with a vacuum cleaner.	
	Wet Cleaning	Weekly	Damp mop to keep dirt from building up.	
E201090 OTHER FIXED INTERIOR FURNISHINGS – INTERPRETIVE PANELS	**Inspect Interpretive Panels**	Weekly	**Weekly inspection to be performed by: Park Interpretive Staff** Inspect for: o Continued legibility o Panel damage o Integrity of frame, including stable connection at floor	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D30 HVAC	**Heating System Inspection**	Daily during heating season	**Daily inspections to be performed by: Park Museum Curation Staff OR Park Interpretive Staff** Look for: o Changes in humidity levels o Unprogrammed changes in temperature o Condensation in attic and roof spaces o Condensation on interior walls	
	Cooling System Inspection	Daily during cooling season	**Daily inspections to be performed by: Park Museum Curation Staff OR Park Interpretive Staff** Look for: o Changes in humidity levels o Unprogrammed changes in temperature o Condensation in attic and roof spaces o Condensation on interior walls	
D50 ELECTRICAL	**System Inspection**	Daily	**Daily Inspection to be performed by: Park Interpretive Staff** Look for: o Light fixtures requiring lamp replacement o Leaves or debris accumulating around light fixtures	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:

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MONTHLY
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D302090 FIREPLACE & HEARTHS	**Inspection**	Monthly	**Inspection to be performed by: Park Museum Curation Staff** Look for: o Dust and soiling o Staining o Evidence of moisture/water damage o Evidence of pests	
	Dry Cleaning	Monthly	Dust masonry fireplace and hearth with a vacuum cleaner	
D30 HVAC	**Heating System Inspection**	Monthly	**Monthly inspection to be performed by: Park Maintenance Staff** Inspection to meet requirements of PMIS 150123 project documentation.	
D5030 Security System	**System Inspection and Maintenance**	Monthly	**Monthly security system inspections should be performed by: Park Safety Officer & Park Maintenance Staff** o Perform functionality check of security alarm system. o Conduct operational check of the camera system. o Troubleshoot issues identified.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection	**Fire Extinguisher Inspection**	Monthly	**Monthly Inspections to be performed by: Park Curation Staff Or Park Interpretive Staff** o NFPA 10 requires extinguishers be inspected when they are initially installed and once a month after that. Inspect extinguishers more frequently if they are installed in locations where they are more prone to rust, impact or tampering**.** ▪ Ensure located in its designated place ▪ Ensure the extinguisher is visible or that there is signage indicating where the extinguisher is located ▪ Ensure easy access to the extinguisher ▪ Ensure the pressure gauge is in the operable range or position ▪ Make sure it is full (this can be done by lifting or weighing) ▪ For wheeled extinguishers, make sure the condition of tires, wheels, carriage, hose, and nozzle are acceptable ▪ For non-rechargeable extinguishers, operate the push-to-test pressure indicators **For further reference:** o Guide to Fire Extinguisher Inspection, Testing and Maintenance | NFPA https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/10/30/guide-to-fire-extinguisher-inspection-testing-and-maintenance Accessed 01/08/2023.	

TEMPLATE
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite)	**Inspect adjacent interior spaces**	Quarterly: JAN, APR, JUL & OCT	**Quarterly Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Staining or other evidence of water infiltration o Water leaks, especially after major storms. o Work with a professional roofing contractor to identify source of water infiltration and to develop a repair plan.	
B301005 GUTTERS & DOWNSPOUTS	**Inspect roof drainage system**	Quarterly: JAN, late APR, mid-JUL, late-OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Sagging and misaligned gutters, downspouts, and boots o Damaged, failing gutter hangers and downspout brackets o Crushed or split gutters and downspouts o Open seams o Dissimilar materials o Damaged boots o Debris accumulating in gutters and at juncture of downspout and boots o Overflowing gutters o Failure or slow to drain at boots o Ice damming and icicles hanging from gutters and downspouts in winter months o Overhanging branches impacting gutters o Growth, moss, and stains NOTE: During quarterly inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G9087 SITE DRAINAGE	**Inspect foundation at grade**	Quarterly: JAN, APR, JUL, OCT	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect in conjunction with the inspection of downspouts to ensure water is being discharged a sufficient distance from the building perimeter to avoid being source of dampness in basement. Also look for: o Depressions or grade sloping toward the foundation (negative drainage) o Standing water o Vegetation growing close to the foundation o Evidence of moisture damage o Evidence of moss or mold from damp conditions related to roof drainage system leaks o Blocked downspout drainage boots o Poorly positioned splash blocks o Foundation gravel that has collected or migrated o Debris and leaves collecting at foundation, handholes, manholes, or drain grates	
	Inspect basement	Quarterly: JAN, APR, JUL & OCT And after heavy rains	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Especially after major storms, look for: o Water infiltration through basement walls o Material deterioration at or near the foundation, including loss of mortar in masonry and rotting wood o Evidence of mold from damp conditions	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3030 CEILING FINISHES (Plaster)	**Inspect**	4 times/year JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, checking, chalking, and delamination o Cracks, blisters, fading colors o Evidence of moisture/staining o Efflorescence/salt o Evidence of pests o Biological growth o Damage	
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a wide dusting brush. o Remove superficial soiling and cobwebs.	
C3010 WALL FINISHES (Plaster)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, chalking, delamination, blisters, and fading colors o Cracks o Evidence of moisture/rising damp o Efflorescence/salt o Staining and/or soiling o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests	
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. Dusting should start in a corner at the floor and move upward to the cornice. o Remove superficial soiling and cobwebs. o Dust routinely all ledge-type horizontal surfaces.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Plaster)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, chalking, delamination, blisters, and fading colors o Cracks o Evidence of moisture/rising damp o Efflorescence/salt o Staining and/or soiling o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests	
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. Dusting should start in a corner at the floor and move upward to the cornice. o Remove superficial soiling and cobwebs. o Dust routinely all ledge-type horizontal surfaces.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Wood)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Failing finishes, including peeling, flaking, checking, chalking, delamination, blisters, and fading colors o Evidence of moisture/rising damp o Staining and/or soiling o Abrasion, including human impact around light switches, thermostats, doors, and the wall side of stairs o Evidence of pests	
	Dry clean/dust	Quarterly	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. Dusting should start in a corner at the floor and move upward to the cornice. o Remove superficial soiling and cobwebs. o Dust routinely all ledge-type horizontal surfaces such as tops of baseboards and cornicework.	
C3010 WALL FINISHES (Glass)	**Inspect**	Quarterly: JAN, APR, JUL, OCT and after heavy rain events	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff or Park Museum Curation Staff** Look for: o Discoloration o Cracks o Staining and/or soiling o Abrasion o Evidence of pests o Biological growth	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C201001 INTERIOR STAIR STRUCTURE (Staircases and Handrails)	**Inspection**	Quarterly	**Quarterly Inspection to be performed by: Park Historical Architect & Park Maintenance Staff** Look for: o Structural integrity including framing, balustrade, steps, and supplemental wall support o Excessive wear and abrasion o Evidence of moisture o Deteriorated finish	
C1020 INTERIOR DOORS	**Clean wood components**	Quarterly: MAR, JUN, SEP, DEC	o Dust using a round, soft, long-haired dusting tool or a vacuum cleaner with a clean round brush attachment. o Remove superficial soiling and cobwebs. o Dust all ledge-type horizontal surfaces, including tops of door panel moldings, trim, and tops of doors.	
D40 Fire Protection	**System Inspection**	Quarterly: JAN, APR, JUL, OCT	**Quarterly Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** **Look for:** o Visible signs of damage or surrounding conditions that might impact operation of fire detection and suppression system devices (heat detectors, smoke detectors, pull alarm stations, strobes) o Damage or changes to original installation of suppression piping, hangers, and heads	

SEMI-ANNUAL
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Slipped, missing, cracked, buckling, abraded, deformed, or broken roof materials o Standing water o Evidence of water infiltration on interior surfaces o Deflection, splitting, evidence of stress within roof framing NOTE: During semi-annual inspections, inspect from the ground using binoculars and access interior framing spaces, if able. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles.	
	Inspect ridges	Semi-Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Lifted, slipped, missing, or damaged ridge material o Loose or raised fasteners NOTE: During semi-annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Metal)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect and Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Missing, cracked, buckling, abraded, or deformed roof materials o Open seams o Standing water o Deterioration, splitting, evidence of stress within roof framing o <u>NOTE:</u> During semi-annual inspections, inspect from the ground using binoculars, if needed.	
B301005 GUTTERS & DOWNSPOUTS	**Clean roof drainage system**	Semi-Annually: late APR & late OCT	o Remove leaves and other debris from gutters, downspouts, and boots. o Use a garden hose to flush out troughs and downspouts. NOTE: If using a ladder to access gutter, utilize a ladder with a brace device to keep ladder from crushing gutter.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2020 EXTERIOR WINDOWS	**Inspect windows**	Semi-Annually: May & OCT	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a window schedule (see sample to follow), according to window number, which includes condition and description of each opening component. Review interior and exterior components. Look for: o Overall material condition, including paint o Unwanted water penetration and surface condensation o Insect infiltration (especially termite and carpenter ant damage), or animal entry o Window sash and shutters that do not open and close properly o Rubbing points/abrasion due to ill-fit or alignment o Loose, open, or decayed joints in frames, sash o Slipped sills and tipped or cupped stools o Loose, damaged, or missing hardware o Broken sash cords/chains, sash pulleys o Missing or damaged sash o Locking difficulties o Deteriorated weatherstripping and flashing o Gaps between sash and sill or window opening o Broken/cracked glass, loose or missing glazing and putty o Loose/damaged moldings, architraves, decayed stiles at sill level o Accumulation of dirt or collection of leaves and debris <u>NOTE:</u> Pay particular attention to exposed horizontal surfaces of window components as they tend to deteriorate faster than vertical surfaces.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2020 EXTERIOR WINDOWS continued	**Clean glass components**	Semi-Annually: MAY & OCT	o Dust sash with a brush or whisk broom. o Wash glass, beginning with top sash, working from top to bottom. o Use mild vinegar and water mixture or a non-alkaline commercial window cleaner. Be cautious with compounds that contain ammonia as they may stain brass or bronze hardware elements. o When using a squeegee blade or sponge, wipe wet corners with a soft dry cloth. o Avoid high-pressure washes. NOTE: Do NOT wash outside windows when the temperature is below freezing.	
B2030 EXTERIOR DOORS	**Inspect doors**	Semi-Annually: MAY & OCT	**Semi-Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Record findings in a door schedule (see sample to follow), according to door number, which includes condition and description of each opening component. Look for: o Overall material condition, including finish o Fit and operation of door o Loose, open, or decayed joints in frames, doors, transoms, and sidelights o Gaps between threshold, door frame, and door opening. o Tipped or cupped thresholds o Drag marks on thresholds o Loose hardware, locking difficulties o Deteriorated weatherstripping and flashing o Wear at the knuckles, loosening of screws, or poor fit of hinges o Functionality of power-assisted doors o Condensation or evidence of water infiltration o Evidence of insect infiltration or animal entry NOTE: Heavily used doors may merit greater inspection frequency.	

1–5 YEARS
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201099 CHIMNEYS	**Inspect chimneys**	Annually from grade: end of SEP	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Plant/biological growth o Cracked stucco parging or loss of aggregate o Failing paint o Dislodged chimney caps o Dislodged flashing NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles	
	Inspect chimneys	Every five years at roof level	**5-Year Inspection to be performed by: Preservation Masonry Contractor**	
	Renew paint system	As needed (anticipate every 5 years)	**Use professional services to renew paint system.** o Scrape and repaint selected areas as needed. o Wash and properly prepare the area before application to obtain good adhesion. o Apply the coating system in accordance with manufacturer's recommendations. o Environmental regulations may restrict the use of certain types of paints. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Composite)	**Inspect roof**	Semi-Annually: Spring (APR) Fall (OCT)	**Semi-Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Overhanging branches o Plant/biological growth o Slipped, missing, cracked, buckling, abraded, deformed, or broken roof materials o Standing water o Evidence of water infiltration on interior surfaces o Deflection, splitting, evidence of stress within roof framing NOTE: During semi-annual inspections, inspect from the ground using binoculars and access interior framing spaces, if able. NOTE: When access to the roof is needed, it is important to wear shoes with slip-resistant soles and to use safety harnesses and ropes. Avoid walking on brittle slate or roof tiles	
	Inspect roof	Every five years at roof level	**5-Year Inspection to be performed by: Certified Roofing Contractor**	
	Inspect ridges	Every five years at roof level	**5-year Inspection to be performed by: Certified Roofing Contractor**	
	Clean roof surfaces	Annually: Fall (OCT)	o Remove excessive debris and biological growth from roof surfaces. Use low-pressure garden hose water and a natural or nylon scrubbing brush, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Avoid using diluted chlorine bleach. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. o Remove overhanging tree branches to minimize abrasion/damage.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
			NOTE: **Tree work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	
B301001 ROOF FINISHES (Metal)	**Inspect roof**	Every five years at roof level	**5-Year Inspection to be performed by: Certified Roofing Contractor**	
	Clean roof surfaces	Annually: Fall (OCT)	o Remove excessive debris and biological growth from roof surfaces. Use low-pressure garden hose water and a natural or nylon scrubbing brush, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Avoid using diluted chlorine bleach. o Remove overhanging tree branches to minimize abrasion/damage. NOTE: **Tree work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	o

B301004 FLASHING	**Inspect flashing and adjacent interior spaces**	Annually: Spring (APR) or Fall (OCT)	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Debris accumulating in valleys o Deteriorated and damaged flashing, including cracks, dents, and dissimilar materials o Failing connections at any intersection of roof areas, of roof and adjacent wall, of roof and chimney, or any flashed projections o Raised edges o Failing paint systems o Staining or other evidence of water infiltration o Water leaks, especially after major storms. NOTE: During annual inspections, inspect from the ground using binoculars. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. NOTE: **Work with a professional roofing contractor** to identify source of water infiltration and to develop a repair plan.	
	Inspect flashing	Every 5 years at roof level	**5-year Inspection to be performed by: Certified Roofing Contractor**	
	Clean flashing	Annually: OCT	o Broom sweep branch and leaf debris away from valleys NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	

B301005 GUTTERS & DOWNSPOUTS	**Inspect roof drainage system**	Every 5 years from roof level	**5-year Inspections to be performed by: Certified Roofing Contractor**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stucco)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. With a ladder or binoculars, look for: o Moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any pattern o Excessive damp spots, often accompanied by staining, peeling paint, moss, or mold. o Evidence of rising damp o Cracks within stucco finish/rendering o Loss of aggregate in pebble dash stucco o Surface salts o Active cracks in joints and around windows and doors. Determine whether movement is seasonal or sign of ongoing problem. o Areas significantly misaligned or where there are bulging wall sections or cracks could be indicative of potential structural problems (**seek professional guidance).** o Failed sealant o Deterioration of mineral finish coat on stucco rendering, including signs of checking, flaking, and chalking o Deterioration of faux finishes o Evidence of insect infestation and vegetative growth o Surface stains o Openings from prior utilities or service pipes	
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls NOTE: **Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stone)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. Look for: o Moisture patterns that may appear after a heavy or sustained rainfall or snow, recording any pattern o Excessive damp spots, often accompanied by moss, or mold o Evidence of rising damp o Cracked or failing mortar o Cracks through masonry o Deteriorating or delaminating masonry o Surface salts o Active cracks in joints and around windows and doors. Determine whether movement is seasonal or sign of ongoing problem. o Areas significantly misaligned or where there are bulging wall sections or cracks could be indicative of potential structural problems (**seek professional guidance).** o Failed sealant o Openings from prior utilities or service pipes	
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls. **<u>NOTE:</u> Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	o

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Wood, Wood Details, Exterior Soffits)	**Inspect exterior walls**	Annually: Spring (APR), during wet & dry weather	**Annual Inspection to be performed by: Park Historical Architect & Facility Maintenance Staff** Inspect during wet and dry weather. Look for: o Moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any pattern o Damp spots, often accompanied by staining, peeling paint, moss, or mold o Evidence of wicking moisture o Failed sealant o Deterioration of paint finish coat on decorative wood elements and wall details, including peeling, checking, flaking, and chalking o Evidence of wood rot, insect infestation, and vegetative growth o Surface stains	
	Trim branches away from walls	Annually, or if change in condition	o Trim tree branches away from walls every 1-2 years o Trim foundation planting branches away from walls every year o Remove ivy and other climbing vegetation from walls NOTE: **Work shall be performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	
	General Repair	As needed	**Consult or use professional services to execute repairs.** o When using traditional or contemporary materials for patching wood ensure that the materials are compatible with the substrate—evaluate strength, vapor permeability, thermal expansion, and appearance.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2020 EXTERIOR WINDOWS	**Repair and repaint windows, frames, and sills**	As needed (anticipate every 5 years)	o Clean out paint chips from window openings using a wet paper towel and dispose of debris prior to repair or repainting. o Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture. Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. o Correct perimeter cracks around windows to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. o Reduce excess air infiltration through windows by repairing, aligning sash frames, and lubricating sash locks so that windows close tightly. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o After a major painting operation sash should be daily opened and closed for the first few days to break the paint film and preventing the windows from becoming "painted in" and inoperative. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2030 EXTERIOR DOORS continued	**Repair and repaint doors, frames, thresholds**	As needed (anticipate every 5 years)	○ Remove insect residue. ○ Clean out paint chips from doorways using a wet paper towel and dispose of debris prior to repair or repainting. ○ Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture. Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. ○ Correct perimeter cracks around doors to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. ○ Reduce excess air infiltration through doors by repairing, aligning door frames, and lubricating locks so doors close tightly. ○ Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. ○ Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2030 PEDESTRIAN PAVING	**Inspect pedestrian paving**	Annually	**Annual Inspections to be performed by: Park Preservation Architect & Park Maintenance Staff** Look for: o Depressions o Loss of aggregate material o Cracks o Deteriorated or damaged curb/edging conditions o Damage to man/hand holes	
G2050 FOUNDATION LANDSCAPE	**Maintain trees**	Annually: DEC	Trim branches to 12'-0" away from building. NOTE: If tree roots appear to be damaging a foundation wall, **consult with a preservation engineer.** NOTE: Tree work shall be **performed by an ISA certified Arborist, in consultation with the NPS regional historical landscape architect.**	
C3030 CEILING FINISHES (Plaster)	**Paint**	As needed (assume every 5 years)	o Be thoughtful in the decision to paint; unnecessary painting slowly obliterates detail of historic moldings and thick paint film can become inflexible and be subject to cracking and peeling. o Use high-quality materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. Reference: Preservation Brief 28: Painting Historic Interiors (Appendix C)	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Plaster)	**Paint**	As needed (assume every 5 years)	o Be thoughtful in the decision to paint; unnecessary painting slowly obliterates detail of historic moldings and thick paint film can become inflexible and be subject to cracking and peeling. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for preparation and application of coatings. Use high-quality coating materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. NOTE: Graffiti "windows" isolate better than with blue tape Reference: Preservation Brief 28: Painting Historic Interiors (Appendix C)	
C302006 BRICK, PAVER and CONCRETE FLOORING	**Inspect**	Annually	**Annual Inspections to be performed by: Park Historical Architect & Facility Maintenance Staff** Look for: o Unstable or excessive wear of walking surfaces o Abrasion o Cracks o Unsafe conditions o Evidence of moisture NOTE: Document moisture conditions for future comparison and development of solutions.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D30 HVAC	**Heating System Inspection**	Annually	**Annual inspection of the heating system to be performed by: Certified HVAC Contractor** Inspection to meet requirements of PMIS 150123 project documentation.	
	Cooling System Inspection	Annually	**Annual inspection of the cooling system to be performed by: Certified HVAC Contractor** Inspection to meet requirements of Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), National Electrical Code 70 (NFPA 70), and PMIS 150123 project documentation.	
D5030 Security System	**System Inspection and Maintenance**	Annually: October	**Security systems and cameras should be inspected by Certified Security and Camera System Contractor** per the requirements of Standard for the Installation of Premises Security Systems (NFPA 731), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE, C2), National Electrical Code (NFPA 70), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. o Inspection shall ensure no changes have been made that affect equipment performance. Potential changes include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness. o Annual inspection includes operational check of all (100%) components of the security system. o Annual inspection includes 100% of the cameras within the system. o Troubleshoot issues identified.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection	**System Inspection**	Annual	**Fire alarm systems should be inspected by qualified persons per the requirements of** National Electrical Code 70 (NFPA 70), National Fire Alarm and Signaling Code (NFPA 72), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation. Inspection shall ensure no changes have been made that effect equipment performance. Potential changes include building modifications, occupancy changes, changes in environmental conditions, device location, physical obstruction, device orientation, physical damage, and degree of cleanliness.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:

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VARIABLE
INSPECTION & MAINTENANCE TASKS

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201099 CHIMNEYS	**Repair Chimneys and Caps**	Immediately, when noted	**Use professional services to make repairs.** Guidelines for repair work: o Remove plant growth. o Correct condition allowing moisture penetration. o Repoint eroded, cracked, or missing joints. Mortar should be lime-based and match historic mortar in color, texture, width, and tooling. Ideally the new mortar should match existing mortar in strength but, at minimum, be slightly weaker than the adjacent masonry. A mortar analysis is suggested. Weaker mortar allows trapped moisture to migrate through the mortar joint instead of through the masonry. Spalled masonry is often evidence of joints that have been pointed with a mortar mix that is too hard for the surrounding masonry. o Stucco parging should be repaired with a stucco mix that matches the existing parging in materials, strength, and tooling. Reference: Preservation Brief 22: The Preservation and Repair of Historic Stucco (Appendix C)	
	Repair flashing	Immediately, when noted	o Re-secure loose flashing. Clean out old mortar, lead, lead wool, or fastening materials. Make sure flashing is properly inserted into reglet (slot) joints, taking care not to damage substrate. o If flashing is no longer intact, replace with flashing matching existing in material, size, shape, and finish. Because cap and step flashings each have specific overlap and extension requirements, replacement flashing should match the existing material and installation unless there has been a proven deficiency. Avoid attaching step flashing with mastic or sealant. Properly re-bed all step flashing. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. NOTE: **Work with Certified Roofing Contractors**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201099 CHIMNEYS continued	**Renew paint system**	As needed (anticipate every 5 years)	**Use professional services to renew paint system.** o Scrape and repaint selected areas as needed. o Wash and properly prepare the area before application to obtain good adhesion. o Apply the coating system in accordance with manufacturer's recommendations. o Environmental regulations may restrict the use of certain types of paints. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: When accessing the roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles.	
B301001 ROOF FINISHES (Composite)	**Repair roof coverings and finishes**	Immediately, when noted	o Repair and replace missing composite materials according to manufacturer's instructions from PMIS 150123 project o Reinstall lifted or slipped ridge materials. If unable to reuse or material missing, replace in-kind NOTE: When accessing a roof, it is important to implement fall protection safeguards and to wear slip-resistant shoes. Avoid walking on brittle slate or roof tiles. NOTE: **Work with Certified Roofing Contractors**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B301001 ROOF FINISHES (Metal)	**Repair roof coverings and finishes**	Immediately, when noted	o Solder patches on sheet metal roofs/hoods NOTE: **Work with Certified Roofing Contractors**	
B301004 FLASHING	**Repair flashing**	Immediately, when noted	**Use professional services to make repairs.** o Re-secure loose flashing. Make sure flashing is properly inserted into reglet (slot) joints, taking care not to damage substrate. o If flashing is no longer intact, replace with flashing that matches material, size, shape, and finish of existing. o Match original installation unless there has been a proven deficiency.	
B301005 GUTTERS & DOWNSPOUTS	**Repair gutters and downspouts**	Immediately, when noted	**Use professional services to make repairs.** o Correct alignment of gutters, downspouts, and boots as necessary so water flows to drains without ponding. o Repair or replace split gutters, downspouts, and damaged boots. o If patching or repairing holes in metal gutters, use traditional brazing techniques. Patching with asphalt compounds (an acidic material) can cause further deterioration of metal gutters.	
	Correct ice dam condition	Immediately, when noted	**Use professional services to determine cause.** o Consider: ▪ Warm air leak or indoor heat loss ▪ Insufficient insulation ▪ Insufficient air circulation o Make improvements as needed.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stucco)	**Clean exterior wall surfaces**	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. o Follow guidance per KEIM Mineral Coatings of America, Inc. when cleaning exterior wall surfaces finished with a KEIM product **NOTE: When graffiti or stains are present, consult a with a conservator for professional removal.**	
	Repair stucco parging	As needed, during summer months	o **Under consultation with a preservation architect and mason,** determine cause of and solution to stucco damage. o Stucco **repairs should be made by a stucco mason or journeyman plasterer.** Guidelines for repair work: o Stucco parging should be repaired with a stucco mix that matches the existing parging in materials, strength, and tooling. Reference: Preservation Brief 22: The Preservation and Repair of Historic Stucco (Appendix C)	
	Paint exterior wall components	As needed, during summer months	o It is ideal to allow exterior paints to wear away before recoating and only paint deteriorated areas, as unnecessary painting slowly obliterates detail and thick coatings can impact moisture migration. Although there may be a slight difference in color and texture between new and old paint, this contrast will be reduced by weathering. Guidelines: o Follow guidance per KEIM Mineral Coatings of America, Inc. when painting exterior wall surfaces finished with a KEIM product o Remove deteriorated caulks and sealants, clean, and reapply appropriate caulks and sealants using backer rods as needed. Follow manufacturer's instructions regarding preparation and installation. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stucco) **continued**	**Faux finish and fresco painting repair**	Immediately, when noted	○ **Under consultation with a preservation architect and conservator,** determine cause of and solution to finish deterioration or damage. ○ Faux finish and fresco work should be executed by an **experienced decorative painter or conservator.**	
B201001 EXTERIOR WALLS (Stone)	**Clean exterior wall surfaces**	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. Guidelines: ○ When cleaning, use the gentlest means possible. Begin treatment with hose-pressure water. If this does not remove soiling, introduce agitation via natural bristle brushes. ○ Avoid abrasive methods, such as mechanical scrapers and high-pressure water or air and additives such as sand, natural soda, ice crystals, or water products, as all abrasive blasting removes some portion of the surface. Avoid power-washing as it drives excessive moisture into wall materials, wall cavities, and interior walls. If required maximum pressure should be 400 psi and a fan tip should be used at a minimum working distance of 12". NOTE: **When graffiti or stains are present, consult a with a conservator for professional removal.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Stone) **continued**	**Repoint masonry**	As needed, during summer months	**Use professional services to make repairs.** o Repoint eroded, cracked, or missing joints. o Rake out joints by hand, generally avoiding rotary saws or drills, to a depth of 2½ times the width of the joint (or until sound mortar is encountered), to ensure new mortar will stay adhered between the masonry units. o Repoint joints using a lime-based mortar and match historic mortar in color, texture, width, and tooling. Ideally the new mortar should match the existing mortar in strength but, at minimum, it must be slightly weaker than the adjacent masonry. A mortar analysis is suggested. Weaker mortar allows trapped moisture to migrate through the mortar joint instead of through the masonry. Spalled masonry is often evidence of joints that have been pointed with a mortar mix that is too hard for the surrounding masonry. o Avoid off-the-shelf, pre-mixed cement mortars as they are inappropriate for most historic buildings. o Avoid use of joint sealants in place of mortar on vertical masonry surfaces as they are not breathable and can lead to moisture-related damage of the adjacent masonry. o Correct areas which trap unwanted moisture. o Damaged stone units may be able to be removed, turned around, and reset; or replaced to match. NOTE: It is important to resolve the cause of cracks or failure before resetting masonry units and repointing.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Wood, Wood Details, Exterior Soffits)	**Clean exterior wall surfaces**	As needed, during summer months	Wash exterior wall surfaces to prevent accumulation of dirt and if dirt or other deposits are causing damage or hiding deterioration. Initial cleanings should include the removal of discoloration on foundations caused by splash back, algae, or mildew. Guidelines: o When cleaning, use the gentlest means possible. Begin treatment with hose-pressure water. If this does not remove soiling, introduce agitation via natural bristle brushes. o A mild detergent may be used. It is recommended that two people work together when using mild detergent – one to brush, and one to pre-wet and rinse. Avoid strong soap solutions as they may leave streaks. It is also recommended to begin cleaning at the bottom and move up the wall. o Avoid abrasive methods, such as mechanical scrapers and high-pressure water or air and additives such as sand, natural soda, ice crystals, or water products, as all abrasive blasting removes some portion of the surface. o Avoid power-washing as it drives excessive moisture into wall materials, wall cavities, and interior walls. NOTE: **When graffiti or stains are present, consult a with a conservator for professional removal.**	
	Repair wood features	As needed	**Repairs to structure/architectural features should be made by a preservation carpenter. Consultation from a preservation architect or engineer may also be necessary.** o Make repairs using wood that matches species of existing feature, if possible. Ensure match of texture, dimension, and tooling. o When temporarily removing wood components, make every effort to reuse the removed component after underlying repair work is needed. o Consider using stainless steel or high strength aluminum nails as appropriate. Putty or fill nail holes flush with wood prior to repainting. o Backprime any installed wood with one coat of primer and coat end grain that might be exposed with two coats of primer. NOTE: Durable hardwoods should be considered for replacement material where beading, chamfering, or other decorative work is required to match historic details. Although appropriate for certain	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B201001 EXTERIOR WALLS (Wood, Wood Details, Exterior Soffits) **continued**			applications, pressure treated lumber is difficult to tool and may inhibit paint adherence if not allowed to weather prior to coating application.	
	General repair	As needed	**Consult or use professional services to execute repairs.** o When using traditional or contemporary materials for patching wood ensure that the materials are compatible with the substrate—evaluate strength, vapor permeability, thermal expansion, and appearance.	
B2020 EXTERIOR WINDOWS	**Repair and maintain weather-stripping**	As needed	Use durable weatherstripping, such as spring metal or a high-quality synthetic material, avoiding common brush and bulb or pile weatherstripping that requires more frequent replacement.	
	Replace broken or missing glass	Immediately, when noted	For historic glass, a conservation approach should be considered to repair limited cracks. Where panes with a distinct appearance are missing, specialty glass should be obtained to match. An inventory should be kept for future needs. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Repair window glazing	As needed	o Repair where deteriorated or missing. o Use care when removing putty so as not to crack or break old glass or damage muntins and sash frames. o Avoid using mechanical devices to remove old putty and match historic putty bevels or details when undertaking work. o Re-glaze with either traditionally formulated oil or modern synthetic putties, making sure to properly bed the glass and secure with glazing points. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2020 EXTERIOR WINDOWS continued	**Repair and repaint windows, frames, and sills**	As needed (anticipate every 5 years)	o Clean out paint chips from window openings using a wet paper towel and dispose of debris prior to repair or repainting. o Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture. Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. o Correct perimeter cracks around windows to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. o Reduce excess air infiltration through windows by repairing, aligning sash frames, and lubricating sash locks so that windows close tightly. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o After a major painting operation sash should be daily opened and closed for the first few days to break the paint film and preventing the windows from becoming "painted in" and inoperative. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2020 EXTERIOR WINDOWS continued	**Clean, repair, and maintain sills**	As needed	o Replace deteriorated or failing individual elements with in-kind materials. o Sand and prepare surfaces and use material-specific patching compounds to fill cracks, holes or areas collecting moisture. Follow manufacturer's instructions for preparation and installation. Do not cover a wood sill with metal panning; this may trap moisture and promote decay. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for preparation and application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Repair and maintain sash as operable	As needed	o Adjust wood sash which bind when operated. o Sash runs were traditionally unpainted between the stop and parting bead. Removing subsequent paint applications will often help improve sash operation. Apply beeswax, paraffin, or similar material to tracks or sash runs for ease of movement. o If sash are loose, replace worn parting beads. o Lubricate sash chains and pulleys using a graphite- or silicone-type lubricant.	
	Clean, repair, maintain sash locks/ hardware	As needed	o Use a soft, damp cloth. o Use mineral spirits or commercial cleaners very sparingly, as repeated use may remove original finishes. Most metal cleaners include ammonia that can streak and stain metal, so it is important to remove all cleaning residue. Polished hardware subject to tarnishing or oxidation often benefit from a thin coat of paste wax (carnauba), hand buffed to remove extra residue. NOTE: Avoid lacquer finishes for high-use areas, as they require more extensive maintenance. NOTE: Patinated finishes should not be cleaned with any chemicals, since subtle aged appearances contribute to the building's character.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2030 EXTERIOR DOORS	**Repair and maintain weather-stripping**	As needed	o Reduce excess air infiltration by repairing and maintaining weatherstripping. o Use durable weatherstripping, such as spring metal or high-quality synthetic material. Avoid common brush and bulb or pile weather stripping that require more frequent replacement.	
	Repair and repaint doors, frames, thresholds	As needed (anticipate every 5 years)	o Remove insect residue. o Clean out paint chips from doorways using a wet paper towel and dispose of debris prior to repair or repainting. o Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture. Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. o Correct perimeter cracks around doors to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. o Reduce excess air infiltration through doors by repairing, aligning door frames, and lubricating locks so doors close tightly. o Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2030 EXTERIOR DOORS continued	**Repair and repaint doors, frames, thresholds**	As needed (anticipate every 5 years)	○ Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Clean, repair, and maintain thresholds	As needed	○ Remove insect residue. ○ Replace deteriorated or failing areas with in-kind materials. ○ Sand and prepare surfaces and use material-specific patching compounds to fill cracks, holes or areas collecting moisture. Follow manufacturer's instructions for preparation and installation. Do not cover a wood threshold with metal panning; this may trap moisture and promote decay. ○ Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use high-quality coating materials. It is considered best practice to avoid painting when sun is shining directly onto surfaces to be painted. ○ Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint.	
	Repair and maintain door as operable	As needed	○ It is best to resolve binding doors via fastener and hardware adjustment/corrections. Last resort is to shave historic wood door. ○ **Contract with a vendor to improve operation of power-assisted doors.**	
	Repair damaged door	As needed	○ **Under consultation with a preservation architect and preservation woodworker, determine** solution to repair damage. ○ Repair should be performed by an **experienced preservation woodworker.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
B2030 EXTERIOR DOORS continued	**Clean, repair, and maintain locks/ hardware**	As needed	o Use a soft, damp cloth. o If the desired level of clean requires is not achieved with a soft, damp cloth, contact a professional conservator for guidance and treatment – particularly if the hardware has an applied, patinated finish. o Microcrystalline wax might prove beneficial in protecting polished hardware from to tarnishing or oxidation, but this should be applied under the supervision of a professional conservator. o Tighten screws in doorframes and lubricate door hinges using a graphite- or silicone-type lubricant. NOTE: Take care not to paint hardware. Consider removing hardware. Reinstallation should only occur after paint has dried.	
G2030 PEDESTRIAN PAVING	**Maintain pedestrian paving**	Immediately, when noted	o Keep paving free from loose aggregate, soil, leaf debris, and snow. Remove as it accumulates using a broom or plastic blade shovel. o Flush clean as needed. o Remove standing water. NOTE: Fixed or revolving brushes may be successful in getting into crevices and sweeping down to the wearing surface. Test for success and potential damage prior to full-scale use. NOTE: Do NOT use snow throwers or snow blades. NOTE: Do NOT apply ice melting chemicals. This can be tracked into buildings and cause damage to interior finishes and materials. It is harmful to many plants and shrubs and causes spalling of brick and stone.	
	Bonded aggregate pavement repair	Immediately, when noted	o **Contact vendor** to make warranty repairs. o After warranty expiration, contract with vendor to make repairs.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
G2050 FOUNDATION LANDSCAPE	**Maintain foundation landscape**	Immediately, when noted during monthly inspections	o Keep foundation plantings 3'-0" from building to allow sufficient air movement for wall surfaces to dry. o Remove weeds, climbing vine roots, and trees that have re-seeded. o Avoid scarring foundations and ramp with grass or weed cutting equipment. NOTE: Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture, and change existing grade slope. NOTE: Avoid using fertilizers with a high-acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry.	
G9087 SITE DRAINAGE	**Improve foundation drainage**	As needed	o Regrade to ensure positive drainage. o Add soil to fill depressions o Redistribute gravel if it has collected or migrated. o Remove collection of debris and leaves NOTE: Ensure soil does not come too close to wood or metal elements; a 6" separation is usually recommended. NOTE: Avoid use of mulching material at foundations as it may change grade slope.	
G204090 OTHER SITE IMPROVEMENTS - INTERPRETIVE PANELS	**Repair panels and frame**	Per recommendation of NPS Media Services	**Consult with Harpers Ferry Media Services for treatment options.**	
	Correct grade issues	Immediately, when noted	**Park Maintenance Staff to make corrections at grade (in consultation with Park Cultural Resource Manager)**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3030 CEILING FINISHES (Plaster)	**Wet clean**	As needed	o Dust first. o Determine/identify finish type. Finishes such as calcimine and whitewash can be damaged by water. o Determine finish coverage. If inconsistent or incomplete, identify substrate to implement an appropriate wet cleaning plan. o Use the gentlest means possible. Begin by gently rubbing with a clean damp sponge and immediately drying with a clean wiping cloth. o A non-ionic detergent solution may be used, followed by damp rinsing and drying with a clean wiping cloth. May require double rinsing and then drying. o **When graffiti or stains are present, consult with a conservator for professional removal.**	
	Paint	As needed (assume every 5 years)	o Be thoughtful in the decision to paint; unnecessary painting slowly obliterates detail of historic moldings and thick paint film can become inflexible and be subject to cracking and peeling. o Use high-quality materials. o Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. Reference: Preservation Brief 28: Painting Historic Interiors (Appendix C)	
	Repair plaster	As needed	**Consult with a preservation architect and architectural conservator** to determine conditions and appropriate repairs. Repairs to flat or decorative plaster **should be made by a journeyman plasterer.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C3010 WALL FINISHES (Plaster)	**Wet clean**	As needed	○ Dust first. ○ Determine/identify finish type. Finishes such as calcimine and whitewash can be damaged by water. ○ Determine finish coverage. If inconsistent or incomplete, identify substrate to implement an appropriate wet cleaning plan. ○ Use the gentlest means possible. Begin by gently rubbing with a clean damp sponge and immediately drying with a clean wiping cloth. ○ A non-ionic detergent solution may be used, followed by damp rinsing, and drying with a clean wiping cloth. May require double rinsing and then drying. ○ **When graffiti or stains are present, consult with a conservator for professional removal.**	
	Paint	As needed (assume every 5 years)	○ Be thoughtful in the decision to paint; unnecessary painting slowly obliterates detail of historic moldings and thick paint film can become inflexible and be subject to cracking and peeling. ○ Repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for preparation and application of coatings. Use high-quality coating materials. ○ Careful records must be kept of paint touch-up work, both in a maintenance log and as part of a separate color schedule for each part of the building. NOTE: Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure. NOTE: Take appropriate safety precautions when working with components finished in lead paint. NOTE: Graffiti "windows" isolate better than with blue tape Reference: Preservation Brief 28: Painting Historic Interiors (Appendix C)	

C3010 WALL FINISHES (Glass)	**Paint**	As needed	○ Follow manufacturer's instructions on refinishing associated metal components. <u>NOTE:</u> Before painting, ensure the compatibility of new and existing paints to avoid premature paint failure.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C201001 INTERIOR STAIR STRUCTURE (Staircases and Handrails)	**Clean handrails and stairs**	As needed	o Keep stairs free from dust, dirt, and debris. Remove as it accumulates using a soft broom or vacuum. o Finished wood surfaces in good condition can be dusted with a dusting product that does not contain silicone or tung, lemon or linseed oils sprayed onto a soft diaper or with an untreated magnetic cleaning cloth. o Dusting unfinished wood: Using the variable rheostat on a vacuum cleaner, use the lowest power setting that will do the job. Use the round brush attachment marked "clean." Carefully vacuum without applying pressure to the object. o **If desire is to clean beyond broom-clean, follow the recommendations of a wood conservator**.	
	Repair stairs and handrails	As needed	**Consult preservation architect and preservation engineer to understand conditions and develop solutions.** o Secure loose connections such as rails and balustrades. Do not modify historic railings or balustrade to make stronger connections. o Carefully remove cupped, damaged, or deteriorated material and replace with wood to match. o Replace deteriorated or failing individual elements with in-kind materials. There may be some instances when repair with wood Dutchman, wood putty, and epoxy filler may be appropriate. NOTE: Take appropriate safety precautions when working with components finished in lead paint and using corrosion-removal products. NOTE: **Repairs should be made by preservation woodworkers.**	
	Refinish stair and handrail components	As needed	**Consult preservation architect and wood conservator to review conditions and develop a refinishing plan.** Prepare and refinish per product manufacturer's guidelines. NOTE: Before refinishing, ensure compatibility between new and existing finishes. NOTE: **Refinishing should be performed by professional conservator or preservation woodworker.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
C101004 INTERIOR GUARDRAILS & SCREENS (Exhibit Barriers)	**Clean**	As needed	Clean per housekeeping plan.	
	Repair	Immediately, when identified	Contract with vendor to make repairs.	
D302090 FIREPLACE & HEARTHS	**Wet Cleaning**	As needed	○ Damp clean finished wood and masonry fireplace components. ○ Periodically damp mop masonry hearth before its appearance becomes dull. ○ Wet mopping and scrubbing masonry hearth are acceptable if required.	
PESTS	**Conduct termite inspections**	Throughout Spring	Swarm season for termites is in the spring. Promptly address termite and other insect infestations, as needed. **Use only a licensed company for treatment.**	
	Treatment	Per recommendation of NPS IPM	**Consult with NPS Regional Integrated Pest Management Program for treatment options.**	
E201090 OTHER FIXED INTERIOR FURNISHINGS – INTERPRETIVE PANELS	**Repair panels and frame**	Per recommendation of NPS Media Services	**Consult with Harpers Ferry Media Services for treatment options.**	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D30 HVAC	**Maintenance**	Variable	**Maintenance to be performed by: Certified HVAC Contractor** Maintenance to meet requirements of Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), and PMIS 150123 project documentation.	
D50 ELECTRICAL	**System Maintenance**	Immediately, when identified	**Repairs to be performed by a licensed and bonded electrician**, compliant with the NFPA 70, NFPA 101, and ANSI/IEEE C2.	
D5030 Security System	**Repair**	Immediately, when identified	**Use a Certified Security and Camera System Contractor** to troubleshoot and perform repairs.	
D40 Fire Protection	**System Inspection and Testing**	Various Intervals	**Fire alarm systems should be inspected and tested by qualified persons per the requirements of** National Electrical Code 70 (NFPA 70), National Fire Alarm and Signaling Code (NFPA 72), Life Safety Code (NFPA 101), American National Standard C2 (ANSI/IEEE C2), NPS Annual Maintenance Program or Annual Service Contract, and PMIS 150123 project documentation.	
	System Maintenance	Various intervals	**Fire alarm systems should be maintained by qualified persons per the requirements** of the National Fire Alarm and Signaling Code 72 (NFPA 72) **and as outlined in PMIS 150123 project documentation.**	
	System Repair	Immediately, when identified	**Use a qualified persons** to troubleshoot and perform repairs.	

Uniformat Code:	Task:	Timeline:	Checklist:	Notes:
D40 Fire Protection continued	**Fire Extinguisher Maintenance**	Various intervals	**Maintenance must be performed by a certified person** (must pass a test acceptable to AHJ) and must be familiar with the requirements in NFPA 10. Fire extinguishers need to have an external maintenance examination conducted on a yearly basis, at the time of hydrostatic test, or when specifically indicated by an inspection discrepancy. Extinguishers need to have an internal examination conducted at anywhere from 1-6 year intervals depending on the type of extinguisher. Maintenance procedures must include the procedures detailed in the manufacturer's service manual and a thorough examination of the basic elements of the fire extinguisher, including the following: o Mechanical parts of all fire extinguishers o Extinguishing agent o Expelling means o Physical condition	

ARHO SOUTH SLAVE QUARTERS
Window Schedule

ARHO SOUTH SLAVE QUARTERS
Window Finish Schedule

Window Number	ARHO Block / Building	Elevation	Age of Opening	Character Defining Feature?	Sash					Sash Finish			
					Type of Sash	Age of Sash	Condition	Notes	Recommendations	Type of Finish	Condition	Notes	Recommendations
101	SSQ	South			3 lite								
102	SSQ	South			3 lite								
103	SSQ	South			3 lite								
104	SSQ	South			3 lite								

ARHO SOUTH SLAVE QUARTERS
Window Hardware Schedule

Window Number	ARHO Block / Building	Elevation	Hardware				Hardware Finish			
			Age of Hardware	Condition	Notes	Recommendations	Type	Condition	Notes	Recommendations
101	SSQ	South								
102	SSQ	South								
103	SSQ	South								
104	SSQ	South								

ARHO SOUTH SLAVE QUARTERS
Door Schedule

ARHO SOUTH SLAVE QAURTERS
Door Finish Schedule

Door Number	ARHO Block / Building	Room	Age of Opening	Character Defining Feature?	Door					Door Finish			
					Type of Door	Age of Door	Condition	Notes	Recommendations	Type of Finish	Condition	Notes	Recommendations
100S	SSQ	100			Glass panel			For access to museum space					
101S	SSQ	101			6 panel								
102S	SSQ	102			6 panel								
103S	SSQ	103			6 panel								
103SA	SSQ	103			N/A			Door is covered by exhibit panel					

ARHO SOUTH SLAVE QUARTERS
Door Hardware Schedule

Door Number	ARHO Block / Building	Room	Hardware				Hardware Finish			
			Age of Hardware	Condition	Notes	Recommendations	Type	Condition	Notes	Recommendations
100S	SSQ	100								
101S	SSQ	101								
102S	SSQ	102								
103S	SSQ	103								
103SA	SSQ	103								

South Slave Quarters
Arlington House, The Robert E. Lee Memorial
Historic Structure Report Part 3 and Preservation Maintenance Plan
1985 - 2021

Appendix C:
Referenced and Supplemental Information

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MAINTENANCE PLANNING FOR HISTORIC BUILDINGS

BY

DAN BABOR and DIANA PLIAN

Abstract. The key to good maintenance of historic buildings is a long-range maintenance plan. Long-range planning recognizes a responsibility to the future to prolong the useful life of a building by preserving it in its present condition and preventing or slowing deterioration and damage from natural or other causes.

Key Words: Historic Building; Maintenance; Preservation.

1. Introduction

Designing a good maintenance plan for a historic building is not hard, but it does require some thought. For instance, it requires being aware of the specific architectural character of the building. Every historic building has certain character-defining architectural features and building elements like: doors, windows, roofs, and ornamental detailing are obvious ones. These elements tell us much about when it was built and why and sometimes even who designed it and for whom it was built. When such features are lost or changed, the building is said to have lost its architectural or historic integrity.

Its essential character is gone. It may still be a good, useful, and even beautiful building, but it is no longer the same building.

Standard modern repair and maintenance techniques and materials are often acceptable for use on historic buildings, but they sometimes do more harm than good. Using wrong materials or methods to maintain or repair (or, when necessary, replace) important features can destroy the integrity of the building and may even shorten its useful life. Each case must be carefully thought through. The earlier the planning takes place, the more likely it is to have a good effect.

An experienced preservation architect may usefully be brought in from outside the government to assist with scoping, plan review, specification writing and construction supervision. This may be accomplished by means of an Indefinite Quantity Contract, or in some instances through the good offices of the Romanian Association of Architects, which can sometimes arrange for professional volunteers or at least minimum cost assistance.

2. Historic Structure Report

A historic structure report is the best place to begin in setting up a long-range maintenance plan. The report is a thorough analysis of the existing structure by a specialist in the field of historic preservation. It should

a) record the existing condition of the structure;

b) point out which materials building are original and which features of the which ones date from later repairs; alterations, or additions (building materials and features are often referred to as the "fabric" of the building);

c) identify both original and early (over 50 years old) building elements, in order to avoid unintentional future changes to historic fabric;

d) identify structural or environmental conditions that may contribute to deterioration; and provide information from which to develop a schedule of regular maintenance procedures.

Buildings deteriorate because of physical, chemical, or biological factors, or a combination of all three. Some of these factors were built into the structure itself, as a natural result of design or building materials chosen. Others come from environmental factors such as temperature, sunlight, humidity, or mechanical equipment vibrations.

Chemical pollutants in the air or solvents used in normal cleaning processes can gradually dissolve or break down building materials. Vegetation, insects, or vermin may take advantage of these conditions and do further damage. A well-planned maintenance program makes it possible to monitor and control conditions in the building in order to slow down deterioration and delay the need for replacement or repair, as well as to predict future problems.

A good maintenance program identifies all the present causes of deterioration, predicts problems that are likely to come up in the future, and sets up an effective treatment program for the entire structure.

3. Other Sources of Help in Maintenance Planning

In addition to the historic structure report, accurately measured architectural drawings and photographs are helpful to record the original fabric of the building, later alterations, and the present physical conditions. These records are sometimes available from regional agencies, such as the Romanian's National Archives or from local or regional archives in libraries and historic or preservation societies. Current drawings and photographs may be needed to supplement historic data (Fig. 1).

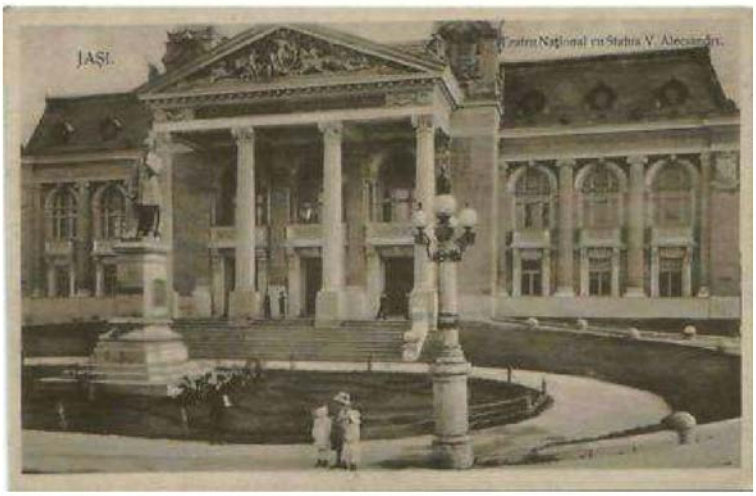

Fig. 1. – V. Alecsandri Theatre, Jassy.

4. Building Use and Maintenance Priorities

Maintenance priorities must take into consideration the buildings use. A building used by the public will face higher levels of stress and different threats to its historic integrity than one used as a private residence.

4.1. Special Considerations

Even on military facilities, maintenance planning may need to include protection from vandalism and control of tourist traffic, which can speed up normal deterioration. Exposed surfaces in high-traffic areas such as stairs and hallways may need extra protection from wear and tear, as well as from fire and vandalism. It may be necessary to establish visitor traffic patterns to reduce structural strains.

5. Maintenance Scheduling

Maintaining an older building is not necessarily complicated or expensive. (In fact, it is usually much cheaper than rehabilitating or demolishing it). However, some maintenance and repair procedures require prolonged testing before they are implemented, and they should not be done hastily.

Delivery schedules for special supplies or replacement materials need advance planning. A realistic maintenance schedule will allow for all these factors.

5.1. Inspections

Careful, systematic inspection of existing conditions at regular intervals can be used to predict the rate of deterioration and the timing of necessary repairs. Control of existing problems can delay the need for repair and replacement.

Continuous monitoring can verify the initial analysis and provide further information on rates of decay.

How often inspections and maintenance procedures need to be done will vary, depending on the materials and methods of construction, the age of specific building components, and the stresses placed on the building by its use and environment.

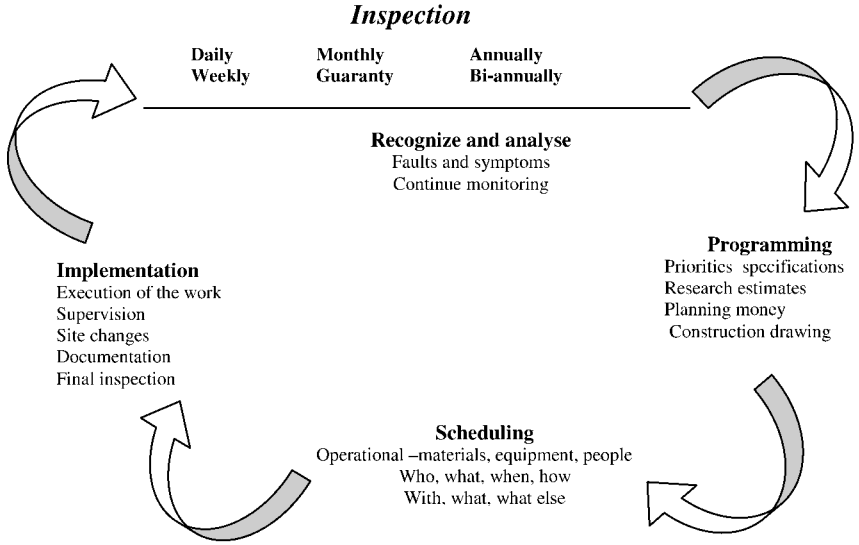

Fig. 2. – The maintenance cycle.

5.2. Training and Supervision

It is vital for maintenance workers to understand and appreciate the importance of historic structures and any original materials that still remain. Their enthusiasm can spell the difference between long life and early decay for these important resources. But workers also need to be trained in the care of old buildings, to ensure that repairs and maintenance will be performed by qualified persons using the best methods possible. An alert supervisor will find many training opportunities for interested staff members; for example, specialized publications and workshops in specific maintenance techniques for historic buildings organized by historic preservation agencies and organizations.

A maintenance manual that details materials and methods to be used, an outline schedule of regular routine procedures, and time and budget allotments are essential to keeping maintenance on track. (Fig. 2)

6. Control Inspections

Inspection is the first step in identifying deficiencies; it provides the benchmark for starting maintenance work. From the four types of inspections (operator, preventive maintenance, controls, and specialized) the control inspection is performed by skilled planners who can recognize potential deficiencies and have the abilities to address problems before they happen.

The objective of the control inspection is to provide a baseline for a successful maintenance plan. The control inspection should describe the items of work in detail and assign them priorities (Figs. 3 and 4). Historic facilities, if they are properly maintained, should cyclically cost no more per year of life than non-historic facilities.

Fig. 3. – Building rehabilitation (Jassy, 2008).

While using the steps to doing control inspections it may be desirable to increase the duration for inspection of older mechanical systems because of the potential for worn parts or material. The additional time gained by early detection will allow for replacement of equipment rather than crash repair. Advance planning for maintenance also may allow for consideration of more replacement alternatives than would be possible when performing emergency/breakdown maintenance.

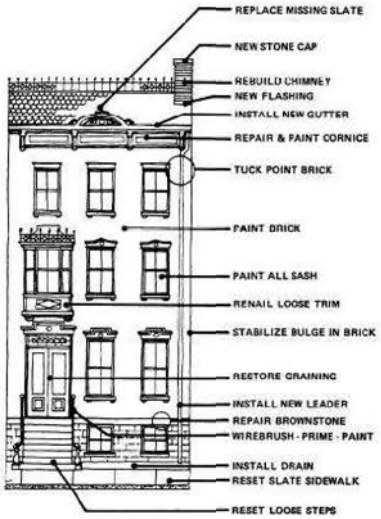

Fig. 4. – Typical work involved in rehabilitating a historic structure.

7. Life-cycle Costing

Life-cycle cost is the total cost of acquiring and owning an asset over its full life time. For a facility or property, it includes the costs of acquisition, development, maintenance, operation, support and, where applicable, disposal. The process is no different for a historic facility than a new facility, except that the life of a historic facility typically is "forever." Therefore, the purpose of an economic analysis for a historic resource is to decide which material or method will provide the best service "forever."

In a typical economic analysis, the three factors that limit the economic life of the resource are

a) Mission life, or the period in which a need for the resource is anticipated.

b) Physical life, or the period in which the resource can be expected to last physically.

c) Technological life, or the period before obsolescence would dictate replacement of the existing asset.

Under the preservation guidelines established for historic facilities, the mission life of the resource is "forever." The technological life of the resource is also a part of the historic fabric which will be preserved "forever." Therefore, the limiting economic factor for evaluating life cycle costs is the physical life of the resource. Many traditional, but expensive, building materials, such as copper, slate, or granite have unusually long lifetimes that may make them economically

feasible for use in historic buildings which also have indefinite life expectancies.

One key to successful funding of historic facilities is to offer priority to maintenance areas in terms of their maximum life benefit to an asset, for instance

a) Roof.
b) Exterior skin.
c) Exterior finish coatings.
d) High use spaces and surface (especially floors).
e) High use/high exposure wall areas.

8. Building Regulations

Building codes are intended to protect life and property by regulating the design and construction of buildings. They are written specifically for new building projects and modern construction practices.

Since most historic buildings were constructed before the introduction of building codes, they often do not comply with modern standards of safety and security, energy conservation, fire protection, or handicapped access. If strictly applied, standard codes may call for alterations that damage the historic or architectural character of a historic building.

Basically, building codes provide for two types of standards namely

a) Prescriptive standards spell out precisely what materials and methods of construction must be used to reach a particular safety goal. They concentrate on the means of making the building safe for people to live or work in.

b) Performance standards specify the result to be achieved (the level of safety or protection) without giving rigid instructions about how to get there. They focus on the desired ends of safety planning. Generally, it is better to use performance standards for historic buildings, since they will allow greater flexibility in finding ways to protect both the historic structure and life and property. Life safety is always the most important consideration. However, considering the intent of building regulations may suggest ways to make the building safe for human occupancy without destroying its character.

9. Fire and Life Safety

Complying with modern standards for fire and life safety may present the greatest challenge to successful preservation and continued use of historic buildings.To some degree most historic buildings fail to meet modern code requirements for materials, methods of construction, and exit systems. on the building's use and the number of occupants.

Normally, there must be two widely separated, enclosed, and fire-protected means of exiting from any point in a building.

Safe access must be provided to fire-protected vertical and horizontal circulation routes leading to the outside of the building. Following prescriptive standards

might require enclosing existing open stairways, widening corridors or doorways, or reversing door swings. But these actions would change the historic appearance and architectural character of the building. Rethinking the problem in terms of performance standards could lead to safe, workable alternatives that preserve the building. For instance, one or more new fireproof stair towers might be added in less visible locations.

Automatic fire detection and suppression systems can lower the risk caused by inadequate exit provisions or obsolete construction materials. However, the system should be carefully selected and installed in a way that will have as little impact as possible on the historic fabric of the structure.

"Archaic" building materials are those which are considered to have been out of general use for at least 30 years. They are not necessarily unsafe. Usually they have gone out of use for economic or technical reasons.

10. Health Hazards

Old buildings that appear to be in good condition may actually be hiding a variety of threats to the health of occupants and maintenance personnel. Becoming aware of these potential hazards is an important part of any safe and effective historic preservation maintenance program. The use of some building materials commonly found in older buildings, such as asbestos, is no longer allowed because the materials have been found to be dangerous to humans. Some restoration techniques use chemical or abrasive cleaners that have to be handled carefully in order not to create hazardous conditions. Old chimneys and flues that are blocked or left uncleaned may prevent ventilation from the heating system. Some old buildings are sealed so tightly with heavy insulation, weather-stripping, and vapour barriers that the indoor air quality is harmed by inadequate ventilation.

With sensible precautions, renovation and preservation maintenance procedures can be performed safely. Be alert to possible hazards; provide adequate ventilation, either natural or mechanical; and wear protective masks or clothing, as needed.

Before beginning any maintenance project, identify and analyse the potential level of risk from hazardous conditions within the structure. Samples of any doubtful materials found should be taken to a qualified laboratory for analysis.

Some of the more typical hazardous materials and their handling are discussed below.

10.1. Asbestos

Asbestos is a naturally occurring mineral that once was considered almost the ideal building material, but is now known to be dangerous to human health. Between 1890 and the early 1970s, it was commonly used as insulation in houses and in as many as 3,000 other products, from spray-on fireproofing, sound

proofing, piping and vessel insulation, vinyl asbestos floor tiles, ceiling tiles, and some types of shingles, to ironing board covers.

When asbestos-containing materials become friable (that is, powdery or easily crumbled), dangerous asbestos fibers may be released into the air. The fibers can then be carried through the entire building by way of the ventilating system. Whenever the presence of asbestos is suspected, it should be reported and tested immediately. Coordinate with the base asbestos control program to determine treatment.

Asbestos can only be positively identified by laboratory tests of samples. There are some clues to watch for, however,

a) Insulating coatings on old boilers: off-white, smooth-surfaced, usually cracked.

b) Cloth-wrapped steam and hot water pipe lagging, especially if the edges look like light-gray corrugated cardboard.

c) Asbestos paper on heating pipes, forced-air ducting, beneath asphalt and linoleum flooring, behind kitchen wallpaper: off-white, usually textured, chalky-feeling.

d) Asbestos-cement shingles used to re-side older framed houses from the 1930s through the 1970s: any colour, cracked and chipped along the edges in high-traffic areas. Asbestos-cement roof shingles used from the 1940s through the 1960s: usually gray, often with brownish-white streaks in areas where water stands, very hard (pebbles tossed against them make a pinging sound).

e) Asbestos-cement board: usually gray, 0.5...0.8 cm thick, brittle, easily broken, often found on joists above a furnace or boiler, around and beneath wood stoves, behind ceramic tile in a bathroom.

10.2. Radon

Radon is a colourless, odorless, radioactive gas that occurs when uranium, a natural element, breaks down.

Public Direction of Health declare the link between some types of cancer and long-term exposure to radon gas.

Buildings in areas where the earth contains large uranium deposits are more likely to have radon contamination.

Since radon rises through the soil, it is most often found in basements, but it can be distributed throughout a building by the ventilation system. Old houses actually are somewhat less likely than newer ones to have radon contamination above the basement level because they have more cracks and better natural ventilation. Detection kits containing charcoal filters can be used to test the presence of radon, but they must be analysed by a qualified laboratory. Corrective measures for radon include sealing cracks in foundation walls and insulating basement areas to keep the gas from rising to the upper floors.

10.3. Lead Paint and Chemical Paint Removers

Almost all structures built before 1940 contain lead paint, whose removal may create health hazards. If the paint is not peeling and remains tight to the surface, it is not a threat. However, paint particles loosened by scraping or sanding can be inhaled, swallowed, or absorbed through the skin to cause lead poisoning and permanent damage to the central nervous system. Chemical removers are considered the safest way to remove lead paint. However, the chemicals themselves release toxic fumes that can cause permanent lung damage with long-term exposure. Most paint-removing solvents contain hazardous chemicals such as: benzene, acetone, and methylene chloride. Many solvents are flammable, and their vapour may cause fire hazards in poorly ventilated spaces.

10.4. Blowtorches

There may be a temptation to try to hurry the process of paint removal by using blowtorches. Blowtorches should never be used on historic structures. The high heat produced by an open flame releases vapours that may contain lead. Blowtorches also pose a serious threat of fire, even when they do not cause visible surface scorching. They can superheat the air inside columns, siding, cornices, and other hollow building elements, igniting debris, such as leaves, birds' nests, and even dust, causing fires to break out long after workmen have left the scene. Electric hot-air blowers and heat plates are considered safer for paint removal because they operate at a temperature that is lower than that required to vaporize lead or cause fires. After removal lead paint residue is hazardous waste that must be disposed of under the hazardous waste disposal program.

Treated surfaces should be damp mopped after cleaning to reduce dust that might contain lead. Most vacuum cleaner filters are too coarse to trap the tiny particles that are a hazard.

10.5. Bird and Bat Deposits

Many old buildings contain large amounts of bird or bat droppings in attic or roof areas. These deposits can cause a number of infectious and potentially fatal diseases of the lungs and central nervous system. Removing the deposits requires special procedures in order to decontaminate the area without risking infection. When entering such areas, wear breathing masks and protective clothing are necessary. A sample of the material should be tested before work begins in order to determine what level of risk exists and decide what precautions should be taken.

10.6. Other Hazards

A. Carbon monoxide gas produced systems. Indoor air quality adversely by inefficient heating affected by the presence of various pollutants released from building - materials, pesticides, or other chemicals used in and around the facility.

Some foam insulations and particle boards contain formaldehyde, a chemical preservative that slowly evaporates out of the material and enters the building air supply.

B. Likewise, some fertilizers and pesticides used around the exterior of the building foundation may infiltrate the building and enter the air supply. There are detection kits that can be used to test indoor air for the presence of various pollutants. However, most indoor air pollution problems can be remedied by an efficient mechanical ventilation system that has exterior air intake vents located away from pollutant sources.

C. Structural hazards, such as joists and beams damaged by termites or by careless plumbers and electricians.

D. Outdated wiring and electrical systems (knob-and-tube), or plumbing systems with lead or lead-soldered pipes.

11. Conclusions

The longer maintenance is ignored, rejected or postponed, the more the advantages of the approach are lost to building owners and managers. It is worth rehearsing what these advantages are. For the owner, maintenance retains the building's appearance and value and safeguards the investment. Clearing gutters or fixing a slipped tile avoids costly problems later.

In social terms, maintenance reduces the cost and disruption to occupants that flow from building failures and from occasional large-scale restoration. In environmental terms, maintenance means less material is used and consequently it reduces extraction, processing, transport, waste and energy use. It prolongs the use of the embodied energy in the built fabric. It contributes to sustainable development and urban and rural regeneration, and reduces the pressure for new build on green field sites.

In cultural terms, maintenance safeguards historic fabric because less material is lost in regular, small-scale repair than in disruptive and extensive restoration. Maintenance is central to protecting cultural significance or value because it is the least destructive of all the 'interventions' which inevitably occur in the process of conserving historic buildings.

In economic terms, maintenance brings business that is steady and counter-cyclical and that particularly boosts small and medium-sized reputable enterprises.

In addition, well-maintained historic buildings improve the quality of life for everyone, help to attract investment to an area, contribute to regeneration and provide a source of local pride and sense of place.

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MENTENANŢA CLĂDIRILOR ISTORICE

(Rezumat)

Gradul de intervenţie asupra unui monument variază de la simple lucrări de întreţinere şi conservare, trecând prin acţiuni de protecţie, consolidare şi întregire şi ajungând la intervenţii complexe de restaurare şi recompunere, de dezasamblare şi reasamblare, sau, în cazuri extreme, de translare sau reconstruire parţială. Documentaţia de restaurare trebuie să cuprindă consemnarea, mai ales prin imagini şi desen, a stării iniţiale de la care s-a pornit restaurarea, cu ce s-a intervenit şi de ce, precum şi, detaliat, modul şi locul în care se fac intervenţiile. Aşa cum nu există arhitectură fără desen, nu există nici restaurare "vorbită". Monumentele istorice trebuie menţinute în permanenţă într-o stare de funcţionare perfectă, fie prin păstrarea, dar şi modernizarea funcţiunilor lor iniţiale, fie prin acordarea de funcţiuni noi, viabile, compatibile cu natura, structura şi/sau valoarea lor. Un monument "exploatat", dar şi întreţinut permanent, menţinut viu, se conservă mult mai bine decât altul, fie şi consolidat şi restaurat, dar neutilizat.

2 PRESERVATION BRIEFS

Repointing Mortar Joints in Historic Masonry Buildings

Robert C. Mack, FAIA
John P. Speweik

U.S. Department of the Interior
National Park Service
Cultural Resources
Heritage Preservation Services

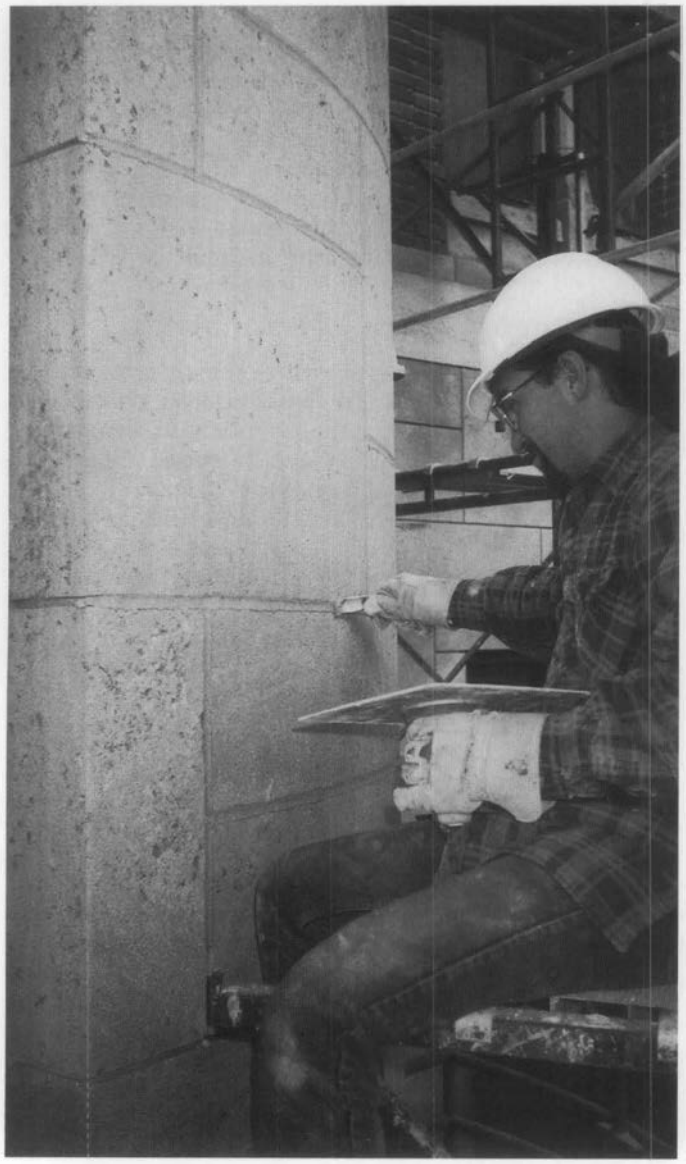


Figure 1. After removing deteriorated mortar, an experienced mason repoints a portion of this early-20th century limestone building. Photo: Robert C. Mack, FAIA.

Masonry — brick, stone, terra-cotta, and concrete block — is found on nearly every historic building. Structures with all-masonry exteriors come to mind immediately, but most other buildings at least have masonry foundations or chimneys. Although generally considered "permanent," masonry is subject to deterioration, especially at the mortar joints. Repointing, also known simply as "pointing"or—somewhat inaccurately—"tuck pointing"*, is the process of removing deteriorated mortar from the joints of a masonry wall and replacing it with new mortar (Fig. 1). Properly done, repointing restores the visual and physical integrity of the masonry. Improperly done, repointing not only detracts from the appearance of the building, but may also cause physical damage to the masonry units themselves.

The purpose of this Brief is to provide general guidance on appropriate materials and methods for repointing historic masonry buildings and it is intended to benefit building owners, architects, and contractors. The Brief should serve as a guide to prepare specifications for repointing historic masonry buildings. It should also help develop sensitivity to the particular needs of historic masonry, and to assist historic building owners in working cooperatively with architects, architectural conservators and historic preservation consultants, and contractors. Although specifically intended for historic buildings, the guidance is appropriate for other masonry buildings as well. This publication updates *Preservation Briefs 2: Repointing Mortar Joints in Historic Brick Buildings* to include all types of historic unit masonry. The scope of the earlier Brief has also been expanded to acknowledge that the many buildings constructed in the first half of the 20th century are now historic and eligible for listing in the National Register of Historic Places, and that they may have been originally constructed with portland cement mortar.

*Tuckpointing technically describes a primarily decorative application of a raised mortar joint or lime putty joint on top of flush mortar joints.

Historical Background

Mortar consisting primarily of lime and sand has been used as an integral part of masonry structures for thousands of years. Up until about the mid-19th century, lime or quicklime (sometimes called lump lime) was delivered to construction sites, where it had to be slaked, or combined with water. Mixing with water caused it to boil and resulted in a wet lime putty that was left to mature in a pit or wooden box for several weeks, up to a year. Traditional mortar was made from lime putty, or slaked lime, combined with local sand, generally in a ratio of 1 part lime putty to 3 parts sand by volume. Often other ingredients, such as crushed marine shells (another source of lime), brick dust, clay, natural cements, pigments, and even animal hair were also added to mortar, but the basic formulation for lime putty and sand mortar remained unchanged for centuries until the advent of portland cement or its forerunner, Roman cement, a natural, hydraulic cement.

Portland cement was patented in Great Britain in 1824. It was named after the stone from Portland in Dorset which it resembled when hard. This is a fast-curing, hydraulic cement which hardens under water. Portland cement was first manufactured in the United States in 1872, although it was imported before this date. But it was not in common use throughout the country until the early 20th century. Up until the turn of the century portland cement was considered primarily an additive, or "minor ingredient" to help accelerate mortar set time. By the 1930s, however, most masons used a mix of equal parts portland cement and lime putty. Thus, the mortar found in masonry structures built between 1873 and 1930 can range from pure lime and sand mixes to a wide variety of lime, portland cement, and sand combinations.

In the 1930s more new mortar products intended to hasten and simplify masons' work were introduced in the U.S. These included **masonry cement**, a premixed, bagged mortar which is a combination of portland cement and ground limestone, and **hydrated lime**, machine-slaked lime that eliminated the necessity of slaking quicklime into putty at the site.

Identifying the Problem Before Repointing

The decision to repoint is most often related to some obvious sign of deterioration, such as disintegrating mortar, cracks in mortar joints, loose bricks or stones, damp walls, or damaged plasterwork. It is, however, erroneous to assume that repointing alone will solve deficiencies that result from other problems (Fig. 2). The root cause of the deterioration—leaking roofs or gutters, differential settlement of the building, capillary action causing rising damp, or extreme weather exposure—should always be dealt with prior to beginning work. Without appropriate repairs to eliminate the source of the problem, mortar deterioration will continue and any repointing will have been a waste of time and money.

Use of Consultants. Because there are so many possible causes for deterioration in historic buildings, it may be desirable to retain a consultant, such as a historic architect or architectural conservator, to analyze the building. In addition to determining the most appropriate solutions to the problems, a consultant can prepare specifications which reflect the particular requirements of each job and can provide oversight of the work in progress. Referrals to preservation consultants frequently can be obtained from State Historic Preservation Offices, the American Institute for Conservation of Historic and Artistic Works (AIC), the Association for Preservation Technology (APT), and local chapters of the American Institute of Architects (AIA).

Figure 2. Much of the mortar on this building has been leached away by water from a leaking downspout. The downspout must be replaced and any other drainage problems repaired before repointing. Photo: Robert C. Mack, FAIA.

Finding an Appropriate Mortar Match

Preliminary research is necessary to ensure that the proposed repointing work is both physically and visually appropriate to the building. Analysis of unweathered portions of the historic mortar to which the new mortar will be matched can suggest appropriate mixes for the repointing mortar so that it will not damage the building because it is excessively strong or vapor impermeable. Examination and analysis of the masonry units—brick, stone or terra cotta—and the techniques used in the original construction will assist in maintaining the building's historic appearance (Figs. 3-4). A simple, non-technical, evaluation of the masonry units and mortar can provide information concerning the relative strength and permeability of each–critical factors in selecting the repointing mortar—while a visual analysis of the historic mortar can provide the information necessary for developing the new mortar mix and application techniques.

Although not crucial to a successful repointing project, for projects involving properties of special historic significance, a mortar analysis by a qualified laboratory can be useful by providing information on the original ingredients. However, there are limitations with such an analysis, and replacement mortar specifications should not be based solely on laboratory analysis. Analysis requires interpretation, and there are important factors which affect the condition and performance of the mortar that cannot be established through laboratory analysis. These may include: the original water content, rate of curing, weather conditions during original construction, the method of mixing and placing the mortar, and the cleanliness and condition of the sand. *The most useful information that can come out of laboratory analysis is the identification of sand by*

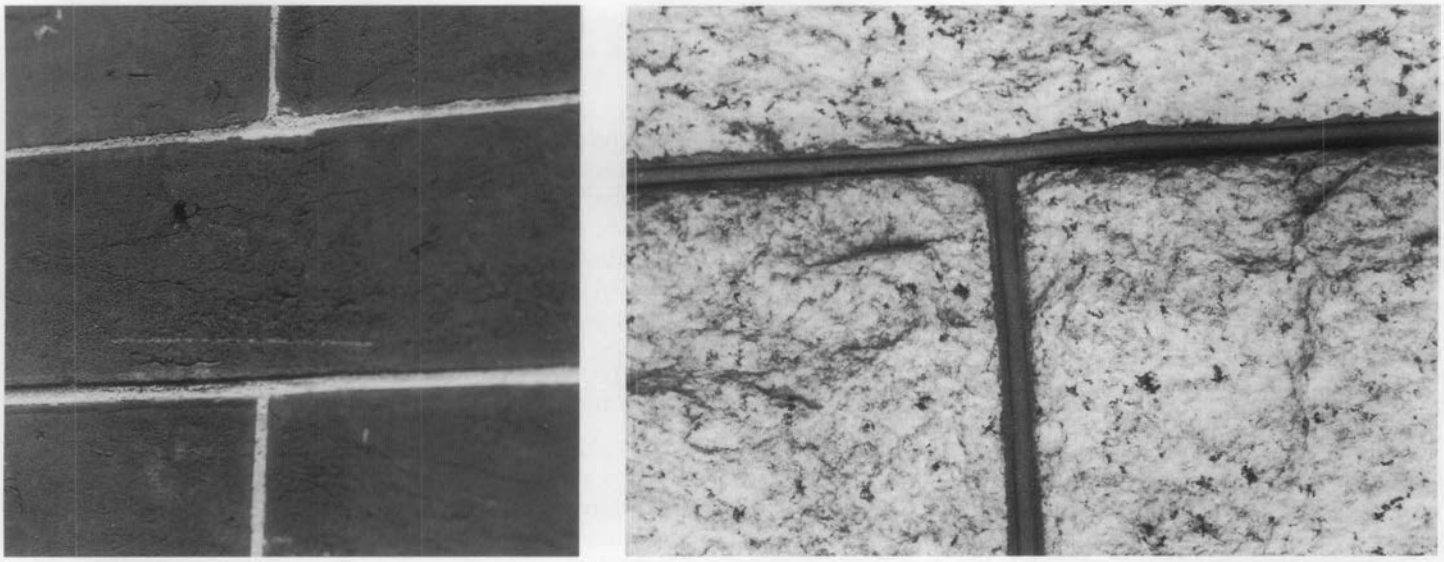


Figure 3. Good-quality repointing closely replicates the original in composition, texture, joint type and profile on this 19th century brick building (left), and on this late-19th century granite on H.H. Richardson's Glessner House in Chicago (right). Photos: Charles E. Fisher: Sharon C. Park, FAIA.

gradation and color. This allows the color and the texture of the mortar to be matched with some accuracy because sand is the largest ingredient by volume.

In creating a repointing mortar that is compatible with the masonry units, the objective is to achieve one that matches the historic mortar as closely as possible, so that the new material can coexist with the old in a sympathetic, supportive and, if necessary, sacrificial capacity. The exact physical and chemical properties of the historic mortar are not of major significance as long as the new mortar conforms to the following criteria:

- The new mortar must match the historic mortar in color, texture and tooling. (If a laboratory analysis is undertaken, it may be possible to match the binder components and their proportions with the historic mortar, if those materials are available.)
- The sand must match the sand in the historic mortar. (The color and texture of the new mortar will usually fall into place if the sand is matched successfully.)
- The new mortar must have **greater vapor permeability** and be **softer** (measured in compressive strength) than the masonry units.
- The new mortar must be **as vapor permeable** and **as soft or softer** (measured in compressive strength) than the historic mortar. (Softness or hardness is not necessarily an indication of permeability; old, hard lime mortars can still retain high permeability.)

Properties of Mortar

Mortars for repointing should be softer or more permeable than the masonry units and no harder or more impermeable than the historic mortar to prevent damage to the masonry units. It is a common error to assume that hardness or high strength is a measure of appropriateness, particularly for lime-based historic mortars. Stresses within a wall caused by expansion, contraction, moisture migration, or settlement must be accommodated in some manner; in a masonry wall these

Figure 4. (left) The poor quality of this repointing–it appears to have been "tooled" with the mason's finger–does not match the delicacy of the original beaded joint on this 19th-century brick wall. (right) It is obvious that the repointing on this "test patch" is not an appropriate replacement mortar joint for this early-19th century stone foundation. Photos: Lee H. Nelson, FAIA.

stresses should be relieved by the mortar rather than by the masonry units. A mortar that is stronger in compressive strength than the masonry units, will not "give," thus causing the stresses to be relieved through the masonry units—resulting in permanent damage to the masonry, such as cracking and spalling, that cannot be repaired easily (Fig. 5). While stresses can also break the bond between the mortar and the masonry units, permitting water to penetrate the resulting hairline cracks, this is easier to correct in the joint through repointing than if the break occurs in the masonry units.

Permeability, or rate of vapor transmission, is also critical. High lime mortars are more permeable than denser cement mortars. Historically, mortar acted as a bedding material–not unlike an expansion joint–rather than a "glue" for the masonry units, and moisture was able to migrate through the mortar joints rather than the masonry units. When moisture evaporates from the masonry it deposits any soluble salts either on the surface as *efflorescence* or below the surface as *subflorescence*. While salts deposited on the surface of masonry units are usually relatively harmless, salt crystallization within a masonry unit creates pressure that can cause parts of the outer surface to spall off or delaminate. If the mortar does not permit moisture or moisture vapor to migrate out of the wall and evaporate, the result will be damage to the masonry units.

Components of Mortar

Sand. Sand is the largest component of mortar and the material that gives mortar its distinctive color, texture and cohesiveness. Sand must be free of impurities, such as salts or clay. The three key characteristics of sand are: particle shape, gradation and void ratios.

Figure 5. The use of hard, portland-cement mortar that is less permeable than the soft bricks has resulted in severe damage to this brick wall. Moisture trapped in the wall was unable to evaporate through the mortar which is intended to be sacrificial, and thus protect the bricks. As a result the moisture remained in the walls until water pressure eventually popped the surface off the bricks. Photo: National Park Service Files.

When viewed under a magnifying glass or low-power microscope, particles of sand generally have either rounded edges, such as found in beach and river sand, or sharp, angular edges, found in crushed or manufactured sand. For repointing mortar, rounded or natural sand is preferred for two reasons. It is usually similar to the sand in the historic mortar and provides a better visual match. It also has better working qualities or plasticity and can thus be forced into the joint more easily, forming a good contact with the remaining historic mortar and the surface of the adjacent masonry units. Although manufactured sand is frequently more readily available, it is usually possible to locate a supply of rounded sand.

The gradation of the sand (particle size distribution) plays a very important role in the durability and cohesive properties of a mortar. Mortar must have a certain percentage of large to small particle sizes in order to deliver the optimum performance. Acceptable guidelines on particle size distribution may be found in ASTM C 144 (American Society for Testing and Materials). However, in actuality, since neither historic nor modern sands are always in compliance with ASTM C 144, matching the same particle appearance and gradation usually requires sieving the sand.

A scoop of sand contains many small voids between the individual grains. A mortar that performs well fills all these small voids with binder (cement/lime combination or mix) in a balanced manner. Well-graded sand generally has a 30 per cent void ratio by volume. Thus, 30 per cent binder by volume generally should be used, unless the historic mortar had a different binder: aggregate ratio. This represents the 1:3 binder to sand ratios often seen in mortar specifications.

For repointing, sand generally should conform to ASTM C 144 to assure proper gradation and freedom from impurities; some variation may be necessary to match the original size and gradation. Sand color and texture also should match the original as closely as possible to provide the proper color match without other additives.

Lime. Mortar formulations prior to the late-19th century used lime as the primary binding material. Lime is derived from heating limestone at high temperatures which burns off the carbon dioxide, and turns the limestone into quicklime. There are three types of limestone—calcium, magnesium, and dolomitic—differentiated by the different levels of magnesium carbonate they contain which impart specific qualities to mortar. Historically, calcium lime was used for mortar rather than the dolomitic lime (calcium magnesium carbonate) most often used today. But it is also important to keep in mind the fact that the historic limes, and other components of mortar, varied a great deal because they were natural, as opposed to modern lime which is manufactured and, therefore, standardized. Because some of the kinds of lime, as well as other components of mortar, that were used historically are no longer readily available, even when a conscious effort is made to replicate a "historic" mix, this may not be achievable due to the differences between modern and historic materials.

Lime, itself, when mixed with water into a paste is very plastic and creamy. It will remain workable and soft indefinitely, if stored in a sealed container. Lime (calcium hydroxide) hardens by carbonation absorbing carbon dioxide primarily from the air, converting itself to calcium carbonate. Once a lime and sand mortar is mixed and placed in a wall, it begins the process of carbonation. If lime mortar is left to dry too rapidly, carbonation of the mortar will be reduced, resulting in poor adhesion and poor durability. In addition, lime mortar is slightly water soluble and thus is able to re-seal any hairline cracks that may develop during the life of the mortar. Lime mortar is soft, porous, and changes little in volume during temperature fluctuations, thus making it a good choice for historic buildings. *Because of these qualities, high calcium lime mortar may be considered for many repointing projects, not just those involving historic buildings.*

For repointing, lime should conform to ASTM C 207, Type S, or Type SA, Hydrated Lime for Masonry Purposes. This machine-slaked lime is designed to assure high plasticity and water retention. The use of quicklime which must be slaked and soaked by hand may have advantages over hydrated lime in some restoration projects if time and money allow.

Lime putty. Lime putty is slaked lime that has a putty or paste-like consistency. It should conform to ASTM C 5. Mortar can be mixed using lime putty according to ASTM C 270 property or proportion specification.

Portland cement. More recent, 20th-century mortar has used portland cement as a primary binding material. A straight portland cement and sand mortar is extremely hard, resists the movement of water, shrinks upon setting, and undergoes relatively large thermal movements. When mixed with water, portland cement forms a harsh, stiff paste that is quite unworkable, becoming hard very quickly. (Unlike lime, portland cement will harden regardless of weather conditions and does not require wetting and drying cycles.) Some portland cement assists the workability and plasticity of the mortar without adversely affecting the finished project; it also provides early strength to the mortar and speeds setting. Thus, it may be appropriate to add some portland cement to an essentially lime-based mortar even when repointing relatively soft 18th or 19th century brick under some circumstances when a slightly harder mortar is required. The more portland cement that is added to a mortar formulation the harder it becomes—and the faster the initial set.

For repointing, portland cement should conform to ASTM C 150. White, non-staining portland cement may provide a better color match for some historic mortars than the more commonly available grey portland cement. But, it should not be assumed, however, that white portland cement is always appropriate for all historic buildings, since the original mortar may have been mixed with grey cement. The cement should not have more than 0.60 per cent alkali to help avoid efflorescence.

Masonry cement. Masonry cement is a preblended mortar mix commonly found at hardware and home repair stores. It is designed to produce mortars with a compressive strength of 750 psi or higher when mixed

MORTAR ANALYSIS

Methods for analyzing mortars can be divided into two broad categories: **wet chemical** and **instrumental**. Many laboratories that analyze historic mortars use a simple **wet-chemical** method called *acid digestion*, whereby a sample of the mortar is crushed and then mixed with a dilute acid. The acid dissolves all the carbonate-containing minerals not only in the binder, but also in the aggregate (such as oyster shells, coral sands, or other carbonate-based materials), as well as any other acid-soluble materials. The sand and fine-grained acid-insoluble material is left behind. There are several variations on the simple acid digestion test. One involves collecting the carbon dioxide gas given off as the carbonate is digested by the acid; based on the gas volume the carbonate content of the mortar can be accurately determined (Jedrzejewska, 1960). Simple acid digestion methods are rapid, inexpensive, and easy to perform, but the information they provide about the original composition of a mortar is limited to the color and texture of the sand. The gas collection method provides more information about the binder than a simple acid digestion test.

Instrumental analysis methods that have been used to evaluate mortars include polarized light or thin-section microscopy, scanning electron microscopy, atomic absorption spectroscopy, X-ray diffraction, and differential thermal analysis. All instrumental methods require not only expensive, specialized equipment, but also highly-trained experienced analysts. However, instrumental methods can provide much more information about a mortar. Thin-section microscopy is probably the most commonly used instrumental method. Examination of thin slices of a mortar in transmitted light is often used to supplement acid digestion methods, particularly to look for carbonate-based aggregate. For example, the new ASTM test method, ASTM C 1324-96 "Test Method for Examination and Analysis of Hardened Mortars" which was designed specifically for the analysis of modern lime-cement and masonry cement mortars, combines a complex series of wet chemical analyses with thin-section microscopy.

The drawback of most mortar analysis methods is that mortar samples of known composition have not been analyzed in order to evaluate the method. Historic mortars were not prepared to narrowly defined specifications from materials of uniform quality; they contain a wide array of locally derived materials combined at the discretion of the mason. While a particular method might be able to accurately determine the original proportions of a lime-cement-sand mortar prepared from modern materials, the usefulness of that method for evaluating historic mortars is questionable unless it has been tested against mortars prepared from materials more commonly used in the past.

Lorraine Schnabel.

Figure 6. Tinted mortar. (left)Black mortar with a beaded joint was used here on this late-19th century hard pressed red brick and, (center) a dark brown tinted mortar with an almost flush joint was used on this early-20th century Roman brick. (right) When constructed at the turn-of-the-century, this building was pointed with a dark gray mortar to blend with the color of the stone, but the light-colored mortar used in spot repointing has destroyed this harmony and adversely impacts the building's historic character. Photos: Anne Grimmer.

with sand and water at the job site. It may contain hydrated lime, but it always contains a large amount of portland cement, as well as ground limestone and other workability agents, including air-entraining agents. Because masonry cements are not required to contain hydrated lime, and generally do not contain lime, they produce high strength mortars that can damage historic masonry. *For this reason, they generally are not recommended for use on historic masonry buildings.*

Lime mortar (pre-blended). Hydrated lime mortars, and pre-blended lime putty mortars with or without a matched sand are commercially available. Custom mortars are also available with color. In most instances, pre-blended lime mortars containing sand may not provide an exact match; however, if the project calls for total repointing, a pre-blended lime mortar may be worth considering as long as the mortar is compatible in strength with the masonry. If the project involves only selected, "spot" repointing, then it may be better to carry out a mortar analysis which can provide a custom pre-blended lime mortar with a matching sand. In either case, if a preblended lime mortar is to be used, it should contain Type S or SA hydrated lime conforming to ASTM C 207.

Water. Water should be potable—clean and free from acids, alkalis, or other dissolved organic materials.

Other Components

Historic components. In addition to the color of the sand, the texture of the mortar is of critical importance in duplicating historic mortar. Most mortars dating from the mid-19th century on—with some exceptions—have a fairly homogeneous texture and color. Some earlier mortars are not as uniformly textured and may contain lumps of partially burned lime or "dirty lime", shell (which often provided a source of lime, particularly in coastal areas), natural cements, pieces of clay, lampblack or other pigments, or even animal hair. The visual characteristics of these mortars can be duplicated through the use of similar materials in the repointing mortar.

Replicating such unique or individual mortars will require writing new specifications for each project. If possible, suggested sources for special materials should be included. For example, crushed oyster shells can be obtained in a variety of sizes from poultry supply dealers.

Pigments. Some historic mortars, particularly in the late 19th century, were tinted to match or contrast with the brick or stone (Fig. 6). Red pigments, sometimes in the form of brick dust, as well as brown, and black pigments were commonly used. Modern pigments are available which can be added to the mortar at the job site, but they should not exceed 10 per cent by weight of the portland cement in the mix, and carbon black should be limited to 2 per cent. Only synthetic mineral oxides, which are alkali-proof and sun-fast, should be used to prevent bleaching and fading.

Modern components. Admixtures are used to create specific characteristics in mortar, and whether they should be used will depend upon the individual project. *Air-entraining agents*, for example, help the mortar to resist freeze-thaw damage in northern climates. *Accelerators* are used to reduce mortar freezing prior to setting while *retarders* help to extend the mortar life in hot climates. Selection of admixtures should be made by the architect or architectural conservator as part of the specifications, not something routinely added by the masons.

Generally, modern chemical additives are unnecessary and may, in fact, have detrimental effects in historic masonry projects. The use of antifreeze compounds is not recommended. They are not very effective with high lime mortars and may introduce salts, which may cause efflorescence later. A better practice is to warm the sand and water, and to protect the completed work from freezing. No definitive study has determined whether air-entraining additives should be used to resist frost action and enhance plasticity, but in areas of extreme exposure requiring high-strength mortars with lower permeability, air-entrainment of 10-16 percent may be desirable (see formula for "severe weather exposure" in **Mortar Type and Mix**). Bonding agents are not a substitute for proper joint preparation, and they should generally be avoided. If the joint is properly prepared, there will be a good bond between the new mortar and the adjacent surfaces. In addition, a bonding agent is difficult to remove if smeared on a masonry surface (Fig. 7).

Mortar Type and Mix

Mortars for repointing projects, especially those involving historic buildings, typically are custom mixed in order to ensure the proper physical and visual qualities. These materials can be combined in varying proportions to create a mortar with the desired performance and durability. The actual specification of a particular mortar type should take into consideration all of the factors affecting the life of the building including: current site conditions, present condition of the masonry, function of the new mortar, degree of weather exposure, and skill of the mason. Thus, no two repointing projects are exactly the same. Modern materials specified for use in repointing mortar should conform to specifications of the American Society for Testing and Materials (ASTM) or comparable federal specifications, and the resulting mortar should conform to ASTM C 270, Mortar for Unit Masonry.

Specifying the proportions for the repointing mortar for a specific job is not as difficult as it might seem. Five mortar types, each with a corresponding recommended mix, have been established by ASTM to distinguish high strength mortar from soft flexible mortars. The ASTM designated them in decreasing order of approximate general strength as Type M (2,500 psi), Type S (1,800 psi), Type N (750 psi), Type O (350 psi) and Type K (75 psi). (The letters identifying the types are from the words MASON WORK using every other letter.) Type K has the highest lime content of the mixes that contain portland cement, although it is seldom used today, except for some historic preservation projects. The designation "L" in the accompanying chart identifies a straight lime and sand mix. Specifying the appropriate ASTM mortar by proportion of ingredients, will ensure the desired physical properties. Unless specified otherwise, measurements or proportions for mortar mixes are always given in the following order: cement-lime-sand. Thus, a Type K mix, for example, would be referred to as 1-3-10, or 1 part cement to 3 parts lime to 10 parts sand. Other requirements to create the desired visual qualities should be included in the specifications.

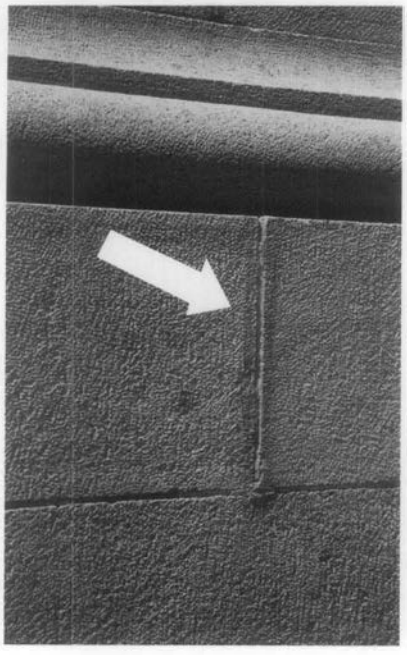


Figure 7. The dark stain on either side of the vertical joint on this sandstone watertable probably resulted from the use of a bonding agent that was not properly cleaned off the masonry after repointing. Photo: Anne Grimmer.

Figure 8. Due to inadequate joint preparation, the repointing mortar has not adhered properly and is falling out of the joint. Photo: Robert C. Mack, FAIA.

The strength of a mortar can vary. If mixed with higher amounts of portland cement, a harder mortar is obtained. The more lime that is added, the softer and more plastic the mortar becomes, increasing its workability. A mortar strong in compressive strength might be desirable for a hard stone (such as granite) pier holding up a bridge deck, whereas a softer, more permeable lime mortar would be preferable for a historic wall of soft brick. Masonry deterioration caused by salt deposition results when the mortar is less permeable that the masonry unit. A strong mortar is still more permeable than hard dense stone. However, in a wall constructed of soft bricks where the masonry unit itself has a relatively high permeability or vapor transmission rate, a soft, high lime mortar is necessary to retain sufficient permeability.

Budgeting and Scheduling

Repointing is both expensive and time consuming due to the extent of handwork and special materials required. It is preferable to repoint only those areas that require work rather than an entire wall, as is often specified. But, if 25 to 50 per cent or more of a wall needs to be repointed, repointing the entire wall may be more cost effective than spot repointing. Total repointing may also be more sensible when access is difficult, requiring the erection of expensive scaffolding (unless the majority of the mortar is sound and unlikely to require replacement in the foreseeable future). Each project requires judgement based on a variety of factors. Recognizing this at the outset will help to prevent many jobs from becoming prohibitively expensive.

In scheduling, seasonal aspects need to be considered first. Generally speaking, wall temperatures between 40 and 95 degrees F (8 and 38 degrees C) will prevent freezing or excessive evaporation of the water in the mortar. Ideally, repointing should be done in shade, away from strong sunlight in order to slow the drying process, especially during hot weather. If necessary, shade can be provided for large-scale projects with appropriate modifications to scaffolding.

The relationship of repointing to other work proposed on the building must also be recognized. For example, if paint removal or cleaning is anticipated, and if the mortar joints are basically sound and need only selective repointing, it is generally better to postpone repointing

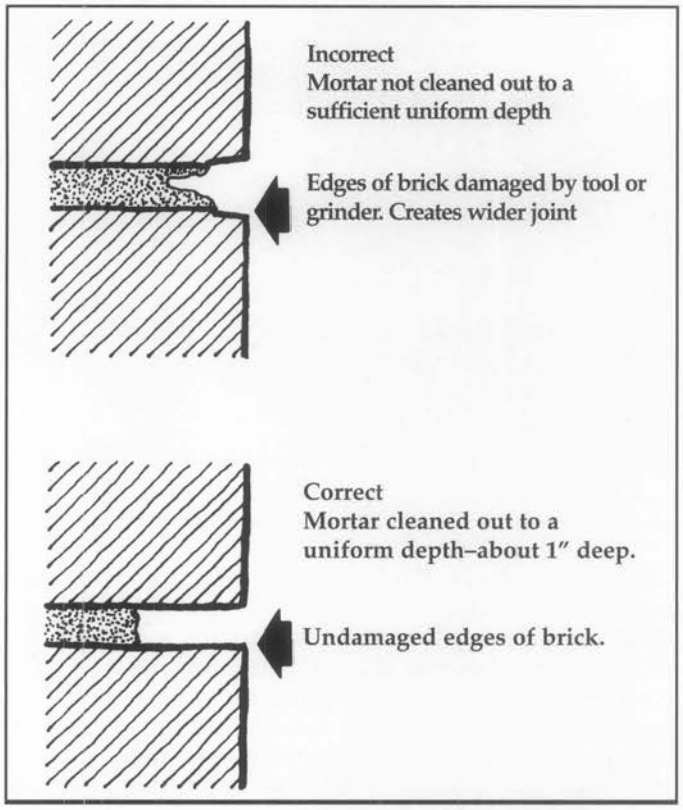


Figure 9. Comparison of incorrect and correct preparation of mortar joints for repointing. Drawing: Robert C. Mack, FAIA, and David W. Look, AIA.

until after completion of these activities. However, if the mortar has eroded badly, allowing moisture to penetrate deeply into the wall, repointing should be accomplished before cleaning. Related work, such as structural or roof repairs, should be scheduled so that they do not interfere with repointing and so that all work can take maximum advantage of erected scaffolding.

Building managers also must recognize the difficulties that a repointing project can create. The process is time consuming, and scaffolding may need to remain in place for an extended period of time. The joint preparation process can be quite noisy and can generate large quantities of dust which must be controlled, especially at air intakes to protect human health, and also where it might damage operating machinery. Entrances may be blocked from time to time making access difficult for both building tenants and visitors. Clearly, building managers will need to coordinate the repointing work with other events at the site.

Contractor Selection

The ideal way to select a contractor is to ask knowledgeable owners of recently repointed historic buildings for recommendations. Qualified contractors then can provide lists of other repointing projects for inspection. More commonly, however, the contractor for a repointing project is selected through a competitive bidding process over which the client or consultant has only limited control. In this situation it is important to ensure that the specifications stipulate that masons must have a minimum of five years' experience with repointing historic masonry buildings to be eligible to bid on the project. Contracts are awarded to the lowest *responsible* bidder, and bidders who have performed poorly on other projects usually can be eliminated from consideration on this basis, even if they have the lowest prices.

The contract documents should call for unit prices as well as a base bid. Unit pricing forces the contractor to determine in advance what the cost addition or reduction will be for work which varies from the scope of the base bid. If, for example, the contractor has fifty linear feet less of stone repointing than indicated on the contract documents but thirty linear feet more of brick repointing, it will be easy to determine the final price for the work. Note that each type of work—brick repointing, stone repointing, or similar items—will have its own unit price. The unit price also should reflect quantities; one linear foot of pointing in five different spots will be more expensive than five contiguous linear feet.

Execution of the Work

Test Panels. These panels are prepared by the contractor using the same techniques that will be used on the remainder of the project. Several panel locations—preferably not on the front or other highly visible location of the building—may be necessary to include all types of masonry, joint styles, mortar colors, and other problems likely to be encountered on the job. If cleaning tests, for

Figure 10. Using a hammer and masonry chisel is the least damaging and, thus, generally the preferred method of removing old mortar in preparation for repointing historic masonry. Photo: John P. Speweik.

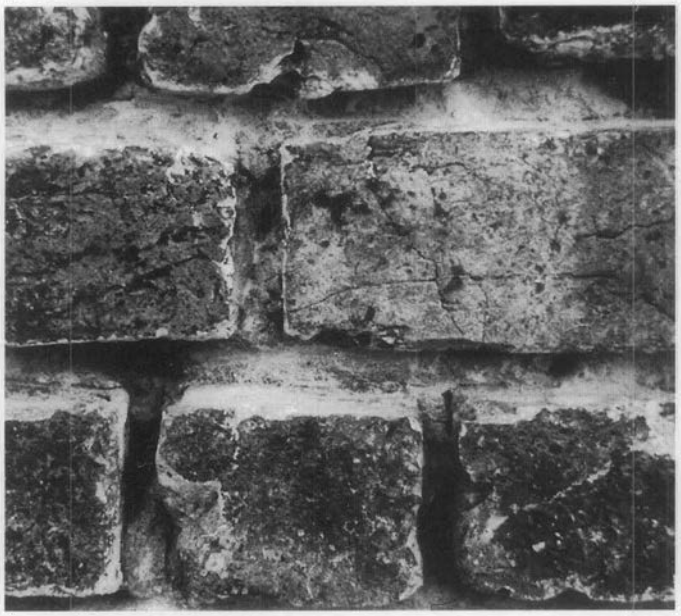


Figure 11. The damage to the edges and corners of these historic bricks was caused by using a mechanical grinder to rake out the joints. Note the overcutting of the head joint and the damage to the arises (corners) of the bricks. Photo: Lee H. Nelson, FAIA.

example, are also to be undertaken, they should be carried out in the same location. Usually a 3 foot by 3 foot area is sufficient for brickwork, while a somewhat larger area may be required for stonework. These panels establish an acceptable standard of work and serve as a benchmark for evaluating and accepting subsequent work on the building.

Joint Preparation. Old mortar should be removed to a minimum depth of 2 to 2- $^1/_2$ times the width of the joint to ensure an adequate bond and to prevent mortar "popouts" (Fig. 8). For most brick joints, this will require removal of the mortar to a depth of approximately $^1/_2$ to 1 inch; for stone masonry with wide joints, mortar may need to be removed to a depth of several inches. Any loose or disintegrated mortar beyond this minimum depth also should be removed (Fig. 9).

Although some damage may be inevitable, careful joint preparation can help limit damage to masonry units. The traditional manner of removing old mortar is through the use of hand chisels and mash hammers (Fig. 10). Though labor-intensive, in most instances this method poses the least threat for damage to historic masonry units and produces the best final product.

The most common method of removing mortar, however, is through the use of power saws or grinders. The use of power tools by unskilled masons can be disastrous for historic masonry, particularly soft brick. Using power saws on walls with thin joints, such as most brick walls, almost always will result in damage to the masonry units by breaking the edges and by overcutting on the head, or vertical joints (Fig. 11).

However, small pneumatically-powered chisels generally can be used safely and effectively to remove mortar on historic buildings as long as the masons maintain appropriate control over the equipment.

Figure 12.. A power grinder, operated correctly by a skilled mason may be used in preparation for repointing to cut wide, horizontal mortar joints, typical of many early-20th century brick structures without causing damage to the brick. Note the use of protective safety equipment. Photo: Robert C. Mack, FAIA.

Under certain circumstances, thin diamond-bladed grinders may be used to cut out *horizontal* joints only on hard portland cement mortar common to most early-20th century masonry buildings (Fig. 12). Usually, automatic tools most successfully remove old mortar without damaging the masonry units when they are used in combination with hand tools in preparation for repointing. Where horizontal joints are uniform and fairly wide, it may be possible to use a power masonry saw to assist the removal of mortar, such as by cutting along the middle of the joint; final mortar removal from the sides of the joints still should be done with a hand chisel and hammer. Caulking cutters with diamond blades can sometimes be used successfully to cut out joints without damaging the masonry. Caulking cutters are slow; they do not rotate, but vibrate at very high speeds, thus minimizing the possibility of damage to masonry units (Fig. 13). Although mechanical tools may be used safely in limited circumstances to cut out horizontal joints in preparation for repointing, they should never be used on vertical joints because of the danger of slipping and cutting into the brick above or below the vertical joint. Using power tools to remove mortar without damaging the surrounding masonry units also necessitates highly skilled masons experienced in working on historic masonry buildings. Contractors

Figure 13. (left) In preparation for repointing, the mortar joints on these granite steps are first cut out mechanically (note the vacuum attached to the cutting tool in foreground to cut down on dust). (right) Final removal of the old mortar is done by hand to avoid damage to the edges of the joints. Mechanical preparation of horizontal joints by an experienced mason may sometimes be acceptable, especially where the joints are quite wide and the masonry is a very hard stone. Photos: Anne Grimmer.

should demonstrate proficiency with power tools before their use is approved.

Using any of these power tools may also be more acceptable on hard stone, such as quartzite or granite, than on terra cotta with its glass-like glaze, or on soft brick or stone. The test panel should determine the acceptability of power tools. If power tools are to be permitted, the contractor should establish a quality control program to account for worker fatigue and similar variables.

Mortar should be removed cleanly from the masonry units, leaving square corners at the back of the cut. Before filling, the joints should be rinsed with a jet of water to remove all loose particles and dust. At the time of filling, the joints should be damp, but with no standing water present. For masonry walls—limestone, sandstone and common brick—that are extremely absorbent, it is recommended that a continual mist of water be applied for a few hours before repointing begins.

Mortar Preparation. Mortar components should be measured and mixed carefully to assure the uniformity of visual and physical characteristics. Dry ingredients are measured by volume and thoroughly mixed before the addition of any water. Sand must be added in a damp, loose condition to avoid over sanding. Repointing mortar is typically pre-hydrated by adding water so it will just hold together, thus allowing it to stand for a period of time before the final water is added. Half the water should be added, followed by mixing for approximately 5 minutes. The remaining water should then be added in small portions until a mortar of the desired consistency is reached. The total volume of water necessary may vary from batch to batch, depending on weather conditions. It is important to keep the water to a minimum for two reasons: first, a drier mortar is cleaner to work with, and it can be compacted tightly into the joints; second, with no excess water to evaporate, the mortar cures without shrinkage cracks. Mortar should be used within approximately 30 minutes of final mixing, and "retempering," or adding more water, should not be permitted.

Using Lime Putty to Make Mortar. Mortar made with lime putty and sand, sometimes referred to as roughage or course stuff, should be measured by volume, and may require slightly different proportions from those used with hydrated lime (Fig. 14). No additional water is usually needed to achieve a workable consistency because enough water is already contained in the putty. Sand is proportioned first, followed by the lime putty, then mixed for five minutes or until all the sand is thoroughly coated with the lime putty. But mixing, in the familiar sense of turning over with a hoe, sometimes may not be sufficient if the best possible performance is to be obtained from a lime putty mortar. Although the old practice of chopping, beating and ramming the mortar has largely been forgotten, recent field work has confirmed that lime putty and sand rammed and beaten with a wooden mallet or ax handle, interspersed by chopping with a hoe, can significantly improve workability and performance. The intensity of this action increases the overall lime/sand contact and removes any surplus water by compacting the other ingredients. It may also be advantageous for larger projects to use a mortar pan mill for mixing. Mortar pan mills which have a long tradition in Europe produce a superior lime putty mortar not attainable with today's modern paddle and drum type mixers.

For larger repointing projects the lime putty and sand can be mixed together ahead of time and stored indefinitely, on or off site, which eliminates the need for piles of sand on the job site. This mixture, which resembles damp brown sugar, must be protected from the air in sealed containers with a wet piece of burlap over the top or sealed in a large plastic bag to prevent evaporation and premature carbonation. The lime putty and sand mixture can be recombined into a workable plastic state months later with no additional water.

If portland cement is specified in a lime putty and sand mortar—Type O (1:2:9) or Type K (1:3:11)—the portland cement should first be mixed into a slurry paste before adding it to the lime putty and sand. Not only will this ensure that the portland cement is evenly distributed throughout the mixture, but if dry portland cement is added to wet ingredients it tends to "ball up," jeopardizing dispersion. (Usually water must be added to the lime putty and sand anyway once the portland cement is introduced.) Any color pigments should be added at this stage and mixed for a full five minutes. The mortar should be used within 30 minutes to 1 ½ hours and it should not be retempered. Once portland cement has been added the mortar can no longer be stored.

Filling the Joint. Where existing mortar has been removed to a depth of greater than 1 inch, these deeper areas should be filled first, compacting the new mortar in several layers. The back of the entire joint should be filled successively by applying approximately ¼ inch of mortar, packing it well into the back corners. This

Figure 14. Mixing mortar using lime putty: (a) proportioning sand; (b) proportioning lime putty; (c) placing lime putty on top of sand; (d) mixing sand over lime putty; (e) hand mixing mortar; and, (f) sample of mortar after mixing. Photos: John P. Speweik.

application may extend along the wall for several feet. As soon as the mortar has reached thumb-print hardness, another ¼ inch layer of mortar—approximately the same thickness—may be applied. Several layers will be needed to fill the joint flush with the outer surface of the masonry. It is important to allow each layer time to harden before the next layer is applied; most of the mortar shrinkage occurs during the hardening process and layering thus minimizes overall shrinkage.

When the final layer of mortar is thumb-print hard, the joint should be tooled to match the historic joint (Fig. 15). Proper timing of the tooling is important for uniform color and appearance. If tooled when too soft, the color will be lighter than expected, and hairline cracks may occur; if tooled when too hard, there may be dark streaks called "tool burning," and good closure of the mortar against the masonry units will not be achieved.

If the old bricks or stones have worn, rounded edges, it is best to recess the final mortar slightly from the face of the masonry. This treatment will help avoid a joint which is visually wider than the actual joint; it also will avoid creation of a large, thin featheredge which is easily damaged, thus admitting water (Fig. 16). After tooling, excess mortar can be removed from the edge of the joint by brushing with a natural bristle or nylon brush. Metal bristle brushes should never be used on historic masonry.

Curing Conditions. The preliminary hardening of high-lime content mortars—those mortars that contain more lime by volume than portland cement, i.e., Type O (1:2:9), Type K (1:3:11), and straight lime/sand, Type "L"(0:1:3) —takes place fairly rapidly as water in the mix is lost to the porous surface of the masonry and through evaporation. A high lime mortar (especially Type "L") left to dry out too rapidly can result in chalking, poor adhesion, and poor durability. Periodic wetting of the repointed area after the mortar joints are thumb-print hard and have been finish tooled may significantly accelerate the carbonation process. When feasible, misting using a hand sprayer with a fine nozzle can be simple to do for a day or two after repointing. Local conditions will dictate the frequency of wetting, but initially it may be as often as every hour and gradually reduced to every three or four hours. Walls should be covered with burlap for the first three days after repointing. (Plastic may be used, but it should be tented out and not placed directly against the wall.) This helps keep the walls damp and protects them from direct sunlight. Once carbonation of the lime has begun, it will continue for many years and the lime will gain strength as it reverts back to calcium carbonate within the wall.

***Aging* the Mortar.** Even with the best efforts at matching the existing mortar color, texture, and materials, there will usually be a visible difference between the old and

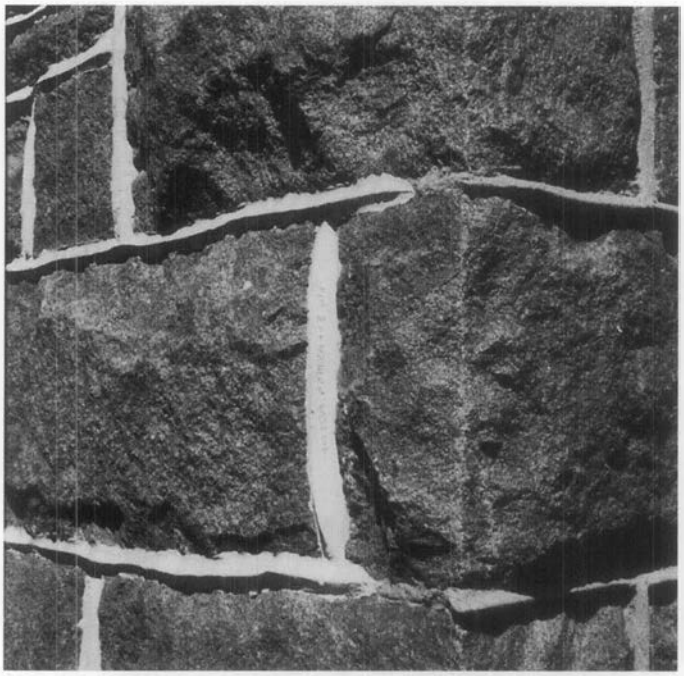


Figure 15. The profile of the repointed joints on the left replicate the historic joints around the corner to the right on the front of this stone building in Leesburg, VA. The contractor's pride in the repointing work is evident by the signature in the vertical joint. Photo: Anne Grimmer.

new work, partly because the new mortar has been matched to the unweathered portions of the historic mortar. Another reason for a slight mismatch may be that the sand is more exposed in old mortar due to the slight erosion of the lime or cement. Although spot repointing is generally preferable and some color difference should be acceptable, if the difference between old and new mortar is too extreme, it may be advisable in some instances to repoint an entire area of a wall, or an entire feature such as a bay, to minimize the difference between the old and the new mortar. If the mortars have been properly matched, usually the best way to deal with surface color differences is to let the mortars age naturally. Other treatments to overcome these differences, including cleaning the non-repointed areas or staining the new mortar, should be carefully tested prior to implementation.

Staining the new mortar to achieve a better color match is generally not recommended, but it may be appropriate in some instances. Although staining may provide an initial match, the old and new mortars may weather at different rates, leading to visual differences after a few seasons. In addition, the mixtures used to stain the mortar may be harmful to the masonry; for example, they may introduce salts into the masonry which can lead to efflorescence.

Cleaning the Repointed Masonry. If repointing work is carefully executed, there will be little need for cleaning other than to remove the small amount of mortar from the edge of the joint following tooling. This can be done with a stiff natural bristle or nylon brush after the mortar has dried, but before it is initially set (1-2 hours). Mortar that has hardened can usually be removed with a wooden paddle or, if necessary, a chisel.

Further cleaning is best accomplished with plain water and natural bristle or nylon brushes. If chemicals must

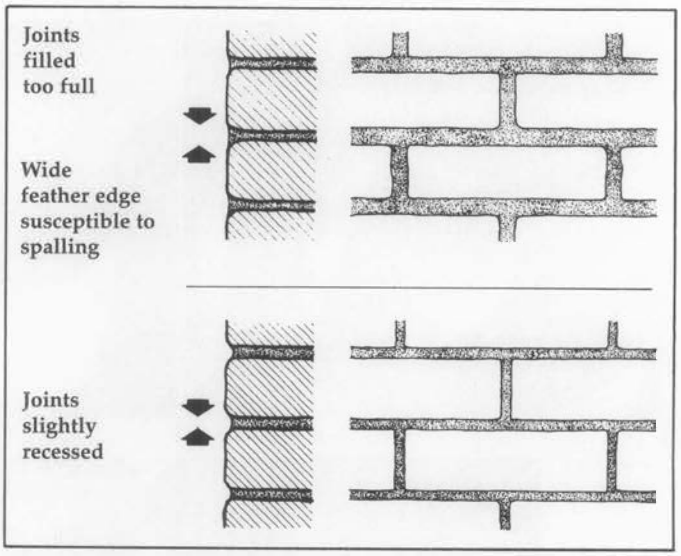


Figure 16. Comparison of visual effect of full mortar joints vs. slightly recessed joints. Filling joints too full hides the actual joint thickness and changes the character of the original brickwork. Drawing: Robert C. Mack, FAIA.

be used, they should be selected with extreme caution. Improper cleaning can lead to deterioration of the masonry units, deterioration of the mortar, mortar smear, and efflorescence. New mortar joints are especially susceptible to damage because they do not become fully cured for several months. Chemical cleaners, particularly acids, should never be used on dry masonry. The masonry should always be completely soaked once with water before chemicals are applied. After cleaning, the walls should be flushed again with plain water to remove all traces of the chemicals.

Several precautions should be taken if a freshly repointed masonry wall is to be cleaned. First, the mortar should be fully hardened before cleaning. Thirty days is usually sufficient, depending on weather and exposure; as mentioned previously, the mortar will continue to cure even after it has hardened. Test panels should be prepared to evaluate the effects of different cleaning

Figure 17. This photograph shows the significant visual change to the character of this historic brick building that has resulted from improper repointing procedures and a noticeably increased thickness of the mortar joints. Photo: Lee H. Nelson, FAIA.

Mortar Types			
(Measured by volume)			
Designation	Cement	Hydrated Lime or Lime Putty	Sand
M	1	1/4	3 - 3 3/4
S	1	1/2	4 - 4 1/2
N	1	1	5 - 6
O	1	2	8 - 9
K	1	3	10 - 12
"L"	0	1	2 1/4 - 3

Suggested Mortar Types for Different Exposures			
	Exposure		
Masonry Material	Sheltered	Moderate	Severe
Very Durable: granite, hard-cored brick, etc.	O	N	S
Moderately Durable: limestone, durable stone, molded brick	K	O	N
Minimally Durable: soft hand-made brick	"L"	K	O

methods. Generally, on newly repointed masonry walls, only very low pressure (100 psi) water washing supplemented by stiff natural bristle or nylon brushes should be used, except on glazed or polished surfaces, where only soft cloths should be used.**

New construction "bloom" or efflorescence occasionally appears within the first few months of repointing and usually disappears through the normal process of weathering. If the efflorescence is not removed by natural processes, the safest way to remove it is by dry brushing with stiff natural or nylon bristle brushes followed by wet brushing. Hydrochloric (muriatic) acid, is generally ineffective, and it should not be used to remove efflorescence. It may liberate additional salts, which, in turn, can lead to more efflorescence.

Surface Grouting is sometimes suggested as an alternative to repointing brick buildings, in particular. This process involves the application of a thin coat of cement-based grout to the mortar joints and the mortar/brick interface. To be effective the grout must extend slightly onto the face of the masonry units, thus widening the joint visually. The change in the joint appearance can alter the historic character of the structure to an unacceptable degree. In addition, although masking of the bricks is intended to keep the grout off the remainder of the face of the bricks, some level of residue, called "veiling," will inevitably remain. Surface grouting cannot substitute for the more extensive work of repointing, and it is not a recommended treatment for historic masonry.

**Additional information on masonry cleaning is presented in *Preservation Briefs 1: The Cleaning and Waterproof Coating of Masonry Buildings*, Robert C. Mack, AIA, Washington, D.C.: Technical Preservation Services, National Park Service, U.S. Department of the Interior, 1975; and *Keeping it Clean: Removing Exterior Dirt, Paint, Stains & Graffiti from Historic Masonry Buildings*, Anne E. Grimmer, Washington, D.C.: Technical Preservation Services, National Park Service, U.S. Department of the Interior, 1988.

Summary

For the Owner/Administrator. The owner or administrator of a historic building should remember that repointing is likely to be a lengthy and expensive process. First, there must be adequate time for evaluation of the building and investigation into the cause of problems. Then, there will be time needed for preparation of the contract documents. The work itself is precise, time-consuming and noisy, and scaffolding may cover the face of the building for some time. Therefore, the owner must carefully plan the work to avoid problems. Schedules for both repointing and other activities will thus require careful coordination to avoid unanticipated conflicts. The owner must avoid the tendency to rush the work or cut corners if the historic building is to retain its visual integrity and the job is to be durable.

For the Architect/Consultant. Because the primary role of the consultant is to ensure the life of the building, a knowledge of historic construction techniques and the special problems found in older buildings is essential. The consultant must assist the owner in planning for logistical problems relating to research and construction. It is the consultant's responsibility to determine the *cause* of the mortar deterioration and ensure that it is corrected before the masonry is repointed. The consultant must also be prepared to spend more time in project inspections than is customary in modern construction.

For the Masons. Successful repointing depends on the masons themselves. Experienced masons understand the special requirements for work on historic buildings and the added time and expense they require. The entire masonry crew must be willing and able to perform the work in conformance with the specifications, even when the specifications may not be in conformance with standard practice. At the same time, the masons should not hesitate to question the specifications if it appears that the work specified would damage the building.

Visually Examining the Mortar and the Masonry Units

A simple in-situ comparison will help determine the hardness and condition of the mortar and the masonry units. Begin by scraping the mortar with a screwdriver, and gradually tapping harder with a cold chisel and mason's hammer. Masonry units can be tested in the same way beginning, even more gently, by scraping with a fingernail. This relative analysis which is derived from the 10-point hardness scale used to describe minerals, provides a good starting point for selection of an appropriate mortar. It is described more fully in "The Russack System for Brick & Mortar Description" referenced in **Selected Reading** at the end of this Brief.

Mortar samples should be chosen carefully, and picked from a variety of locations on the building to find unweathered mortar, if possible. Portions of the building may have been repointed in the past while other areas may be subject to conditions causing unusual deterioration. There may be several colors of mortar dating from different construction periods or sand used from different sources during the initial construction. Any of these situations can give false readings to the visual or physical characteristics required for the new mortar. Variations should be noted which may require developing more than one mix.

1) Remove with a chisel and hammer three or four unweathered samples of the mortar to be matched from several locations on the building. (Set the largest sample aside—this will be used later for comparison with the repointing mortar). Removing a full representation of samples will allow selection of a "mean" or average mortar sample.

2) Mash the remaining samples with a wooden mallet, or hammer if necessary, until they are separated into their constituent parts. There should be a good handful of the material.

3) Examine the powdered portion—the lime and/or cement matrix of the mortar. Most particularly, note the color. There is a tendency to think of historic mortars as having white binders, but grey portland cement was available by the last quarter of the 19th century, and traditional limes were also sometimes grey. Thus, in some instances, the natural color of the historic binder may be grey, rather than white. The mortar may also have been tinted to create a colored mortar, and this color should be identified at this point.

4) Carefully blow away the powdery material (the lime and/or cement matrix which bound the mortar together).

5) With a low power (10 power) magnifying glass, examine the remaining sand and other materials such as lumps of lime or shell.

6) Note and record the wide range of color as well as the varying sizes of the individual grains of sand, impurities, or other materials.

Other Factors to Consider

Color. Regardless of the color of the binder or colored additives, the sand is the primary material that gives mortar its color. A surprising variety of colors of sand may be found in a single sample of historic mortar, and the different sizes of the grains of sand or other materials, such as incompletely ground lime or cement, play an important role in the texture of the repointing mortar. Therefore, when specifying sand for repointing mortar, it may be necessary to obtain sand from several sources and to combine or screen them in order to approximate the range of sand colors and grain sizes in the historic mortar sample.

Figure 19. Mortar joints of 18th century brick buildings were often as much as 1/2 inch wide, cut flush and struck with a grapevine joint, but for window and door surrounds where a finer quality rubbed brick was used, mortar joints were very thin. Photo: National Park Service Files.

Pointing Style. Close examination of the historic masonry wall and the techniques used in the original construction will assist in maintaining the visual qualities of the building (Fig. 18). Pointing styles and the methods of producing them should be examined. It is important to look at both the horizontal and the vertical joints to determine the order in which they were tooled and whether they were the same style. Some late-19th and early-20th century buildings, for example, have horizontal joints that were raked back while the vertical joints were finished flush and stained to match the bricks, thus creating the illusion of horizontal bands. Pointing styles may also differ from one facade to another; front walls often received greater attention to mortar detailing than side and rear walls (Fig. 19). **Tuckpointing** is not true repointing but the

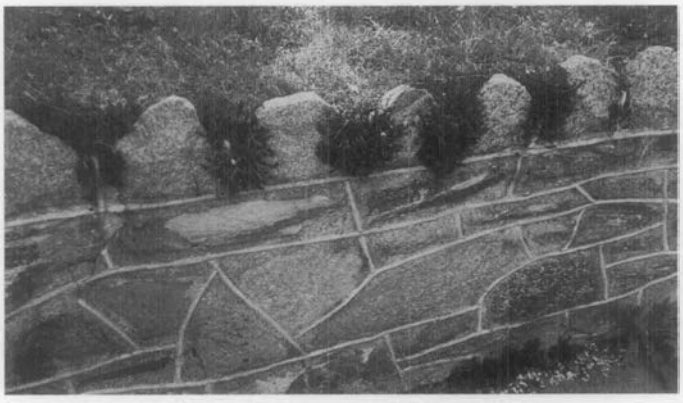
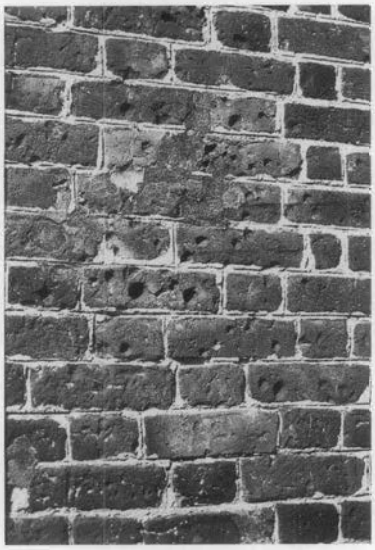


Figure 20. This stone garden wall was tuckpointed to match the tuckpointing on the c. 1920s house on the property. Photo: Anne Grimmer.



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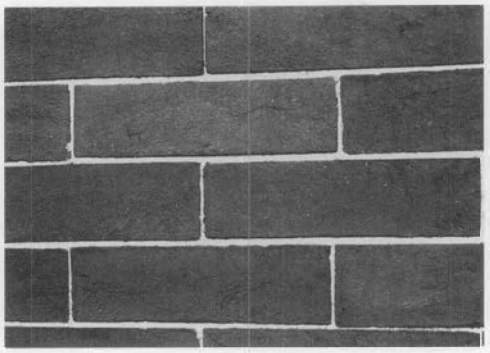

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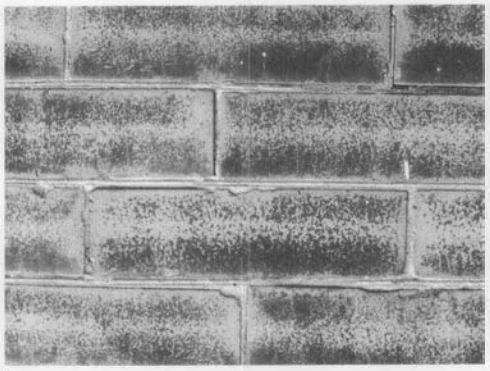

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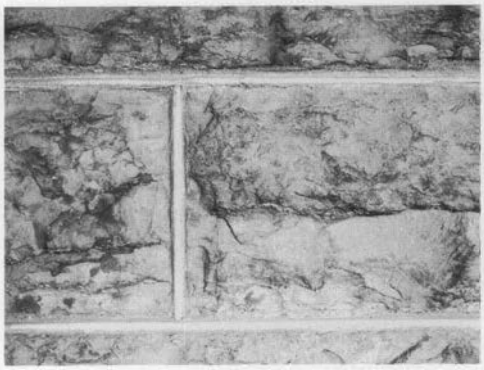

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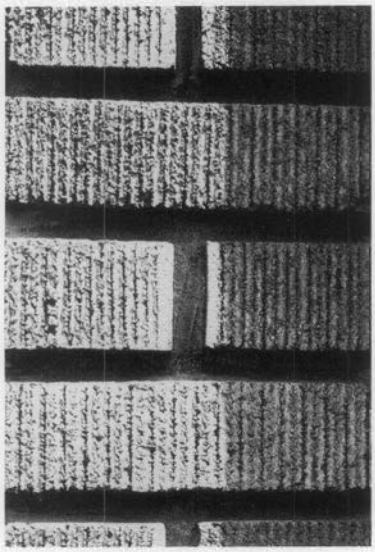

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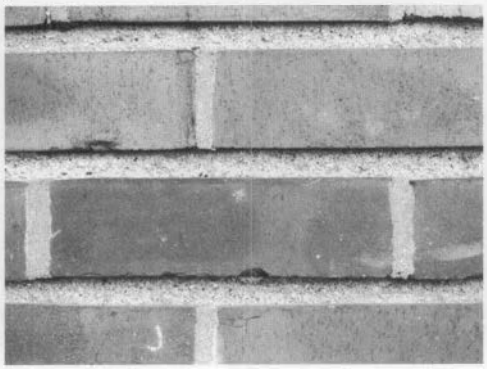

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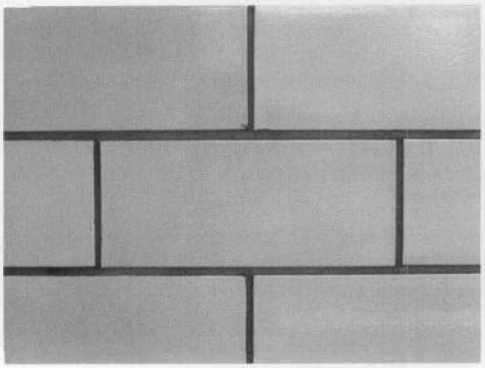

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Figure 18. A cross-section of mortar joint types. (a) Grapevine joints on a mid-18th century brick building; (b) flush joints on a mid-to-late 19th century brick building; (c) beaded joints on a late-19th century brick building; (d) early-20th century beaded joints on rough-cut limestone where the vertical joints were struck prior to the horizontal joints; (e) raked joints on 1920s wire brick; (f) horizontal joints on a 1934 building designed by Frank Lloyd Wright were raked back from the face of the bricks, and the vertical joints were filled with a red-tinted mortar to emphasize the horizontality of the narrow bricks, and struck flush with the face of the bricks; (g) the joints on this 20th century glazed terra-cotta tile building are raked slightly, emphasizing the glazed block face. Photos: National Park Service Files (a,b,e); Robert C. Mack, FAIA (c,d,f,g).

application of a raised joint or lime putty joint on top of flush mortar joints (Fig. 20). **Penciling** is a purely decorative, painted surface treatment over a mortar joint, often in a contrasting color.

Masonry Units. The masonry units should also be examined so that any replacement units will match the historic masonry. Within a wall there may be a wide range of colors, textures, and sizes, particularly with hand-made brick or rough-cut, locally-quarried stone. Replacement units should blend in with the full range of masonry units rather than a single brick or stone.

Matching Color and Texture of the Repointing Mortar

New mortar should match the unweathered interior portions of the historic mortar. The simplest way to check the match is to make a small sample of the proposed mix and allow it to cure at a temperature of approximately 70 degrees F for about a week, or it can be baked in an oven to speed up the curing; this sample is then broken open and the surface is compared with the surface of the largest "saved" sample of historic mortar.

If a proper color match cannot be achieved through the use of natural sand or colored aggregates like crushed marble or brick dust, it may be necessary to use a modern mortar pigment.

During the early stages of the project, it should be determined how closely the new mortar should match the historic mortar. Will "quite close" be sufficient, or is "exactly" expected? The specifications should state this clearly so that the contractor has a reasonable idea how much time and expense will be required to develop an acceptable match.

The same judgment will be necessary in matching replacement terra cotta, stone or brick. If there is a known source for replacements, this should be included in the specifications. If a source cannot be determined prior to the bidding process, the specifications should include an estimated price for the replacement materials with the final price based on the actual cost to the contractor.

Conclusion

A good repointing job is meant to last, at least 30 years, and preferably 50-100 years. Shortcuts and poor craftsmanship result not only in diminishing the historic character of a building, but also in a job that looks bad, and will require future repointing sooner than if the work had been done correctly (Fig. 17). The mortar joint in a historic masonry building has often been called a wall's "first line of defense." Good repointing practices guarantee the long life of the mortar joint, the wall, and the historic structure. Although careful maintenance will help preserve the freshly repointed mortar joints, it is important to remember that mortar joints are intended to be sacrificial and will probably require repointing some time in the future. Nevertheless, if the historic mortar joints proved durable for many years, then careful repointing should have an equally long life, ultimately contributing to the preservation of the entire building.

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Useful Addresses

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This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Comments about this publication should be directed to de Teel Patterson Tiller, Chief, Heritage Preservation Services Program, National Park Service, 1849 C Street, N.W. Suite NC200, Washington, D.C. 20240. This publication is not copyrighted and can be reproduced without penalty. Normal procedures for credit to the authors and the National Park Service are appreciated.

Front Cover: Repointing a historic brick building using a lime-based mortar. Traditional lime mortars have a consistency that enables the mortar to cling to a repointing tool while in a vertical position. Photo: John P. Speweik.

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4 PRESERVATION BRIEFS

Roofing for Historic Buildings

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HABS

U.S. Department of the Interior
National Park Service
Cultural Resources
Heritage Preservation Services

Significance of the Roof

A weather-tight roof is basic in the preservation of a structure, regardless of its age, size, or design. In the system that allows a building to work as a shelter, the roof sheds the rain, shades from the sun, and buffers the weather.

During some periods in the history of architecture, the roof imparts much of the architectural character. It defines the style and contributes to the building's aesthetics. The hipped roofs of Georgian architecture, the turrets of Queen Anne, the Mansard roofs, and the graceful slopes of the Shingle Style and Bungalow designs are examples of the use of roofing as a major design feature.

But no matter how decorative the patterning or how compelling the form, the roof is a highly vulnerable element of a shelter that will inevitable fail. A poor roof will permit the accelerated deterioration of historic building materials—masonry, wood, plaster, paint—and will cause general disintegration of the basic structure. Furthermore, there is an urgency involved in repairing a leaky roof since such repair costs will quickly become prohibitive. Although such action is desirable as soon as a failure is discovered, temporary patching methods should be carefully chosen to prevent inadvertent damage to sound or historic roofing materials and related features. Before any repair work is performed, the historic value of the materials used on the roof should be understood. Then a complete internal and external inspection of the roof should be planned to determine all the causes of failure and to identify the alternatives for repair or replacement of the roofing.

Historic Roofing Materials in America

Clay Tile: European settlers used clay tile for roofing as early as the mid-17th century; many pantiles (S-curved tiles), as well as flat roofing tiles, were used in Jamestown, Virginia. In some cities such as New York and Boston, clay was popularly used as a precaution against such fire as those that engulfed London in 1666 and scorched Boston in 1679.

Tiles roofs found in the mid-18th century Moravian settlements in Pennsylvania closely resembled those found in Germany. Typically, the tiles were 14–15″ long, 6–7″ wide with a curved butt. A lug on the back allowed the tiles to hang on the lathing without nails or pegs. The tile surface was usually scored with finger marks to promote drainage. In the Southwest, the tile roofs of the Spanish missionaries (mission tiles) were first manufactured (ca. 1780) at the Mission San Antonio de Padua in California. These semicircular tiles were made by molding clay over sections of logs, and they were generally 22″ long and tapered in width.

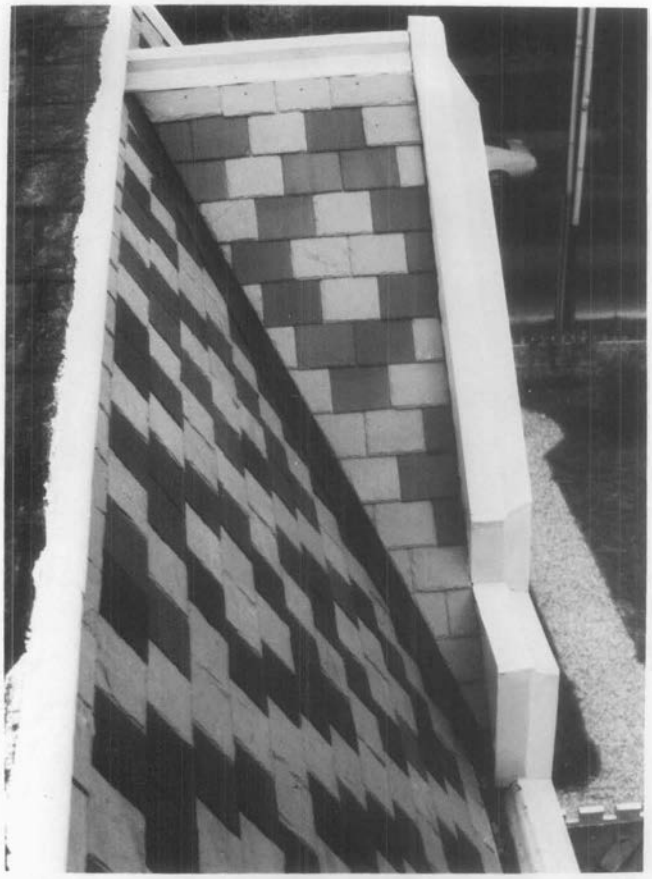
Repairs on this pantile roof were made with new tiles held in place with metal hangers. (Main Building, Ellis Island, New York)

The plain or flat rectangular tiles most commonly used from the 17th through the beginning of the 19th century measured about 10″ by 6″ by ½″, and had two holes at one end for a nail or peg fastener. Sometimes mortar was applied between the courses to secure the tiles in a heavy wind.

In the mid-19th century, tile roofs were often replaced by sheet-metal roofs, which were lighter and easier to install and maintain. However, by the turn of the century, the Romanesque Revival and Mission style buildings created a new demand and popularity for this picturesque roofing material.

Slate: Another practice settlers brought to the New World was slate roofing. Evidence of roofing slates have been found also among the ruins of mid-17th-century Jamestown. But because of the cost and the time required to obtain the material, which was mostly imported from Wales, the use of slate was initially limited. Even in Philadelphia (the second largest city in the English-speaking world at the time of the Revolution) slates were so rare that "The Slate Roof House" distinctly referred to William Penn's home built late in the 1600s. Sources of native slate were known to exist along the eastern seaboard from Maine to Virginia, but difficulties in inland transportation limited its availability to the cities, and contributed to its expense. Welsh slate continued to be imported until the development of canals and railroads in the mid-19th century made American slate more accessible and economical.

Slate was popular for its durability, fireproof qualities, and



The Victorians loved to used different colored slates to create decorative patterns on their roofs, an effect which cannot be easily duplicated by substitute materials. Before any repair work on a roof such as this, the slate sizes, colors, and position of the patterning should be carefully recorded to assure proper replacement. (Ebenezer Maxwell Mansion, Philadelphia, Pennsylvania, photo courtesy of William D. Hershey)

Replacement of particular historic details is important to the individual historic character of a roof, such as the treatment at the eaves of this rounded butt wood shingle roof. Also note that the surface of the roof was carefully sloped to drain water away from the side of the dormer. In the restoration, this function was augmented with the addition of carefully concealed modern metal flashing. (Mount Vernon, Virginia)

Galvanized sheet-metal shingles imitating the appearance of pantiles remained popular from the second half of the 19th century into the 20th century. (Episcopal Church, now the Jerome Historical Society Building, Jerome, Arizona, 1927)

aesthetic potential. Because slate was available in different colors (red, green, purple, and blue-gray), it was an effective material for decorative patterns on many 19th-century roofs (Gothic and Mansard styles). Slate continued to be used well into the 20th century, notably on many Tudor revival style buildings of the 1920s.

Shingles: Wood shingles were popular throughout the country in all periods of building history. The size and shape of the shingles as well as the detailing of the shingle roof differed according to regional craft practices. People within particular regions developed preferences for the local species of wood that most suited their purposes. In New England and the Delaware Valley, white pine was frequently used: in the South, cypress and oak; in the far west, red cedar or redwood. Sometimes a protective coating was applied to increase the durability of the shingle such as a mixture of brick dust and fish oil, or a paint made of red iron oxide and linseed oil.

Commonly in urban areas, wooden roofs were replaced with more fire resistant materials, but in rural areas this was not a major concern. On many Victorian country houses, the practice of wood shingling survived the technological advances of metal roofing in the 19th century, and near the turn of the century enjoyed a full revival in its namesake, the Shingle Style. Colonial revival and the Bungalow styles in the 20th century assured wood shingles a place as one of the most fashionable, domestic roofing materials.

Metal: Metal roofing in America is principally a 19th-century phenomenon. Before then the only metals commonly used were lead and copper. For example, a lead roof covered "Rosewell," one of the grandest mansions in 18th-century Virginia. But more often, lead was used for protective flashing. Lead, as well as copper, covered roof surfaces where wood, tile, or slate shingles were inappropriate because of the roof's pitch or shape.

Copper with standing seams covered some of the more notable early American roofs including that of Christ Church (1727–1744) in Philadelphia. Flat-seamed copper was used on many domes and cupolas. The copper sheets were imported from England until the end of the 18th century when facilities for rolling sheet metal were developed in America.

Sheet iron was first known to have been manufactured here by the Revolutionary War financier, Robert Morris, who had a rolling mill near Trenton, New Jersey. At his mill Morris produced the roof of his own Philadelphia mansion, which he started in 1794. The architect Benjamin H. Latrobe used sheet iron to replace the roof on Princeton's "Nassau Hall," which had been gutted by fire in 1802.

The method for corrugating iron was originally patented in England in 1829. Corrugating stiffened the sheets, and allowed greater span over a lighter framework, as well as reduced installation time and labor. In 1834 the American architect William Strickland proposed corrugated iron to cover his design for the market place in Philadelphia.

Galvanizing with zinc to protect the base metal from rust was developed in France in 1837. By the 1850s the material was used on post offices and customhouses, as well as on train sheds and factories. In 1857 one of the first metal roofs in the

Repeated repair with asphalt, which cracks as it hardens, has created a blistered surface on this sheet-metal roof and built-in gutter, which will retain water. Repairs could be made by carefully heating and scraping the surface clean, repairing the holes in the metal with a flexible mastic compound or a metal patch, and coating the surface with a fibre paint. (Roane County Courthouse, Kingston, Tennessee, photo courtesy of Building Conservation Technology, Inc.)

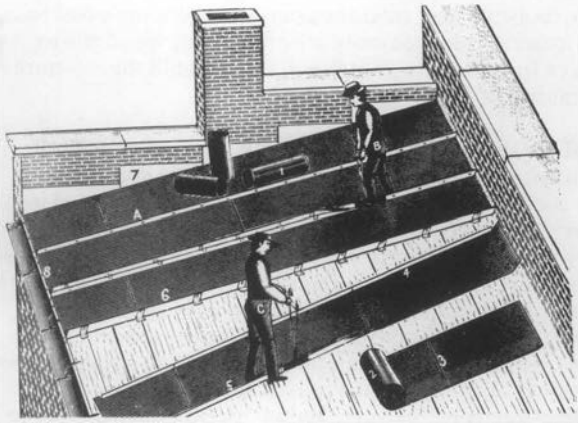
South was installed on the U.S. Mint in New Orleans. The Mint was thereby "fireproofed" with a 20-gauge galvanized, corrugated iron roof on iron trusses.

Tin-plate iron, commonly called "tin roofing," was used extensively in Canada in the 18th century, but it was not as common in the United States until later. Thomas Jefferson was an early advocate of tin roofing, and he installed a standing-seam tin roof on "Monticello" (ca. 1770–1802). The Arch Street Meetinghouse (1804) in Philadelphia had tin shingles laid in a herringbone pattern on a "piazza" roof.

However, once rolling mills were established in this country, the low cost, light weight, and low maintenance of tin plate made it the most common roofing material. Embossed tin shingles, whose surfaces created interesting patterns, were popular throughout the country in the late 19th century. Tin roofs were kept well-painted, usually red; or, as the architect A. J. Davis suggested, in a color to imitate the green patina of copper.

Terne plate differed from tin plate in that the iron was dipped in an alloy of lead and tin, giving it a duller finish. Historic, as well as modern, documentation often confuses the two, so much that it is difficult to determine how often actual "terne" was used.

Zinc came into use in the 1820s, at the same time tin plate was becoming popular. Although a less expensive substitute for lead, its advantages were controversial, and it was never widely used in this country.



A Chicago firm's catalog dated 1896 illustrates a method of unrolling, turning the edges, and finishing the standing seam on a metal roof.

Tin shingles, commonly embossed to imitate wood or tile, or with a decorative design, were popular as an inexpensive, textured roofing material. These shingles $8^3/_8$ inch by $12^1/_2$ inch on the exposed surface) were designed with interlocking edges, but they have been repaired by surface nailing, which may cause future leakage. (Ballard House, Yorktown, Virgina, photo by Gordie Whittington, National Park Service)

Other Materials: Asphalt shingles and roll roofing were used in the 1890s. Many roofs of asbestos, aluminum, stainless steel, galvinized steel, and lead-coated copper may soon have historic values as well. Awareness of these and other traditions of roofing materials and their detailing will contribute to more sensitive preservation treatments.

Locating the Problem

Failures of Surface Materials

When trouble occurs, it is important to contact a professional, either an architect, a reputable roofing contractor, or a craftsman familiar with the inherent characteristics of the particular historic roofing system involved. These professionals may be able to advise on immediate patching procedures and help plan more permanent repairs. A thorough examination of the roof should start with an appraisal of the existing condition and quality of the roofing material itself. Particular attention should be given to any southern slope because year-round exposure to direct sun may cause it to break down first.

Wood: Some historic roofing materials have limited life expectancies because of normal organic decay and "wear." For example, the flat surfaces of wood shingles erode from exposure to rain and ultraviolet rays. Some species are more hardy than others, and heartwood, for example, is stronger and more durable than sapwood.

Ideally, shingles are split with the grain perpendicular to

the surface. This is because if shingles are sawn across the grain, moisture may enter the grain and cause the wood to deteriorate. Prolonged moisture on or in the wood allows moss or fungi to grow, which will further hold the moisture and cause rot.

Metal: Of the inorganic roofing materials used on historic buildings, the most common are perhaps the sheet metals: lead, copper, zinc, tin plate, terne plate, and galvanized iron. In varying degrees each of these sheet metals are likely to deteriorate from chemical action by pitting or streaking. This can be caused by airborn pollutants; acid rainwater; acids from lichen or moss; alkalis found in lime mortars or portland cement, which might be on adjoining features and washes down on the roof surface; or tannic acids from adjacent wood sheathings or shingles made of red cedar or oak.

Corrosion from "galvanic action" occurs when dissimilar metals, such as copper and iron, are used in direct contact. Corrosion may also occur even though the metals are physically separated; one of the metals will react chemically against the other in the presence of an electrolyte such as rainwater. In roofing, this situation might occur when either a copper roof is decorated with iron cresting, or when steel nails are used in copper sheets. In some instances the corrosion can be prevented by inserting a plastic insulator between the dissimilar materials. Ideally, the fasteners should be a metal sympathetic to those involved.

Iron rusts unless it is well-painted or plated. Historically this problem was avoided by use of tin plating or galvinizing. But this method is durable only as long as the coating remains intact. Once the plating is worn or damaged, the exposed iron will rust. Therefore, any iron-based roofing material needs to be undercoated, and its surface needs to be kept well-painted to prevent corrosion.

One cause of sheet metal deterioration is fatigue. Depending upon the size and the gauge of the metal sheets, wear and metal failure can occur at the joints or at any protrusions in the sheathing as a result from the metal's alternating movement to thermal changes. Lead will tear because of "creep," or the gravitational stress that causes the material to move down the roof slope.

Slate: Perhaps the most durable roofing materials are slate and tile. Seemingly indestructable, both vary in quality. Some slates are hard and tough without being brittle. Soft slates are more subject to erosion and to attack by airborne and rainwater chemicals, which cause the slates to wear at nail holes, to delaminate, or to break. In winter, slate is very susceptible to breakage by ice, or ice dams.

Tile: Tiles will weather well, but tend to crack or break if hit, as by tree branches, or if they are walked on improperly. Like slates, tiles cannot support much weight. Low quality tiles that have been insufficiently fired during manufacture, will craze and spall under the effects of freeze and thaw cycles on their porous surfaces.

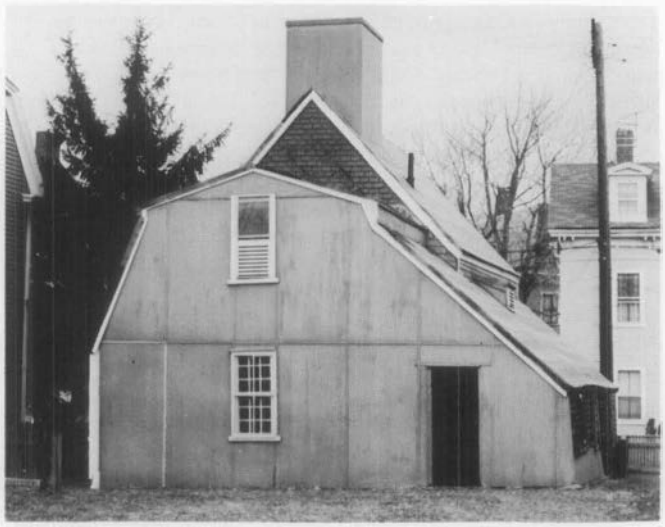
Failures of Support Systems

Once the condition of the roofing material has been determined, the related features and support systems should be examined on the exterior and on the interior of the roof. The gutters and downspouts need periodic cleaning and maintenance since a variety of debris fill them, causing water to back up and seep under roofing units. Water will eventually cause fasteners, sheathing, and roofing structure to deteriorate. During winter, the daily freeze-thaw cycles can cause ice floes to develop under the roof surface. The pressure from these ice floes will dislodge the roofing material, especially slates, shingles, or tiles. Moreover, the buildup of ice dams above the gutters can trap enough moisture to rot the sheathing or the structural members.

Many large public buildings have built-in gutters set within the perimeter of the roof. The downspouts for these gutters may run within the walls of the building, or drainage may be through the roof surface or through a parapet to exterior downspouts. These systems can be effective if properly maintained; however, if the roof slope is inadequate for good runoff, or if the traps are allowed to clog, rainwater will form pools on the roof surface. Interior downspouts can collect debris and thus back up, perhaps leaking water into the surrounding walls. Exterior downspouts may fill with water, which in cold weather may freeze and crack the pipes. Conduits from the built-in gutter to the exterior downspout may also leak water into the surrounding roof structure or walls.

Failure of the flashing system is usually a major cause of roof deterioration. Flashing should be carefully inspected for failure caused by either poor workmanship, thermal stress, or metal deterioration (both of flashing material itself and of the fasteners). With many roofing materials, the replacement of flashing on an existing roof is a major operation, which may require taking up large sections of the roof surface. Therefore, the installation of top quality flashing material on

This detail shows slate delamination caused by a combination of weathering and pollution. In addition, the slates have eroded around the repair nails, incorrectly placed in the exposed surface of the slates. (Lower Pontalba Building, New Orleans, photo courtesy of Building Conservation Technology, Inc.)



Temporary stabilization or "mothballing" with materials such as plywood and building paper can protect the roof of a project until it can be properly repaired or replaced. (Narbonne House, Salem, Massachusetts)

These two views of the same house demonstrate how the use of a substitute material can drastically affect the overall character of a structure. The textural interest of the original tile roof was lost with the use of asphalt shingles. Recent preservation efforts are replacing the tile roof. (Frank House, Kearney, Nebraska, photo courtesy of the Nebraska State Historical Society, Lincoln, Nebraska)

a new or replaced roof should be a primary consideration. *Remember, some roofing and flashing materials are not compatible.*

Roof fasteners and clips should also be made of a material compatible with all other materials used, or coated to prevent rust. For example, the tannic acid in oak will corrode iron nails. Some roofs such as slate and sheet metals may fail if nailed too rigidly.

If the roof structure appears sound and nothing indicates recent movement, the area to be examined most closely is the roof substrate—the sheathing or the battens. The danger spots would be near the roof plates, under any exterior patches, at the intersections of the roof planes, or at vertical surfaces such as dormers. Water penetration, indicating a breach in the roofing surface or flashing, should be readily apparent, usually as a damp spot or stain. Probing with a small pen knife may reveal any rot which may indicate previously undetected damage to the roofing membrane. Insect infestation evident by small exit holes and frass (a sawdust-like debris) should also be noted. Condensation on the underside of the roofing is undesirable and indicates improper ventilation. Moisture will have an adverse effect on any roofing material; a good roof stays dry inside and out.

Repair or Replace

Understanding potential weaknesses of roofing material also requires knowledge of repair difficulties. Individual slates can be replaced normally without major disruption to the rest of the roof, but replacing flashing on a slate roof can require substantial removal of surrounding slates. If it is the substrate or a support material that has deteriorated, many surface materials such as slate or tile can be reused if handled carefully during the repair. Such problems should be evaluated at the outset of any project to determine if the roof can be effectively patched, or if it should be completely replaced.

Will the repairs be effective? Maintenance costs tend to multiply once trouble starts. As the cost of labor escalates, repeated repairs could soon equal the cost of a new roof.

The more durable the surface is initially, the easier it will be to maintain. Some roofing materials such as slate are expensive to install, but if top quality slate and flashing are used, it will last 40–60 years with minimal maintenance. Although the installation cost of the roof will be high, low maintenance needs will make the lifetime cost of the roof less expensive.

Historical Research

In a restoration project, research of documents and physical investigation of the building usually will establish the roof's history. Documentary research should include any original plans or building specifications, early insurance surveys, newspaper descriptions, or the personal papers and files of people who owned or were involved in the history of the building. Old photographs of the building might provide evidence of missing details.

Along with a thorough understanding of any written history of the building, a physical investigation of the roofing and its structure may reveal information about the roof's construction history. Starting with an overall impression of the structure, are there any changes in the roof slope, its configuration, or roofing materials? Perhaps there are obvious patches or changes in patterning of exterior brickwork where a gable roof was changed to a gambrel, or where a whole upper story was added. Perhaps there are obvious stylistic changes in the roof line, dormers, or ornamentation. These observations could help one understand any important alteration, and could help establish the direction of further investigation.

Because most roofs are physically out of the range of careful scrutiny, the "principle of least effort" has probably limited the extent and quality of previous patching or replacing, and usually considerable evidence of an earlier roof surface remains. Sometimes the older roof will be found as an underlayment of the current exposed roof. Original roofing may still be intact in awkward places under later features on a roof. Often if there is any unfinished attic space, remnants of roofing may have been dropped and left when the roof was being built or repaired. If the configuration of the roof has been changed, some of the original material might still be in place under the existing roof. Sometimes whole sections of the roof and roof framing will have been left intact under the higher roof. The profile and/or flashing of the earlier roof may be apparent on the interior of the walls at the level of the alteration. If the sheathing or lathing appears to have survived changes in the roofing surface, they may contain evidence of the roofing systems. These may appear either as dirt marks, which provide "shadows" of a roofing material, or as nails broken or driven down into the wood, rather than pulled out during previous alterations or repairs. Wooden headers in the roof framing may indicate that earlier chimneys or skylights have been removed. Any metal ornamentation that might have existed may be indicated by anchors or unusual markings along the ridge or at other edges of the roof. This primary

evidence is essential for a full understanding of the roof's history.

Caution should be taken in dating early "fabric" on the evidence of a single item, as recycling of materials is not a mid-20th-century innovation. Carpenters have been reusing materials, sheathing, and framing members in the interest of economy for centuries. Therefore, any analysis of the materials found, such as nails or sawmarks on the wood, requires an accurate knowledge of the history of local building practices before any final conclusion can be accurately reached. It is helpful to establish a sequence of construction history for the roof and roofing materials; any historic fabric or pertinent evidence in the roof should be photographed, measured, and recorded for future reference.

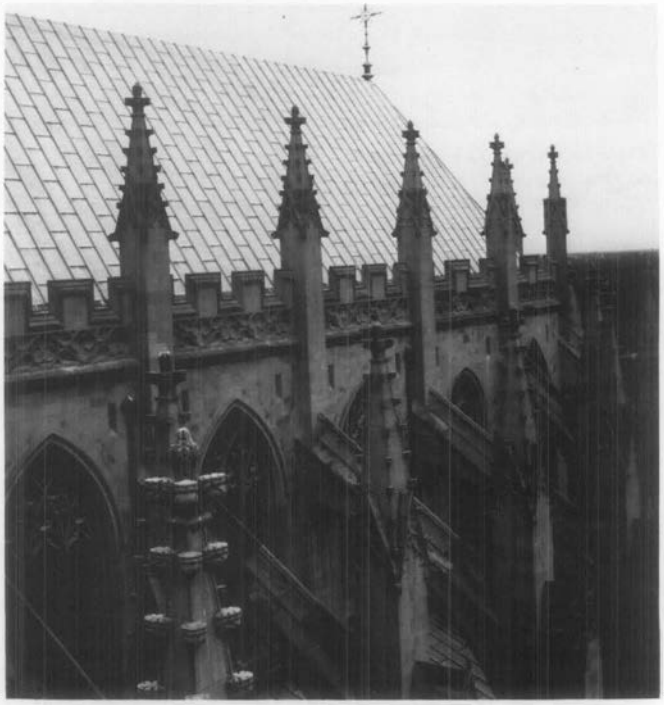
During the repair work, useful evidence might unexpectedly appear. It is essential that records be kept of any type of work on a historic building, before, during, and after the project. Photographs are generally the easiest and fastest method, and should include overall views and details at the gutters, flashing, dormers, chimneys, valleys, ridges, and eaves. All photographs should be immediately labeled to insure accurate identification at a later date. Any patterning or design on the roofing deserves particular attention. For example, slate roofs are often decorative and have subtle changes in size, color, and texture, such as a gradually decreasing coursing length from the eave to the peak. If not carefully noted before a project begins, there may be problems in replacing the surface. The standard reference for this phase of the work is *Recording Historic Buildings,* compiled by Harley J. McKee for the Historic American Buildings Survey, National Park Service, Washington, D.C., 1970.

Replacing the Historic Roofing Material

Professional advice will be needed to assess the various aspects of replacing a historic roof. With some exceptions, most historic roofing materials are available today. If not, an architect or preservation group who has previously worked with the same type material may be able to recommend suppliers. Special roofing materials, such as tile or embossed metal shingles, can be produced by manufacturers of related products that are commonly used elsewhere, either on the exterior or interior of a structure. With some creative thinking and research, the historic materials usually can be found.

Because of the roof's visibility, the slate detailing around the dormers is important to the character of this structure. Note how the slates swirl from a horizontal pattern on the main roof to a diamond pattern on the dormer roofs and side walls. (18th and Que Streets, NW, Washington, D.C.)

Craft Practices: Determining the craft practices used in the installation of a historic roof is another major concern in roof restoration. Early builders took great pride in their work, and experience has shown that the "rustic" or irregular designs commercially labled "Early American" are a 20th-century invention. For example, historically, wood shingles underwent several distinct operations in their manufacture including splitting by hand, and smoothing the surface with a draw knife. In modern nomenclature, the same item would be a "tapersplit" shingle which has been dressed. Unfortunately, the rustic appearance of today's commercially available "handsplit" and re-sawn shingle bears no resemblance to the hand-made roofing materials used on early American buildings.



Good design and quality materials for the roof surface, fastenings, and flashing minimize roofing failures. This is essential on roofs such as on the National Cathedral where a thorough maintenance inspection and minor repairs cannot be done easily without special scaffolding. However, the success of the roof on any structure depends on frequent cleaning and repair of the gutter system. (Washington, D.C., photo courtesy of John Burns, A.I.A.)

Early craftsmen worked with a great deal of common sense; they understood their materials. For example they knew that wood shingles should be relatively narrow; shingles much wider than about 6" would split when walked on, or they may curl or crack from varying temperature and moisture. It is important to understand these aspects of craftsmanship, remembering that people wanted their roofs to be weather-tight and to last a long time. The recent use of "mother-goose" shingles on historic structures is a gross underestimation of the early craftsman's skills.

Supervision: Finding a modern craftsman to reproduce historic details may take some effort. It may even involve some special instruction to raise his understanding of certain historic craft practices. At the same time, it may be pointless (and expensive) to follow historic craft practices in any construction that will not be visible on the finished product. But if the roofing details are readily visible, their appearance should be based on architectural evidence or on historic prototypes. For instance, the spacing of the seams on a standing-seam metal roof will affect the building's overall scale and should therefore match the original dimensions of the seams.

Many older roofing practices are no longer performed because of modern improvements. Research and review of specific detailing in the roof with the contractor before beginning the project is highly recommended. For example, one early craft practice was to finish the ridge of a wood shingle roof with a roof "comb"—that is, the top course of one slope of the roof was extended uniformly beyond the peak to shield the ridge, and to provide some weather protection for the raw horizontal edges of the shingles on the other slope. If the "comb" is known to have been the correct detail, it should be used. Though this method leaves the top course vulnerable to the weather, a disguised strip of flashing will strengthen this weak point.

Detail drawings or a sample mock-up will help ensure that the contractor or craftsman understands the scope and special requirements of the project. It should never be assumed that the modern carpenter, slater, sheet metal worker, or roofer will know all the historic details. Supervision is as important as any other stage of the process.

Special problems inherent in the design of an elaborate historic roof can be controlled through the use of good materials and regular maintenance. The shape and detailing are essential elements of the building's historic character, and should not be modified, despite the use of alternative surface materials. (Gamwell House, Bellingham, Washington)

Alternative Materials

The use of the historic roofing material on a structure may be restricted by building codes or by the availability of the materials, in which case an appropriate alternative will have to be found.

Some municipal building codes allow variances for roofing materials in historic districts. In other instances, individual variances may be obtained. Most modern heating and cooking is fueled by gas, electricity, or oil—none of which emit the hot embers that historically have been the cause of roof fires. Where wood burning fireplaces or stoves are used, spark arrestor screens at the top of the chimneys help to prevent flaming material from escaping, thus reducing the number of fires that start at the roof. In most states, insurance rates have been equalized to reflect revised considerations for the risks involved with various roofing materials.

In a rehabilitation project, there may be valid reasons for replacing the roof with a material other than the original. The historic roofing may no longer be available, or the cost of obtaining specially fabricated materials may be prohibitive. But the decision to use an alternative material should be weighed carefully against the primary concern to keep the historic character of the building. If the roof is flat and is not visible from any elevation of the building, and if there are advantages to substituting a modern built-up composition roof for what might have been a flat metal roof, then it may make better economic and construction sense to use a modern roofing method. But if the roof is readily visible, the alternative material should match as closely as possible the scale, texture, and coloration of the historic roofing material.

Asphalt shingles or ceramic tiles are common substitute materials intended to duplicate the appearance of wood shingles, slates, or tiles. Fire-retardant, treated wood shingles are currently available. The treated wood tends, however, to be brittle, and may require extra care (and expense) to install. In some instances, shingles laid with an interlay of fire-retardent building paper may be an acceptable alternative.

Lead-coated copper, terne-coated steel, and aluminum/zinc-coated steel can successfully replace tin, terne plate, zinc, or lead. Copper-coated steel is a less expensive (and less durable) substitute for sheet copper.

The search for alternative roofing materials is not new. As early as the 18th century, fear of fire cause many wood shingle or board roofs to be replaced by sheet metal or clay tile. Some historic roofs were failures from the start, based on over-ambitious and naive use of materials as they were first developed. Research on a structure may reveal that an inadequately designed or a highly combustible roof was replaced early in its history, and therefore restoration of a later roof material would have a valid precedent. In some cities, the substitution of sheet metal on early row houses occurred as soon as the rolled material became available.

Cost and ease of maintenance may dictate the substitution of a material wholly different in appearance from the original. The practical problems (wind, weather, and roof pitch) should be weighed against the historical consideration of scale, texture, and color. Sometimes the effect of the alternative material will be minimal. But on roofs with a high degree of visibility and patterning or texture, the substitution may seriously alter the architectural character of the building.

Temporary Stabilization

It may be necessary to carry out an immediate and temporary stabilization to prevent further deterioration until research can determine how the roof should be restored or rehabilitated, or until funding can be provided to do a proper job. A simple covering of exterior plywood or roll roofing might provide adequate protection, but any temporary covering should be applied with caution. One should be careful not to overload the roof structure, or to damage or destroy historic evidence or fabric that might be incorporated into a new roof at a later date. In this sense, repairs with caulking or bituminous patching compounds should be recognized as potentially harmful, since they are difficult to remove, and at their best, are very temporary.

Precautions

The architect or contractor should warn the owner of any precautions to be taken against the specific hazards in installing the roofing material. Soldering of sheet metals, for instance, can be a fire hazard, either from the open flame or from overheating and undected smoldering of the wooden substrate materials.

Thought should be given to the design and placement of any modern roof appurtenances such as plumbing stacks, air vents, or TV antennas. Consideration should begin with the placement of modern plumbing on the interior of the building, otherwise a series of vent stacks may pierce the roof membrane at various spots creating maintenance problems as well as aesthetic ones. Air handling units placed in the attic space will require vents which, in turn, require sensitive design. Incorporating these in unused chimneys has been very successful

in the past.

Whenever gutters and downspouts are needed that were not on the building historically, the additions should be made as unobtrusively as possible, perhaps by painting them out with a color compatible with the nearby wall or trim.

Maintenance

Although a new roof can be an object of beauty, it will not be protective for long without proper maintenance. At least twice a year, the roof should be inspected against a checklist. All changes should be recorded and reported. Guidelines should be established for any foot traffic that may be required for the maintenance of the roof. Many roofing materials should not be walked on at all. For some—slate, asbestos, and clay tile—a self-supporting ladder might be hung over the ridge of the roof, or planks might be spanned across the roof surface. Such items should be specifically designed and kept in a storage space accessible to the roof. If exterior work ever requires hanging scaffolding, use caution to insure that the anchors do not penetrate, break, or wear the roofing surface, gutters, or flashing.

Any roofing system should be recognized as a membrane that is designed to be self-sustaining, but that can be easily damaged by intrusions such as pedestrian traffic or fallen tree branches. Certain items should be checked at specific times. For example, gutters tend to accumulate leaves and debris during the spring and fall and after heavy rain. Hidden gutter screening both at downspouts and over the full length of the gutter could help keep them clean. The surface material would require checking after a storm as well. Periodic checking of the underside of the roof from the attic after a storm or winter freezing may give early warning of any leaks. Generally, damage from water or ice is less likely on a roof that has good flashing on the outside and is well ventilated and insulated on the inside. Specific instructions for the maintenance of the different roof materials should be available from the architect or contractor.

Summary

The essential ingredients for replacing and maintaining a historic roof are:

- Understanding the historic character of the building and being sympathetic to it.
- Careful examination and recording of the existing roof and any evidence of earlier roofs.
- Consideration of the historic craftsmanship and detailing and implementing them in the renewal wherever visible.
- Supervision of the roofers or maintenance personnel to assure preservation of historic fabric and proper understanding of the scope and detailing of the project.
- Consideration of alternative materials where the original cannot be used.
- Cyclical maintenance program to assure that the staff understands how to take care of the roof and of the particular trouble spots to safeguard.

With these points in mind, it will be possible to preserve the architectural character and maintain the physical integrity of the roofing on a historic building.

This Preservation Brief was written by Sarah M. Sweetser, Architectural Historian, Technical Preservation Services Division. Much of the technical information was based upon an unpublished report prepared under contract for this office by John G. and Diana S. Waite. Some of the historical information was from Charles E. Peterson, FAIA, "American Notes," *Journal of the Society of Architectural Historians.*

The illustrations for this brief not specifically credited are from the files of the Technical Preservation Services Division.

This publication was prepared pursuant to Executive Order 11593, "Protection and Enhancement of the Cultural Environment," which directs the Secretary of the Interior to "develop and make available to Federal agencies and State and local governments information concerning professional methods and techniques for preserving, improving, restoring and maintaining historic properties." The Brief has been developed under the technical editorship of Lee H. Nelson, AIA, Chief, Preservation Assistance Division, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. Comments on the usefulness of this information are welcome and can be sent to Mr. Nelson at the above address. This publication is not copyrighted and can be reproduced without penalty. Normal procedures for credit to the author and the National Park Service are appreciated. **February 1978.**

Decorative features such as cupolas require extra maintenance. The flashing is carefully detailed to promote run-off, and the wooden ribbing must be kept well-painted. This roof surface, which was originally tin plate, has been replaced with lead-coated copper for maintenance purposes. (Lyndhurst, Tarrytown, New York, photo courtesy of the National Trust for Historic Preservation)

Additional readings on the subject of roofing are listed below.

Boaz, Joseph N., ed. *Architectural Graphic Standards.* New York: John Wiley and Sons, Inc., 1970. (Modern roofing types and detailing)

Briggs, Martin S. *A Short History of the Building Crafts.* London: Oxford University Press, 1925. (Descriptions of historic roofing materials)

Bulletin of the Association for Preservation Technology. Vol. 2 (nos. 1–2) 1970. (Entirely on roofing)

Holstrom, Ingmar; and Sandstrom, Christina. *Maintenance of Old Buildings: Preservation from the Technical and Antiquarian Standpoint.* Stockholm: National Swedish Building Research, 1972. (Contains a section on roof maintenance problems)

Insall, Donald. *The Care of Old Buildings Today.* London: The Architectural Press, 1972. (Excellent guide to some problems and solutions for historic roofs)

Labine, R.A. Clem. "Repairing Slate Roofs." *The Old House Journal* 3 (no. 12, Dec. 1975): 6–7.

Lefer, Henry. "A Birds-eye View." *Progressive Architecture.* (Mar. 1977), pp. 88–92. (Article on contemporary sheet metal)

National Slate Association. *Slate Roofs.* Reprint of 1926 edition, now available from the Vermont Structural Slate Co., Inc., Fairhaven, VT 05743. (An excellent reference for the many designs and details of slate roofs)

Peterson, Charles E. "Iron in Early American Roofs." *The Smithsonian Journal of History* 3 (no. 3). Edited by Peter C. Welsh. Washington, D.C.: Smithsonian Institution, 1968, pp. 41–76.

Waite, Diana S. *Nineteenth Century Tin Roofing and its Use at Hyde Hall.* Albany: New York State Historic Trust, 1971.

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10 PRESERVATION BRIEFS

Exterior Paint Problems on Historic Woodwork

Kay D. Weeks and David W. Look, AIA

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National Park Service
Cultural Resources

Heritage Preservation Services

A cautionary approach to paint removal is included in the guidelines to "The Secretary of the Interior Standards for Historic Preservation Projects." Removing paints down to bare wood surfaces using harsh methods can permanently damage those surfaces; therefore such methods are not recommended. Also, total removal obliterates evidence of the historical paints and their sequence and architectural context.

This Brief expands on that advice for the architect, building manager, contractor, or homeowner by identifying and describing common types of paint surface conditions and failures, then recommending appropriate treatments for preparing exterior wood surfaces for repainting[1] to assure the best adhesion and greatest durability of the new paint. Although the Brief focuses on responsible methods of "paint removal," several paint surface conditions will be described which do not require any paint removal, and still others which can be successfully handled by limited paint removal. In all cases, the information is intended to address the concerns related to *exterior wood*. It will also be generally assumed that, because houses built before 1950 involve one or more layers of lead-base paint,[2] the majority of conditions warranting paint removal will mean dealing with this toxic substance along with the dangers of the paint removal tools and chemical strippers themselves.

Purposes of Exterior Paint

Paint[3] applied to exterior wood must withstand yearly extremes of both temperature and humidity. While never expected to be more than a temporary physical shield—requiring re-application every 5-8 years—its importance should not be minimized. Because one of the main causes of wood deterioration is moisture penetration, a primary purpose for painting wood is to exclude such moisture, thereby slowing deterioration not only of a building's exterior siding and decorative features but, ultimately, its underlying structural members. Another important purpose for painting wood is, of course, to define and accent architectural features and to improve appearance.

Treating Paint Problems in Historic Buildings

Exterior paint is constantly deteriorating through the processes of weathering, but in a program of regular maintenance—assuming all other building systems are functioning properly—surfaces can be cleaned, lightly scraped, and hand sanded in preparation for a new finish coat. Unfortunately, these are ideal conditions. More often, complex maintenance problems are inherited by owners of historic buildings, including areas of paint that have failed[4] beyond the point of mere cleaning, scraping, and hand sanding (although much so-called "paint failure" is attributable to interior or exterior moisture problems or surface preparation and application mistakes with previous coats).

Although paint problems are by no means unique to historic buildings, treating multiple layers of hardened, brittle paint on complex, ornamental—and possibly fragile—exterior wood surfaces necessarily requires an extremely cautious approach (see figure 1). In the case of recent construction, this level of concern is not needed because the wood is generally less detailed and, in addition, retention of the sequence of paint layers as a partial record of the building's history is not an issue.

When historic buildings are involved, however, a special set of problems arises—varying in complexity depending upon their age, architectural style, historical importance, and physical soundness of the wood—which must be carefully evaluated so that decisions can be made that are sensitive to the longevity of the resource.

Justification for Paint Removal

At the outset of this Brief, it must be emphasized that removing paint from historic buildings—with the exception of cleaning, light scraping, and hand sanding as part of routine maintenance—should be avoided unless absolutely essential. *Once conditions warranting removal have*

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[1] General paint type recommendations will be made, but paint color recommendations are beyond the scope of this Brief.

[2] Douglas R. Shier and William Hall, *Analysis of Housing Data Collected in a Lead-Based Paint Survey in Pittsburgh, Pennsylvania, Part 1*, National Bureau of Standards, Inter-Report 77-1250, May 1977.

[3] Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer which is converted to an opaque solid film after application. *Paint and Coatings Dictionary*, 1978. Federation of Societies for Coatings and Technology.

[4] For purposes of the Brief, this includes any area of painted exterior woodwork displaying signs of peeling, cracking, or alligatoring to bare wood. See descriptions of these and other paint surface conditions as well as recommended treatments on pp. 5-10.

Fig. 1 *Excessive paint build-up on architectural details such as this ornamental bracket does not in itself justify total paint removal. If paint is cracked and peeling down to bare wood, however, it should be removed using the gentlest means possible. Photo: David W. Look, AIA.*

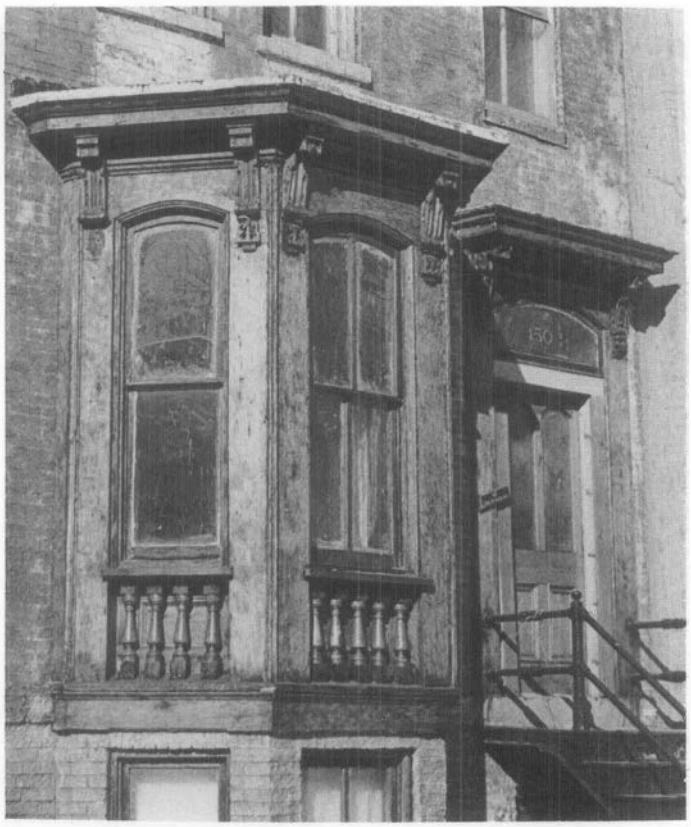

Fig. 2 *A traditionally painted bay window has been stripped to bare wood, then varnished. In addition to being historically inaccurate, the varnish will break down faster as a result of the sun's ultraviolet rays than would primer and finish coats of paint. Photo: David W. Look, AIA.*

been identified, the general approach should be to remove paint to the next sound layer using the gentlest means possible, then to repaint (see figure 2). Practically speaking as well, paint can adhere just as effectively to existing paint as to bare wood, providing the previous coats of paint are also adhering uniformly and tightly to the wood and the surface is properly prepared for repainting—cleaned of dirt and chalk and dulled by sanding. But, if painted exterior wood surfaces display continuous patterns of deep cracks or if they are extensively blistering and peeling so that bare wood is visible, then the old paint should be completely removed before repainting. The only other justification for removing all previous layers of paint is if doors, shutters, or windows have literally been "painted shut," or if new wood is being pieced-in adjacent to old painted wood and a smooth transition is desired (see figure 3).

Paint Removal Precautions

Because paint removal is a difficult and painstaking process, a number of costly, regrettable experiences have occurred—and continue to occur—for both the historic building and the building owner. Historic buildings have been set on fire with blow torches; wood irreversibly scarred by sandblasting or by harsh mechanical devices such as rotary sanders and rotary wire strippers; and layers of historic paint inadvertently and unnecessarily removed. In addition, property owners, using techniques that substitute speed for safety, have been injured by toxic lead vapors or dust from the paint they were trying to remove or by misuse of the paint removers themselves.

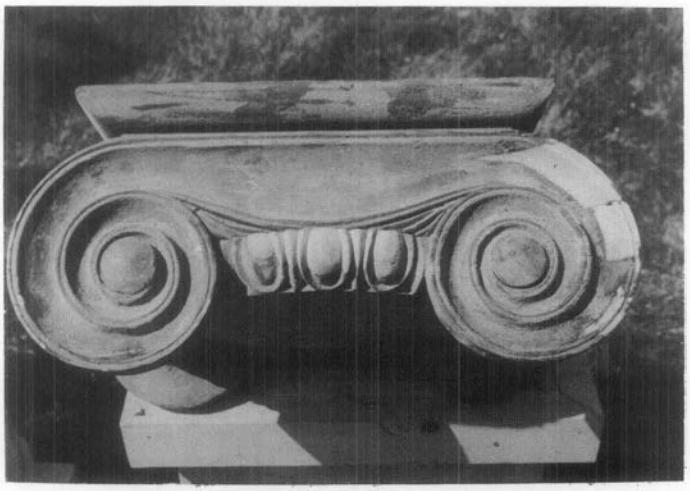

Fig. 3 *If damage to parts of a wooden element is severe, new sections of wood will need to be pieced-in. When such piecing is required, paint on the adjacent woodwork should be removed so that the old and new woods will make a smooth profile when joined. After repainting, the repair should be virtually impossible to detect. Photo: Morgan W. Phillips.*

Owners of historic properties considering paint removal should also be aware of the amount of time and labor involved. While removing damaged layers of paint from a door or porch railing might be readily accomplished within a reasonable period of time by one or two people, removing paint from larger areas of a building can, with-

out professional assistance, easily become unmanageable and produce less than satisfactory results. The amount of work involved in any paint removal project must therefore be analyzed on a case-by-case basis. Hiring qualified professionals will often be a cost-effective decision due to the expense of materials, the special equipment required, and the amount of time involved. Further, paint removal companies experienced in dealing with the inherent health and safety dangers of paint removal should have purchased such protective devices as are needed to mitigate any dangers and should also be aware of State or local environmental and/or health regulations for hazardous waste disposal.

All in all, paint removal is a messy, expensive, and potentially dangerous aspect of rehabilitating or restoring historic buildings and should not be undertaken without careful thought concerning first, its necessity, and second, which of the available recommended methods is the safest and most appropriate for the job at hand.

Repainting Historic Buildings for Cosmetic Reasons

If existing exterior paint on wood siding, eaves, window sills, sash, and shutters, doors, and decorative features shows no evidence of paint deterioration such as chalking, blistering, peeling, or cracking, then there is no *physical reason* to repaint, much less remove paint! Nor is color fading, of itself, sufficient justification to repaint a historic building.

The decision to repaint may not be based altogether on paint failure. Where there is a new owner, or even where ownership has remained constant through the years, taste in colors often changes. Therefore, if repainting is primarily to alter a building's primary and accent colors, a technical factor of paint accumulation should be taken into consideration. When paint builds up to a thickness of approximately 1/16" (approximately 16-30 layers), one or more extra coats of paint may be enough to trigger cracking and peeling in limited or even widespread areas of the building's surface. This results because excessively thick paint is less able to withstand the shrinkage or pull of an additional coat as it dries and is also less able to tolerate thermal stresses. Thick paint invariably fails at the weakest point of adhesion—the oldest layers next to the wood. Cracking and peeling follow. Therefore, if there are no signs of paint failure, it may be somewhat risky to add still another layer of unneeded paint simply for color's sake (extreme changes in color may also require more than one coat to provide proper hiding power and full color). When paint appears to be nearing the critical thickness, a change of accent colors (that is, just to limited portions of the trim) might be an acceptable compromise without chancing cracking and peeling of paint on wooden siding.

If the decision to repaint is nonetheless made, the "new" color or colors should, at a minimum, be appropriate to the style and setting of the building. On the other hand, where the intent is to restore or accurately reproduce the colors originally used or those from a significant period in the building's evolution, they should be based on the results of a paint analysis.[5]

Identification of Exterior Paint Surface Conditions/Recommended Treatments

It is assumed that a preliminary check will already have been made to determine, first, that the painted exterior surfaces are indeed wood—and not stucco, metal, or other wood substitutes—and second, that the wood has not decayed so that repainting would be superfluous. For example, if any area of bare wood such as window sills has been exposed for a long period of time to standing water, wood rot is a strong possibility (see figure 4). Repair or replacement of deteriorated wood should take place before repainting. After these two basic issues have been resolved, the surface condition identification process may commence.

The historic building will undoubtedly exhibit a variety of exterior paint surface conditions. For example, paint on the wooden siding and doors may be adhering firmly; paint on the eaves peeling; and paint on the porch balusters and window sills cracking and alligatoring. The accurate identification of each paint problem is therefore the first step in planning an appropriate overall solution.

Paint surface conditions can be grouped according to their relative severity: CLASS I conditions include minor blemishes or dirt collection and generally require *no* paint removal; CLASS II conditions include failure of the top layer or layers of paint and generally require *limited* paint removal; and CLASS III conditions include substantial or multiple-layer failure and generally require *total* paint removal. It is precisely because conditions will vary at different points on the building that a careful inspection is critical. Each item of painted exterior woodwork (i.e., siding, doors, windows, eaves, shutters, and decorative elements) should be examined early in the planning phase and surface conditions noted.

CLASS I Exterior Surface Conditions Generally Requiring No Paint Removal

- **Dirt, Soot, Pollution, Cobwebs, Insect Cocoons, etc.**

Cause of Condition

Environmental "grime" or organic matter that tends to cling to painted exterior surfaces and, in particular, protected surfaces such as eaves, do not constitute a paint problem unless painted over rather than removed prior to repainting. If not removed, the surface deposits can be a barrier to proper adhesion and cause peeling.

Recommended Treatment

Most surface matter can be loosened by a strong, direct stream of water from the nozzle of a garden hose. Stubborn dirt and soot will need to be scrubbed off using ½ cup of household detergent in a gallon of water with a medium soft bristle brush. The cleaned surface should then be rinsed thoroughly, and permitted to dry before further inspection to determine if repainting is necessary. Quite often, cleaning provides a satisfactory enough result to postpone repainting.

[5] See the Reading List for paint research and documentation information. See also *The Secretary of the Interior's Standards for Historic Preservation Projects with Guidelines for Applying the Standards* for recommended approaches on paints and finishes within various types of project work treatments.

- **Mildew**

Cause of Condition

Mildew is caused by fungi feeding on nutrients contained in the paint film or on dirt adhering to any surface. Because moisture is the single most important factor in its growth, mildew tends to thrive in areas where dampness and lack of sunshine are problems such as window sills, under eaves, around gutters and downspouts, on the north side of buildings, or in shaded areas near shrubbery. It may sometimes be difficult to distinguish mildew from dirt, but there is a simple test to differentiate: if a drop of household bleach is placed on the suspected surface, mildew will immediately turn white whereas dirt will continue to look like dirt.

Recommended Treatment

Because mildew can only exist in shady, warm, moist areas, attention should be given to altering the environment that is conducive to fungal growth. The area in question may be shaded by trees which need to be pruned back to allow sunlight to strike the building; or may lack rain gutters or proper drainage at the base of the building. If the shady or moist conditions can be altered, the mildew is less likely to reappear. A recommend solution for removing mildew consists of one cup non-ammoniated detergent, one quart household bleach, and one gallon water. When the surface is scrubbed with this solution using a medium soft brush, the mildew should disappear; however, for particularly stubborn spots, an additional quart of bleach may be added. After the area is mildew-free, it should then be rinsed with a direct stream of water from the nozzle of a garden hose, and permitted to dry thoroughly. When repainting, specially formulated "mildew-resistant" primer and finish coats should be used.

- **Excessive Chalking**

Cause of Condition

Chalking—or powdering of the paint surface—is caused by the gradual disintegration of the resin in the paint film. (The amount of chalking is determined both by the formulation of the paint and the amount of ultraviolet light to which the paint is exposed.) In moderation, chalking is the ideal way for a paint to "age," because the chalk, when rinsed by rainwater, carries discoloration and dirt away with it and thus provides an ideal surface for repainting. In excess, however, it is not desirable because the chalk can wash down onto a surface of a different color beneath the painted area and cause streaking as well as rapid disintegration of the paint film itself. Also, if a paint contains too much pigment for the amount of binder (as the old white lead carbonate/oil paints often did), excessive chalking can result.

Recommended Treatment

The chalk should be cleaned off with a solution of ½ cup household detergent to one gallon water, using a medium soft bristle brush. After scrubbing to remove the chalk, the surface should be rinsed with a direct stream of water from the nozzle of a garden hose, allowed to dry thoroughly, (but not long enough for the chalking process to recur) and repainted, using a non-chalking paint.

- **Staining**

Cause of Condition

Staining of paint coatings usually results from excess moisture reacting with materials within the wood substrate. There are two common types of staining, neither of which requires paint removal. The most prevalent type of stain is due to the oxidation or rusting of iron nails or metal (iron, steel, or copper) anchorage devices. A second type of stain is caused by a chemical reaction between moisture and natural extractives in certain woods (red cedar or redwood) which results in a surface deposit of colored matter. This is most apt to occur in new replacement wood within the first 10-15 years.

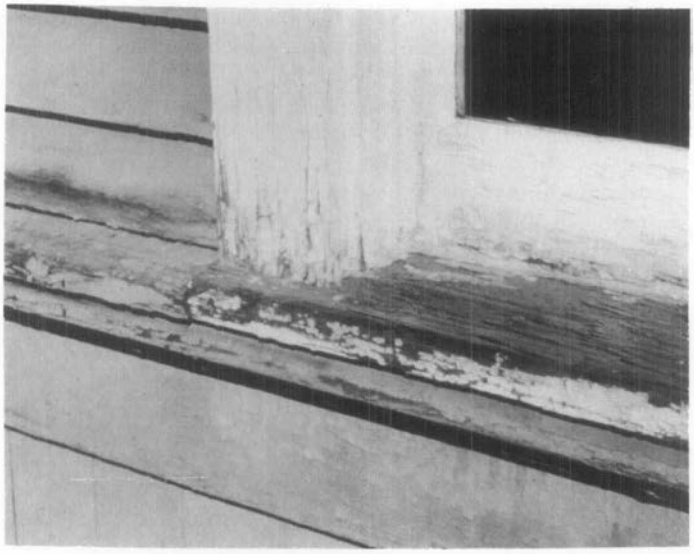

Fig. 4 *Paint films wear unevenly depending on exposure and location. Exterior locations which are susceptible to accelerated deterioration are horizontal surfaces such as window sills. These and similar areas will require repainting more often than less vulnerable surfaces. In the case of this window sill where paint has peeled off and adjacent areas have cracked and alligatored, the paint should be totally removed. Prior to repainting, any weathered wood should be rejuvenated using a solution of 3 cups exterior varnish, 1 oz. paraffin wax, and mineral spirits/paint thinner/or turpentine to make 1 gallon. Liberal brush application should be made. This formula was tested over a 20-year period by the U.S. Department of Agriculture's Forest Products Laboratory and proved to be just as effective as water-repellent preservatives containing pentachlorophenol. After the surface has thoroughly dried (2-3 days of warm weather), the treated surface can be painted. A high quality oil-base primer followed by two top coats of a semi-gloss oil-enamel or latex-enamel paint is recommended. Photo: Baird M. Smith, AIA.*

Recommended Treatment

In both cases, the source of the stain should first be located and the moisture problem corrected.

When stains are caused by rusting of the heads of nails used to attach shingles or siding to an exterior wall or by rusting or oxidizing iron, steel, or copper anchorage devices adjacent to a painted surface, the metal objects themselves should be hand sanded and coated with a rust-inhibitive primer followed by two finish coats. (Exposed nail heads should ideally be countersunk, spot primed, and the holes filled with a high quality wood filler except where exposure of the nail head was part of the original construction system or the wood is too fragile to withstand the countersinking procedure.)

Discoloration due to color extractives in replacement wood can usually be cleaned with a solution of equal parts denatured alcohol and water. After the affected area

has been rinsed and permitted to dry, a "stain-blocking primer" especially developed for preventing this type of stain should be applied (two primer coats are recommended for severe cases of bleeding prior to the finish coat). Each primer coat should be allowed to dry at least 48 hours.

CLASS II Exterior Surface Conditions Generally Requiring Limited Paint Removal

- **Crazing**

Cause of Condition

Crazing—fine, jagged interconnected breaks in the top layer of paint—results when paint that is several layers thick becomes excessively hard and brittle with age and is consequently no longer able to expand and contract with the wood in response to changes in temperature and humidity (see figure 5). As the wood swells, the bond between paint layers is broken and hairline cracks appear. Although somewhat more difficult to detect as opposed to other more obvious paint problems, it is well worth the time to scrutinize all surfaces for crazing. If not corrected, exterior moisture will enter the crazed surface, resulting in further swelling of the wood and, eventually, deep cracking and alligatoring, a Class III condition which requires total paint removal.

Recommended Treatment

Crazing can be treated by hand or mechanically sanding the surface, then repainting. Although the hairline cracks may tend to show through the new paint, the surface will be protected against exterior moisture penetration.

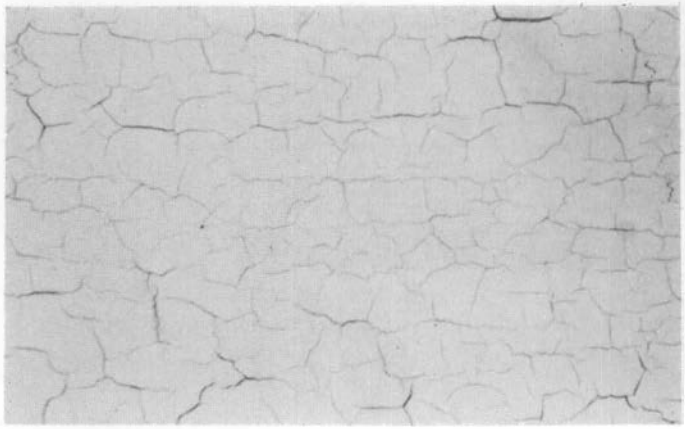

Fig. 5 *Crazing—or surface cracking—is an exterior surface condition which can be successfully treated by sanding and painting. Photo: Courtesy, National Decorating Products Association.*

- **Intercoat Peeling**

Cause of Condition

Intercoat peeling can be the result of improper surface preparation prior to the last repainting. This most often occurs in protected areas such as eaves and covered porches because these surfaces do not receive a regular rinsing from rainfall, and salts from air-borne pollutants thus accumulate on the surface. If not cleaned off, the new paint coat will not adhere properly and that layer will peel.

Another common cause of intercoat peeling is incompatibility between paint types (see figure 6). For example, if oil paint is applied over latex paint, peeling of the top coat can sometimes result since, upon aging, the oil paint becomes harder and less elastic than the latex paint. If latex paint is applied over old, chalking oil paint, peeling can also occur because the latex paint is unable to penetrate the chalky surface and adhere.

Recommended Treatment

First, where salts or impurities have caused the peeling, the affected area should be washed down thoroughly after scraping, then wiped dry. Finally, the surface should be hand or mechanically sanded, then repainted.

Where peeling was the result of using incompatible paints, the peeling top coat should be scraped and hand or mechanically sanded. Application of a high quality oil type exterior primer will provide a surface over which either an oil or a latex topcoat can be successfully used.

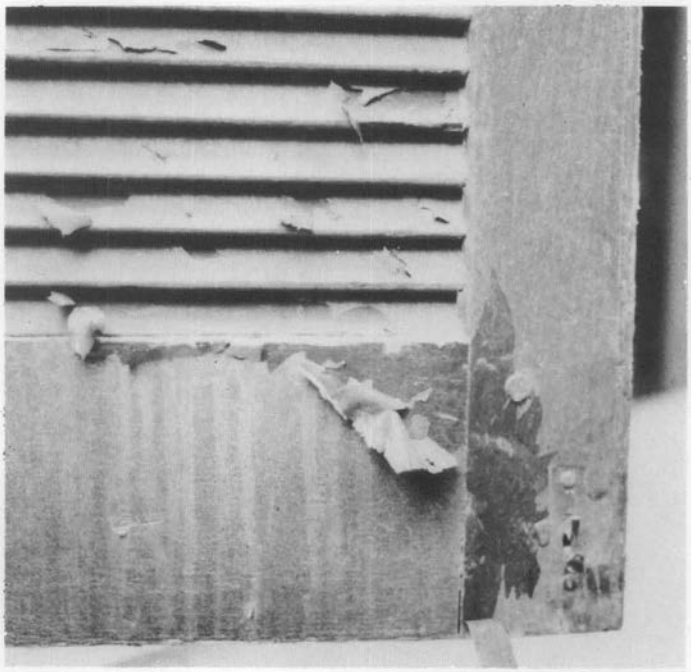

Fig. 6 *This is an example of intercoat peeling. A latex top coat was applied directly over old oil paint and, as a result, the latex paint was unable to adhere. If latex is being used over oil, an oil-base primer should be applied first. Although much of the peeling latex paint can be scraped off, in this case, the best solution may be to chemically dip strip the entire shutter to remove all of the paint down to bare wood, rinse thoroughly, then repaint. Photo: Mary L. Oehrlein, AIA.*

- **Solvent Blistering**

Cause of Condition

Solvent blistering, the result of a less common application error, is not caused by moisture, but by the action of ambient heat on paint solvent or thinners in the paint film. If solvent-rich paint is applied in direct sunlight, the top surface can dry too quickly and, as a result, solvents become trapped beneath the dried paint film. When the solvent vaporizes, it forces its way through the paint film, resulting in surface blisters. This problem occurs more often with dark colored paints because darker colors absorb more heat than lighter ones. To distinguish between solvent blistering and blistering caused by moisture, a blister should be cut open. If another layer of paint is visible, then solvent blistering is likely the problem whereas if bare wood is revealed, moisture is probably to blame. Solvent blisters are generally small.

Recommended Treatment

Solvent-blistered areas can be scraped, hand or mechanically sanded to the next sound layer, then repainted. In order to prevent blistering of painted surfaces, paint should not be applied in direct sunlight.

- **Wrinkling**

Cause of Condition

Another error in application that can easily be avoided is wrinkling (see figure 7). This occurs when the top layer of paint dries before the layer underneath. The top layer of paint actually moves as the paint underneath (a primer, for example) is drying. Specific causes of wrinkling include: (1) applying paint too thick; (2) applying a second coat before the first one dries; (3) inadequate brushing out; and (4) painting in temperatures higher than recommended by the manufacturer.

Recommended Treatment

The wrinkled layer can be removed by scraping followed by hand or mechanical sanding to provide as even a surface as possible, then repainted following manufacturer's application instructions.

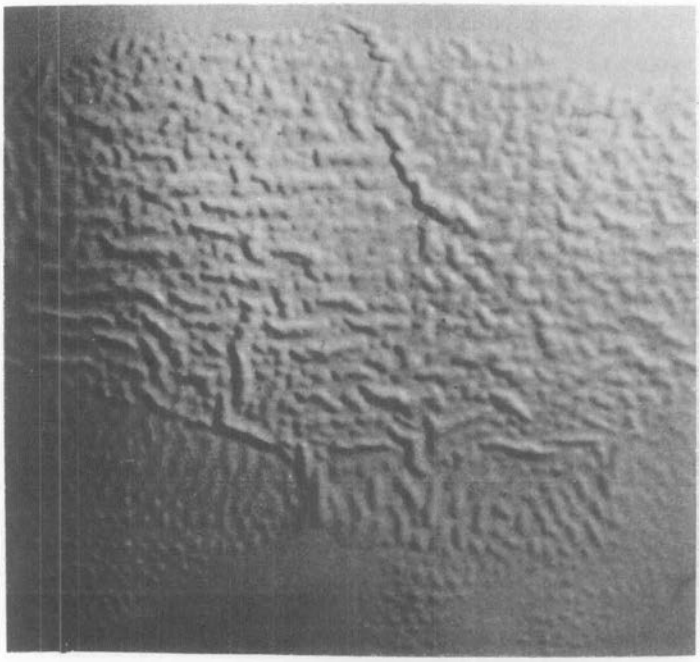

Fig. 7 *Wrinkled layers can generally be removed by scraping and sanding as opposed to total paint removal. Following manufacturers' application instructions is the best way to avoid this surface condition. Photo: Courtesy, National Decorating Products Association.*

CLASS III Exterior Surface Conditions Generally Requiring Total Paint Removal

If surface conditions are such that the majority of paint will have to be removed prior to repainting, it is suggested that a small sample of intact paint be left in an inconspicuous area either by covering the area with a metal plate, or by marking the area and identifying it in some way. (When repainting does take place, the sample should not be painted over). This will enable future investigators to have a record of the building's paint history.

- **Peeling**

Cause of Condition

Peeling to bare wood is most often caused by excess interior or exterior moisture that collects behind the paint film, thus impairing adhesion (see figure 8). Generally beginning as blisters, cracking and peeling occur as moisture causes the wood to swell, breaking the adhesion of the bottom layer.

Recommended Treatment

There is no sense in repainting before dealing with the moisture problems because new paint will simply fail. Therefore, the first step in treating peeling is to locate and remove the source or sources of the moisture, not only because moisture will jeopardize the protective coating of paint but because, if left unattended, it can ultimately cause permanent damage to the wood. Excess interior moisture should be removed from the building through installation of exhaust fans and vents. Exterior moisture should be eliminated by correcting the following conditions prior to repainting: faulty flashing; leaking gutters; defective roof shingles; cracks and holes in siding and trim; deteriorated caulking in joints and seams; and shrubbery growing too close to painted wood. After the moisture problems have been solved, the wood must be permitted to dry out thoroughly. The damaged paint can then be scraped off with a putty knife, hand or mechanically sanded, primed, and repainted.

Fig. 8 *Peeling to bare wood—one of the most common types of paint failure—is usually caused by an interior or exterior moisture problem. Photo: Anne E. Grimmer.*

- **Cracking/Alligatoring**

Cause of Condition

Cracking and alligatoring are advanced stages of crazing (see figure 9). Once the bond between layers has been broken due to intercoat paint failure, exterior moisture is able to penetrate the surface cracks, causing the wood to swell and deeper cracking to take place. This process continues until cracking, which forms parallel to grain, extends to bare wood. Ultimately, the cracking becomes an overall pattern of horizontal and vertical breaks in the paint layers that looks like reptile skin; hence, "alligatoring." In advanced stages of cracking and alligatoring, the surfaces will also flake badly.

Recommended Treatment

If cracking and alligatoring are present only in the top layers they can probably be scraped, hand or mechanically sanded to the next sound layer, then repainted. However, if cracking and/or alligatoring have progressed to

bare wood and the paint has begun to flake, it will need to be totally removed. Methods include scraping or paint removal with the electric heat plate, electric heat gun, or chemical strippers, depending on the particular area involved. Bare wood should be primed within 48 hours, then repainted.

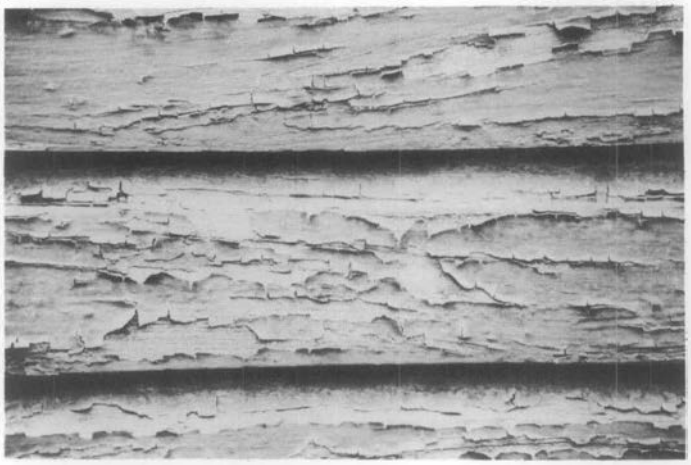

Fig. 9 *Cracking, alligatoring, and flaking are evidence of long-term neglect of painted surfaces. The remaining paint on the clapboard shown here can be removed with an electric heat plate and wide-bladed scraper. In addition, unsound wood should be replaced and moisture problems corrected before primer and top coats of paint are applied. Photo: David W. Look, AIA.*

Selecting the Appropriate/Safest Method to Remove Paint

After having presented the "hierarchy" of exterior paint surface conditions—from a mild condition such as mildewing which simply requires cleaning prior to repainting to serious conditions such as peeling and alligatoring which require total paint removal—one important thought bears repeating: if a paint problem has been identified that warrants either limited or total paint removal, the gentlest method possible for the particular wooden element of the historic building should be selected from the many available methods.

The treatments recommended—based upon field testing as well as onsite monitoring of Department of Interior grant-in-aid and certification of rehabilitation projects—are therefore those which take three over-riding issues into consideration (1) the continued protection and preservation of the historic exterior woodwork; (2) the retention of the sequence of historic paint layers; and (3) the health and safety of those individuals performing the paint removal. By applying these criteria, it will be seen that no paint removal method is without its drawbacks and all recommendations are qualified in varying degrees.

Methods for Removing Paint

After a particular exterior paint surface condition has been identified, the next step in planning for repainting—if paint removal is required—is selecting an appropriate method for such removal.

The method or methods selected should be suitable for the specific paint problem as well as the particular wooden element of the building. Methods for paint removal can be divided into three categories (frequently, however, a combination of the three methods is used). Each method is defined below, then discussed further and specific recommendations made:

Abrasive—"Abrading" the painted surface by manual and/or mechanical means such as scraping and sanding. Generally used for surface preparation and limited paint removal.

Thermal—Softening and raising the paint layers by applying heat followed by scraping and sanding. Generally used for total paint removal.

Chemical—Softening of the paint layers with chemical strippers followed by scraping and sanding. Generally used for total paint removal.

- **Abrasive Methods (Manual)**

If conditions have been identified that require limited paint removal such as crazing, intercoat peeling, solvent blistering, and wrinkling, scraping and hand sanding should be the first methods employed before using mechanical means. Even in the case of more serious conditions such as peeling—where the damaged paint is weak and already sufficiently loosened from the wood surface—scraping and hand sanding may be all that is needed prior to repainting.

Recommended Abrasive Methods (Manual)

Putty Knife/Paint Scraper: Scraping is usually accomplished with either a putty knife or a paint scraper, or both. Putty knives range in width from one to six inches and have a beveled edge. A putty knife is used in a pushing motion going under the paint and working from an area of loose paint toward the edge where the paint is still firmly adhered and, in effect, "beveling" the remaining layers so that as smooth a transition as possible is made between damaged and undamaged areas (see figure 10).

Paint scrapers are commonly available in 1⅝, 2½, and 3½ inch widths and have replaceable blades. In addition, profiled scrapers can be made specifically for use on moldings. As opposed to the putty knife, the paint scraper is used in a pulling motion and works by raking the damaged areas of paint away.

The obvious goal in using the putty knife or the paint scraper is to selectively remove the affected layer or layers of paint; however, both of these tools, particularly the paint scraper with its hooked edge, must be used with care to properly prepare the surface and to avoid gouging the wood.

Sandpaper/Sanding Block/Sanding sponge: After manually removing the damaged layer or layers by scraping, the uneven surface (due to the almost inevitable removal of varying numbers of paint layers in a given area) will need to be smoothed or "feathered out" prior to repainting. As stated before, hand sanding, as opposed to harsher mechanical sanding, is recommended if the area is relatively limited. A coarse grit, open-coat flint sandpaper—the least expensive kind—is useful for this purpose because, as the sandpaper clogs with paint it must be discarded and this process repeated until all layers adhere uniformly.

Blocks made of wood or hard rubber and covered with sandpaper are useful for handsanding flat surfaces. Sanding sponges—rectangular sponges with an abrasive aggregate on their surfaces—are also available for detail work that requires reaching into grooves because the sponge easily conforms to curves and irregular surfaces. All sanding should be done with the grain.

Summary of Abrasive Methods (Manual)

Recommended: Putty knife, paint scraper, sandpaper, sanding block, sanding sponge.
Applicable areas of building: All areas.
For use on: Class I, Class II, and Class III conditions.
Health/Safety factors: Take precautions against lead dust, eye damage; dispose of lead paint residue properly.

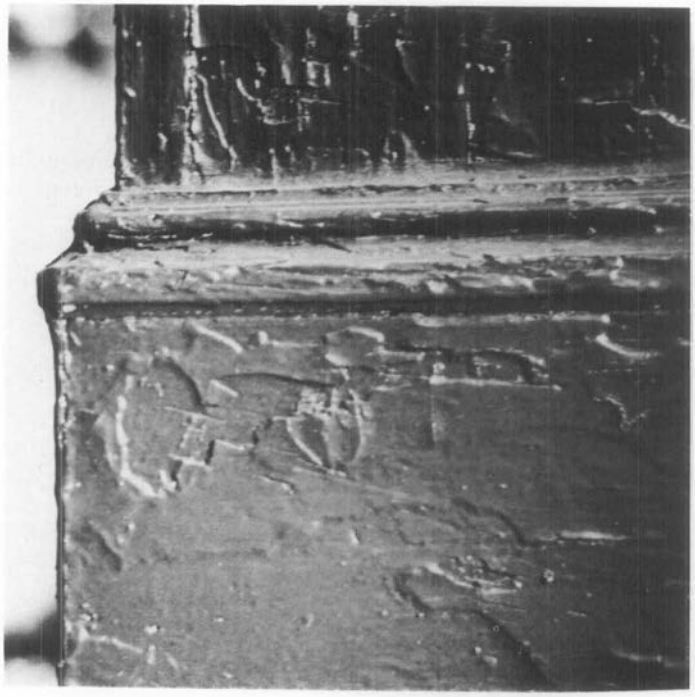

Fig. 10 *An excellent example of inadequate scraping before repainting, the problems here are far more than cosmetic. This improperly prepared surface will permit moisture to get behind the paint film which, in turn, will result in chipping and peeling. Photo: Baird M. Smith, AIA.*

- **Abrasive Methods (Mechanical)**

If hand sanding for purposes of surface preparation has not been productive or if the affected area is too large to consider hand sanding by itself, mechanical abrasive methods, i.e., power-operated tools may need to be employed; however, it should be noted that the majority of tools available for paint removal can cause damage to fragile wood and must be used with great care.

Recommended Abrasive Methods (Mechanical)

Orbital sander: Designed as a finishing or smoothing tool—not for the removal of multiple layers of paint—the oribital sander is thus recommended when limited paint removal is required prior to repainting. Because it sands in a small diameter circular motion (some models can also be switched to a back-and-forth vibrating action), this tool is particularly effective for "feathering" areas where paint has first been scraped (see figure 11). The abrasive surface varies from about 3×7 inches to 4×9 inches and sandpaper is attached either by clamps or sliding clips. A medium grit, open-coat aluminum oxide sandpaper should be used; fine sandpaper clogs up so quickly that it is ineffective for smoothing paint.

Belt sander: A second type of power tool—the belt sander—can also be used for removing limited layers of paint but, in this case, the abrasive surface is a continuous belt of sandpaper that travels at high speeds and consequently offers much less control than the orbital sander. Because of the potential for more damage to the paint or the wood, use of the belt sander (also with a medium grit sandpaper) should be limited to flat surfaces and only skilled operators should be permitted to operate it within a historic preservation project.

Fig. 11 *The orbital sander can be used for limited paint removal, i.e., for smoothing flat surfaces after the majority of deteriorated paint has already been scraped off. Photo: Charles E. Fisher, III.*

Not Recommended

Rotary Drill Attachments: Rotary drill attachments such as the rotary sanding disc and the rotary wire stripper should be avoided. The disc sander—usually a disc of sandpaper about 5 inches in diameter secured to a rubber based attachment which is in turn connected to an electric drill or other motorized housing—can easily leave visible circular depressions in the wood which are difficult to hide, even with repainting. The rotary wire stripper—clusters of metals wires similarly attached to an electric drill-type unit—can actually shred a wooden surface and is thus to be used exclusively for removing corrosion and paint from metals.

Waterblasting: Waterblasting above 600 p.s.i. to remove paint is not recommended because it can force water into the woodwork rather than cleaning loose paint and grime from the surface; at worst, high pressure waterblasting causes the water to penetrate exterior sheathing and damages interior finishes. A detergent solution, a medium soft bristle brush, and a garden hose for purposes of rinsing, is the gentlest method involving water and is recommended when cleaning exterior surfaces prior to repainting.

Sandblasting: Finally—and undoubtedly most vehemently "not recommended"—sandblasting painted exterior woodwork will indeed remove paint, but at the same time can scar wooden elements beyond recognition. As with rotary wire strippers, sandblasting erodes the soft porous fibers (spring wood) faster than the hard, dense fibers (summer wood), leaving a pitted surface with ridges and valleys. Sandblasting will also erode projecting areas of carvings and moldings before it removes paint from concave areas (see figure 12). Hence, this abrasive method is potentially the most damaging of all possibilities, even if a contractor promises that blast pressure can be controlled so that the paint is removed without harming the historic exterior woodwork. (For Additional Information, See Presevation Briefs 6, "Dangers of Abrasive Cleaning to Historic Buildings".)

Fig. 12 *Sandblasting has permanently damaged this ornamental bracket. Even paint will not be able to hide the deep erosion of the wood. Photo: David W. Look, AIA.*

Summary of Abrasive Methods (Mechanical)

Recommended: Orbital sander, belt sander (skilled operator only).
Applicable areas of building: Flat surfaces, i.e., siding, eaves, doors, window sills.
For use on: Class II and Class III conditions.
Health/Safety factors: Take precautions against lead dust and eye damage; dispose of lead paint residue properly.
Not Recommended: Rotary drill attachments, high pressure waterblasting, sandblasting.

- **Thermal Methods**

Where exterior surface conditions have been identified that warrant total paint removal such as peeling, cracking, or alligatoring, two thermal devices—the electric heat plate and the electric heat gun—have proven to be quite successful for use on different wooden elements of the historic building. One thermal method—the blow torch—is not recommended because it can scorch the wood or even burn the building down!

Recommended Thermal Methods

Electric heat plate: The electric heat plate (see figure 13) operates between 500 and 800 degrees Fahrenheit (not hot enough to vaporize lead paint), using about 15 amps of power. The plate is held close to the painted exterior surface until the layers of paint begin to soften and blister, then moved to an adjacent location on the wood while the softened paint is scraped off with a putty knife (it should be noted that the heat plate is most successful when the paint is very thick!). With practice, the operator can successfully move the heat plate evenly across a flat surface such as wooden siding or a window sill or door in a continuous motion, thus lessening the risk of scorching the wood in an attempt to reheat the edge of the paint sufficiently for effective removal. Since the electric heat plate's coil is "red hot," extreme caution should be taken to avoid igniting clothing or burning the skin. If an extension cord is used, it should be a heavy-duty cord (with 3-prong grounded plugs). A heat plate could overload a circuit or, even worse, cause an electrical fire; therefore, it is recommended that this implement be used with a single circuit and that a fire extinguisher always be kept close at hand.

Fig. 13 *The electric heat plate (with paint scraper) is particularly useful for removing paint down to bare wood on flat surfaces such as doors, window frames, and siding. After scraping, some light sanding will probably be necessary to smooth the surface prior to application of primer and top coats. Photo: David W. Look, AIA.*

Electric heat gun: The electric heat gun (electric hot-air gun) looks like a hand-held hairdryer with a heavy-duty metal case (see figure 14). It has an electrical resistance coil that typically heats between 500 and 750 degrees Fahrenheit and, again, uses about 15 amps of power which requires a heavy-duty extension cord. There are some heat guns that operate at higher temperatures but they should not be purchased for removing old paint

because of the danger of lead paint vapors. The temperature is controlled by a vent on the side of the heat gun. When the vent is closed, the heat increases. A fan forces a stream of hot air against the painted woodwork, causing a blister to form. At that point, the softened paint can be peeled back with a putty knife. It can be used to best advantage when a paneled door was originally varnished, then painted a number of times. In this case, the paint will come off quite easily, often leaving an almost pristine varnished surface behind. Like the heat plate, the heat gun works best on a heavy paint build-up. (It is, however, not very successful on only one or two layers of paint or on surfaces that have only been varnished. The varnish simply becomes sticky and the wood scorches.)

Although the heat gun is heavier and more tiring to use than the heat plate, it is particularly effective for removing paint from detail work because the nozzle can be directed at curved and intricate surfaces. Its use is thus more limited than the heat plate, and most successfully used in conjunction *with* the heat plate. For example, it takes about two to three hours to strip a paneled door with a heat gun, but if used in combination with a heat plate for the large, flat area, the time can usually be cut in half. Although a heat gun seldom scorches wood, it can cause fires (like the blow torch) if aimed at the dusty cavity between the exterior sheathing and siding and interior lath and plaster. A fire may smolder for hours before flames break through to the surface. Therefore, this thermal device is best suited for use on solid decorative elements, such as molding, balusters, fretwork, or "gingerbread."

Fig. 14 *The nozzle on the electric heat gun permits hot air to be aimed into cavities on solid decorative elements such as this applied column. After the paint has been sufficiently softened, it can be removed with a profiled scraper. Photo: Charles E. Fisher, III.*

Not Recommended

Blow Torch: Blow torches, such as hand-held propane or butane torches, were widely used in the past for paint removal because other thermal devices were not available. With this technique, the flame is directed toward the paint until it begins to bubble and loosen from the surface. Then the paint is scraped off with a putty knife. Although this is a relatively fast process, at temperatures between 3200 and 3800 degrees Fahrenheit the open flame is not only capable of burning a careless operator and causing severe damage to eyes or skin, it can easily scorch or ignite the wood. The other fire hazard is more insidious. Most frame buildings have an air space between the exterior sheathing and siding and interior lath and plaster. This cavity usually has an accumulation of dust which is also easily ignited by the open flame of a blow torch. Finally, lead-base paints will vaporize at high temperatures, releasing toxic fumes that can be unknowingly inhaled. Therefore, because both the heat plate and the heat gun are generally safer to use—that is, the risks are much more controllable—the blow torch should definitely be avoided!

Summary of Thermal Methods

Recommended: Electric heat plate, electric heat gun.
Applicable areas of building: Electric heat plate—flat surfaces such as siding, eaves, sash, sills, doors. Electric heat gun—solid decorative molding, balusters, fretwork, or "gingerbread."
For use on: Class III conditions.
Health/Safety factors: Take precautions against eye damage and fire. Dispose of lead paint residue properly.
Not Recommended: Blow torch.

- **Chemical Methods**

With the availability of effective thermal methods for total paint removal, the need for chemical methods—in the context of preparing historic exterior woodwork for repainting—becomes quite limited. Solvent-base or caustic strippers may, however, play a supplemental role in a number of situations, including:

- Removing paint residue from intricate decorative features, or in cracks or hard to reach areas if a heat gun has not been completely effective;
- Removing paint on window muntins because heat devices can easily break the glass;
- Removing varnish on exterior doors after all layers of paint have been removed by a heat plate/heat gun if the original varnish finish is being restored;
- Removing paint from detachable wooden elements such as exterior shutters, balusters, columns, and doors by dip-stripping when other methods are too laborious.

Recommended Chemical Methods
(Use With Extreme Caution)

Because all chemical paint removers can involve potential health and safety hazards, no wholehearted recommendations can be made from that standpoint. Commonly known as "paint removers" or "strippers," both solvent-base or caustic products are commercially available that, when poured, brushed, or sprayed on painted exterior woodwork are capable of softening several layers of paint at a time so that the resulting "sludge"—which should be remembered is nothing less than the sequence of historic

paint layers—can be removed with a putty knife. Detachable wood elements such as exterior shutters can also be "dip-stripped."

Solvent-base Strippers: The formulas tend to vary, but generally consist of combinations of organic solvents such as methylene chloride, isopropanol, toluol, xylol, and methanol; thickeners such as methyl cellulose; and various additives such as paraffin wax used to prevent the volatile solvents from evaporating before they have time to soak through multiple layers of paint. Thus, while some solvent-base strippers are quite thin and therefore unsuitable for use on vertical surfaces, others, called "semi-paste" strippers, are formulated for use on vertical surfaces or the underside of horizontal surfaces.

However, whether liquid or semi-paste, there are two important points to stress when using any solvent-base stripper: First, the vapors from the organic chemicals can be highly toxic if inhaled; skin contact is equally dangerous because the solvents can be absorbed; second, many solvent-base strippers are flammable. Even though application out-of-doors may somewhat mitigate health and safety hazards, a respirator with special filters for organic solvents is recommended and, of course, solvent-base strippers should never be used around open flames, lighted cigarettes, or with steel wool around electrical outlets.

Although appearing to be the simplest for exterior use, a particular type of solvent-base stripper needs to be mentioned here because it can actually cause the most problems. Known as "water-rinsable," such products have a high proportion of methylene chloride together with emulsifiers. Although the dissolved paint can be rinsed off with water with a minimum of scraping, this ultimately creates more of a problem in cleaning up and properly disposing of the sludge. In addition, these strippers can leave a gummy residue on the wood that requires removal with solvents. Finally, water-rinsable strippers tend to raise the grain of the wood more than regular strippers.

On balance, then, the regular strippers would seem to work just as well for exterior purposes and are perhaps even better from the standpoint of proper lead sludge disposal because they must be hand scraped as opposed to rinsed off (a coffee-can with a wire stretched across the top is one effective way to collect the sludge; when the putty knife is run across the wire, the sludge simply falls into the can. Then, when the can is filled, the wire is removed, the can capped, and the lead paint sludge disposed of according to local health regulations).

Caustic Strippers: Until the advent of solvent-base strippers, caustic strippers were used exclusively when a chemical method was deemed appropriate for total paint removal prior to repainting or refinishing. Now, it is more difficult to find commercially prepared caustic solutions in hardware and paint stores for home-owner use with the exception of lye (caustic soda) because solvent-base strippers packaged in small quantities tend to dominate the market.

Most commercial dip stripping companies, however, continue to use variations of the caustic bath process because it is still the cheapest method available for removing paint. Generally, dip stripping should be left to professional companies because caustic solutions can dissolve skin and permanently damage eyes as well as present serious disposal problems in large quantities.

If exterior shutters or other detachable elements are being sent out[6] for stripping in a caustic solution, it is wise to see samples of the company's finished work. While some companies do a first-rate job, others can leave a residue of paint in carvings and grooves. Wooden elements may also be soaked too long so that the wood grain is raised and roughened, requiring extensive hand sanding later. In addition, assurances should be given by these companies that caustic paint removers will be neutralized with a mild acid solution or at least thoroughly rinsed with water after dipping (a caustic residue makes the wood feel slippery). If this is not done, the lye residue will cause new paint to fail.

Summary of Chemical Methods

Recommended, with extreme caution: Solvent-base strippers, caustic strippers.
Applicable areas of buildings: decorative features, window muntins, doors, exterior shutters, columns, balusters, and railings.
For use on: Class III Conditions.
Health/Safety factors: Take precautions against inhaling toxic vapors; fire; eye damage; and chemical poisoning from skin contact. Dispose of lead residue properly

General Paint Type Recommendations

Based on the assumption that the exterior wood has been painted with oil paint many times in the past and the existing top coat is therefore also an oil paint,* it is recommended that for CLASS I and CLASS II paint surface conditions, a top coat of high quality oil paint be applied when repainting. The reason for recommending oil rather than latex paints is that a coat of latex paint applied directly over old oil paint is more apt to fail. The considerations are twofold. First, because oil paints continue to harden with age, the old surface is sensitive to the added stress of shrinkage which occurs as a new coat of paint dries. Oil paints shrink less upon drying than latex paints and thus do not have as great a tendency to pull the old paint loose. Second, when exterior oil paints age, the binder releases pigment particles, causing a chalky surface. Although for best results, the chalk (or dirt, etc.) should *always* be cleaned off prior to repainting, a coat of new oil paint is more able to penetrate a chalky residue and adhere than is latex paint. Therefore, unless it is possible to thoroughly clean a heavy chalked surface, oil paints—on balance—give better adhesion.

If however, a latex top coat is going to be applied over several layers of old oil paint, an oil primer should be applied first (the oil primer creates a flat, porous surface to which the latex can adhere). After the primer has thoroughly dried, a latex top coat may be applied. In the long run, changing paint types is more time consuming and expensive. An application of a new oil-type top coat on the old oil paint is, thus, the preferred course of action.

[6] Marking the original location of the shutter by number (either by stamping numbers into the end grain with metal numeral dies or cutting numbers into the end with a pen knife) will minimize difficulties when rehanging them.

* If the top coat is latex paint (when viewed by the naked eye or, preferably, with a magnifying glass, it looks like a series of tiny craters) it may either be repainted with new latex paint or with oil paint. Normal surface preparation should precede any repainting.

If **CLASS III** conditions have necessitated total paint removal, there are two options, both of which assure protection of the exterior wood: (1) an oil primer may be applied followed by an oil-type top coat, preferably by the same manufacturer; or (2) an oil primer may be applied followed by a latex top coat, again using the same brand of paint. It should also be noted that primers were never intended to withstand the effects of weathering; therefore, the top coat should be applied as soon as possible after the primer has dried.

Conclusion

The recommendations outlined in this Brief are cautious because at present there is no completely safe and effective method of removing old paint from exterior woodwork. This has necessarily eliminated descriptions of several methods still in a developmental or experimental stage, which can therefore neither be recommended nor precluded from future recommendation. With the ever-increasing number of buildings being rehabilitated, however, paint removal technology should be stimulated and, in consequence, existing methods refined and new methods developed which will respect both the historic wood and the health and safety of the operator.

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This publication has been prepared pursuant to The Economic Recovery Tax Act of 1981, which directs the Secretary of the Interior to certify rehabilitations of historic buildings that are consistent with their historic character; the advice and guidance in this brief will assist property owners in complying with the requirements of this law.

Preservation Briefs 10 has been developed under the technical editorship of Lee H. Nelson, AIA, Chief, Preservation Assistance Division, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. Comments on the usefulness of this information are welcomed and can be sent to Mr. Nelson at the above address.

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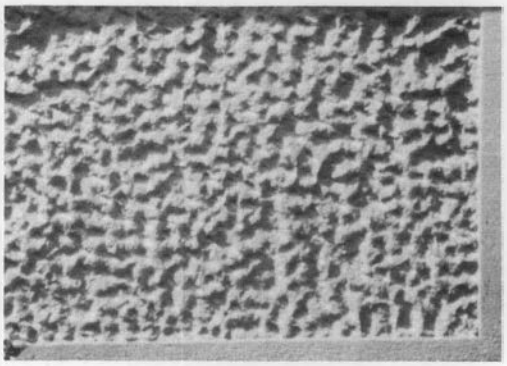
17 PRESERVATION BRIEFS



Architectural Character: Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character

Lee H. Nelson, FAIA

U.S. Department of the Interior
National Park Service
Cultural Resources

Heritage Preservation Services

The Secretary of the Interior's "Standards for Historic Preservation Projects" embody two important goals: 1) the preservation of historic materials and, 2) the preservation of a building's distinguishing character. Every old building is unique, with its own identity and its own distinctive character. Character refers to all those visual aspects and physical features that comprise the appearance of every historic building. Character-defining elements include the overall shape of the building, its materials, craftsmanship, decorative details, interior spaces and features, as well as the various aspects of its site and environment.

The purpose of this Brief is to help the owner or the architect identify those features or elements that give the building its *visual character* and that should be taken into account in order to preserve them to the maximum extent possible.

There are different ways of understanding old buildings. They can be seen as examples of specific building types, which are usually related to a building's function, such as schools, courthouses or churches. Buildings can be studied as examples of using specific materials such as concrete, wood, steel, or limestone. They can also be considered as examples of an historical period, which is often related to a specific architectural style, such as Gothic Revival farmhouses, one-story bungalows, or Art Deco apartment buildings.

There are many other facets of an historic building besides its functional type, its materials or construction or style that contribute to its historic qualities or significance. Some of these qualities are feelings conveyed by the sense of time and place or in buildings associated with events or people. A complete understanding of any property may require documentary research about its style, construction, function, its furnishings or contents; knowledge about the original builder, owners, and later occupants; and knowledge about the evolutionary history of the building. Even though buildings may be of historic, rather than architectural significance, it is their tangible elements that embody its significance for association with specific events or persons and it is those *tangible elements* both on the exterior and interior that should be preserved.

Therefore, the approach taken in this Brief is limited to identifying those visual and tangible aspects of the historic building. While this may aid in the planning process for carrying out any ongoing or new use or restoration of the building, this approach is not a substitute for developing an understanding about the significance of an historic building and the district in which it is located.

If the various materials, features and spaces that give a building its visual character are not recognized and preserved, then essential aspects of its character may be damaged in the process of change.

A building's character can be irreversibly damaged or changed in many ways, for example, by inappropriate repointing of the brickwork, by removal of a distinctive side porch, by changes to the window sash, by changes to the setting around the building, by changes to the major room arrangements, by the introduction of an atrium, by painting previously unpainted woodwork, etc.

A Three-Step Process to Identify A Building's Visual Character

This Brief outlines a three-step approach that can be used by anyone to identify those materials, features and spaces that contribute to the visual character of a building. This approach involves first examining the building from afar to understand its overall setting and architectural context; then moving up very close to appreciate its materials and the craftsmanship and surface finishes evident in these materials; and then going into and through the building to perceive those spaces, rooms and details that comprise its interior visual character.

Step 1: Identify the Overall Visual Aspects

Identifying the overall visual character of a building is nothing more than looking at its distinguishing physical aspects without focusing on its details. The major contributors to a building's overall character are embodied

in the general aspects of its *setting;* the *shape* of the building; its *roof* and roof features, such as chimneys or cupolas; the various *projections* on the building, such as porches or bay windows; the *recesses* or voids in a building, such as open galleries, arcades, or recessed balconies; the *openings* for windows and doorways; and finally the various exterior *materials* that contribute to the building's character. Step one involves looking at the building from a distance to understand the character of its site and setting, and it involves walking around the building where that is possible. Some buildings will have one or more sides that are more important than the others because they are more highly visible. This does not mean that the rear of the building is of no value whatever but it simply means that it is less important to the overall character. On the other hand, the rear may have an interesting back porch or offer a private garden space or some other aspect that may contribute to the visual character. Such a general approach to looking at the building and site will provide a better understanding of its overall character without having to resort to an infinitely long checklist of its possible features and details. Regardless of whether a building is complicated or relatively plain, it is these broad categories that contribute to an understanding of the overall character rather than the specifics of architectural features such as moldings and their profiles.

Step 2: Identify the Visual Character at Close Range

Step two involves looking at the building at close range or arm's length, where it is possible to see all the surface qualities of the materials, such as their *color* and *texture,* or surface evidence of craftsmanship or age. In some instances, the visual character is the result of the juxtaposition of materials that are contrastingly different in their color and texture. The surface qualities of the materials may be important because they impart the very sense of craftsmanship and age that distinguishes historic buildings from other buildings. Furthermore, many of these close up qualities can be easily damaged or obscured by work that affects those surfaces. Examples of this could include painting previously unpainted masonry, rotary disk sanding of smooth wood siding to remove paint, abrasive cleaning of tooled stonework, or repointing reddish mortar joints with gray portland cement.

There is an almost infinite variety of surface materials, textures and finishes that are part of a building's character which are fragile and easily lost.

Step 3: Identify the Visual Character of the Interior Spaces, Features and Finishes

Perceiving the character of interior spaces can be somewhat more difficult than dealing with the exterior. In part, this is because so much of the exterior can be seen at one time and it is possible to grasp its essential character rather quickly. To understand the interior character, it is necessary to move through the spaces one at a time. While it is not difficult to perceive the character of one individual room, it becomes more difficult to deal with spaces that are interconnected and interrelated. Sometimes, as in office buildings, it is the vestibules or lobbies or corridors that are important to the interior character of the building. With other groups of buildings the visual qualities of the interior are related to the plan of the building, as in a church with its axial plan creating a narrow tunnel-like space which obviously has a different character than an open space like a sports pavilion. Thus the shape of the space may be an essential part of its character. With some buildings it is possible to perceive that there is a visual linkage in a sequence of spaces, as in a hotel, from the lobby to the grand staircase to the ballroom. Closing off the openings between those spaces would change the character from visually linked spaces to a series of closed spaces. For example, in a house that has a front and back parlor linked with an open archway, the two rooms are perceived together, and this visual relationship is part of the character of the building. To close off the open archway would change the character of such a residence.

The importance of interior features and finishes to the character of the building should not be overlooked. In relatively simple rooms, the primary visual aspects may be in features such as fireplace mantels, lighting fixtures or wooden floors. In some rooms, the absolute plainness is the character-defining aspect of the interior. So-called secondary spaces also may be important in their own way, from the standpoint of history or because of the family activities that occurred in those rooms. Such secondary spaces, while perhaps historically significant, are not usually perceived as important to the *visual* character of the building. Thus we do not take them into account in the visual understanding of the building.

Conclusion

Using this three-step approach, it is possible to conduct a walk through and identify all those elements and features that help define the visual character of the building. In most cases, there are a number of aspects about the exterior and interior that are important to the character of an historic building. The visual emphasis of this brief will make it possible to ascertain those things that should be preserved because their loss or alteration would diminish or destroy aspects of the historic character whether on the outside, or on the inside of the building.

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Overall Visual Character: Shape

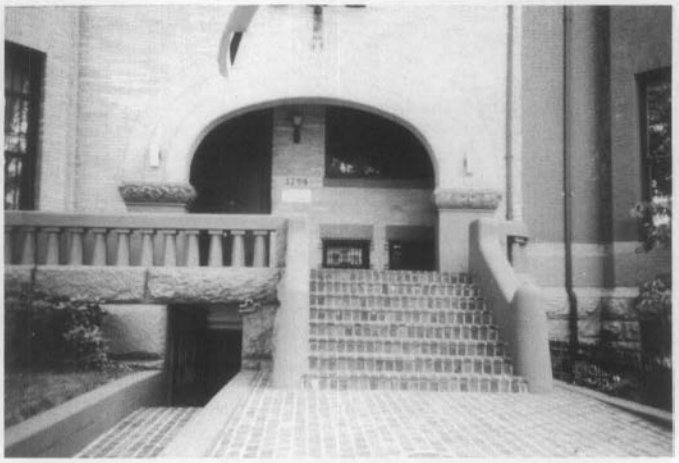
The shape of a building can be an important aspect of its overall visual character. The building illustrated here, for example, has a distinctive horizontal box-like shape with the middle portion of the box projecting up an extra story. This building has other visual aspects that help define its overall character, including the pattern of vertical bands of windows, the decorative horizontal bands which separate the base of the building from the upper floors, the dark brown color of the brick, the large arched entranceway, and the castle-like tower behind the building.

Overall Visual Character: Openings

Window and door openings can be important to the overall visual character of historic buildings. This view shows only part of a much larger building, but the windows clearly help define its character, partly because of their shape and rhythm: the upper floor windows are grouped in a 4,3,4,1,4 rhythm, and the lower floor windows are arranged in a regular 1,1,1,... rhythm. The individual windows are tall, narrow and arched, and they are accented by the different colored arched heads, which are connected where there are multiple windows so that the color contrast is a part of its character. If additional windows were inserted in the gap of the upper floors, the character would be much changed, as it would if the window heads were painted to match the color of the brick walls. Photo by Susan I. Dynes

Overall Visual Character: Shape

It should not be assumed that only large or unusual buildings have a shape that is distinctive or identifiable. The front wall of this modest commercial building has a simple three-part shape that is the controlling aspect of its overall visual character. It consists of a large center bay with a two story opening that combines the storefront and the windows above. The upward projecting parapet and the decorative stonework also relate to and emphasize its shape. The flanking narrow bays enframe the side windows and the small iron balconies, and the main entrance doorway into the store. Any changes to the center portion of this three-part shape, could drastically affect the visual character of this building. Photo by Emogene A. Bevitt



Overall Visual Character: Openings

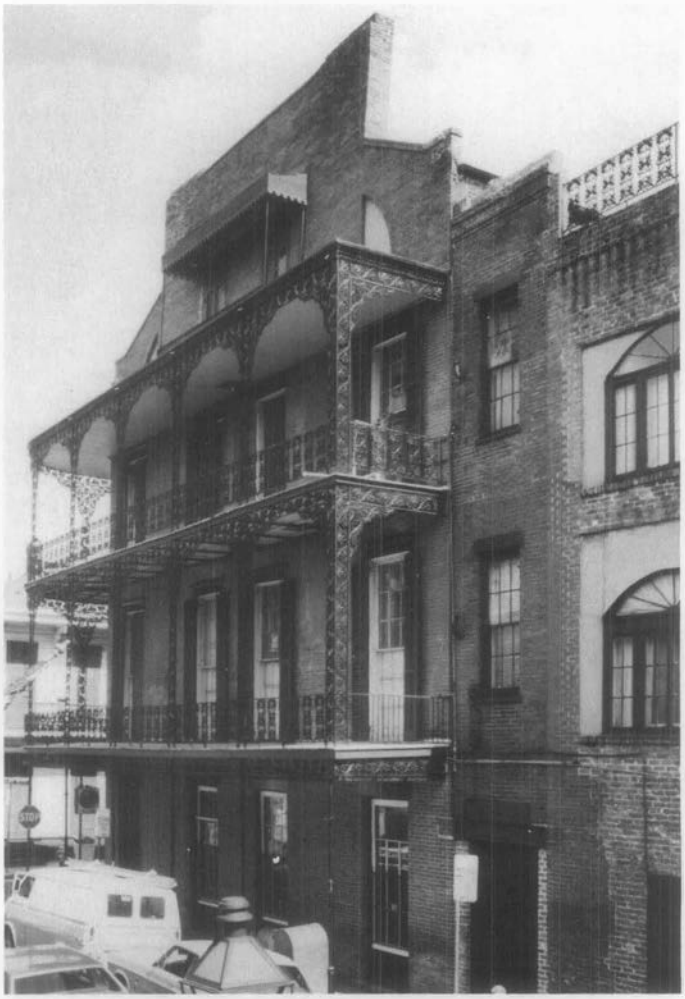
The opening illustrated here dominates the visual character of this building because of its size, shape, location, materials, and craftsmanship. Because of its relation to the generous staircase, this opening places a strong emphasis on the principal entry to the building. Enclosing this arcade-like entry with glass, for example, would materially and visually change the character of the building. Photo by Lee H. Nelson.

Overall Visual Character: Roof and Related Features

This building has a number of character-defining aspects which include the windows and the decorative stonework, but certainly the roof and its related features are visually important to its overall visual character. The roof is not only highly visible, it has elaborate stone dormers, and it also has decorative metalwork and slatework. The red and black slates of differing sizes and shapes are laid in patterns that extend around the roof of this large and freestanding building. Any changes to this patterned slatework, or to the other roofing details would damage the visual character of the building. Photo by Laurie R. Hammel

Overall Visual Character: Roof and Related Features

On this building, the most important visual aspects of its character are the roof and its related features such as the dormers and chimneys. The roof is important to the visual character because its steepness makes it highly visible, and its prominence is reinforced by the patterned tinwork, the six dormers and the two chimneys. Changes to the roof or its features, such as removal or alterations to the dormers, for example, would certainly change the character of this building. This does not discount the importance of its other aspects, such as the porch, the windows, the brickwork, or its setting; but the roof is clearly crucial to understanding the overall visual character of this building as seen from a distance. Photo by Lee H. Nelson



Overall Visual Character: Projections

A projecting porch or balcony can be very important to the overall visual character of almost any building and to the district in which it is located. Despite the size of this building (3 1/2 stories), and its distinctive roofline profile, and despite the importance of the very large window openings, the lacy wrap-around iron balcony is singularly important to the visual character of this building. It would seriously affect the character to remove the balcony, to enclose it, or to replace it with a balcony lacking the same degree of detail of the original material. Photo by Baird M. Smith

Overall Visual Character: Projections

Since these are row houses, any evaluation of their visual exterior character is necessarily limited to the front and rear walls; and while there are a number of things competing for attention in the front, it is the half round projecting bays with their conical roofs that contribute most prominently to the visual character. Their removal would be a devastating loss to the overall character, but even if preserved, the character could be easily damaged by changes to their color (as seen in the left bay which has been painted a dark color), or changes to their windows, or changes to their tile roofs. Though these houses have other fine features that contribute to the visual character and are worthy of preservation, these half-round bays demonstrate the importance of projecting features on an already rich and complex facade. Because of the repetitive nature of these projecting bays on adjacent row houses, along with the buildings' size, scale, openings, and materials, they also contribute to the overall visual character of the streetscape in the historic district. Any evaluation of the visual character of such a building should take into account the context of this building within the district. Photo by Lee H. Nelson

Overall Visual Character: Projections

Many buildings have projecting features such as porches, bay windows, or overhanging roofs, that help define their overall visual character. This projecting porch because of its size and shape, and because it copies the pitch and material of the main roof, is an important contributor to the visual character of this simple farmhouse. The removal or alteration of this porch would drastically alter the character of this building. If the porch were enclosed with wood or glass, or if gingerbread brackets were added to the porch columns, if the tin roof was replaced with asphalt, or if the porch railing was opened to admit a center stairway, the overall visual character could be seriously damaged. Although this projecting porch is an important feature, almost any other change to this house, such as changes to the window pattern, or changes to the main roof, or changes to the setting, would also change its visual character. Photo by Hugh C. Miller

Overall Visual Character: Trim

If one were to analyze the overall shape or form of this building, it would be seen that it is a gable-roofed house with dormers and a wrap-around porch. It is similar to many other houses of the period. It is the wooden trim on the eaves and around the porch that gives this building its own identify and its special visual character. Although such wooden trim is vulnerable to the elements, and must be kept painted to prevent deterioration; the loss of this trim would seriously damage the overall visual character of this building, and its loss would obliterate much of the close-up visual character so dependent upon craftsmanship for the moldings, carvings, and the see-through jigsaw work. Photo by Hugh C. Miller

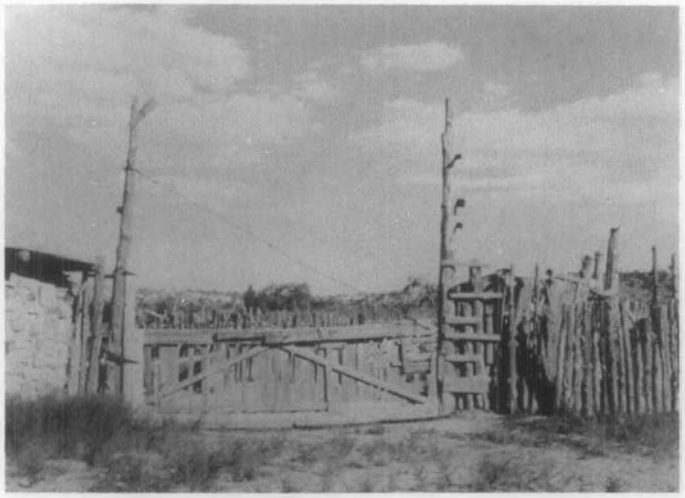
Overall Visual Character: Setting

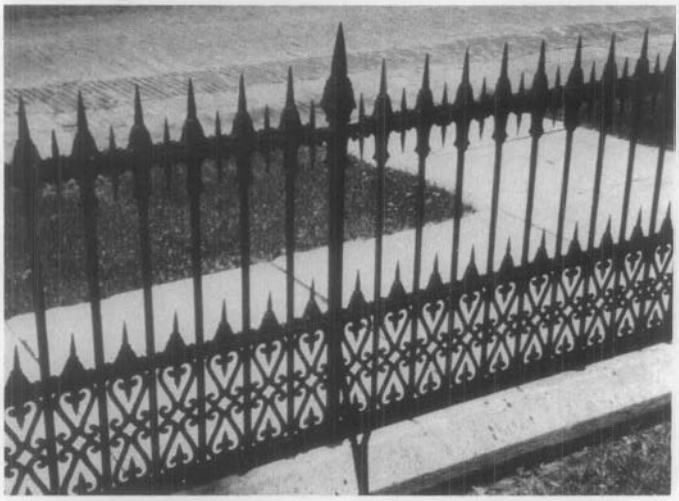
In the process of identifying the overall visual character, the aspect of setting should not be overlooked. Obviously, the setting of urban row houses differs from that of a mansion with a designed landscape. However, there are many instances where the relationship between the building and its place on the streetscape, or its place in the rural environment, in other words its setting, may be an important contributor to its overall character.

In this instance, the corner tower and the arched entryway are important contributors to the visual character of the building itself, but there is also a relationship between the building and the two converging streets that is also an important aspect of this historic building. The curb, sidewalk, fence, and the yard interrelate with each other to establish a setting that is essential to the overall visual character of the historic property. Removing these elements or replacing them with a driveway or parking court would destroy an important visual aspect. Photo by Lee H. Nelson

Overall Visual Character: Setting

Even architecturally modest buildings frequently will have a setting that contributes to their overall character. In this very urban district, set-backs are the exception, so that the small front yard is something of a luxury, and it is important to the overall character because of its design and materials, which include the iron fence along the sidewalk, the curved walk leading to the porch, and the various plantings. In a district where parking spaces are in great demand, such front yards are sometimes converted to off-street parking, but in this instance, that would essentially destroy its setting and would drastically change the visual character of this historic property. Photo by Lee H. Nelson





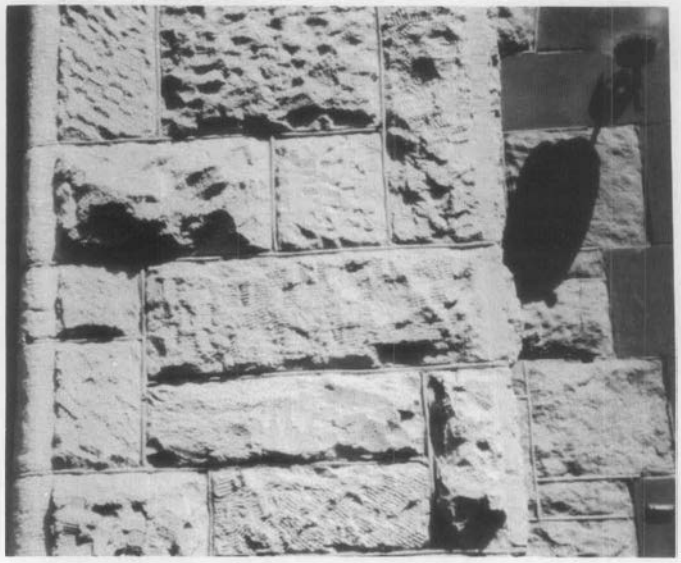
Overall Visual Character: Setting

Among the various visual aspects relating to the setting of an historic property are such site features as gardens, walks, fences, etc. This can include their design and materials. There is a dramatic difference in the visual character between these two fence constructions—one utilizing found materials with no particular regard to their uniformity of size or placement, and the other being a product of the machine age utilizing cast iron components assembled into a pattern of precision and regularity. If the corral fence were to be repaired or replaced with lumberyard materials its character would be dramatically compromised. The rhythm and regularity of the cast iron fence is so important to its visual character that its character could be altered by accidental damage or vandalism, if some of the fence top spikes were broken off thus interrupting the rhythm or pattern. Photos by Lee H. Nelson

Arm's Length Visual Character: Materials

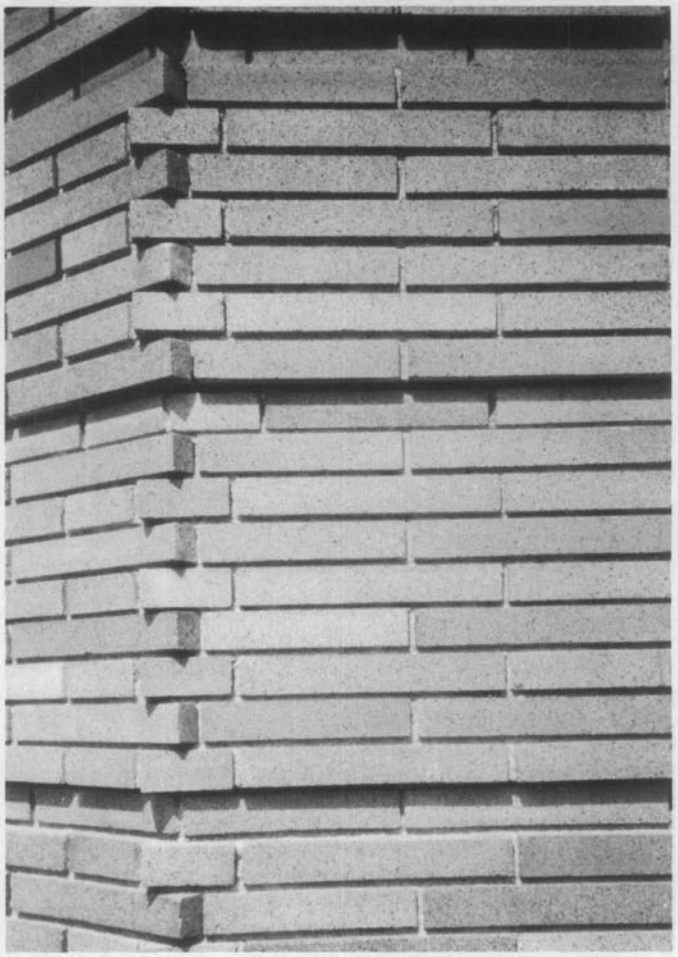
At arm's length, the visual character is most often determined by the surface qualities of the materials and craftsmanship; and while these aspects are often inextricably related, the original choice of materials often plays the dominant role in establishing the close-range character because of the color, texture, or shape of the materials.

In this instance, the variety and arrangement of the materials is important in defining the visual character, starting with the large pieces of broken stone which form the projecting base for the building walls, then changing to a wall of roughly rectangular stones which vary in size, color, and texture, all with accentuated, projecting beads of mortar, then there is a rather precise and narrow band of cut and dressed stones with minimal mortar joints, and finally, the main building walls are composed of bricks, rather uniform in color, with fairly generous mortar joints. It is the juxtaposition and variety of these materials (and of course, the craftsmanship) that is very important to the visual character. Changing the raised mortar joints, for example, would drastically alter the character at arm's length. Photo by Lee H. Nelson



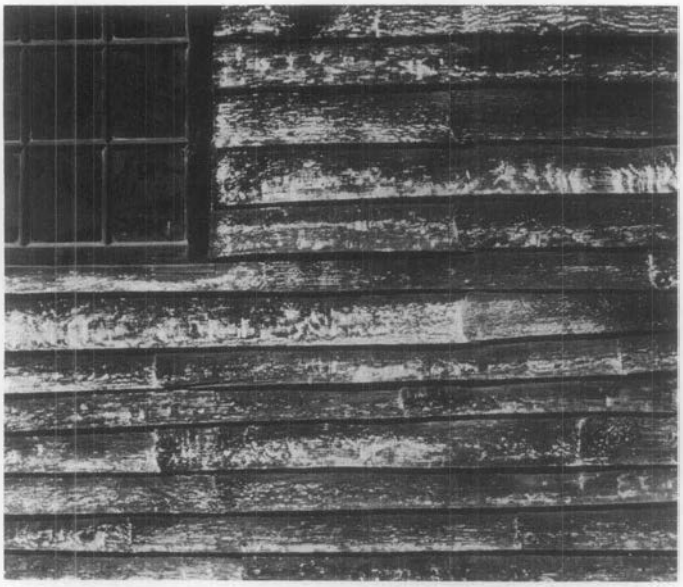
Arm's Length Visual Character: Craft Details

There are many instances where craft details dominate the arm's length visual character. As seen here, the craft details are especially noticeable because the stones are all of a uniform color, and they are all squared off, but their surfaces were worked with differing tools and techniques to create a great variety of textures, resulting in a tour-de-force of craft details. This texture is very important at close range. It was a deliberately contrived surface that is an important contributor to the visual character of this building. Photo by Lee H. Nelson



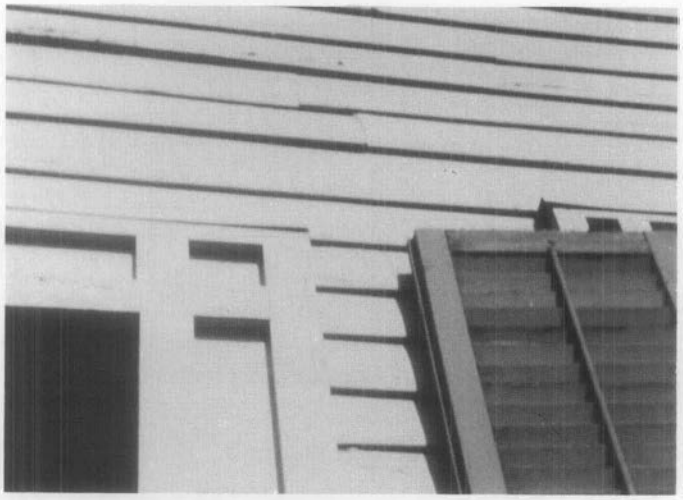
Arm's Length Visual Character: Craft Details

The arm's length visual character of this building is a combination of the materials and the craft details. Most of the exterior walls of this building consist of early 20th century Roman brick, precisely made, unusually long bricks, in varying shades of yellow-brown, with a noticeable surface spotting of dark iron pyrites. While this brick is an important contributor to the visual character, the related craft details are perhaps more important, and they consist of: unusually precise coursing of the bricks, almost as though they were laid up using a surveyor's level; a row of recessed bricks every ninth course, creating a shadow pattern on the wall; deeply recessed mortar joints, creating a secondary pattern of shadows; and a toothed effect where the bricks overlap each other at the corner of the building. The cumulative effect of this artisanry is important to the arm's length visual character, and it is evident that it would be difficult to match if it were damaged, and the effect could be easily damaged through insensitive treatments such as painting the brickwork or by careless repointing. Photo by Lee H. Nelson



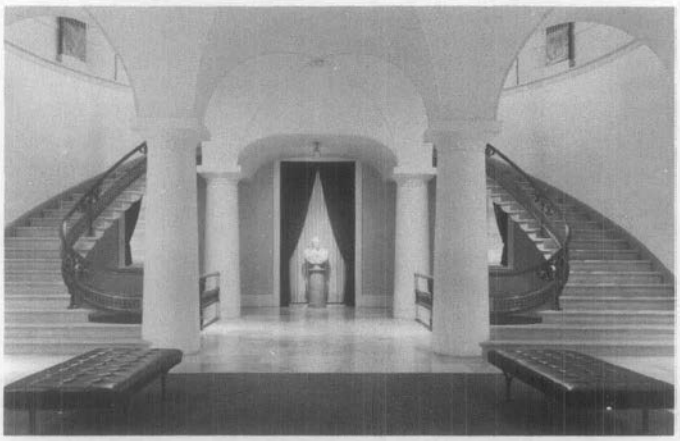
Arm's Length Visual Character: Craft Details

On some buildings, there are subtle aspects of visual character that cannot be perceived from a distance. This is especially true of certain craft details that can be seen only at close range. On this building, it is easily understood that the narrow, unpainted, and weathered clapboards are an important aspect of its overall visual character; but at close range there are a number of subtle but very important craft details that contribute to the handmade quality of this building, and which clearly differentiate it from a building with machine sawn clapboards. The clapboards seen here were split by hand and the bottom edges were not dressed, so that the boards vary in width and thickness, and thus they give a very uneven shadow pattern. Because they were split from oak that is unpainted, there are occasional wavy rays in the wood that stand against the grain. Also noticeable is the fact that the boards are of relatively short lengths, and that they have feather-edged ends that overlap each other, a detail that is very different from butted joints. The occasional large nail heads and the differential silver-gray weathering add to the random quality of the clapboards. All of these qualities contribute to the arm's length visual character. Photo by Lee H. Nelson



Arm's Length Visual Character: Craft Details

While hand-split clapboards are distinctive visual elements in their own way, machine-sawn and painted wood siding is equally important to the overall visual character in most other instances. At arm's length, however, the machine sawn siding may not be so distinctive; but there might be other details that add visual character to the wooden building, such as the details of wooden trim and louvered shutters around the windows (as seen here), or similar surface textures on other buildings, such as the saw marks on wall shingles, the joints in leaded glass, decorative tinwork on a rain conductor box, the rough surface of pebble-dash stuccowork, or the pebbly surface of exposed aggregate concrete. Such surfaces can only be seen at arm's length and they add to the visual character of a historic building. Photo by Hugh C. Miller



Interior Visual Character: Individually Important Spaces

In assessing the interior visual character of any historic building, it is necessary to ask whether there are spaces that are important to the character of this particular building, whether the building is architecturally rich or modest, or even if it is a simple or utilitarian structure.

The character of the individually important space which is illustrated here is a combination of its size, the twin curving staircases, the massive columns and curving vaulted ceilings, in addition to the quality of the materials in the floor and in the stairs. If the ceiling were to be lowered to provide space for heating ducts, or if the stairways were to be enclosed for code reasons, the shape and character of this space would be damaged, even if there was no permanent physical damage. Such changes can easily destroy the visual character of an individually important interior space. Thus, it is important that the visual aspects of a building's interior character be recognized before planning any changes or alterations. Photo by National Portrait Gallery

Interior Visual Character: Related Spaces

Many buildings have interior spaces that are visually or physically related so that, as you move through them, they are perceived not as separate spaces, but as a sequence of related spaces that are important in defining the interior character of the building. The example which is illustrated here consists of three spaces that are visually linked to each other.

The first of these spaces is the vestibule which is of a generous size and unusual in its own right, but more important, it visually relates to the second space which is the main stairhall.

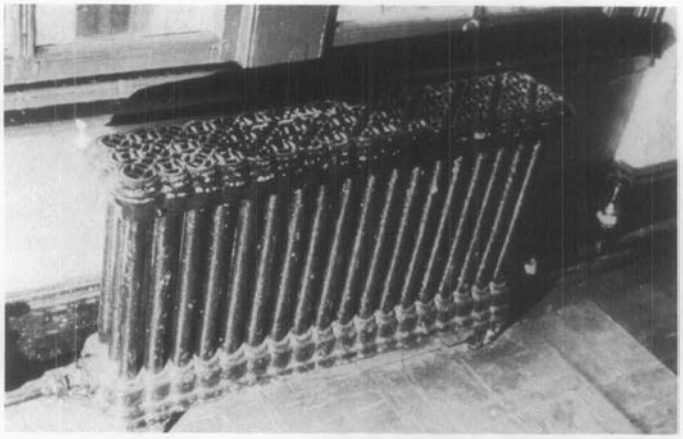
The hallway is the circulation artery for the building, and leads both horizontally and vertically to other rooms and spaces, but especially to the open and inviting stairway.

The stairway is the third part of this sequence of related spaces, and it provides continuing access to the upper floors.

These related spaces are very important in defining the interior character of this building. Almost any change to these spaces, such as installing doors between the vestibule and the hallway, or enclosing the stair would seriously impact their character and the way that character is perceived. Top photo by Mel Chamowitz, others by John Tennant

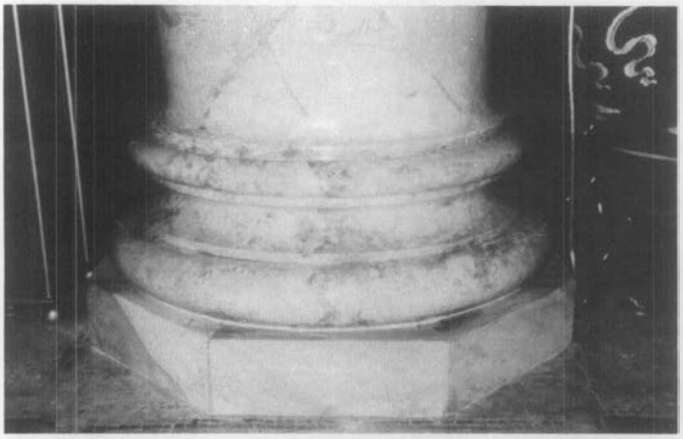
Interior Visual Character: Interior Features

Interior features are three-dimensional building elements or architectural details that are an integral part of the building as opposed to furniture. Interior features are often important in defining the character of an individual room or space. In some instances, an interior feature, like a large and ornamental open stairway may dominate the visual character of an entire building. In other instances, a modest iron stairway (like the one illustrated here) may be an important interior feature, and its preservation would be crucial to preserving the interior character of the building. Such features can also include the obvious things like fireplace mantles, plaster ceiling medallions, or panelling, but they also extend to features like hardware, lighting fixtures, bank tellers cages, decorative elevator doors, etc. Photo by David W. Look



Interior Visual Character: Interior Features

Modern heating or cooling devices usually add little to the interior character of a building; but historically, radiators, for instance, may have contributed to the interior character by virtue of their size or shape, or because of their specially designed bases, piping, and decorative grillage or enclosures. Sometimes they were painted with several colors to highlight their integral, cast-in details. In more recent times, it has been common to overpaint and conceal such distinctive aspects of earlier heating and plumbing devices, so that we seldom have the opportunity to realize how important they can be in defining the character of interior rooms and spaces. For that reason, it is important to identify their character-defining potential, and consider their preservation, retention, or restoration. Photo by David W. Look



Interior Visual Character: Surface Materials and Finishes

When identifying the visual character of historic interior spaces one should not overlook the importance of those materials and finishes that comprise the surfaces of walls, floors and ceilings. The surfaces may have evidence of either hand-craft or machine-made products that are important contributors to the visual character, including patterned or inlaid designs in the wood flooring, decorative painting practices such as stenciling, imitation marble or wood grain, wallpapering, tinwork, tile floors, etc.

The example illustrated here involves a combination of real marble at the base of the column, imitation marble patterns on the plaster surface of the column (a practice called scagliola), and a tile floor surface that uses small mosaic tiles arranged to form geometric designs in several different colors. While such decorative materials and finishes may be important in defining the interior visual character of this particular building, it should be remembered that in much more modest buildings, the plainness of surface materials and finishes may be an essential aspect of their historic character. Photo by Lee H. Nelson

Fragility of A Building's Visual Character

Some aspects of a building's visual character are fragile and are easily lost. This is true of brickwork, for example, which can be irreversibly damaged with inappropriate cleaning techniques or by insensitive repointing practices. At least two factors are important contributors to the visual character of brickwork, namely the brick itself and the craftsmanship. Between these, there are many more aspects worth noting, such as color range of bricks, size and shape variations, texture, bonding patterns, together with the many variable qualities of the mortar joints, such as color, width of joint and tooling. These qualities could be easily damaged by painting the brick, by raking out the joint with power tools, or repointing with a joint that is too wide. As seen here during the process of repointing, the visual character of this front wall is being dramatically changed from a wall where the bricks predominate, to a wall that is visually dominated by the mortar joints. Photo by Lee H. Nelson

Preservation Briefs 17

The Architectural Character Checklist/Questionnaire

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This checklist can be taken to the building and used to identify those aspects that give the building and setting its essential visual qualities and character. This checklist consists of a series of questions that are designed to help in identifying those things that contribute to a building's character. The use of this checklist involves the three-step process of looking for: 1) the overall visual aspects, 2) the visual character at close range, and 3) the visual character of interior spaces, features and finishes.

Because this is a process to identify *architectural character,* it does not address those intangible qualities that give a property or building or its contents its historic significance, instead this checklist is organized on the assumption that historic significance is embodied in those *tangible* aspects that include the building's setting, its form and fabric.

Step One

1. Shape

What is there about the form or shape of the building that gives the building its identity? Is the shape distinctive in relation to the neighboring buildings? Is it simply a low, squat box, or is it a tall, narrow building with a corner tower? Is the shape highly consistent with its neighbors? Is the shape so complicated because of wings, or ells, or differences in height, that its complexity is important to its character? Conversely, is the shape so simple or plain that adding a feature like a porch would change that character? Does the shape convey its historic function as in smoke stacks or silos?

Notes on the Shape or Form of the Building:

2. Roof and Roof Features

Does the roof shape or its steep (or shallow) slope contribute to the building's character? Does the fact that the roof is highly visible (or not visible at all) contribute to the architectural identity of the building? Are certain roof features important to the profile of the building against the sky or its background, such as cupolas, multiple chimneys, dormers, cresting, or weathervanes? Are the roofing materials or their colors or their patterns (such as patterned slates) more noticeable than the shape or slope of the roof?

Notes on the Roof and Roof Features:

3. Openings

Is there a rhythm or pattern to the arrangement of windows or other openings in the walls; like the rhythm of windows in a factory building, or a three-part window in the front bay of a house; or is there a noticeable relationship between the width of the window openings and the wall space between the window openings? Are there distinctive openings, like a large arched entranceway, or decorative window lintels that accentuate the importance of the window openings, or unusually shaped windows, or patterned window sash, like small panes of glass in the windows or doors, that are important to the character? Is the plainness of the window openings such that adding shutters or gingerbread trim would radically change its character? Is there a hierarchy of facades that make the front windows more important than the side windows? What about those walls where the absence of windows establishes its own character?

Notes on the Openings:

4. Projections

Are there parts of the building that are character-defining because they project from the walls of the building like porches, cornices, bay windows, or balconies? Are there turrets, or widely overhanging eaves, projecting pediments or chimneys?

Notes on the Projections:

5. Trim and Secondary Features

Does the trim around the windows or doors contribute to the character of the building? Is there other trim on the walls or around the projections that, because of its decoration or color or patterning contributes to the character of the building? Are there secondary features such as shutters, decorative gables, railings, or exterior wall panels?

Notes on the Trim and Secondary Features:

6. Materials

Do the materials or combination of materials contribute to the overall character of the building as seen from a distance because of their color or patterning, such as broken faced stone, scalloped wall shingling, rounded rock foundation walls, boards and battens, or textured stucco?

Notes on the Materials:

7. Setting

What are the aspects of the setting that are important to the visual character? For example, is the alignment of buildings along a city street and their relationship to the sidewalk the essential aspect of its setting? Or, conversely, is the essential character dependent upon the tree plantings and out buildings which surround the farmhouse? Is the front yard important to the setting of the modest house? Is the specific site important to the setting such as being on a hilltop, along a river, or, is the building placed on the site in such a way to enhance its setting? Is there a special relationship to the adjoining streets and other buildings? Is there a view? Is there fencing, planting, terracing, walkways or any other landscape aspects that contribute to the setting?

Notes on the Setting:

Step Two

8. Materials at Close Range

Are there one or more materials that have an inherent texture that contributes to the close range character, such as stucco, exposed aggregate concrete, or brick textured with vertical grooves? Or materials with inherent colors such as smooth orange-colored brick with dark spots of iron pyrites, or prominently veined stone, or green serpentine stone? Are there combinations of materials, used in juxtaposition, such as several different kinds of stone, combinations of stone and brick, dressed stones for window lintels used in conjunction with rough stones for the wall? Has the choice of materials or the combinations of materials contributed to the character?

Notes on the Materials at Close Range:

9. Craft Details

Is there high quality brickwork with narrow mortar joints? Is there hand-tooled or patterned stonework? Do the walls exhibit carefully struck vertical mortar joints and recessed horizontal joints? Is the wall shinglework laid up in patterns or does it retain evidence of the circular saw marks or can the grain of the wood be seen through the semi-transparent stain? Are there hand split or hand-dressed clapboards, or machine smooth beveled siding, or wood rusticated to look like stone, or Art Deco zigzag designs executed in stucco?

Almost any evidence of craft details, whether handmade or machinemade, will contribute to the character of a building because it is a manifestation of the materials, of the times in which the work was done, and of the tools and processes that were used. It further reflects the effects of time, of maintenance (and/or neglect) that the building has received over the years. All of these aspects are a part of the surface qualities that are seen only at close range.

Notes on the Craft Details:

Step Three

10. Individual Spaces

Are there individual rooms or spaces that are important to this building because of their size, height, proportion, configuration, or function, like the center hallway in a house, or the bank lobby, or the school auditorium, or the ballroom in a hotel, or a courtroom in a county courthouse?

Notes on the Individual Spaces:

11. Related Spaces and Sequences of Spaces

Are there adjoining rooms that are visually and physically related with large doorways or open archways so that they are perceived as related rooms as opposed to separate rooms? Is there an important sequence of spaces that are related to each other, such as the sequence from the entry way to the lobby to the stairway and to the upper balcony as in a theatre; or the sequence in a residence from the entry vestibule to the hallway to the front parlor, and on through the sliding doors to the back parlor; or the sequence in an office building from the entry vestibule to the lobby to the bank of elevators?

Notes on the Related Spaces and Sequences of Spaces:

12. Interior Features

Are there interior features that help define the character of the building, such as fireplace mantels, stairways and balustrades, arched openings, interior shutters, inglenooks, cornices, ceiling medallions, light fixtures, balconies, doors, windows, hardware, wainscotting, panelling, trim, church pews, courtroom bars, teller cages, waiting room benches?

Notes on the Interior Features:

13. Surface Finishes and Materials

Are there surface finishes and materials that can affect the design, the color or the texture of the interior? Are there materials and finishes or craft practices that contribute to the interior character, such as wooden parquet floors, checkerboard marble floors, pressed metal ceilings, fine hardwoods, grained doors or marblized surfaces, or polychrome painted surfaces, or stencilling, or wallpaper that is important to the historic character? Are there surface finishes and materials that, because of their plainness, are imparting the essential character of the interior such as hard or bright, shiny wall surfaces of plaster or glass or metal?

Notes on the Surface Finishes and Materials:

14. Exposed Structure

Are there spaces where the exposed structural elements define the interior character such as the exposed posts, beams, and trusses in a church or train shed or factory? Are there rooms with decorative ceiling beams (non-structural) in bungalows, or exposed vigas in adobe buildings?

Notes on the Exposed Structure:

This concludes the three-step process of identifying the visual aspects of historic buildings and is intended as an aid in preserving their character and other distinguishing qualities. It is not intended as a means of understanding the significance of historical properties or districts, nor of the events or people associated with them. That can only be done through other kinds of research and investigation.

This Preservation Brief was originally developed as a slide talk/methodology in 1982 to discuss the use of the Secretary of the Interior's Standards for Rehabilitation in relation to preserving historic character; and it was amplified and modified in succeeding years to help guide preservation decisionmaking, initially for maintenance personnel in the National Park Service. A number of people contributed to the evolution of the ideas presented here. Special thanks go to Emogene Bevitt and Gary Hume, primarily for the many and frequent discussions relating to this approach in its evolutionary stages; to Mark Fram, Ontario Heritage Foundation, Toronto, for suggesting several additions to the Checklist; and more recently, to my co-workers, both in Washington and in our regional offices, especially Ward Jandl, Sara Blumenthal, Charles Fisher, Sharon Park, AIA, Jean Travers, Camille Martone, Susan Dynes, Michael Auer, Anne Grimmer, Kay Weeks, Betsy Chittenden, Patrick Andrus, Carol Shull, Hugh Miller, FAIA, Jerry Rogers, Paul Alley, David Look, AIA, Margaret Pepin-Donat, Bonnie Halda, Keith Everett, Thomas Keohan, the Preservation Services Division, Mid-Atlantic Region, and several reviewers in state preservation offices, especially Ann Haaker, Illinois; and Stan Graves, AIA, Texas; for providing very critical and constructive review of the manuscript.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended. Comments on the usefulness of this information are welcomed and can be sent to Mr. Nelson, Preservation Assistance Division, National Park Service, U.S. Department of the Interior, P.O. Box 37127, Washington, D.C. 20013-7127. This publication is not copyrighted and can be reproduced without penalty. Normal procedures for credit to the author and the National Park Service are appreciated.

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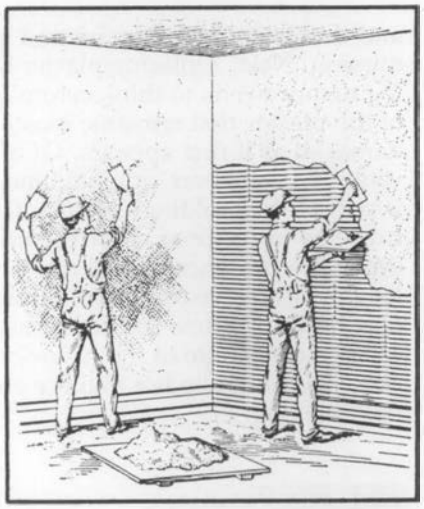

Repairing Historic Flat Plaster—Walls and Ceilings

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Preservation Assistance Division Technical Preservation Services

Plaster in a historic building is like a family album. The handwriting of the artisans, the taste of the original occupants, and the evolving styles of decoration are embodied in the fabric of the building. From modest farmhouses to great buildings, regardless of the ethnic origins of the occupants, plaster has traditionally been used to finish interior walls.

A versatile material, plaster could be applied over brick, stone, half-timber, or frame construction. It provided a durable surface that was easy to clean and that could be applied to flat or curved walls and ceilings.

Plaster could be treated in any number of ways: it could receive stenciling, decorative painting, wallpaper, or whitewash. This variety and the adaptability of the material to nearly any building size, shape, or configuration meant that plaster was the wall surface chosen for nearly all buildings until the 1930s or 40s (Fig. 1).

Historic plaster may first appear so fraught with problems that its total removal seems the only alternative. But there are practical and historical reasons for saving it. First, three-coat plaster is unmatched in strength

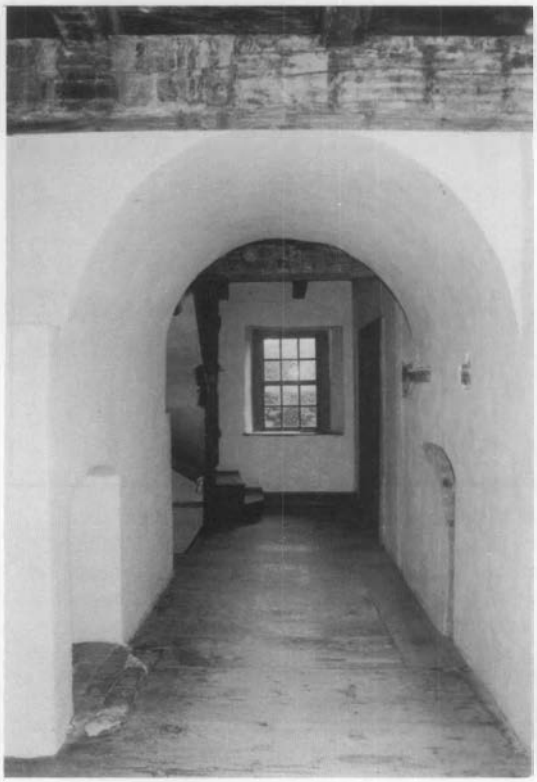


Fig. 1. Left: Schifferstadt, Frederick, Maryland, 1756. Right: First Christian Church, Eugene, Oregon, 1911. Although these two structures are separated in history by over 150 years and differences in size, ethnic origin, geography, construction techniques, and architectural character, their builders both used plaster as the interior surface coating for flat and curved walls. Photo left: Kay Weeks. Photo right: Kaye Ellen Simonson.

and durability. It resists fire and reduces sound transmission. Next, replacing plaster is expensive. A building owner needs to think carefully about the condition of the plaster that remains; plaster is often not as badly damaged as it first appears. Of more concern to preservationists, however, original lime and gypsum plaster is part of the building's historic fabric—its smooth-troweled or textured surfaces and subtle contours evoke the presence of America's earlier craftsmen. Plaster can also serve as a plain surface for irreplaceable decorative finishes. For both reasons, plaster walls and ceilings contribute to the historic character of the interior and should be left in place and repaired if at all possible (Fig. 2).

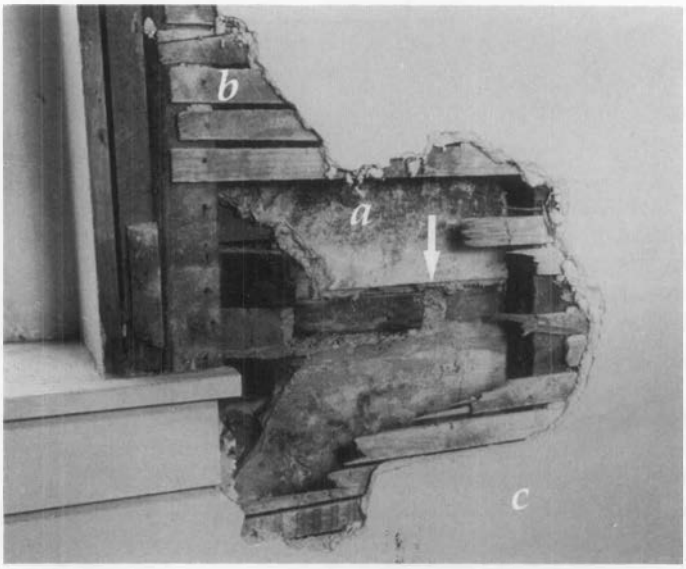


Fig. 2. A hole in the wall of a 1760s Custom House in Chestertown, Maryland illustrates the evolution of the room. (a) The original plaster was applied directly to an exterior masonry wall and the chairrail (missing here, see arrow) was in place before the wet plaster was applied to the wall. Sometime later when the interior was modified, the masonry was furred out. Machine-sawn wood lath (b) was nailed to the furring strips and (c) new three-coat plaster was applied. Photo: Maryland Historical Trust.

The approaches described in this Brief stress repairs using *wet* plaster, and traditional materials and techniques that will best assist the preservation of historic plaster walls and ceilings—and their appearance. Dry wall repairs are not included here, but have been written about extensively in other contexts. Finally, this Brief describes a replacement option when historic plaster cannot be repaired. Thus, a veneer plaster system is discussed rather than dry wall. Veneer systems include a coat or coats of *wet* plaster—although thinly applied—which can, to a greater extent, simulate traditional hand-troweled or textured finish coats. This system is generally better suited to historic preservation projects than dry wall.

To repair plaster, a building owner must often enlist the help of a plasterer. Plastering is a skilled craft, requiring years of training and special tools (Fig. 3). While minor repairs can be undertaken by building owners, most repairs will require the assistance of a plasterer.

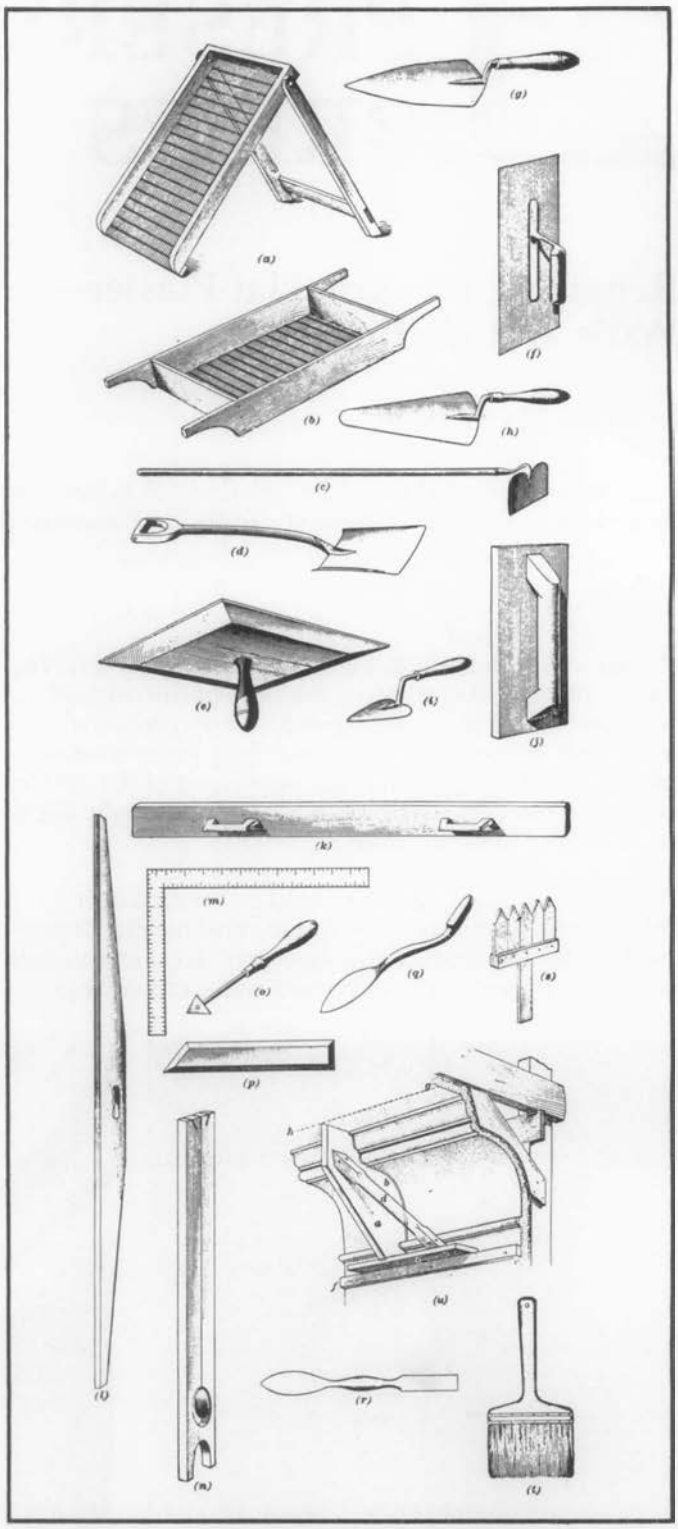


Fig. 3. Many of these traditional plastering tools are still used today: (a) screen to separate coarse sand from fine sand; (b) lime screen to remove unslaked particles of lime; (c) hoe; (d) shovel; (e) hawk to hold small amounts of plaster; (f) angle float to apply finishes to inside angles; (g), (h), (i) assorted trowels to apply basecoats and finish coat; (j) padded float to level off humps and fill in hollows caused by other tools; (k) a two-handled float or "darby" to float larger surfaces; (l) a simple straight edge; (m) a square to test the trueness of angles; (n) plumb to check verticality of plastered surfaces; (o), (p), (q), (r) jointing and mitering tools to pick out angles in decorative moldings; (s) comb made of sharpened lath pieces to scratch the basecoat of plaster; (t) brush to dampen plaster surfaces while they are worked smooth; (u) template made of wood and metal to cut a required outline for a fancy mold.

Historical Background

Plasterers in North America have relied on two materials to create their handiwork—lime and gypsum. Until the end of the 19th century, plasterers used lime plaster. Lime plaster was made from four ingredients: lime, aggregate, fiber, and water. The lime came from ground-and-heated limestone or oyster shells; the aggregate from sand; and the fiber from cattle or hog hair. Manufacturing changes at the end of the 19th century made it possible to use gypsum as a plastering material. Gypsum and lime plasters were used in combination for the base and finish coats during the early part of the 20th century; gypsum was eventually favored because it set more rapidly and, initially, had a harder finish.

Not only did the basic plastering material change, but the method of application changed also. In early America, the windows, doors, and all other trim were installed before the plaster was applied to the wall (Fig. 4). Generally the woodwork was prime-painted before plastering. Obtaining a plumb, level wall, while working against built-up mouldings, must have been difficult. But sometime in the first half of the 19th century, builders began installing wooden plaster "grounds" around windows and doors and at the base of the wall. Installing these grounds so that they were level and plumb made the job much easier because the plasterer could work from a level, plumb, straight surface. Woodwork was then nailed to the "grounds" after the walls were plastered (Fig. 5). Evidence of plaster behind trim is often an aid to dating historic houses, or to discerning their physical evolution.

Fig. 4. The builders of this mid-18th century house installed the baseboard moulding first, then applied a mud and horse hair plaster (called paling) to the masonry wall. Lime was used for the finish plaster. Also shown are the hacking marks which prepared the wall for a subsequent layer of plaster. Photo: Kay Weeks.

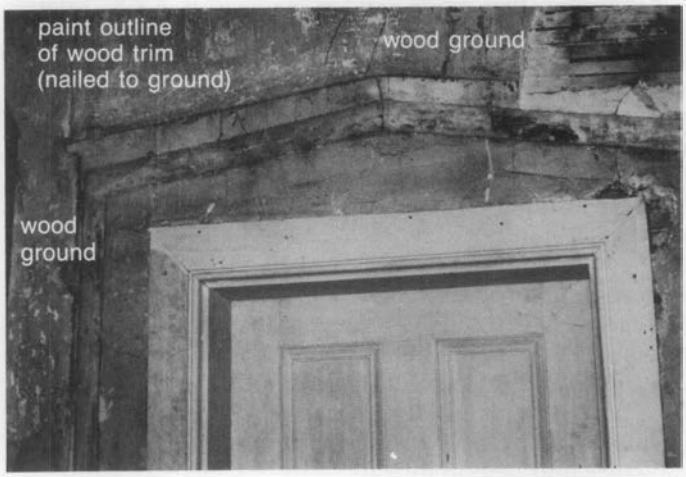
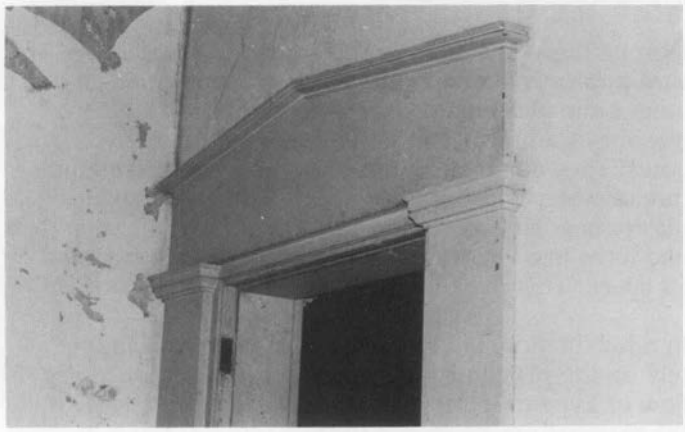


Fig. 5 (a). The photo above shows the use of wooden plaster "grounds" nailed to the wall studs of the mid-19th century Lockwood House in Harpers Ferry, West Virginia. This allowed the plasterer to work flush with the surface of the grounds. Afterwards, the carpenter could nail the finish woodwork to the ground, effectively hiding the joint between the plaster and the ground. The trim was painted after its installation, leaving a paint outline on the plaster. Fig. 5 (b). The photo below shows door trim and mouldings in place after the plastering was complete. Photos: Kaye Ellen Simonson.



Lime Plaster

When building a house, plasterers traditionally mixed bags of quick lime with water to "hydrate" or "slake" the lime. As the lime absorbed the water, heat was given off. When the heat diminished, and the lime and water were thoroughly mixed, the lime putty that resulted was used to make plaster.

When lime putty, sand, water, and animal hair were mixed, the mixture provided the plasterer with "coarse stuff." This mixture was applied in one or two layers to build up the wall thickness. But the best plaster was done with three coats. The first two coats made up the coarse stuff; they were the *scratch* coat and the *brown* coat. The finish plaster, called "setting stuff" contained a much higher proportion of lime putty, little aggregate, and no fiber, and gave the wall a smooth white surface finish.

Compared to the 3/8-inch-thick layers of the scratch and brown coats, the finish coat was a mere 1/8-inch thick. Additives were used for various finish qualities.

For example, fine white sand was mixed in for a "float finish." This finish was popular in the early 1900s. (If the plasterer raked the sand with a broom, the plaster wall would retain swirl marks or stipples.) Or marble dust was added to create a hard-finish white coat which could be smoothed and polished with a steel trowel. Finally, a little plaster of Paris, or "gauged stuff," was often added to the finish plaster to accelerate the setting time.

Although lime plaster was used in this country until the early 1900s, it had certain disadvantages. A plastered wall could take more than a year to dry; this delayed painting or papering. In addition, bagged quick lime had to be carefully protected from contact with air, or it became inert because it reacted with ambient moisture and carbon dioxide. Around 1900, gypsum began to be used as a plastering material.

Gypsum Plaster

Gypsum begins to cure as soon as it is mixed with water. It sets in minutes and completely dries in two to three weeks. Historically, gypsum made a more rigid plaster and did not require a fibrous binder. However, it is difficult to tell the difference between lime and gypsum plaster once the plaster has cured.

Despite these desirable working characteristics, gypsum plaster was more vulnerable to water damage than lime. Lime plasters had often been applied directly to masonry walls (without lathing), forming a suction bond. They could survive occasional wind-driven moisture or water wicking up from the ground. Gypsum plaster needed protection from water. Furring strips had to be used against masonry walls to create a dead air space. This prevented moisture transfer.

In rehabilitation and restoration projects, one should rely on the plasterer's judgment about whether to use lime or gypsum plaster. In general, gypsum plaster is the material plasterers use today. Different types of aggregate may be specified by the architect such as clean river sand, perlite, pumice, or vermiculite; however, if historic finishes and textures are being replicated, sand should be used as the base-coat aggregate. Today, if fiber is required in a base coat, a special gypsum is available which includes wood fibers. Lime putty, mixed with about 35 percent gypsum (gauging plaster) to help it harden, is still used as the finish coat.

Lath

Lath provided a means of holding the plaster in place. Wooden lath was nailed at right angles directly to the structural members of the buildings (the joists and studs), or it was fastened to non-structural spaced strips known as furring strips. Three types of lath can be found on historic buildings (Fig. 6).

Wood Lath. Wood lath is usually made up of narrow, thin strips of wood with spaces in between. The plasterer applies a slight pressure to push the wet plaster through the spaces. The plaster slumps down on the inside of the wall, forming plaster "keys." These keys hold the plaster in place.

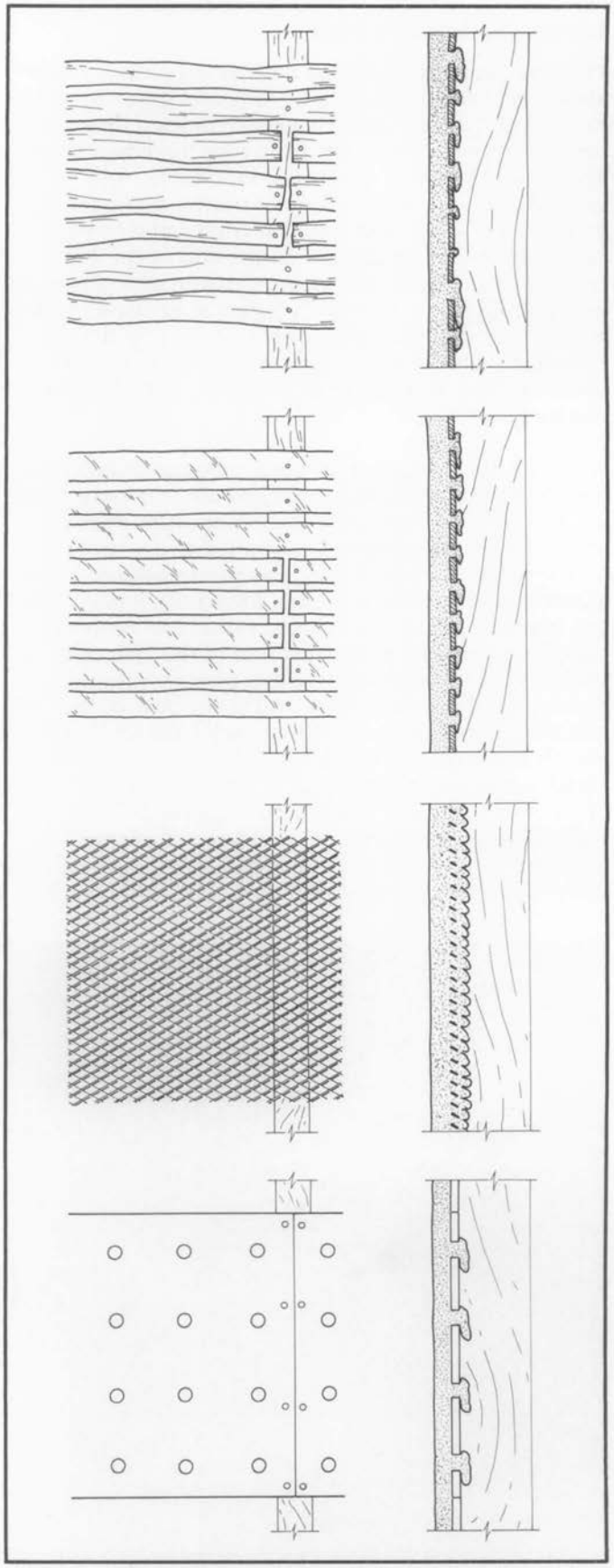


Fig. 6. Top to bottom: Hand-riven lath, machine-sawn wood lath, expanded metal (diamond mesh) lath, and perforated gypsum board lath. Profile views of their keying characteristics are shown to the right. For plaster repairs or replastering, galvanized metal lath is the most reliable in terms of longevity, stability, and proper keying. Drawing: Kaye Ellen Simonson.

Metal Lath. Metal lath, patented in England in 1797, began to be used in parts of the United States toward the end of the 19th century. The steel making up the metal lath contained many more spaces than wood lath had contained. These spaces increased the number of keys; metal lath was better able to hold plaster than wood lath had been.

Rock Lath. A third lath system commonly used was rock lath (also called plaster board or gypsum-board lath). In use as early as 1900, rock lath was made up of compressed gypsum covered by a paper facing. Some rock lath was textured or perforated to provide a key for wet plaster. A special paper with gypsum crystals in it provides the key for rock lath used today; when wet plaster is applied to the surface, a crystalline bond is achieved.

Rock lath was the most economical of the three lathing systems. Lathers or carpenters could prepare a room more quickly. By the late 1930s, rock lath was used almost exclusively in residential plastering.

Common Plaster Problems

When plaster dries, it is a relatively rigid material which should last almost indefinitely. However, there are conditions that cause plaster to crack, effloresce, separate, or become detached from its lath framework (Fig. 7). These include:

- Structural Problems
- Poor Workmanship
- Improper Curing
- Moisture

Structural Problems

Overloading. Stresses within a wall, or acting on the house as a whole, can create stress cracks. Appearing as diagonal lines in a wall, stress cracks usually start at a door or window frame, but they can appear anywhere in the wall, with seemingly random starting points.

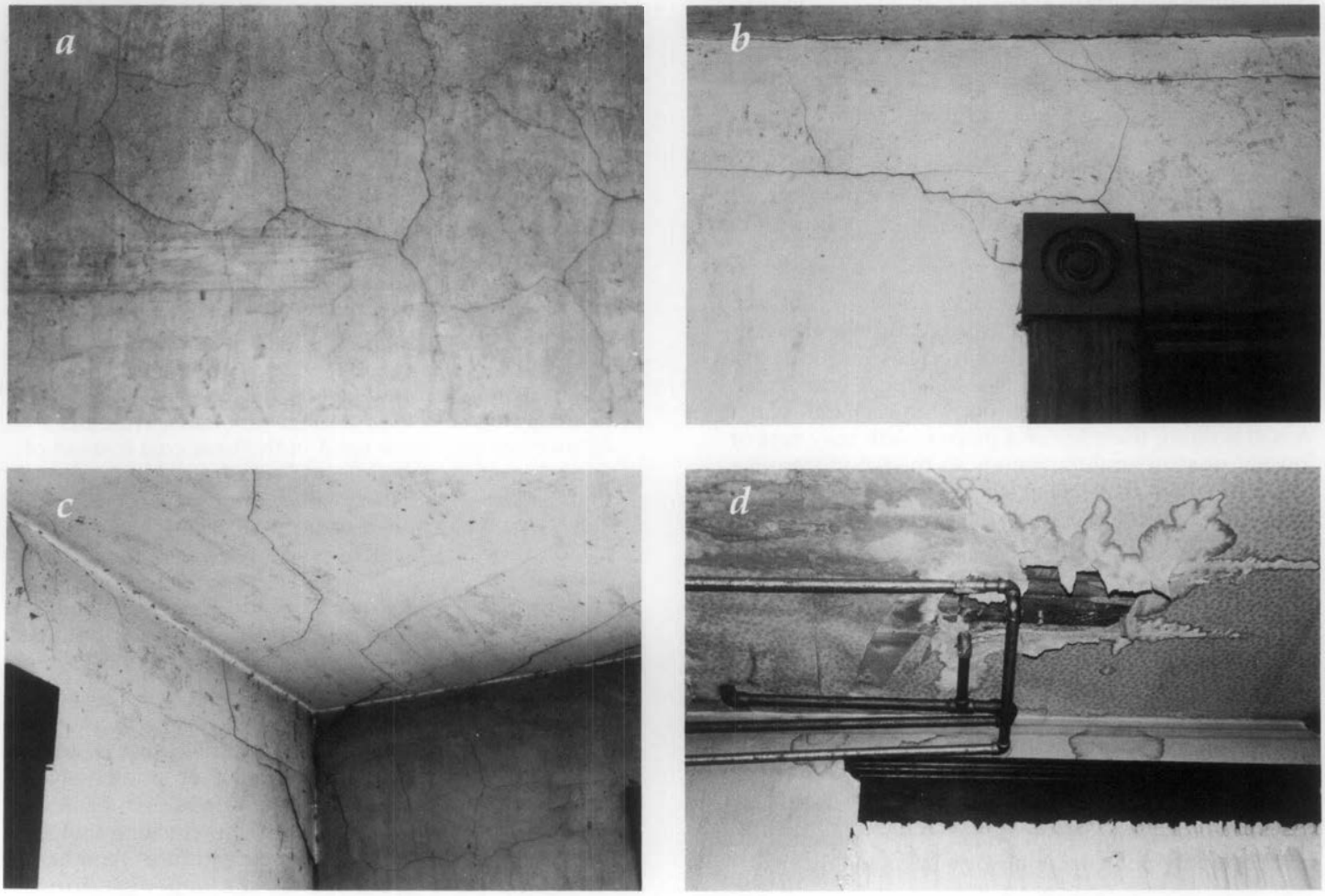


Fig. 7 (a) to (d). A series of photographs taken in different rooms of an early 20th century house in West Virginia reveal a variety of plaster wall surface problems, most of which can easily be remedied through sensitive repair: Hairline cracks (a) in an otherwise sound wall can be filled with joint compound or patching plaster. The wall can also be canvassed or wallpapered. Stress cracks (b) in plaster over a kitchen door frame can be repaired using fiberglass mesh tape and joint compound. Settlement cracks (c) in a bedroom can be similarly repaired. The dark crack at the juncture between walls, however, may be a structural crack and should be investigated for its underlying cause. Moisture damage (d) from leaking plumbing on the second floor has damaged both wallpaper and plaster in the dining room. After fixing the leaking pipes, the wall covering and rotted plaster will need to be replaced and any holes repaired. Photos: Kay Weeks.

Builders of now-historic houses had no codes to help them size the structural members of buildings. The weight of the roof, the second and third stories, the furniture, and the occupants could impose a heavy burden on beams, joists, and studs. Even when houses were built properly, later remodeling efforts may have cut in a doorway or window without adding a structural beam or "header" across the top of the opening. Occasionally, load-bearing members were simply too small to carry the loads above them. Deflection or wood "creep" (deflection that occurs over time) can create cracks in plaster.

Overloading and structural movement (especially when combined with rotting lath, rusted nails, or poor quality plaster) can cause plaster to detach from the lath. The plaster loses its key. When the mechanical bond with the lath is broken, plaster becomes loose or bowed. If repairs are not made, especially to ceilings, gravity will simply cause chunks of plaster to fall to the floor.

Settlement/Vibration. Cracks in walls can also result when houses settle. Houses built on clay soils are especially vulnerable. Many types of clay (such as montmorillonite) are highly expansive. In the dry season, water evaporates from the clay particles, causing them to contract. During the rainy season, the clay swells. Thus, a building can be riding on an unstable footing. Diagonal cracks running in opposite directions suggest that house settling and soil conditions may be at fault. Similar symptoms occur when there is a nearby source of vibration—blasting, a train line, busy highway, or repeated sonic booms.

Lath movement. Horizontal cracks are often caused by lath movement. Because it absorbs moisture from the air, wood lath expands and contracts as humidity rises and falls. This can cause cracks to appear year after year. Cracks can also appear between rock lath panels. A nail holding the edge of a piece of lath may rust or loosen, or structural movement in the wood framing behind the lath may cause a seam to open. Heavy loads in a storage area above a rock-lath ceiling can also cause ceiling cracks.

Errors in initial building construction such as improper bracing, poor corner construction, faulty framing of doors and windows, and undersized beams and floor joists eventually "telegraph" through to the plaster surface.

Poor Workmanship

In addition to problems caused by movement or weakness in the structural framework, plaster durability can be affected by poor materials or workmanship.

Poorly proportioned mix. The proper proportioning and mixing of materials are vital to the quality of the plaster job. A bad mix can cause problems that appear years later in a plaster wall. Until recently, proportions of aggregate and lime were mixed on the job. A plasterer may have skimped on the amount of cementing material (lime or gypsum) because sand was the cheaper material. Oversanding can cause the plaster to weaken or crumble (Fig. 8). Plaster made from a poorly proportioned mix may be more difficult to repair.

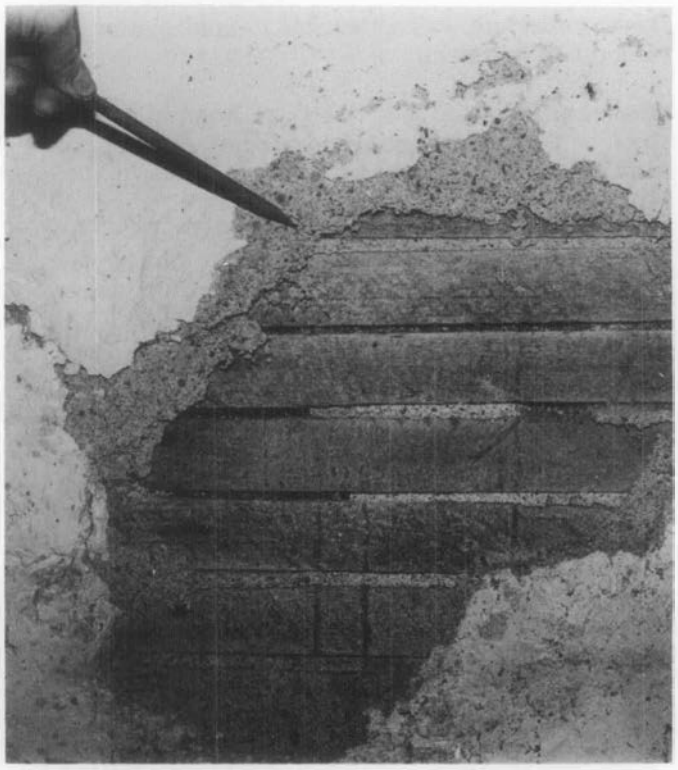


Fig. 8. Too much aggregate (sand) and not enough cementing material (lime or gypsum) in the base coat has made this plaster surface weak and crumbly. Besides losing its key with the lath, the layers are disintegrating. It will most likely need to be totally removed and replaced with all new plaster. Photo: Marylee MacDonald.

Incompatible basecoats and finish coats. Use of perlite as an aggregate also presented problems. Perlite is a lightweight aggregate used in the base coat instead of sand. It performs well in cold weather and has a slightly better insulating value. But if a smooth lime finish coat was applied over perlited base coats on wood or rock lath, cracks would appear in the finish coat and the entire job would have to be re-done. To prevent this, a plasterer had to add fine silica sand or finely crushed perlite to the finish coat to compensate for the dramatically differing shrinkage rates between the base coat and the finish coat.

Improper plaster application. The finish coat is subject to "chip cracking" if it was applied over an excessively dry base coat, or was insufficiently troweled, or if too little gauging plaster was used. Chip cracking looks very much like an alligatored paint surface. Another common problem is called map cracking—fine, irregular cracks that occur when the finish coat has been applied to an oversanded base coat or a very thin base coat.

Too much retardant. Retarding agents are added to slow down the rate at which plaster sets, and thus inhibit hardening. They have traditionally included ammonia,

glue, gelatin, starch, molasses, or vegetable oil. If the plasterer has used too much retardant, however, a gypsum plaster will not set within a normal 20 to 30 minute time period. As a result, the surface becomes soft and powdery.

Inadequate plaster thickness. Plaster is applied in three coats over wood lath and metal lath—the scratch, brown, and finish coats. In three-coat work, the scratch coat and brown coat were sometimes applied on successive days to make up the required wall thickness. Using rock lath allowed the plasterer to apply one base coat and the finish coat—a two-coat job.

If a plasterer skimped on materials, the wall may not have sufficient plaster thickness to withstand the normal stresses within a building. The minimum total thickness for plaster on gypsum board (rock lath) is 1/2 inch. On metal lath the minimum thickness is 5/8 inch; and for wood lath it is about 3/4 to 7/8 inch. This minimum plaster thickness may affect the thickness of trim projecting from the wall's plane.

Improper Curing

Proper temperature and air circulation during curing are key factors in a durable plaster job. The ideal temperature for plaster to cure is between 55–70 degrees Fahrenheit. However, historic houses were sometimes plastered before window sashes were put in. There was no way to control temperature and humidity.

Dryouts, freezing, and sweat-outs. When temperatures were too hot, the plaster would return to its original condition before it was mixed with water, that is, calcined gypsum. A plasterer would have to spray the wall with alum water to re-set the plaster. If freezing occurred before the plaster had set, the job would simply have to be re-done. If the windows were shut so that air could not circulate, the plaster was subject to sweat-out or rot. Since there is no cure for rotted plaster, the affected area had to be removed and replastered.

Moisture

Plaster applied to a masonry wall is vulnerable to water damage if the wall is constantly wet. When salts from the masonry substrate come in contact with water, they migrate to the surface of the plaster, appearing as dry bubbles or efflorescence. The source of the moisture must be eliminated before replastering the damaged area.

Sources of Water Damage. Moisture problems occur for several reasons. Interior plumbing leaks in older houses are common. Roofs may leak, causing ceiling damage. Gutters and downspouts may also leak, pouring rain water next to the building foundation. In brick buildings, dampness at the foundation level can wick up into the above-grade walls. Another common source of moisture is splash-back. When there is a paved area next to a masonry building, rainwater splashing up from the paving can dampen masonry walls. In both cases water travels through the masonry and damages interior plaster. Coatings applied to the interior are not effective over the long run. The moisture problem must be stopped on the outside of the wall.

Repairing Historic Plaster

Many of the problems described above may not be easy to remedy. If major structural problems are found to be the source of the plaster problem, the structural problem should be corrected. Some repairs can be made by removing only small sections of plaster to gain access. Minor structural problems that will not endanger the building can generally be ignored. Cosmetic damages from minor building movement, holes, or bowed areas can be repaired without the need for wholesale demolition. However, it may be necessary to remove deteriorated plaster caused by rising damp in order for masonry walls to dry out. Repairs made to a wet base will fail again.

Canvassing Uneven Wall Surfaces

Uneven wall surfaces, caused by previous patching or by partial wallpaper removal, are common in old houses. As long as the plaster is generally sound, cosmetically unattractive plaster walls can be "wallpapered" with strips of a canvas or fabric-like material. Historically, canvassing covered imperfections in the plaster and provided a stable base for decorative painting or wallpaper.

Filling Cracks

Hairline cracks in wall and ceiling plaster are not a serious cause for concern as long as the underlying plaster is in good condition. They may be filled easily with a patching material (see **Patching Materials,** page 13). For cracks that re-open with seasonal humidity change, a slightly different method is used. First the crack is widened slightly with a sharp, pointed tool such as a crack widener or a triangular can opener. Then the crack is filled. For more persistent cracks, it may be necessary to bridge the crack with tape. In this instance, a fiberglass mesh tape is pressed into the patching material. After the first application of a quick-setting joint compound dries, a second coat is used to cover the tape, feathering it at the edges. A third coat is applied to even out the surface, followed by light sanding. The area is cleaned off with a damp sponge, then dried to remove any leftover plaster residue or dust.

When cracks are larger and due to structural movement, repairs need to be made to the structural system *before* repairing the plaster. Then, the plaster on each side of the crack should be removed to a width of about 6 inches down to the lath. The debris is cleaned out, and metal lath applied to the cleared area, leaving the existing wood lath in place. The metal lath usually prevents further cracking. The crack is patched with an appropriate plaster in three layers (i.e., basecoats and finish coat). If a crack seems to be expanding, a structural engineer should be consulted.

Replacing Delaminated Areas of the Finish Coat

Sometimes the finish coat of plaster comes loose from the base coat (Fig. 9). In making this type of repair, the plasterer paints a liquid plaster-bonding agent onto the areas of base-coat plaster that will be replastered with a new lime finish coat. A homeowner wishing to repair small areas of delaminated finish coat can use the methods described in **Patching Materials.**

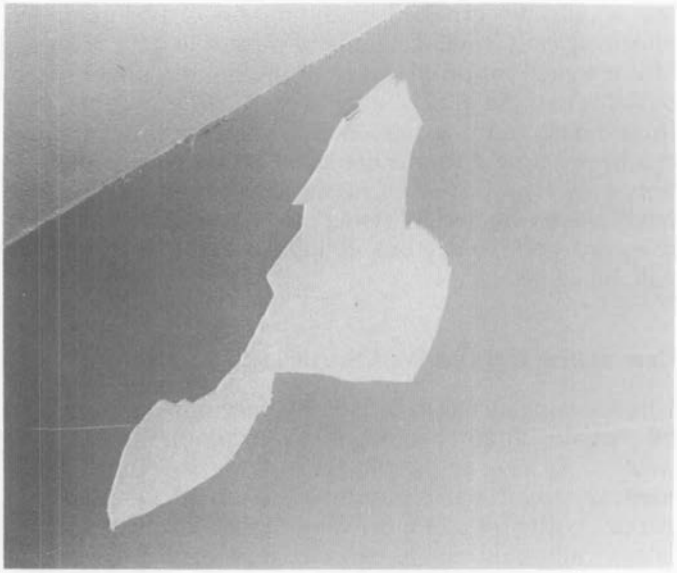


Fig. 9. The smooth-troweled lime finish coat has delaminated from the brown coat underneath. This is another repair that can be undertaken without further loss of the historic plaster. Photo: Marylee MacDonald.

Patching Holes in Walls

For small holes (less than 4 inches in diameter) that involve loss of the brown and finish coats, the repair is made in two applications. First, a layer of basecoat plaster is troweled in place and scraped back below the level of the existing plaster. When the base coat has set but not dried, more plaster is applied to create a smooth, level surface. One-coat patching is not generally recommended by plasterers because it tends to produce concave surfaces that show up when the work is painted. Of course, if the lath only had one coat of plaster originally, then a one-coat patch is appropriate (Fig. 10).

For larger holes where all three coats of plaster are damaged or missing down to the wood lath, plasterers generally proceed along these lines. First, all the old plaster is cleaned out and any loose lath is re-nailed. Next, a water mist is sprayed on the old lath to keep it from twisting when the new, wet plaster is applied, or better still, a bonding agent is used. To provide more reliable keying and to strengthen the patch, expanded metal lath (diamond mesh) should be attached to the wood lath with tie wires or nailed over the wood lath with lath nails (Fig. 11). The plaster is then applied in three layers over the metal lath, lapping each new layer of plaster over the old plaster so that old and new are evenly joined. This stepping is recommended to produce a strong, invisible patch (Fig. 12). Also, if a patch is made in a plaster wall that is slightly wavy, the contour of the patch should be made to conform to the irregularities of the existing work. A flat patch will stand out from the rest of the wall.

Fig. 10 (a) and (b). In this New Hampshire residence dating from the 1790s, the original plaster was a single coat of lime, sand, and horsehair applied over split lath. A one-coat repair, in this case, is appropriate. To the left: a flat sheet of galvanized expanded metal lath is placed over the patch area and an outline marked with a large soft lumber crayon. The metal lath is then cut to fit the hole and nailed to the lath. To the right: the edges of the original plaster and wood lath beneath have been thoroughly soaked with water. A steel trowel is used to apply the plaster in large, rough strokes. Finally, it will be scraped and smoothed off. Because only one coat of plaster is used, without a finish coat, a clean butt-joint is made with the original plaster. Photos: John Leeke.

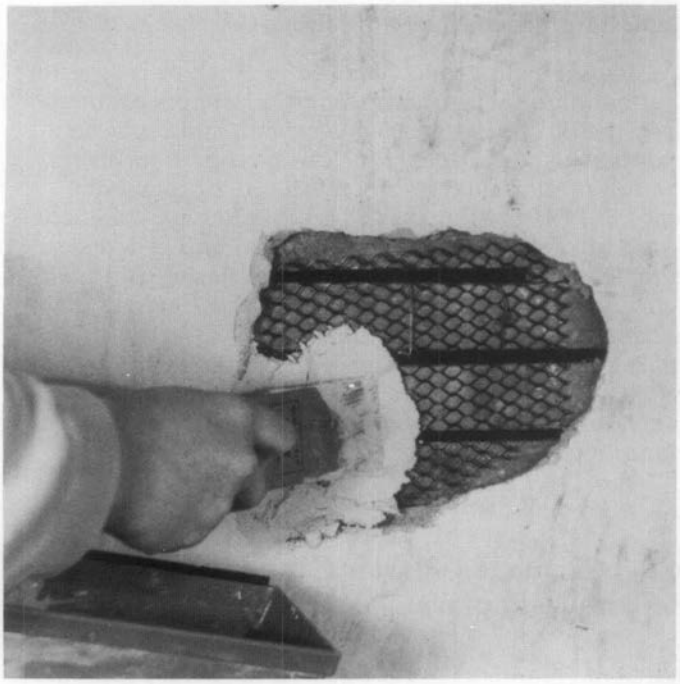


Fig. 11. Repairs are being made to the historic plaster in an early 20th century residence in Tennessee. A fairly sizeable hole in three-coat plaster extends to the wood lath. Expanded metal lath has been cut to fit the hole, then attached to the wood lath with a tie-wire. Two ready-mix gypsum base coats are in the process of being applied. After they set, the finish coat will be smooth-troweled gauged lime to match the existing wall. Photo: Walter Jowers.

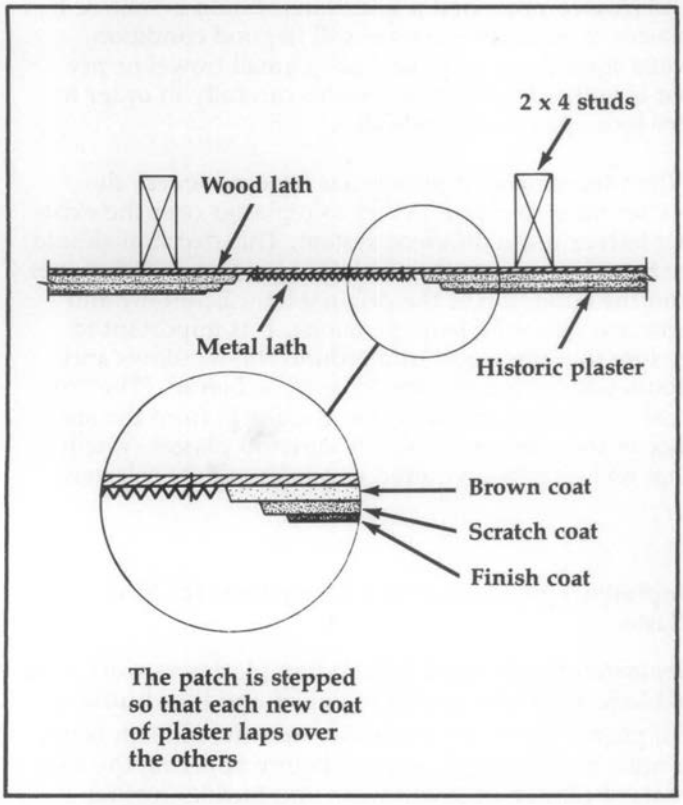


Fig. 12. This explains how a hole in historic plaster is repaired over the existing wood lath. First, metal lath is secured over the wood lath with a tie wire, then the new plaster is applied in three layers, "stepped" so that each new coat overlaps the old plaster to create a good adhesive bond. Drawing: Kaye Ellen Simonson.

Patching Holes in Ceilings

Hairline cracks and holes may be unsightly, but when portions of the ceiling come loose, a more serious problem exists (Fig. 13). The keys holding the plaster to the ceiling have probably broken. First, the plaster around the loose plaster should be examined. Keys may have deteriorated because of a localized moisture problem, poor quality plaster, or structural overloading; yet, the surrounding system may be intact. If the areas surrounding the loose area are in reasonably good condition, the loose plaster can be reattached to the lath using flat-head wood screws and plaster washers (Fig. 14). To patch a hole in the ceiling plaster, metal lath is fastened over the wood lath; then the hole is filled with successive layers of plaster, as described above.

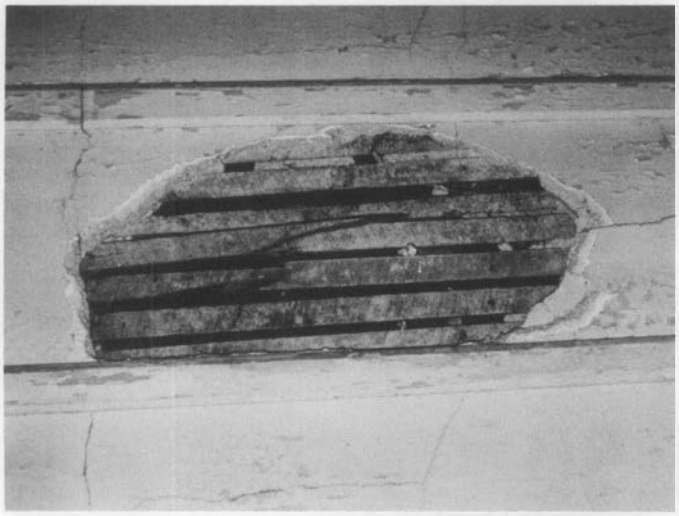


Fig. 13. This beaded ceiling in one of the bedrooms of the 1847 Lockwood House, Harpers Ferry, West Virginia, is missing portions of plaster due to broken keys. This is attributable, in part, to deterioration of the wood lath. Photo: Kaye Ellen Simonson.

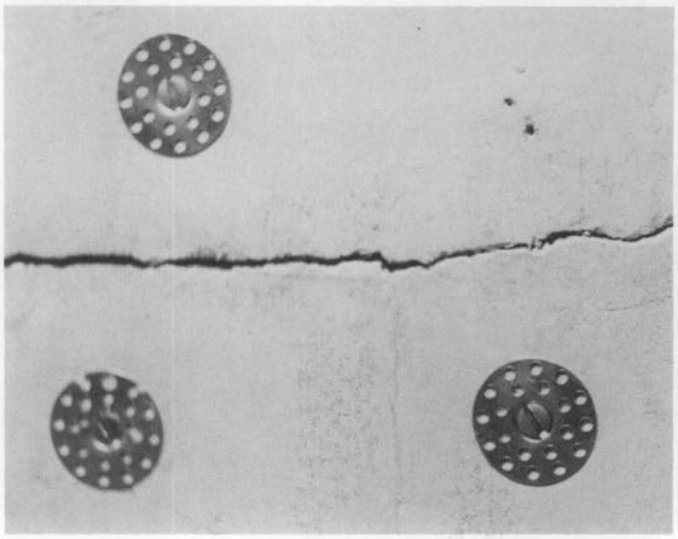


Fig. 14. In a late 18th century house in Massachusetts, flat-head wood screws and plaster washers were used to reattach loose ceiling plaster to the wood lath. After the crack is covered with fiberglass mesh tape, both the taped crack and the plaster washers will be skim-coated with a patching material. Photo: John Obed Curtis.

Establishing New Plaster Keys

If the back of the ceiling lath is accessible (usually from the attic or after removing floor boards), small areas of bowed-out plaster can be pushed back against the lath. A padded piece of plywood and braces are used to secure the loose plaster. After dampening the old lath and coating the damaged area with a bonding agent, a fairly liquid plaster mix (with a glue size retardant added) is applied to the backs of the lath, and worked into the voids between the faces of the lath and the back of the plaster. While this first layer is still damp, plaster-soaked strips of jute scrim are laid across the backs of the lath and pressed firmly into the first layer as reinforcement. The original lath must be secure, otherwise the weight of the patching plaster may loosen it.

Loose, damaged plaster can also be re-keyed when the goal is to conserve decorative surfaces or wallpaper. Large areas of ceilings and walls can be saved. This method requires the assistance of a skilled conservator—it is not a repair technique used by most plasterers. The conservator injects an acrylic adhesive mixture through holes drilled in the face of the plaster (or through the lath from behind, when accessible). The loose plaster is held firm with plywood bracing until the adhesive bonding mixture sets. When complete, gaps between the plaster and lath are filled, and the loose plaster is secure (Fig. 15).

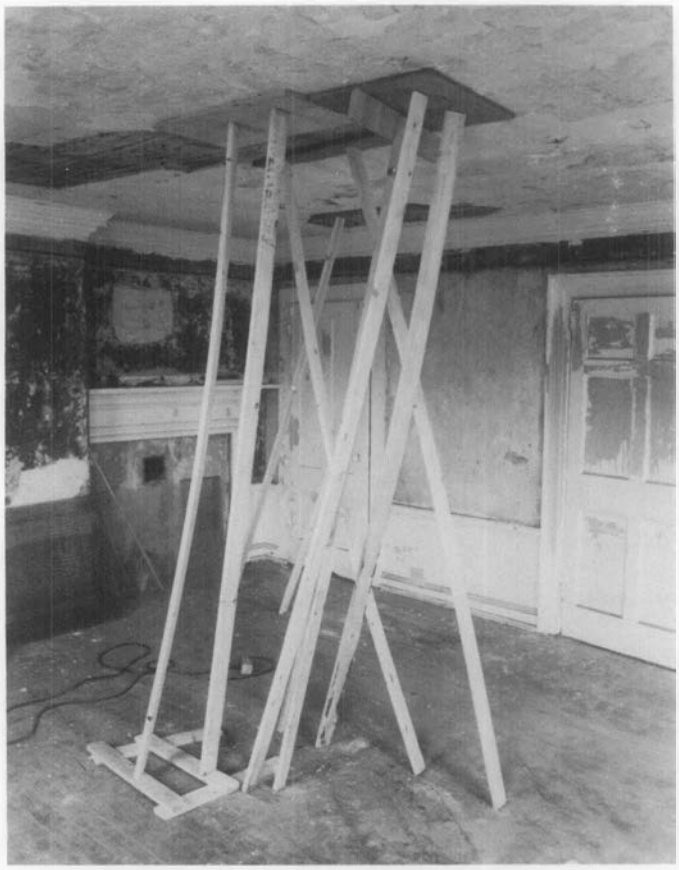


Fig. 15. When ceiling repairs are made with wet plaster or with an injected adhesive mixture, the old loose plaster must be supported with a plywood brace until re-keying is complete. Photo: John Leeke.

Replastering Over the Old Ceiling

If a historic ceiling is too cracked to patch or is sagging (but not damaged from moisture), plasterers routinely keep the old ceiling and simply relath and replaster over it. This repair technique can be used if lowering the ceiling slightly does not affect other ornamental features. The existing ceiling is covered with 1x3-inch wood furring strips, one to each joist, and fastened completely through the old lath and plaster using a screw gun. Expanded metal lath or gypsum board lath is nailed over the furring strips. Finally, two or three coats are applied according to traditional methods. Replastering over the old ceiling saves time, creates much less dust than demolition, and gives added fire protection.

When Damaged Plaster Cannot be Repaired—Replacement Options

Partial or complete removal may be necessary if plaster is badly damaged, particularly if the damage was caused by long-term moisture problems. Workers undertaking demolition should wear OSHA-approved masks because the plaster dust that flies into the air may contain decades of coal soot. Lead, from lead-based paint, is another danger. Long-sleeved clothing and head-and-eye protection should be worn. Asbestos, used in the mid-twentieth century as an insulating and fireproofing additive, may also be present and OSHA-recommended precautions should be taken. If plaster in adjacent rooms is still in good condition, walls should not be pounded—a small trowel or pry bar is worked behind the plaster carefully in order to pry loose pieces off the wall.

When the damaged plaster has been removed, the owner must decide whether to replaster over the existing lath or use a different system. This decision should be based in part on the thickness of the original plaster and the condition of the original lath. Economy and time are also valid considerations. It is important to ensure that the wood trim around the windows and doors will have the same "reveal" as before. (The "reveal" is the projection of the wood trim from the surface of the plastered wall). A lath and plaster system that will give this required depth should be selected.

Replastering—Alternative Lath Systems for New Plaster

Replastering old wood lath. When plasterers work with old lath, each lath strip is re-nailed and the chunks of old plaster are cleaned out. Because the old lath is dry, it must be thoroughly soaked before applying the base coats of plaster, or it will warp and buckle; furthermore, because the water is drawn out, the plaster will fail to set properly. As noted earlier, if new metal lath is installed *over* old wood lath as the base for new plaster,

many of these problems can be avoided and the historic lath can be retained (Fig. 16). The ceiling should still be sprayed unless a vapor barrier is placed behind the metal lath.

Replastering over new metal lath. An alternative to reusing the old wood lath is to install a different lathing system. Galvanized metal lath is the most expensive, but also the most reliable in terms of longevity, stability, and proper keying. When lathing over open joists, the plasterer should cover the joists with kraft paper or a polyethylene vapor barrier. Three coats of wet plaster are applied consecutively to form a solid, monolithic unit with the lath. The scratch coat keys into the metal lath; the second, or brown, coat bonds to the scratch coat and builds the thickness; the third, or finish coat, consists of lime putty and gauging plaster.

Replastering over new rock lath. It is also possible to use rock lath as a plaster base. Plasterers may need to remove the existing wood lath to maintain the woodwork's reveal. Rock lath is a 16x36-inch, 1/2-inch thick, gypsum-core panel covered with absorbent paper with gypsum crystals in the paper. The crystals in the paper bond the wet plaster and anchor it securely. This type of lath requires two coats of new plaster—the brown coat and the finish coat. The gypsum lath itself takes the place of the first, or scratch, coat of plaster.

Painting New Plaster

The key to a successful paint job is proper drying of the plaster. Historically, lime plasters were allowed to cure for at least a year before the walls were painted or papered. With modern ventilation, plaster cures in a shorter time; however, fresh gypsum plaster with a lime finish coat should still be perfectly dry before paint is applied—or the paint may peel. (Plasterers traditionally used the "match test" on new plaster. If a match would light by striking it on the new plaster surface, the plaster was considered dry.) Today it is best to allow new plaster to cure two to three weeks. A good alkaline-resistant primer, specifically formulated for new plaster, should then be used. A compatible latex or oil-based paint can be used for the final coat.

A Modern Replacement System

Veneer Plaster. Using one of the traditional lath and plaster systems provides the highest quality plaster job. However, in some cases, budget and time considerations may lead the owner to consider a less expensive replacement alternative. Designed to reduce the cost of materials, a more recent lath and plaster system is less expensive than a two-or-three coat plaster job, but only slightly more expensive than drywall. This plaster system is called veneer plaster.

Fig. 16. In the restoration of a ca. 1830s house in Maine, split-board lath has been covered with expanded metal lath in preparation for new coats of plaster. This method permits the early lath to be saved while the metal lath, with its superior keying, serves as reinforcement. Photo: National Park Service files.

The system uses gypsum-core panels that are the same size as drywall (4x8 feet), and specially made for veneer plaster. They can be installed over furring channels to masonry walls or over old wood lath walls and ceilings. Known most commonly as "blueboard," the panels are covered with a special paper compatible with veneer plaster. Joints between the 4-foot wide sheets are taped with fiberglass mesh, which is bedded in the veneer plaster. After the tape is bedded, a thin, 1/16-inch coat of high-strength veneer plaster is applied to the entire wall surface. A second veneer layer can be used as the "finish" coat, or the veneer plaster can be covered with a gauged lime finish-coat—the same coat that covers ordinary plaster (Fig. 17).

Fig. 17. This contemporary plasterer is mixing a lime finish coat in much the same way as America's earlier artisans. The ring consists of lime putty; the white powder inside is gauging plaster. After the mixture is blended, a steel trowel will be used to apply it. It should be noted that a traditional lime finish coat can be applied over a veneer plaster base coat to approximate the look of historic plaster walls and ceilings. Photo: Marylee MacDonald.

Although extremely thin, a two-coat veneer plaster system has a 1,500 psi rating and is thus able to withstand structural movements in a building or surface abrasion. With either a veneer finish or a gauged lime-putty finish coat, the room will be ready for painting almost immediately. When complete, the troweled or textured wall surface looks more like traditional plaster than drywall.

The thin profile of the veneer system has an added benefit, especially for owners of uninsulated masonry buildings. Insulation can be installed between the pieces of furring channel used to attach blueboard to masonry walls. This can be done without having to furr out the window and door jambs. The insulation plus the veneer system will result in the same thickness as the original plaster. Occupants in the rooms will be more comfortable because they will not be losing heat to cold wall surfaces.

Summary

The National Park Service recommends retaining historic plaster if at all possible. Plaster is a significant part of the "fabric" of the building. Much of the building's history is documented in the layers of paint and paper found covering old plaster. For buildings with decorative painting, conservation of historic flat plaster is even more important. Consultation with the National Park Service, with State Historic Preservation Officers, local preservation organizations, historic preservation consultants, or with the Association for Preservation Technology is recommended. Where plaster cannot be repaired or conserved using one of the approaches outlined in this Brief, documentation of the layers of wallpaper and paint should be undertaken before removing the historic plaster. This information may be needed to complete a restoration plan.

Patching Materials

Plasterers generally use ready-mix base-coat plaster for patching, especially where large holes need to be filled. The ready-mix plaster contains gypsum and aggregate in proper proportions. The plasterer only needs to add water.

Another mix plasterers use to patch cracks or small holes, or for finish-coat repair, is a "high gauge" lime putty (50 percent lime; 50 percent gauging plaster). This material will produce a white, smooth patch. It is especially suitable for surface repairs.

Although property owners cannot duplicate the years of accumulated knowledge and craft skills of a professional plasterer, there are materials that can be used for do-it-yourself repairs. For example, fine cracks can be filled with an all-purpose drywall joint compound. For bridging larger cracks using fiberglass tape, a homeowner can use a "quick-setting" joint compound. This compound has a fast drying time—60, 90, or 120 minutes. Quick-setting joint compound dries because of a chemical reaction, not because of water evaporation. It shrinks less than all-purpose joint compound and has much the same workability as ready-mix base-coat plaster. However, because quick-set joint compounds are hard to sand, they should only be used to bed tape or to fill large holes. All-purpose joint compound should be used as the final coat prior to sanding.

Homeowners may also want to try using a ready-mix perlited base-coat plaster for scratch and brown coat repair. The plaster can be hand-mixed in small quantities, but bagged ready-mix should be protected from ambient moisture. A "mill-mixed pre-gauged" lime finish coat plaster can also be used by homeowners. A base coat utilizing perlite or other lightweight aggregates should only be used for making small repairs (less than 4 ft. patches). For large-scale repairs and entire room re-plastering, see the precautions in Table 1 for using perlite.

Homeowners may see a material sold as "patching plaster" or "plaster of Paris" in hardware stores. This dry powder cannot be used by itself for plaster repairs. It must be combined with lime to create a successful patching mixture.

When using a lime finish coat for any repair, wait longer to paint, or use an alkaline-resistant primer.

TABLE 1
REPLASTERING
Selected Plaster Bases/Compatible Basecoats and Finish Coats

Traditional Plaster Bases	*Compatible Basecoats*	*Compatible Finish Coats*
OLD WOOD LATH	gypsum/sand plaster	lime putty/gauging plaster
	gypsum/perlite plaster [2]	lime putty/gauging plaster
METAL LATH	gypsum/sand plaster (high strength)	lime putty/gauging plaster
	gypsum/perlite plaster [2]	lime putty/gauging plaster
GYPSUM (ROCK) LATH PANELS	gypsum/sand plaster	lime putty/gauging plaster
	gypsum/perlite plaster [2]	lime putty/gauging plaster
UNGLAZED BRICK/CLAY TILE	gypsum/perlite plaster [2] (*masonry* type)	lime putty/gauging plaster
Modern Plaster Base	***Compatible Basecoat***	***Compatible Finish Coat***
GYPSUM CORE VENEER PANELS (BLUE BOARD)	veneer plaster	veneer plaster *or* lime putty/gauging plaster

[1] On traditional bases (wood, metal, and rock lath), the thickness of base coat plaster is one of the most important elements of a good plaster job. Grounds should be set to obtain the following minimum plaster thicknesses: (1) Over rock lath—1/2" (2) Over brick, clay tile, or other masonry—5/8" (3) Over metal lath, measured from face of lath—5/8" (4) Over wood lath—7/8". In no case should the total plaster thickness be less than 1/2". The allowance for the finish coat is approximately 1/16" which requires the base coat to be 7/16" for 1/2" grounds. This is a *minimum* base coat thickness on rock lath. The standard for other masonry units and metal lath is 5/8" thick, including the finish. Certain types of construction or fire ratings may require an increase in plaster thickness (and/or an increase in the gypsum to aggregate ration) but never a thinner application of plaster than recommended above. Job experience indicates that thin applications of plaster often evidence cracking where normal applications to standard grounds do not. This condition is a direct result of the inability of thin section areas to resist external forces as adequately as thicker, normal applications of plaster.

[2] Perlite is a lightweight aggregate often used in gypsum plaster in place of sand. It performs well in cold weather and has a slightly better insulating value than sand. In a construction with metal lath, perlite aggregate is not recommended in the basecoat except under a sand or "float" finish. When gypsum/perlite basecoats are used over any other base (i.e., wood, rock lath, brick) and the finish coat is to be a "white" finish coat (smooth-troweled gauged lime putty) it is necessary to add fine silica sand or perlite fines to the finish coat. This measure prevents cracking of the "white" finish coat due to differential shrinkage.

Plaster Terms

Scratch coat. The first base coat put on wood or metal lath. The wet plaster is "scratched" with a scarifier or comb to provide a rough surface so the next layer of base coat will stick to it.

Brown coat. The brown coat is the second application of wet, base-coat plaster with wood lath or metal systems. With gypsum board lath (rock lath, plasterboard), it is the only base coat needed.

Finish coat. Pure lime, mixed with about 35 percent gauging plaster to help it harden, is used for the very thin surface finish of the plaster wall. Fine sand can be added for a sanded finish coat.

Casing Bead. Early casing bead was made of wood. In the 19th century, metal casing beads were sometimes used around fireplace projections, and door and window openings. Like a wood ground, they indicate the proper thickness for the plaster.

Corner Bead. Wire mesh with a rigid metal spline used on outside corners. Installing the corner bead plumb is important.

Cornerite. Wire mesh used on inside corners of adjoining walls and ceilings. It keeps corners from cracking.

Ground. Plasterers use metal or wood strips around the edges of doors and windows and at the bottom of walls. These grounds help keep the plaster the same thickness and provide a stopping edge for the plaster. Early plaster work, however, did not use grounds. On early buildings, the woodwork was installed and primed before plastering began. Some time in the early 19th century, a transition occurred, and plasterers applied their wall finish before woodwork was installed.

Gypsum. Once mined from large gypsum quarries near Paris (thus the name plaster of Paris), gypsum in its natural form is calcium sulfate. When calcined (or heated), one-and-a-half water molecules are driven off, leaving a hemi-hydrate of calcium sulfate. When mixed with water, it becomes calcium sulfate again. While gypsum was used in base-coat plaster from the 1890s on, it has always been used in finish coat and decorative plaster. For finish coats, gauging plaster was added to lime putty; it causes the lime to harden. Gypsum is also the ingredient in moulding plaster, a finer plaster used to create decorative mouldings in ornamental plasterwork.

Lime. Found in limestone formations or shell mounds, naturally occurring lime is calcium carbonate. When heated, it becomes calcium oxide. After water has been added, it becomes calcium hydroxide. This calcium hydroxide reacts with carbon dioxide in the air to recreate the original calcium carbonate.

Screed. Screeds are strips of plaster run vertically or horizontally on walls or ceilings. They are used to plumb and straighten uneven walls and level ceilings. Metal screeds are used to separate different types of plaster finishes or to separate lime and cement plasters.

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22 PRESERVATION BRIEFS

The Preservation and Repair of Historic Stucco

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The term "stucco" is used here to describe a type of exterior plaster applied as a two-or-three part coating directly onto masonry, or applied over wood or metal lath to a log or wood frame structure. Stucco is found in many forms on historic structures throughout the United States. It is so common, in fact, that it frequently goes unnoticed, and is often disguised or used to imitate another material. Historic stucco is also sometimes incorrectly viewed as a sacrificial coating, and consequently removed to reveal stone, brick or logs that historically were never intended to be exposed. Age and lack of maintenance hasten the deterioration of many historic stucco buildings. Like most historic building materials, stucco is at the mercy of the elements, and even though it is a protective coating, it is particularly susceptible to water damage.

Stucco is a material of deceptive simplicity: in most cases its repair should not be undertaken by a property owner unfamiliar with the art of plastering. Successful stucco repair requires the skill and experience of a professional plasterer. Therefore, this Brief has been prepared to provide background information on the nature and components of traditional stucco, as well as offer guidance on proper maintenance and repairs. The Brief will outline the requirements for stucco repair, and, when necessary, replacement. Although several stucco mixes representative of different periods are provided here for reference, this Brief does not include specifications for carrying out repair projects. Each project is unique, with its own set of problems that require individual solutions.

Historical Background

Stucco has been used since ancient times. Still widely used throughout the world, it is one of the most common of traditional building materials (Fig. 1). Up until

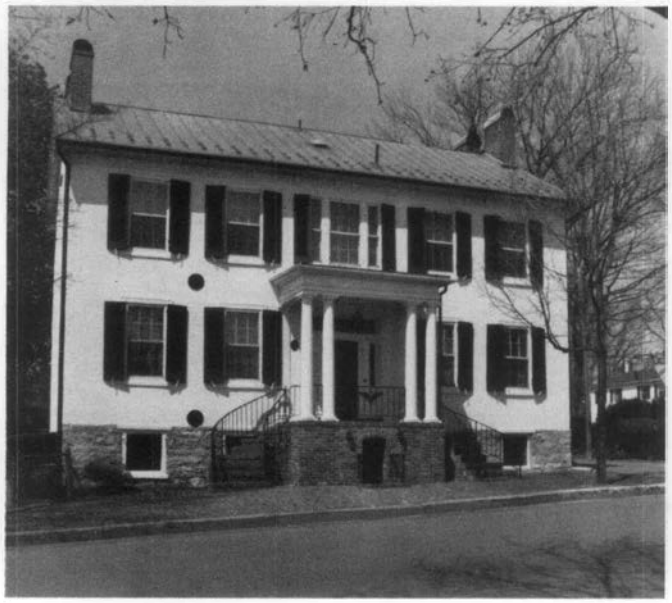


Fig. 1. These two houses in a residential section of Winchester, Virginia, illustrate the continuing popularity of stucco (a) from this early 19th century, Federal style house on the left, (b) to the English Cotswold style cottage that was built across the street in the 1930's. Photos: Anne Grimmer.

the late 1800's, stucco, like mortar, was primarily lime-based, but the popularization of portland cement changed the composition of stucco, as well as mortar, to a harder material. Historically, the term "plaster" has often been interchangeable with "stucco"; the term is still favored by many, particularly when referring to the traditional lime-based coating. By the nineteenth century "stucco," although originally denoting fine interior ornamental plasterwork, had gained wide acceptance in the United States to describe exterior plastering. "Render" and "rendering" are also terms used to describe stucco, especially in Great Britain. Other historic treatments and coatings related to stucco in that they consist at least in part of a similarly plastic or malleable material include: parging and pargeting, wattle and daub, "cob" or chalk mud, pisé de terre, rammed earth, briqueté entre poteaux or bousillage, half-timbering, and adobe. All of these are regional variations on traditional mixtures of mud, clay, lime, chalk, cement, gravel or straw. Many are still used today.

The Stucco Tradition in the United States

Stucco is primarily used on residential buildings and relatively small-scale commercial structures. Some of the earliest stucco buildings in the United States include examples of the Federal, Greek and Gothic Revival styles of the eighteenth and the nineteenth centuries that emulated European architectural fashions. Benjamin Henry Latrobe, appointed by Thomas Jefferson as Surveyor of Public Buildings of the United States in 1803, was responsible for the design of a number of important stucco buildings, including St. John's Church (1816), in Washington, D.C. (Fig. 2). Nearly half a century later Andrew Jackson Downing also advocated the use of stucco in his influential book *The Architecture of Country Houses*, published in 1850. In Downing's opinion, stucco was superior in many respects to plain brick or stone because it was cheaper, warmer and dryer, and could be "agreeably" tinted. As a result of his advice, stuccoed Italianate style urban and suburban villas proliferated in many parts of the country during the third quarter of the nineteenth century.

Revival Styles Promote Use of Stucco

The introduction of the many revival styles of architecture around the turn of the twentieth century, combined with the improvement and increased availability of portland cement resulted in a "craze" for stucco as a building material in the United States. Beginning about 1890 and gaining momentum into the 1930's and 1940's, stucco was associated with certain historic architectural styles, including: Prairie; Art Deco, and Art Moderne; Spanish Colonial, Mission, Pueblo, Mediterranean, English Cotswold Cottage, and Tudor Revival styles; as well as the ubiquitous bungalow and "four-square" house (Fig. 3). The fad for Spanish Colonial Revival, and other variations on this theme, was especially important in furthering stucco as a building material in the United States during this period, since stucco clearly looked like adobe (Fig. 4).

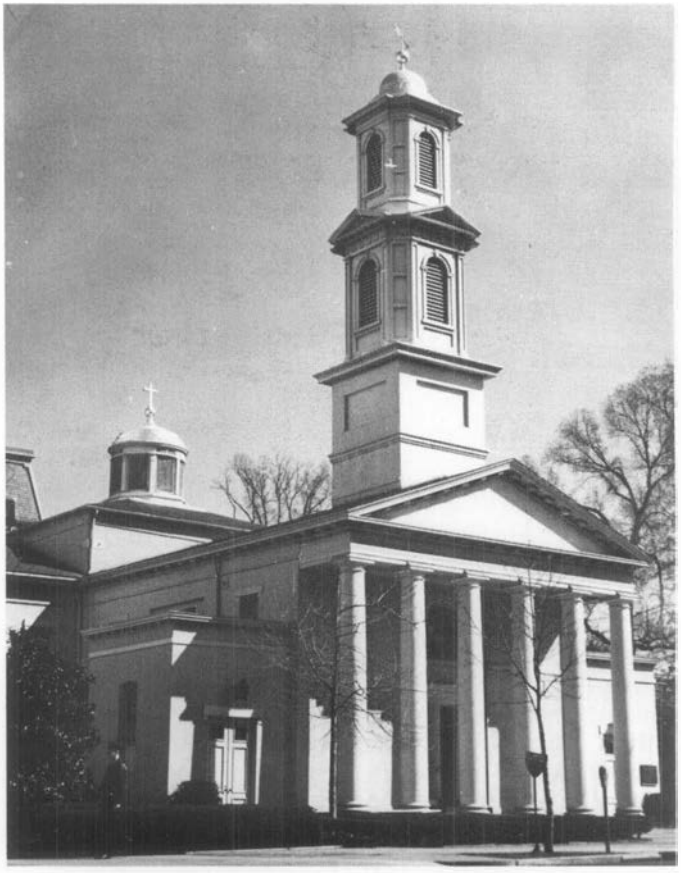


Fig. 2. St. John's Church, Washington, D.C., constructed of brick and stuccoed immediately upon completion in 1816, reflects the influence of European, and specifically English, architectural styles. Photo: Russell Jones, HABS Collection.

Fig. 3. The William Gray and Edna S. Purcell House, Minneapolis, Minnesota, was designed in 1913 by the architects Purcell and Elmslie in the Prairie style. Stuccoed in a salmon-pink, sand (float) finish, it is unusual in that it featured a 3-color geometric frieze stencilled below the eaves of the 2nd story. The Minneapolis Institute of Art has removed the cream-colored paint added at a later date, and restored the original color and texture of the stucco. Photo: Courtesy MacDonald and Mack Partnership.

Although stucco buildings were especially prevalent in California, the Southwest and Florida, ostensibly because of their Spanish heritage, this period also spawned stucco-coated, revival-style buildings all over the United States and Canada. The popularity of stucco as a cheap, and readily available material meant that by the 1920's, it was used for an increasing variety of building types. Resort hotels, apartment buildings, private mansions and movie theaters, railroad stations, and even gas stations and tourist courts took advantage of the "romance" of period styles, and adopted the stucco construction that had become synonymous with these styles (Fig. 5).

Fig. 4. The elaborate Spanish Colonial Revival style of this building designed by Bertram Goodhue for the 1915 Panama California Exposition held in San Diego's Balboa Park emphasizes the sculptural possibilities of stucco. Photo: C.W. Snell, National Historic Landmark Files.

A Practical Building Material

Stucco has traditionally been popular for a variety of reasons. It was an inexpensive material that could simulate finely dressed stonework, especially when "scored" or "lined" in the European tradition. A stucco coating over a less finished and less costly substrate such as rubblestone, fieldstone, brick, log or wood frame, gave the building the appearance of being a more expensive and important structure. As a weather-repellent coating, stucco protected the building from wind and rain penetration, and also offered a certain amount of fire protection. While stucco was usually applied during construction as part of the building design, particularly over rubblestone or fieldstone, in some instances it was added later to protect the structure, or when a rise in the owner's social status demanded a comparable rise in his standard of living.

Composition of Historic Stucco

Before the mid-to-late nineteenth century, stucco consisted primarily of hydrated or slaked lime, water and sand, with straw or animal hair included as a binder. Natural cements were frequently used in stucco mixes after their discovery in the United States during the 1820's. Portland cement was first manufactured in the United States in 1871, and it gradually replaced natural cement. After about 1900, most stucco was composed primarily of portland cement, mixed with some lime. With the addition of portland cement, stucco became even more versatile and durable. No longer used just as a coating for a substantial material like masonry or log, stucco could now be applied over wood or metal lath attached to a light wood frame. With this increased strength, stucco ceased to be just a veneer and became a more integral part of the building structure.

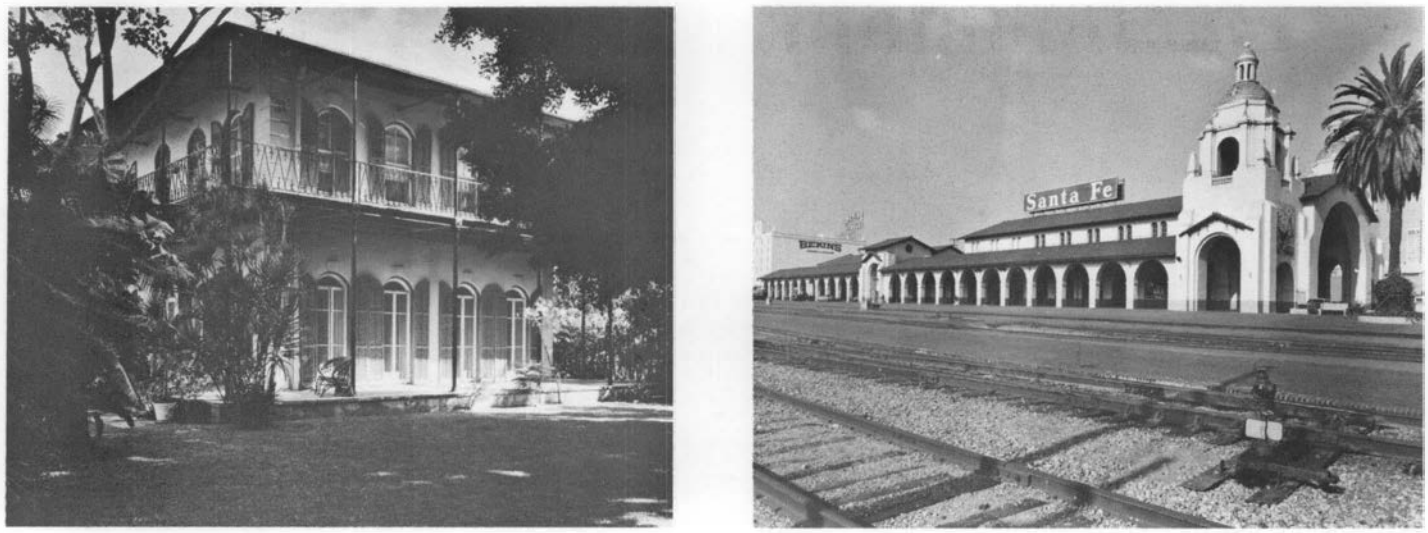


Fig. 5. During the 19th and 20th centuries stucco has been a popular material not only for residential, but also for commercial buildings in the Spanish style. Two such examples are (a) the 1851 Ernest Hemingway House, Key West, Florida, built of stuccoed limestone in a Spanish Caribbean style; and (b) the Santa Fe Depot (Union Station), San Diego, California, designed by the architects Bakewell and Brown in 1914 in a Spanish Colonial Revival style, and constructed of stucco over brick and hollow tile. Photos: (a) J.F. Brooks, HABS Collection, (b) Marvin Rand, HABS Collection.

Today, gypsum, which is hydrated calcium sulfate or sulfate of lime, has to a great extent replaced lime. Gypsum is preferred because it hardens faster and has less shrinkage than lime. Lime is generally used only in the finish coat in contemporary stucco work.

The composition of stucco depended on local custom and available materials. Stucco often contained substantial amounts of mud or clay, marble or brick dust, or even sawdust, and an array of additives ranging from animal blood or urine, to eggs, keratin or gluesize (animal hooves and horns), varnish, wheat paste, sugar, salt, sodium silicate, alum, tallow, linseed oil, beeswax, and wine, beer, or rye whiskey. Waxes, fats and oils were included to introduce water-repellent properties, sugary materials reduced the amount of water needed and slowed down the setting time, and alcohol acted as an air entrainer. All of these additives contributed to the strength and durability of the stucco.

The appearance of much stucco was determined by the color of the sand—or sometimes burnt clay, used in the mix, but often stucco was also tinted with natural pigments, or the surface whitewashed or colorwashed after stuccoing was completed. Brick dust could provide color, and other coloring materials that were not affected by lime, mostly mineral pigments, could be added to the mix for the final finish coat. Stucco was also marbled or marbleized—stained to look like stone by diluting oil of vitriol (sulfuric acid) with water, and mixing this with a yellow ochre, or another color (Fig. 6). As the twentieth century progressed, manufactured or synthetic pigments were added at the factory to some prepared stucco mixes.

Methods of Application

Stucco is applied directly, without lath, to masonry substrates such as brick, stone, concrete or hollow tile (Fig. 7). But on wood structures, stucco, like its interior counterpart plaster, must be applied over lath in order to obtain an adequate key to hold the stucco. Thus, when applied over a log structure, stucco is laid on horizontal wood lath that has been nailed on vertical wood furring strips attached to the logs (Fig. 8). If it is applied over a wood frame structure, stucco may be applied to wood or metal lath nailed directly to the wood frame; it may also be placed on lath that has been attached to furring strips. The furring strips are themselves laid over building paper covering the wood sheathing (Fig. 9). Wood lath was gradually superseded by expanded metal lath introduced in the late-nineteenth and early-twentieth century. When stuccoing over a stone or brick substrate, it was customary to cut back or rake out the mortar joints if they were not already recessed by natural weathering or

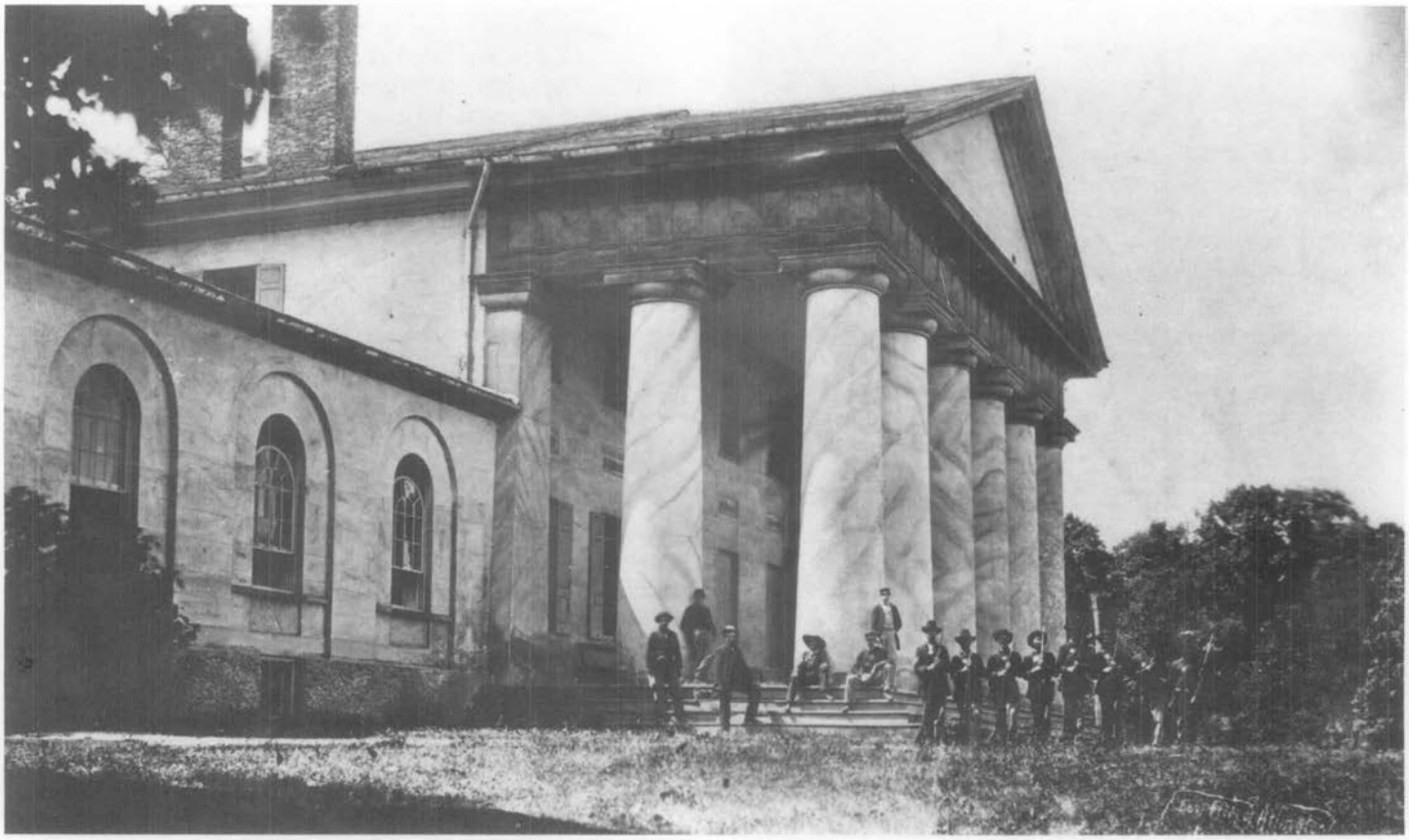


Fig. 6. Arlington House, Arlington, Virginia, was built between 1802–1818 of brick covered with stucco. It was designed by George Hadfield for George Washington Parke Custis, grandson of Martha Washington, and was later the home of Robert E. Lee. This photograph taken on June 28, 1864, by Captain Andrew J. Russell, a U.S. Signal Corps photographer, shows the stucco after it had been marbleized during the 1850's. Yellow ochre and burnt umber pigments were combined to imitate Sienna marble, and the stucco, with the exception of the roughcast foundation, was scored to heighten the illusion of stone. Photo: National Archives, Arlington House Collection, National Park Service.

Fig. 7. Patches of stucco have fallen off this derelict 19th century structure exposing the rough-cut local stone substrate. The missing wood entablature on the side and the rough wood lintel now exposed above a second-floor window, offer clues that the building was stuccoed originally. Photo: National Park Service Files.

Fig. 8. Removal of deteriorated stucco in preparation for stucco repair on this late-18th century log house in Middleway, West Virginia, reveals that the stucco was applied to hand-riven wood lath nailed over vertical wood strips attached to the logs. Photo: Anne Grimmer.

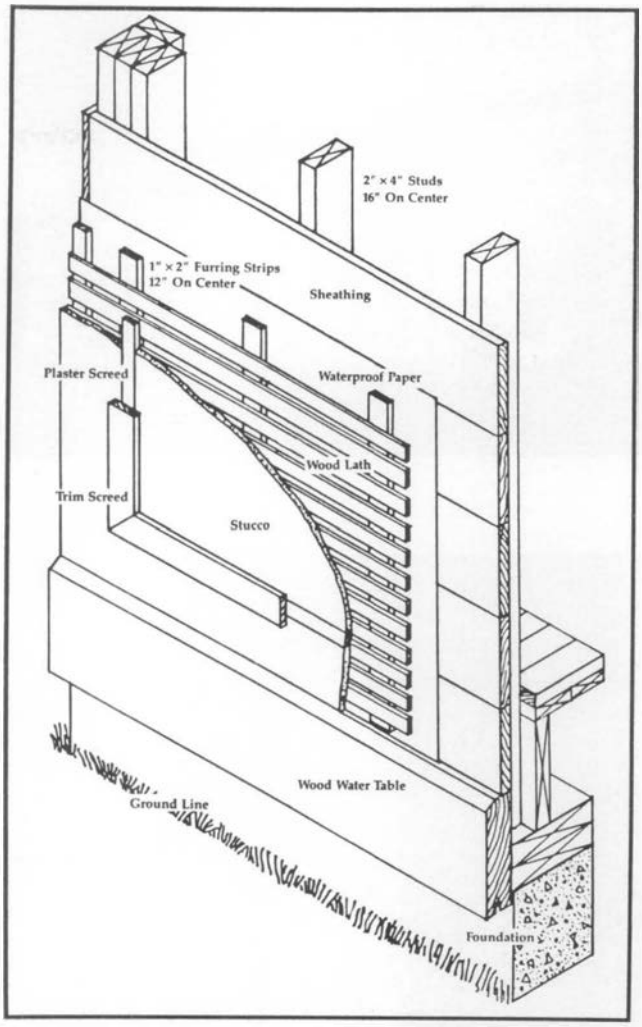


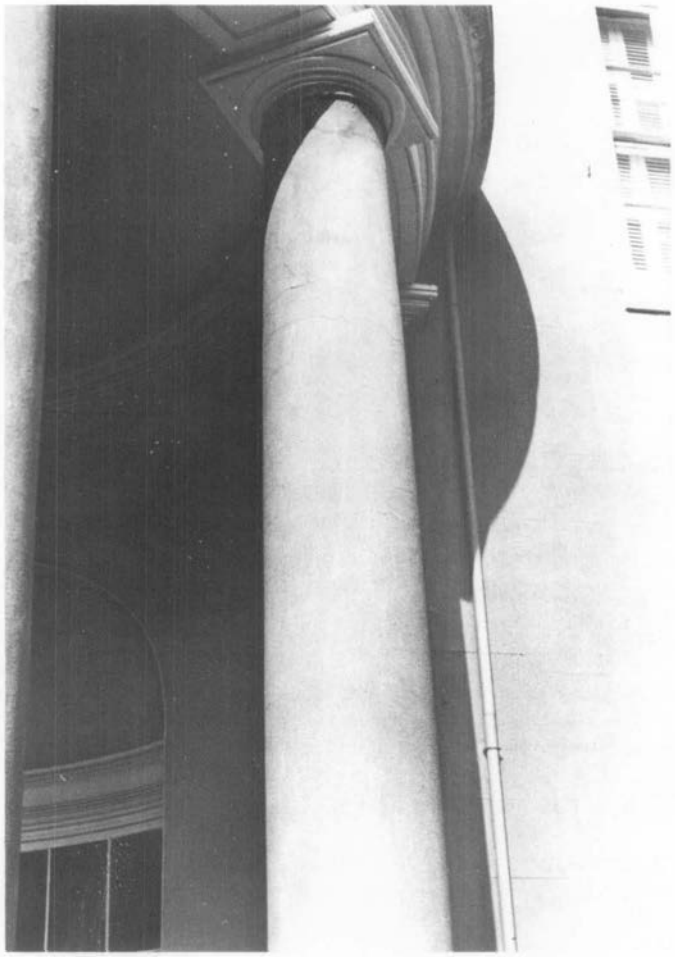
Fig. 9. This cutaway drawing shows the method of attachment for stucco commonly used on wood frame or balloon frame structures from the late-19th to the 20th century. Drawing: Brian Conway, "Illinois Preservation Series Number 2: Stucco."

erosion, and sometimes the bricks themselves were gouged to provide a key for the stucco. This helped provide the necessary bond for the stucco to remain attached to the masonry, much like the key provided by wood or metal lath on frame buildings.

Like interior wall plaster, stucco has traditionally been applied as a multiple-layer process, sometimes consisting of two coats, but more commonly as three. Whether applied directly to a masonry substrate or onto wood or metal lath, this consists of a first "scratch" or "pricking-up" coat, followed by a second scratch coat, sometimes referred to as a "floating" or "brown" coat, followed finally by the "finishing" coat. Up until the late-nineteenth century, the first and the second coats were of much the same composition, generally consisting of lime, or natural cement, sand, perhaps clay, and one or more of the additives previously mentioned. Straw or animal hair was usually added to the first coat as a binder. The third, or finishing coat, consisted primarily of a very fine mesh grade of lime and sand, and sometimes pigment. As already noted, after the 1820's, natural cement was also a common ingredient in stucco until it was replaced by portland cement.

A

B



C

D

Fig. 10. (a) Tudor Place, Washington, D.C. (1805–1816), was designed by Dr. William Thornton. Like its contemporary, Arlington House, it is stuccoed and scored, with a roughcast base, but here the stucco is a monochromatic sandstone color tinted by sand and mineral pigments (b). Although the original stucco was replaced in the early-20th century with a portland cement-based stucco, the family, who retained ownership until 1984 when the house was opened to the public, left explicit instructions for future stucco repairs. The mix recommended for repairing hairline cracks (c), consists of sharp sand, cement and lime, burnt umber, burnt sienna, and a small amount of raw sienna. Preparation of numerous test samples, the size of "a thick griddle cake," will be necessary to match the stucco color, and when the exact color has been achieved, the mixture is to be diluted to the "consistency of cream," brushed on the wall and rubbed into the cracks with a rubber sponge or float. Note the dark color visible under the eaves intended to replicate the stronger color of the original limewashed stucco (d). Photos: Anne Grimmer.

Both masonry and wood lath must be kept wet or damp to ensure a good bond with the stucco. Wetting these materials helps to prevent them from pulling moisture out of the stucco too rapidly, which results in cracking, loss of bond, and generally poor quality stuccowork.

Traditional Stucco Finishes

Until the early-twentieth century when a variety of novelty finishes or textures were introduced, the last coat of stucco was commonly given a smooth, troweled finish, and then scored or lined in imitation of ashlar. The illusion of masonry joints was sometimes enhanced by a thin line of white lime putty, graphite, or some other pigment. Some nineteenth century buildings feature a water table or raised foundation of rough-cast stucco that differentiates it from the stucco surface above, which is smooth and scored (Fig. 10). Other novelty or textured finishes associated with the "period" or revival styles of the early-twentieth century include: the English cottage finish, adobe and Spanish, pebble-dashed or dry-dash surface, fan and sponge texture, reticulated and vermiculated, roughcast (or wet dash), and sgraffito (Fig. 11).

Repairing Deteriorated Stucco

Regular Maintenance

Although A. J. Downing alluded to stuccoed houses in Pennsylvania that had survived for over a century in relatively good condition, historic stucco is inherently not a particularly permanent or long-lasting building material. Regular maintenance is required to keep it in good condition. Unfortunately, many older or historic buildings are not always accorded this kind of care.

Because building owners knew stucco to be a protective, but also somewhat fragile coating, they employed a variety of means to prolong its usefulness. The most common treatment was to whitewash stucco, often annually. The lime in the whitewash offered protection and stability and helped to harden the stucco. Most importantly, it filled hairline cracks before they could develop into larger cracks and let in moisture. To improve water repellency, stucco buildings were also sometimes coated with paraffin, another type of wax, or other stucco-like coatings, such as oil mastics.

Assessing Damage

Most stucco deterioration is the result of water infiltration into the building structure, either through the roof, around chimneys, window and door openings, or excessive ground water or moisture penetrating through, or splashing up from the foundation. Potential causes of deterioration include: ground settlement, lintel and door frame settlement, inadequate or leaking gutters and downspouts, intrusive vegetation, moisture migration within walls due to interior condensation and humidity, vapor drive problems caused by furnace, bathroom and kitchen vents, and rising damp resulting from excessive ground water and poor drainage around the foundation. Water infiltration will cause wood lath to rot, and metal lath and nails to rust, which eventually will cause stucco to lose its bond and pull away from its substrate.

Fig. 11. The Hotel Washington, Washington, D.C. (1916–1917), is notable for its decorative ***sgraffito*** *surfaces. Stucco panels under the cornice and around the windows feature classical designs created by artists who incised the patterns in the outer layer of red-colored stucco while still soft, thereby exposing a stucco undercoat of a contrasting color. Photo: Kaye Ellen Simonson.*

After the cause of deterioration has been identified, any necessary repairs to the building should be made first before repairing the stucco. Such work is likely to include repairs designed to keep excessive water away from the stucco, such as roof, gutter, downspout and flashing repairs, improving drainage, and redirecting rainwater runoff and splash-back away from the building. Horizontal areas such as the tops of parapet walls or chimneys are particularly vulnerable to water infiltration, and may require modifications to their original design, such as the addition of flashing to correct the problem.

Previous repairs inexpertly carried out may have caused additional deterioration, particularly if executed in portland cement, which tends to be very rigid, and therefore incompatible with early, mostly soft lime-based stucco that is more "flexible." Incompatible

repairs, external vibration caused by traffic or construction, or building settlement can also result in cracks which permit the entrance of water and cause the stucco to fail (Fig. 12).

Before beginning any stucco repair, an assessment of the stucco should be undertaken to determine the extent of the damage, and how much must be replaced or repaired. Testing should be carried out systematically on all elevations of the building to determine the overall condition of the stucco. Some areas in need of repair will be clearly evidenced by missing sections of stucco or stucco layers. Bulging or cracked areas are obvious places to begin. Unsound, punky or soft areas that have lost their key will echo with a hollow sound when tapped gently with a wooden or acrylic hammer or mallet.

Identifying the Stucco Type

Analysis of the historic stucco will provide useful information on its primary ingredients and their proportions, and will help to ensure that the new replacement stucco will duplicate the old in strength, composition, color and texture as closely as possible. However, unless authentic, period restoration is required, it may not be worthwhile, nor in many instances possible, to attempt to duplicate *all* of the ingredients (particularly some of the additives), in creating the new stucco mortar. Some items are no longer available, and others, notably sand and lime—the major components of traditional stucco—have changed radically over time. For example, most sand used in contemporary masonry work is manufactured sand, because river sand, which was used historically, is difficult to obtain today in many parts of the country. The physical and visual qualities of manufactured sand versus river sand, are quite different, and this affects the way stucco works, as well as the way it looks. The same is true of lime, which is frequently replaced by gypsum in modern stucco mixes. And even if identification of all the items in the historic stucco mix were possible, the analysis would still not reveal how the original stucco was mixed and applied.

There are, however, simple tests that can be carried out on a small piece of stucco to determine its basic make-up. A dilute solution of hydrochloric (muriatic) acid will dissolve lime-based stucco, but not portland cement. Although the use of portland cement became common after 1900, there are no precise cut-off dates, as stuccoing practices varied among individual plasterers, and from region to region. Some plasterers began using portland cement in the 1880's, but others may have continued to favor lime stucco well into the early-twentieth century. While it is safe to assume that a late-eighteenth or early-nineteenth century stucco is lime-based, late-nineteenth or early-twentieth century

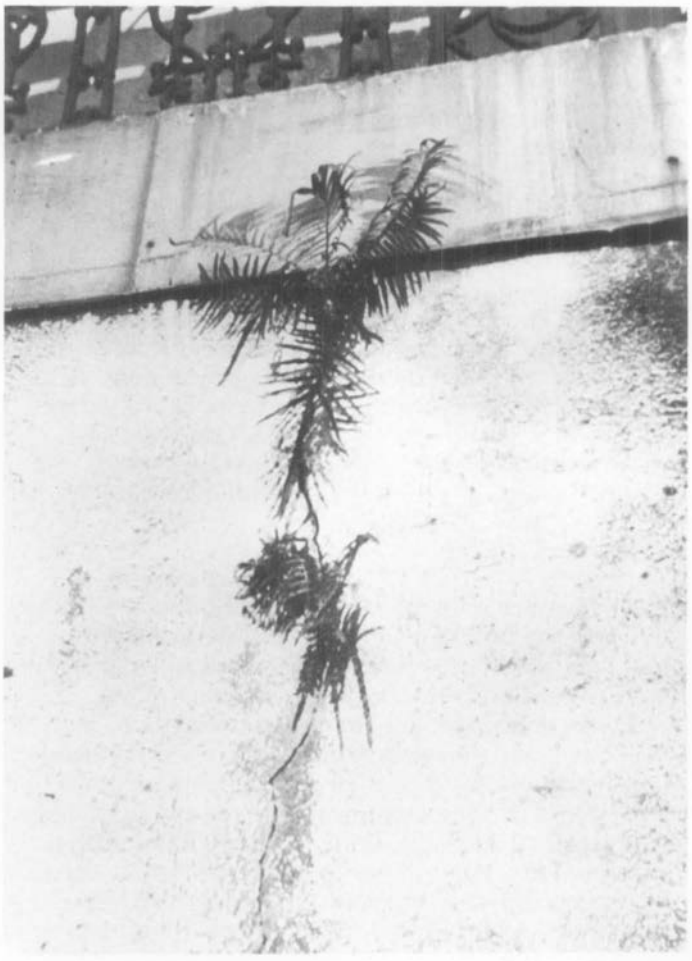


Fig. 12. (a) Water intrusion caused by rusting metal, or (b) plant growth left unattended will gradually enlarge these cracks, resulting in spalling, and eventually requiring extensive repair of the stucco. Photos: National Park Service Files.

Fig. 13. (a) In preparation for repainting, hairline cracks on this Mediterranean style stucco apartment building were filled with a commercial caulking compound; (b) dirt is attracted and adheres to the texture of the caulked areas, and a year after painting, these inappropriate repairs are highly obvious. Photos: Anne Grimmer.

stucco may be based on either lime or portland cement. Another important factor to take into consideration is that an early lime-stucco building is likely to have been repaired many times over the ensuing years, and it is probable that at least some of these patches consist of portland cement.

Planning the Repair

Once the extent of damage has been determined, a number of repair options may be considered. Small hairline cracks usually are not serious and may be sealed with a thin slurry coat consisting of the finish coat ingredients, or even with a coat of paint or whitewash. Commercially available caulking compounds are not suitable materials for patching hairline cracks. Because their consistency and texture is unlike that of stucco, they tend to weather differently, and attract more dirt; as a result, repairs made with caulking compounds may be highly visible, and unsightly (Fig. 13). Larger cracks will have to be cut out in preparation for more extensive repair. Most stucco repairs will require the skill and expertise of a professional plasterer (Fig. 14).

In the interest of saving or preserving as much as possible of the historic stucco, patching rather than wholesale replacement is preferable. When repairing heavily textured surfaces, it is not usually necessary to replace an entire wall section, as the textured finish, if well-executed, tends to conceal patches, and helps them to blend in with the existing stucco. However, because of the nature of smooth-finished stucco, patching a number of small areas scattered over one elevation may not be a successful repair approach unless the stucco has been previously painted, or is to be painted following the repair work. On unpainted stucco such patches are hard to conceal, because they may not match exactly or blend in with the rest of the historic stucco surface. For

Fig. 14. This poorly executed patch is not the work of a professional plasterer. While it may serve to keep out water, it does not match the original surface, and is not an appropriate repair for historic stucco. Photo: Betsy Chittenden.

this reason it is recommended, if possible, that stucco repair be carried out in a contained or well-defined area, or if the stucco is scored, the repair patch should be "squared-off" in such a way as to follow existing scoring. In some cases, especially in a highly visible location, it may be preferable to restucco an entire wall section or feature. In this way, any differences between the patched area and the historic surface will not be so readily apparent.

Repair of historic stucco generally follows most of the same principles used in plaster repair. First, all deteriorated, severely cracked and loose stucco should be removed down to the lath (assuming that the lath is securely attached to the substrate), or down to the masonry if the stucco is directly applied to a masonry substrate. A clean surface is necessary to obtain a good

bond between the stucco and substrate. The areas to be patched should be cleaned of all debris with a bristle brush, and all plant growth, dirt, loose paint, oil or grease should be removed (Fig. 15). If necessary, brick or stone mortar joints should then be raked out to a depth of approximately 5/8" to ensure a good bond between the substrate and the new stucco.

To obtain a neat repair, the area to be patched should be squared-off with a butt joint, using a cold chisel, a hatchet, a diamond blade saw, or a masonry bit. Sometimes it may be preferable to leave the area to be patched in an irregular shape which may result in a less conspicuous patch. Proper preparation of the area to be patched requires very sharp tools, and extreme caution on the part of the plasterer not to break keys of surrounding good stucco by "over-sounding" when removing deteriorated stucco. To ensure a firm bond, the new patch must not overlap the old stucco. If the stucco has lost its bond or key from wood lath, or the lath has deteriorated or come loose from the substrate, a decision must be made whether to try to reattach the old lath, to replace deteriorated lath with new wood lath, or to leave the historic wood lath in place and supplement it with modern expanded metal lath. Unless authenticity is important, it is generally preferable (and easier) to nail new metal lath over the old wood lath to support the patch. Metal lath that is no longer securely fastened to the substrate may be removed and replaced in kind, or left in place, and supplemented with new wire lath.

When repairing lime-based stucco applied directly to masonry, the new stucco should be applied in the same manner, directly onto the stone or brick. The stucco will bond onto the masonry itself without the addition of lath because of the irregularities in the masonry or those of its mortar joints, or because its surface has been scratched, scored or otherwise roughened to provide an additional key. Cutting out the old stucco at a diagonal angle may also help secure the bond between the new and the old stucco. For the most part it is not advisable to insert metal lath when restuccoing historic masonry in sound condition, as it can hasten deterioration of the repair work. Not only will attaching the lath damage the masonry, but the slightest moisture penetration can cause metal lath to rust. This will cause metal to expand, eventually resulting in spalling of the stucco, and possibly the masonry substrate too.

If the area to be patched is properly cleaned and prepared, a bonding agent is usually not necessary. However, a bonding agent may be useful when repairing hairline cracks, or when dealing with substrates that do not offer a good bonding surface. These may include dense stone or brick, previously painted or stuccoed

Fig. 15. (a) After reattaching any loose wood lath to the furring strips underneath, the area to be patched has been cleaned, the lath thoroughly wetted, and (b) the first coat of stucco has been applied and scratched to provide a key to hold the second layer of stucco. Photos: Betsy Chittenden.

masonry, or spalling brick substrates. A good mechanical bond is always preferable to reliance on bonding agents. Bonding agents should not be used on a wall that is likely to remain damp or where large amounts of salts are present. Many bonding agents do not survive well under such conditions, and their use could jeopardize the longevity of the stucco repair.

A stucco mix compatible with the historic stucco should be selected after analyzing the existing stucco. It can be adapted from a standard traditional mix of the period, or based on one of the mixes included here. Stucco consisting mostly of portland cement generally will not be physically compatible with the softer, more flexible lime-rich historic stuccos used throughout the eighteenth and much of the nineteenth centuries. The differing expansion and contraction rates of lime stucco and portland cement stucco will normally cause the stucco to crack. Choosing a stucco mix that is durable and compatible with the historic stucco on the building is likely to involve considerable trial and error, and probably will require a number of test samples, and even more if it is necessary to match the color. It is best to let the stucco test samples weather as long as possible—ideally one year, or at least through a change of seasons, in order to study the durability of the mix and its compatibility with the existing stucco, as well as the weathering of the tint if the building will not be painted and color match is an important factor. If the test samples are not executed on the building, they should be placed next to the stucco remaining on the building to compare the color, texture and composition of the samples with the original. The number and thickness of stucco coats used in the repair should also match the original.

After thoroughly dampening the masonry or wood lath, the first, scratch coat should be applied to the masonry substrate, or wood or metal lath, in a thickness that corresponds to the original if extant, or generally about 1/4" to 3/8". The scratch coat should be scratched or cross-hatched with a comb to provide a key to hold the second coat. It usually takes 24–72 hours, and longer in cold weather, for each coat to dry before the next coat can be applied. The second coat should be about the same thickness as the first, and the total thickness of the first two coats should generally not exceed about 5/8". This second or leveling coat should be roughened using a wood float with a nail protruding to provide a key for the final or finish coat. The finish coat, about 1/4" thick, is applied after the previous coat has initially set. If this is not feasible, the base coat should be thoroughly dampened when the finish coat is applied later. The finish coat should be worked to match the texture of the original stucco (Fig. 16).

Colors and Tints for Historic Stucco Repair

The color of most early stucco was supplied by the aggregate included in the mix—usually the sand. Sometimes natural pigments were added to the mix, and eighteenth and nineteenth-century scored stucco was often marbleized or painted in imitation of marble or granite. Stucco was also frequently coated with whitewash or a colorwash. This tradition later evolved into the use of paint, its popularity depending on the vagaries of fashion as much as a means of concealing repairs. Because most of the early colors were derived from nature, the resultant stucco tints tended to be mostly earth-toned. This was true until the advent of brightly colored stucco in the early decades of the twentieth century. This was the so-called "Jazz Plaster" developed by O.A. Malone, the "man who put color into California," and who founded the California Stucco Products Corporation in 1927. California Stucco was revolutionary for its time as the first stucco/plaster to contain colored pigment in its pre-packaged factory mix.

When patching or repairing a historic stucco surface known to have been tinted, it may be possible to determine through visual or microscopic analysis whether the source of the coloring is sand, cement or pigment. Although some pigments or aggregates used traditionally may no longer be available, a sufficiently close color-match can generally be approximated using sand, natural or mineral pigments, or a combination of these. Obtaining such a match will require testing and comparing the color of dried test samples with the original. Successfully combining pigments in the dry stucco mix prepared for the finish coat requires considerable skill. The amount of pigment must be carefully measured for each batch of stucco. Overworking the mix can make the pigment separate from the lime. Changing the amount of water added to the mix, or using water to apply the tinted finish coat, will also affect the color of the stucco when it dries.

Generally, the color obtained by hand-mixing these ingredients will provide a sufficiently close match to cover an entire wall or an area distinct enough from the rest of the structure that the color differences will not be obvious. However, it may not work for small patches conspicuously located on a primary elevation, where color differences will be especially noticeable. In these instances, it may be necessary to conceal the repairs by painting the entire patched elevation, or even the whole building.

Many stucco buildings have been painted over the years and will require repainting after the stucco repairs have been made. Limewash or cement-based paint, latex paint, or oil-based paint are appropriate coatings for stucco buildings. The most important factor to consider when repainting a previously painted or coated surface is that the new paint be compatible with any coating already on the surface. In preparation for repainting, all loose or peeling paint or other coating material not firmly adhered to the stucco must be removed by hand-scraping or natural bristle brushes. The surface should then be cleaned.

Cement-based paints, most of which today contain some portland cement and are really a type of limewash, have traditionally been used on stucco buildings. The ingredients were easily obtainable. Furthermore, the lime in such paints actually bonded or joined with the stucco and provided a very durable coating. In many regions, whitewash was applied annually during spring cleaning. Modern, commercially available premixed masonry and mineral-based paints may also be used on historic stucco buildings.

Fig. A

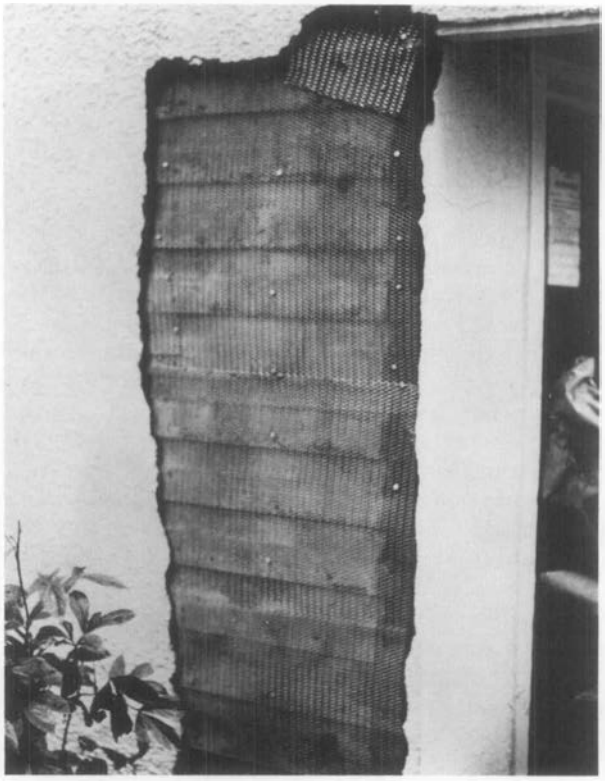


Fig. B

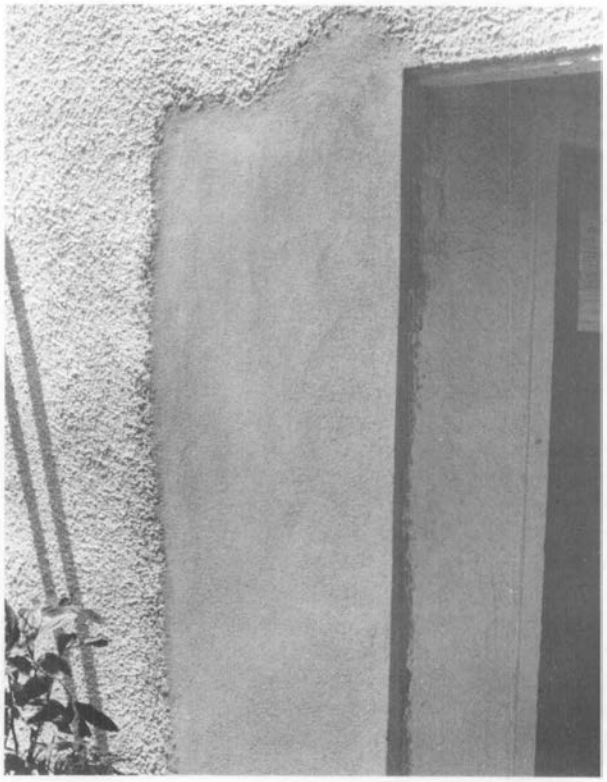


Fig. C

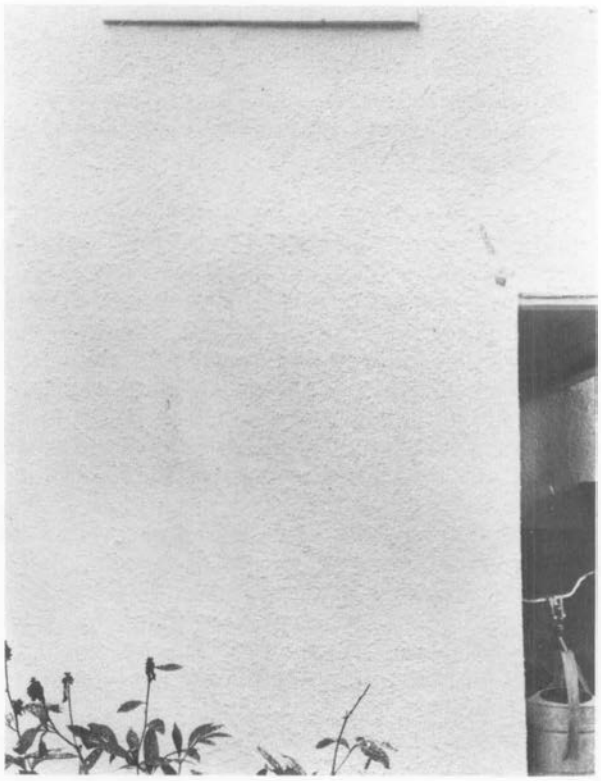


Fig. D

Fig. 16. (a) In preparation for stucco repair, this plasterer is mixing the dry materials in a mortar box with a mortar hoe (note the 2 holes in the blade), pulling it through the box using short choppy strokes. After the dry materials are thoroughly combined, water is added and mixed with them using the same choppy, but gradually lengthening stokes, making sure that the hoe cuts completely through the mix to the bottom of the box. (b) The deteriorated stucco has been cut away, and new metal lath has been nailed to the clapboarding in the area to be patched. (Although originally clapboarded when built in the 19th century, the house was stuccoed around the turn-of-the-century on metal lath nailed over the clapboard.) (c) The first, scratch coat and the second coat have been applied here, and await the spatterdash or rough-cast finish of the final coat (d) which was accomplished by the plasterer using a whisk broom to throw the stucco mortar against the wall surface. This well-executed patch is barely discernable, and lacks only a coat of paint to make it blend completely with the rest of the painted wall surface. Photos: Anne Grimmer.

If the structure must be painted for the first time to conceal repairs, almost any of these coatings may be acceptable depending on the situation. Latex paint, for example, may be applied to slightly damp walls or where there is an excess of moisture, but latex paint will not stick to chalky or powdery areas. Oil-based, or alkyd paints must be applied only to dry walls; new stucco must cure up to a year before it can be painted with oil-based paint.

Contemporary Stucco Products

There are many contemporary stucco products on the market today. Many of them are not compatible, either physically or visually, with historic stucco buildings. Such products should be considered for use only after consulting with a historic masonry specialist. However, some of these prepackaged tinted stucco coatings may be suitable for use on stucco buildings dating from the late-nineteenth or early-twentieth century, as long as the color and texture are appropriate for the period and style of the building. While some masonry contractors may, as a matter of course, suggest that a water-repellent coating be applied after repairing old stucco, in most cases this should not be necessary, since colorwashes and paints serve the same purpose, and stucco itself is a protective coating.

Cleaning Historic Stucco Surfaces

Historic stucco buildings often exhibit multiple layers of paint or limewash. Although some stucco surfaces may be cleaned by water washing, the relative success of this procedure depends on two factors: the surface texture of the stucco, and the type of dirt to be removed. If simply removing airborne dirt, **smooth unpainted stucco,** and **heavily-textured painted stucco** may sometimes be cleaned using a low-pressure water wash, supplemented by scrubbing with soft natural bristle brushes, and possibly non-ionic detergents. Organic plant material, such as algae and mold, and metallic stains may be removed from stucco using poultices and appropriate solvents. Although these same methods may be employed to clean **unpainted roughcast, pebble-dash, or any stucco surface featuring exposed aggregate,** due to the surface irregularities, it may be difficult to remove dirt, without also removing portions of the decorative textured surface. Difficulty in cleaning these surfaces may explain why so many of these textured surfaces have been painted.

When Total Replacement is Necessary

Complete replacement of the historic stucco with new stucco of either a traditional or modern mix will probably be necessary only in cases of extreme deterioration—that is, a loss of bond on over 40–50 per cent of the stucco surface. Another reason for total removal might be that the physical and visual integrity of the historic stucco has been so compromised by prior incompatible and ill-conceived repairs that patching would not be successful.

When stucco no longer exists on a building there is more flexibility in choosing a suitable mix for the replacement. Since compatibility of old and new stucco will not be an issue, the most important factors to consider are durability, color, texture and finish. Depending on the construction and substrate of the building, in some instances it may be acceptable to use a relatively strong cement-based stucco mortar. This is certainly true for many late-nineteenth and early-twentieth century buildings, and may even be appropriate to use on some stone substrates even if the original mortar would have been weaker, as long as the historic visual qualities noted above have been replicated. Generally, the best principle to follow for a masonry building is that the stucco mix, whether for repair or replacement of historic stucco, should be somewhat weaker than the masonry to which it is to be applied in order not to damage the substrate.

General Guidance for Historic Stucco Repair

A skilled professional plasterer will be familiar with the properties of materials involved in stucco repair and will be able to avoid some of the pitfalls that would hinder someone less experienced. General suggestions for successful stucco repair parallel those involving restoration and repair of historic mortar or plaster. In addition, the following principles are important to remember:

- Mix only as much stucco as can be used in one and one-half to two hours. This will depend on the weather (mortar will harden faster under hot and dry, or sunny conditions); and experience is likely to be the best guidance. Any remaining mortar should be discarded; it should not be retempered.

- Stucco mortar should not be over-mixed. (Hand mix for 10–15 minutes after adding water, or machine mix for 3–4 minutes after all ingredients are in mixer.) Over-mixing can cause crazing and discoloration, especially in tinted mortars. Over-mixing will also tend to make the mortar set too fast, which will result in cracking and poor bonding or keying to the lath or masonry substrate.

- Wood lath or a masonry substrate, but not metal lath, must be thoroughly wetted before applying stucco patches so that it does not draw moisture out of the stucco too rapidly. To a certain extent, bonding agents also serve this same purpose. Wetting the substrate helps retard drying.

- To prevent cracking, it is imperative that stucco not dry too fast. Therefore, the area to be stuccoed should be shaded, or even covered if possible, particularly in hot weather. It is also a good idea in hot weather to keep the newly stuccoed area damp, at approximately 90 per cent humidity, for a period of 48 to 72 hours.

- Stucco repairs, like most other exterior masonry work, should not be undertaken in cold weather (below 40 degrees fahrenheit, and preferably warmer), or if there is danger of frost.

Historic Stucco Textures

Most of the oldest stucco in the U.S. dating prior to the late-nineteenth century, will generally have a **smooth, troweled finish** (sometimes called a **sand** or **float finish**), possibly scored to resemble ashlar masonry units. Scoring may be incised to simulate masonry joints, the scored lines may be emphasized by black or white penciling, or the lines may simply be drawn or painted on the surface of the stucco. In some regions, at least as early as the first decades of the nineteenth century, it was not uncommon to use a **roughcast finish** on the foundation or base of an otherwise **smooth-surfaced** building (Fig. a). **Roughcast** was also used as an overall stucco finish for some outbuildings, and other less important types of structures.

A wide variety of decorative surface textures may be found on revival style stucco buildings, particularly residential architecture. These styles evolved in the late-nineteenth century and peaked in popularity in the early decades of the twentieth century. Frank Lloyd Wright favored a **smooth finish** stucco, which was imitated on much of the Prairie style architecture inspired by his work. Some of the more picturesque surface textures include: **English Cottage** or **English Cotswold finish**; **sponge finish** (Fig. b); **fan texture**; **adobe finish** (Fig. c), and **Spanish** or **Italian finish.** Many of these finishes and countless other regional and personalized variations on them are still in use.

The most common early-twentieth century stucco finishes are often found on bungalow-style houses, and include: **spatter** or **spatterdash** (sometimes called **roughcast, harling,** or **wetdash**), and **pebbledash** or **drydash.** The **spatterdash** finish is applied by throwing the stucco mortar against the wall using a whisk broom or a stiff fiber brush, and it requires considerable skill on the part of the plasterer to achieve a consistently rough wall surface. The mortar used to obtain this texture is usually composed simply of a regular sand, lime, and cement mortar, although it may sometimes contain small pebbles or crushed stone aggregate, which replaces one-half the normal sand content. The **pebbledash** or **drydash finish** is accomplished manually by the plasterer throwing or "dashing" dry pebbles (about 1/8" to 1/4" in size), onto a coat of stucco freshly applied by another plasterer. The pebbles must be thrown at the wall with a scoop with sufficient force and skill that they will stick to the stuccoed wall. A more even or uniform surface can be achieved by patting the stones down with a wooden float. This finish may also be created using a texturing machine (Figs. d–f illustrate 3 versions of this finish. Photos: National Park Service Files).

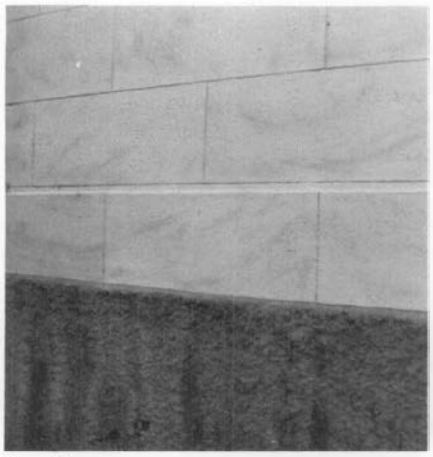


Fig. A

Fig. B

Fig. C

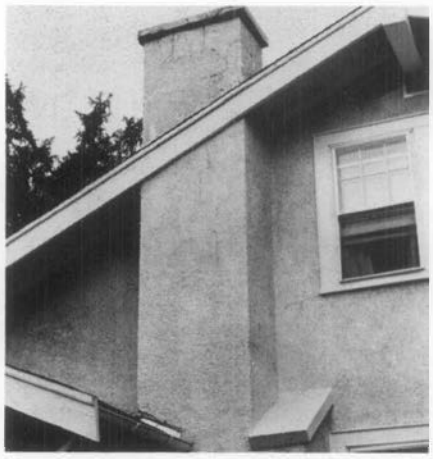


Fig. D

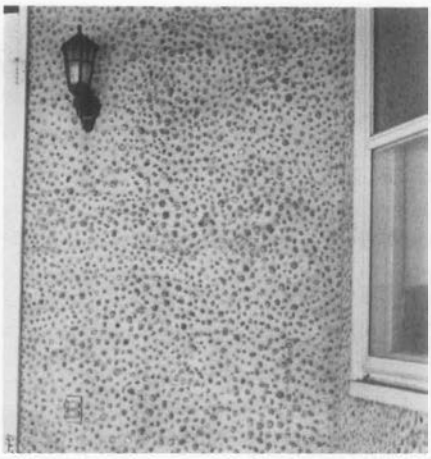


Fig. E

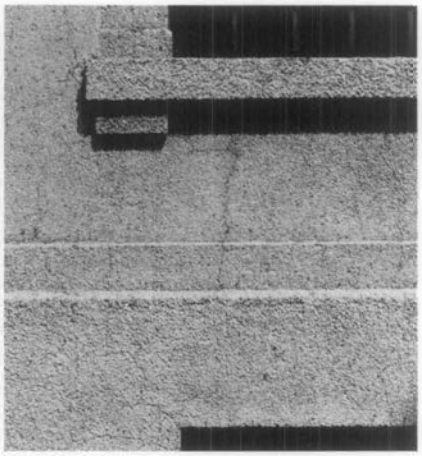


Fig. F

Summary

Stucco on historic buildings is especially vulnerable not only to the wear of time and exposure to the elements, but also at the hands of well-intentioned "restorers," who may want to remove stucco from eighteenth and nineteenth century structures, to expose what they believe to be the original or more "historic" brick, stone or log underneath. Historic stucco is a character-defining feature and should be considered an important historic building material, significant in its own right. While many eighteenth and nineteenth century buildings were stuccoed at the time of construction, others were stuccoed later for reasons of fashion or practicality. As such, it is likely that this stucco has acquired significance over time, as part of the history and evolution of a building. Thus, even later, non-historic stucco should be retained in most instances; and similar logic dictates that new stucco should not be applied to a historic building that was not stuccoed previously. When repairing historic stucco, the new stucco should duplicate the old as closely as possible in strength, composition, color and texture.

Mixes for Repair of Historic Stucco

Historic stucco mixes varied a great deal regionally, depending as they did on the availability of local materials. There are probably almost as many mixes that can be used for repair of historic stucco as there are historic stucco buildings. For this reason it is recommended that at least a rudimentary analysis of the existing historic stucco be carried out in order to determine its general proportions and primary ingredients. However, if this is not possible, or if test results are inconclusive, the following mixes are provided as reference. Many of the publications listed under "Selected Reading" include a variety of stucco mixes and should also be consulted for additional guidance.

Materials Specifications should conform to those contained in *Preservation Briefs 2: Repointing Mortar Joints in Historic Brick Buildings*, and are as follows:

- Lime should conform to ASTM C-207, Type S, Hydrated Lime for Masonry Purposes.
- Sand should conform to ASTM C-144 to assure proper gradation and freedom from impurities. Sand, or other type of aggregate, should match the original as closely as possible.
- Cement should conform to ASTM C-150, Type II (white, non-staining), portland cement.
- Water should be fresh, clean and potable.
- If hair or fiber is used, it should be goat or cattle hair, or pure manilla fiber of good quality, 1/2" to 2" in length, clean, and free of dust, dirt, oil, grease or other impurities.
- Rules to remember: More lime will make the mixture more plastic, but stucco mortar with a very large proportion of lime to sand is more likely to crack because of greater shrinkage; it is also weaker and slower to set. More sand or aggregate, will minimize shrinkage, but make the mixture harder to trowel smooth, and will weaken the mortar.

Soft Lime Stucco (suitable for application to buildings dating from 1700–1850)

A.J. Downing's Recipe for Soft Lime Stucco

1 part lime

2 parts sand

(A.J. Downing, "The Architecture of Country Houses," 1850)

Vieux Carre Masonry Maintenance Guidelines

Base Coats (2):

1 part by volume hydrated lime

3 parts by volume aggregate [sand]—size to match original

6 pounds/cubic yards hair or fiber

Water to form a workable mix.

Finish Coat:

1 part by volume hydrated lime

3 parts aggregate [sand]—size to match original

Water to form a workable mix.

Note: No portland cement is recommended in this mix, but if it is needed to increase the workability of the mix and to decrease the setting time, the amount of portland cement added should never exceed 1 part to 12 parts lime and sand.

("Vieux Carre Masonry Maintenance Guidelines," June, 1980.)

"Materials for Soft Brick Mortar and for Soft Stucco"

5 gallons hydrated lime

10 gallons sand

1 quart white, non-staining portland cement (1 cup only for pointing)

Water to form a workable mix.

(Koch and Wilson, Architects, New Orleans, Louisiana, February, 1980)

Mix for Repair of Traditional Natural Cement or Hydraulic Lime Stucco

1 part by volume hydrated lime

2 parts by volume white portland cement

3 parts by volume fine mason's sand

If hydraulic lime is available, it may be used instead of lime-cement blends.

("Conservation Techniques for the Repair of Historical Ornamental Exterior Stucco, January, 1990)

Early-twentieth century Portland Cement Stucco

1 part portland cement

2 1/2 parts sand

Hydrated lime = to not more than 15% of the cement's volume

Water to form a workable mix.

The same basic mix was used for all coats, but the finish coat generally contained more lime than the undercoats. ("Illinois Preservation Series No. 2: Stucco," January, 1980)

American Portland Cement Stucco Specifications (c. 1929)

Base Coats:

5 pounds, dry, hydrated lime

1 bag portland cement (94 lbs.)

Not less than 3 cubic feet (3 bags) sand (passed through a #8 screen)

Water to make a workable mix.

Finish Coat:

Use WHITE portland cement in the mix in the same proportions as above.

To color the stucco add not more than 10 pounds pigment for each bag of cement contained in the mix.

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This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Comments on the usefulness of this publication may be directed to H. Ward Jandl, Chief, Technical Preservation Services Branch, Preservation Assistance Division, National Park Service, P.O. Box 37127, Washington, D.C. 20013–7127. This publication is not copyrighted and can be reproduced without penalty. Normal procedures for credit to the author and the National Park Service are appreciated.

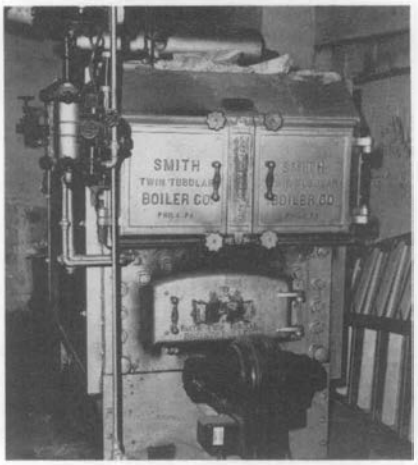
October 1990

Cover Photograph: St. James Church, Goose Creek, Berkeley County, South Carolina (1713–1719), is constructed of brick covered with stucco. Although much restored, it is notable for its ornamental stucco detailing, including rusticated quoins, cherub head "keystones" above the windows, flaming hearts, and a pelican in piety—symbol of the sacrament, in the pediment over the front door. Photo: Gary Hume.

24 PRESERVATION BRIEFS

Heating, Ventilating, and Cooling Historic Buildings: Problems and Recommended Approaches

Sharon C. Park, AIA



U.S. Department of the Interior
National Park Service
Cultural Resources
Heritage Preservation Services

The need for modern mechanical systems is one of the most common reasons to undertake work on historic buildings. Such work includes upgrading older mechanical systems, improving the energy efficiency of existing buildings, installing new heating, ventilation or air conditioning (HVAC) systems, or—particularly for museums—installing a climate control system with humidification and dehumidification capabilities. Decisions to install new HVAC or climate control systems often result from concern for occupant health and comfort, the desire to make older buildings marketable, or the need to provide specialized environments for operating computers, storing artifacts, or displaying museum collections. Unfortunately, occupant comfort and concerns for the objects within the building are sometimes given greater consideration than the building itself. In too many cases, applying modern standards of interior climate comfort to historic buildings has proven detrimental to historic materials and decorative finishes.

This Preservation Brief underscores the importance of careful planning in order to balance the preservation objectives with interior climate needs of the building. It is not intended as a technical guide to calculate tonnage or to size piping or ductwork. Rather, this Brief identifies some of the problems associated with installing mechanical systems in historic buildings and recommends approaches to minimizing the physical and visual damage associated with installing and maintaining these new or upgraded systems.

Historic buildings are not easily adapted to house modern precision mechanical systems. Careful planning must be provided early on to ensure that decisions made during the design and installation phases of a new system are appropriate. Since new mechanical and other related systems, such as electrical and fire suppression, can use up to 10% of a building's square footage and 30%–40% of an overall rehabilitation budget, decisions must be made in a systematic and coordinated manner. The installation of inappropriate mechanical systems may result in any or all of the following:

- large sections of historic materials are removed to install or house new systems.
- historic structural systems are weakened by carrying the weight of, and sustaining vibrations from, large equipment.
- moisture introduced into the building as part of a new system migrates into historic materials and causes damage, including biodegradation, freeze/thaw action, and surface staining.
- exterior cladding or interior finishes are stripped to install new vapor barriers and insulation.
- historic finishes, features, and spaces are altered by dropped ceilings and boxed chases or by poorly located grilles, registers, and equipment.
- systems that are too large or too small are installed before there is a clearly planned use or a new tenant.

For historic properties it is critical to understand what spaces, features, and finishes are historic in the building, what should be retained, and what the *realistic* heating, ventilating, and cooling needs are for the building, its occupants, and its contents. A systematic approach, involving preservation planning, preservation design, and a follow-up program of monitoring and maintenance, can ensure that new systems are successfully added—or existing systems are suitably upgraded—while preserving the historic integrity of the building.

No set formula exists for determining what type of mechanical system is best for a specific building. Each building and its needs must be evaluated separately. Some buildings will be so significant that every effort must be made to protect the historic materials and systems in place with minimal intrusion from new systems. Some buildings will have museum collections that need special climate control. In such cases, curatorial needs must be considered—but not to the ultimate detriment of the historic building resource. Other

buildings will be rehabilitated for commercial use. For them, a variety of systems might be acceptable, as long as significant spaces, features, and finishes are retained.

Most mechanical systems require upgrading or replacement within 15–30 years due to wear and tear or the availability of improved technology. Therefore, historic buildings should not be greatly altered or otherwise sacrificed in an effort to meet short-term systems objectives.

History of Mechanical Systems

The history of mechanical systems in buildings involves a study of inventions and ingenuity as building owners, architects, and engineers devised ways to improve the interior climate of their buildings. Following are highlights in the evolution of heating, ventilating, and cooling systems in historic buildings.

Eighteenth Century. Early heating and ventilation in America relied upon common sense methods of *managing the environment* (see figure 1). Builders purposely sited houses to capture winter sun and prevailing summer cross breezes; they chose materials that could help protect the inhabitants from the elements, and took precautions against precipitation and damaging drainage patterns. The location and sizes of windows, doors, porches, and the floor plan itself often evolved to maximize ventilation. Heating was primarily from fireplaces or stoves and, therefore, was at the source of delivery. In 1744, Benjamin Franklin designed his "Pennsylvania stove" with a fresh air intake in order to maximize the heat radiated into the room and to minimize annoying smoke.

Thermal insulation was rudimentary—often wattle and daub, brick and wood nogging. The comfort level for occupants was low, but the relatively small difference between internal and external temperatures and relative humidity allowed building materials to expand and contract with the seasons.

Regional styles and architectural features reflected regional climates. In warm, dry and sunny climates, thick adobe walls offered shelter from the sun and kept the inside temperatures cool. Verandas, courtyards, porches, and high ceilings also reduced the impact of the sun. Hot and humid climates called for elevated living floors, louvered grilles and shutters, balconies, and interior courtyards to help circulate air.

Nineteenth Century. The industrial revolution provided the technological means for *controlling the environment* for the first time (see figure 2). The dual developments of steam energy from coal and industrial mass production made possible early central heating systems with distribution of heated air or steam using metal ducts or pipes. Improvements were made to early wrought iron boilers and by late century, steam and low pressure hot water radiator systems were in common use, both in offices and residences. Some large institutional buildings heated air in furnaces and distributed it throughout the building in brick flues with a network of metal pipes delivering heated air to individual rooms. Residential designs of the period often used gravity hot air systems utilizing decorative floor and ceiling grilles.

Ventilation became more scientific and the introduc-

1. Eighteenth century and later vernacular architecture depended on the siting of the building, deciduous trees, cross ventilation, and the placement of windows and chimneys to maximize winter heating and natural summer cooling. Regional details, as seen in this Virginia house, include external chimneys and a separate summer kitchen to reduce fire risk and isolate heat in the summer. Photo: NPS Files.

2. Nineteenth century buildings continued to use architectural features such as porches, cupolas, and awnings to make the buildings more comfortable in summer, but heating was greatly improved by hot water or steam radiators. Photo: NPS Files

tion of fresh air into buildings became an important component of heating and cooling. Improved forced air ventilation became possible in mid-century with the introduction of power-driven fans. Architectural features such as porches, awnings, window and door transoms, large open-work iron roof trusses, roof monitors, cupolas, skylights and clerestory windows helped to dissipate heat and provide healthy ventilation.

Cavity wall construction, popular in masonry structures, improved the insulating qualities of a building and also provided a natural cavity for the dissipation of moisture produced on the interior of the building. In some buildings, cinder chips and broken masonry filler between structural iron beams and jack arch floor vaults provided thermal insulation as well as fireproofing. Mineral wool and cork were new sources of lightweight insulation and were forerunners of contemporary batt and blanket insulation.

The technology of the age, however, was not sufficient to produce "tight" buildings. There was still only a moderate difference between internal and external temperatures. This was due, in part, to the limitations of early insulation, the almost exclusive use of single glazed windows, and the absence of air-tight construction. The presence of ventilating fans and the reliance on architectural features, such as operable windows, cupolas and transoms, allowed sufficient air movement to keep buildings well ventilated. Building materials could behave in a fairly traditional way, expanding and contracting with the seasons.

Twentieth Century. The twentieth century saw intensive development of new technologies and the notion of fully *integrating mechanical systems* (see figure 3). Oil and gas furnaces developed in the nineteenth century were improved and made more efficient, with electricity becoming the critical source of power for building systems in the latter half of the century. Forced air heating systems with ducts and registers became popular for all types of buildings and allowed architects to experiment with architectural forms free from mechanical encumbrances. In the 1920s large-scale theaters and auditoriums introduced central air conditioning, and by mid-century forced air systems which combined heating and air conditioning in the same ductwork set a new standard for comfort and convenience. The combination and coordination of a variety of systems came together in the post-World War II highrise buildings; complex heating and air conditioning plants, electric elevators, mechanical towers, ventilation fans, and full service electric lighting were integrated into the building's design.

The insulating qualities of building materials improved. Synthetic materials, such as spun fiberglass batt insulation, were fully developed by mid-century. Prototypes of insulated thermal glazing and integral storm window systems were promoted in construction journals. Caulking to seal out perimeter air around window and door openings became a standard construction detail.

The last quarter of the twentieth century has seen making HVAC systems more energy efficient and better integrated. The use of vapor barriers to control moisture migration, thermally efficient windows, caulking and gaskets, compressed thin wall insulation, has become standard practice. New integrated systems now combine interior climate control with fire suppression, lighting, air filtration, temperature and humidity control, and security detection. Computers regulate the performance of these integrated systems based on the time of day, day of the week, occupancy, and outside ambient temperature.

3. The circa 1928 Fox Theater in Detroit, designed by C. Howard Crane, was one of the earliest twentieth century buildings to provide air conditioning to its patrons. The early water-cooled system was recently restored. Commercial and highrise buildings of the twentieth century were able, mostly through electrical power, to provide sophisticated systems that integrated many building services. Photo: William Kessler and Associates, Architects.

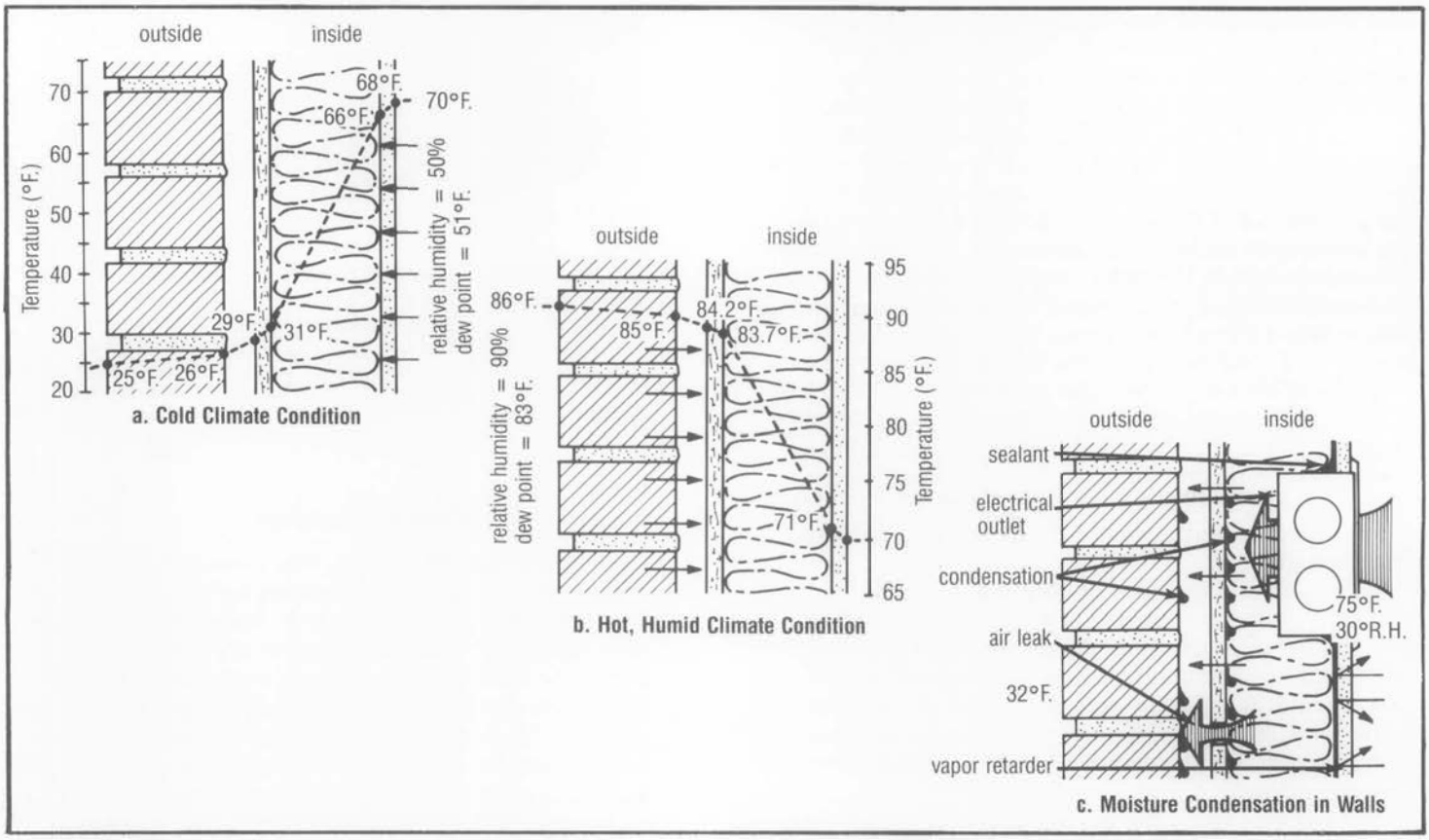
Climate Control and Preservation

Although twentieth century mechanical systems technology has had a tremendous impact on making historic buildings comfortable, the introduction of these new systems in older buildings is not without problems. The attempt to meet and maintain modern climate control standards *may in fact be damaging to historic resources*. Modern systems are often over-designed to compensate for inherent inefficiencies of some historic buildings materials and plan layouts. Energy retrofit measures, such as installing exterior wall insulation and vapor barriers or the sealing of operable window and vents, ultimately affect the performance and can reduce the life of aging historic materials.

In general, the greater the differential between the interior and exterior temperature and humidity levels, the greater the potential for damage. As natural vapor pressure moves moisture from a warm area to a colder, dryer area, condensation will occur on or in building materials in the colder area (see figure 4). Too little humidity in winter, for example, can dry and crack historic wooden or painted surfaces. Too much humidity in winter causes moisture to collect on cold surfaces, such as windows, or to migrate into walls. As a result, this condensation deteriorates wooden or metal windows and causes rotting of walls and wooden structural elements, dampening insulation and holding moisture against exterior surfaces. Moisture migration through walls can cause the corrosion of metal anchors, angles, nails or wire lath, can blister and peel exterior paint, or can leave efflorescence and salt deposits on exterior masonry. In cold climates, freeze-thaw damage can result from excessive moisture in external walls.

To avoid these types of damage to a historic building, it is important to understand how building components work together as a system. Methods for controlling interior temperature and humidity and improving ventilation must be considered in any new or upgraded HVAC or climate control system. While certain energy retrofit measures will have a positive effect on the overall building, installing effective vapor barriers in historic walls is difficult and often results in destruction of significant historic materials (see figure 5).

5. The installation of vapor retarders in walls of historic buildings in an effort to contain interior moisture can cause serious damage to historic finishes as shown here. In this example, all the wall plaster and lath have been stripped in preparation for a vapor barrier prior to replastering. Controlling interior temperature and relative humidity can be more effective than adding insulation and vapor barriers to historic perimeter walls. Photo: Ernest A. Conrad, P.E.



4. Mechanical heating and cooling systems change the interior climate of a building. Moisture in the air will dissipate from the warmer area of a building to the colder area and can cause serious deterioration of historic materials. Condensation can form if the dew point occurs within the building wall, particularly one that has been insulated (see a and b). Even when vapor retarders are installed (c), any non-continuous areas will provide spaces for moisture to pass. Wall Section Drawings: NPS files

Planning the New System

Climate control systems are generally classified according to the medium used to condition the temperature: air, water, or a combination of both (see overview on page 6). The complexity of choices facing a building owner or manager means that a *systematic approach* is critical in determining the most suitable system for a building, its contents, and its occupants. No matter which system is installed, a change in the interior climate will result. This physical change will in turn affect how the building materials perform. New registers, grilles, cabinets, or other accessories associated with the new mechanical system will also visually change the interior (and sometimes the exterior) appearance of the building. Regardless of the type or extent of a mechanical system, the owner of a historic building should know *before* a system is installed what it will look like and what problems can be anticipated during the life of that system. The potential harm to a building and costs to an owner of selecting the wrong mechanical system are very great.

The use of a building and its contents will largely determine the best type of mechanical system. The historic building materials and construction technology as well as the size and availability of secondary spaces within the historic structure will affect the choice of a system. It may be necessary to investigate a combination of systems. In each case, the needs of the user, the needs of the building, and the needs of a collection or equipment must be considered. It may not be necessary to have a comprehensive climate control system if climate-sensitive objects can be accommodated in special areas or climate-controlled display cases. It may not be necessary to have central air conditioning in a mild climate if natural ventilation systems can be improved through the use of operable windows, awnings, exhaust fans, and other "low-tech" means. Modern standards for climate control developed for new construction may not be achievable or desirable for historic buildings. *In each case, the lowest level of intervention needed to successfully accomplish the job should be selected.*

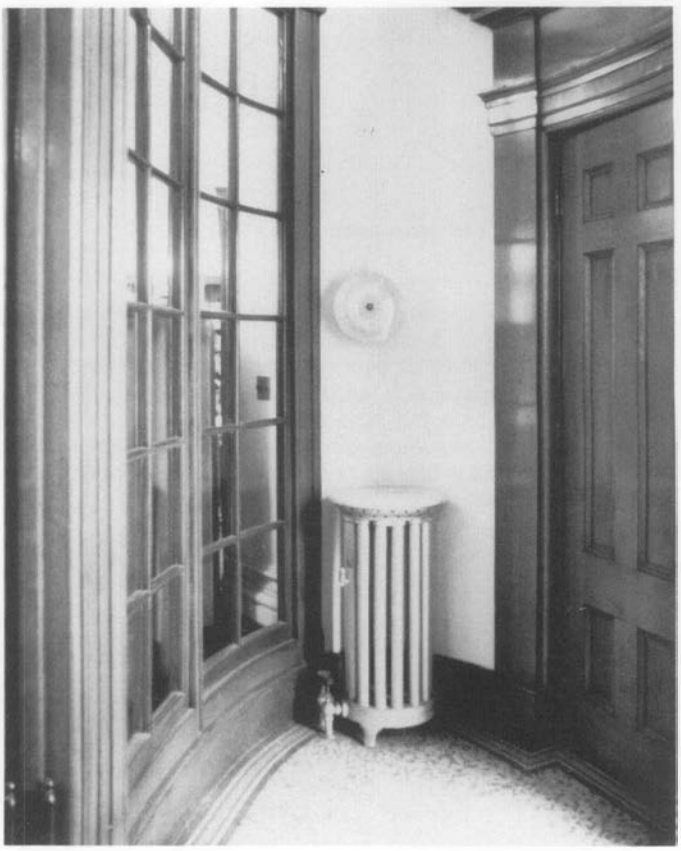
Before a system is chosen, the following planning steps are recommended:

1. **Determine the use of the building.** The proposed use of the building (museum, commercial, residential, retail) will influence the type of system that should be installed. The number of people and functions to be housed in a building will establish the level of comfort and service that must be provided. Avoid uses that require major modifications to significant architectural spaces. What is the intensity of use of the building: intermittent or constant use, special events or seasonal events? Will the use of the building require major new services such as restaurants, laundries, kitchens, locker rooms, or other areas that generate moisture that may exacerbate climate control within the historic space? In the context of historic preservation, uses that require radical reconfigurations of historic spaces are inappropriate for the building.

2. **Assemble a qualified team.** This team ideally should consist of a preservation architect, mechanical engineer, electrical engineer, structural engineer, and preservation consultants, each knowledgeable in codes and local requirements. If a special use (church, museum, art studio) or a collection is involved, a specialist familiar with the mechanical requirements of that building type or collection should also be hired.

Team members should be familiar with the needs of historic buildings and be able to balance complex factors: the preservation of the historic architecture (aesthetics and conservation), requirements imposed by mechanical systems (quantified heating and cooling loads), building codes (health and safety), tenant requirements (quality of comfort, ease of operation), access (maintenance and future replacement), and the overall cost to the owner.

3. **Undertake a condition assessment of the existing building and its systems.** What are the existing construction materials and mechanical systems? What condition are they in and are they reusable (see figure 6)? Where are existing chillers, boilers, air handlers, or cooling towers located? Look at the condition of all other services that may benefit from being integrated into a new system, such as electrical and fire suppression systems. Where can energy efficiency be improved to help downsize any new equipment added, and which of the historic features, e.g. shutters, awnings, skylights, can be reused (see figure 7)? Evaluate air infiltration through the exterior envelope; monitor the interior for temperature and humidity levels with hygrothermographs for at least a year. Identify building, site, or equipment deficiencies or the presence of asbestos that must be corrected prior to the installation or upgrading of mechanical systems.



6. A condition assessment during the planning stage would identify this round radiator in a small oval-shaped vestibule as a significant element of the historic heating system. In upgrading the mechanical system, the radiator should be retained. Photo: Michael C. Henry, P.E., AIA.

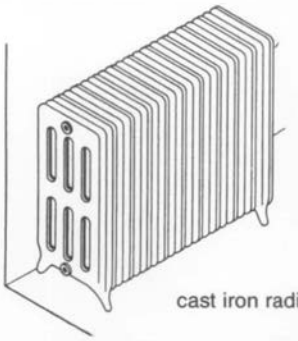
Overview of HVAC Systems

WATER SYSTEMS: Hydronic radiators, Fan coil, or radiant pipes

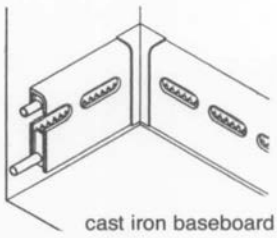
Water systems are generally called *hydronic* and use a network of pipes to deliver water to hot water radiators, radiant pipes set in floors or fan coil cabinets which can give both heating and cooling. Boilers produce hot water or steam; chillers produce chilled water for use with fan coil units. Thermostats control the temperature by zone for radiators and radiant floors. Fan coil units have individual controls. Radiant floors provide quiet, even heat, but are not common.

Advantages: Piped systems are generally easier to install in historic buildings because the pipes are smaller than ductwork.
Disadvantages: There is the risk, however, of hidden leaks in the wall or burst pipes in winter if boilers fail. Fan coil condensate pans can overflow if not properly maintained. Fan coils may be noisy.

Hydronic Radiators: Radiators or baseboard radiators are looped together and are usually set under windows or along perimeter walls. New boilers and circulating pumps can upgrade older systems. Most piping was cast iron although copper systems can be used if separately zoned. Modern cast iron baseboards and copper fin-tubes are available. Historic radiators can be reconditioned.

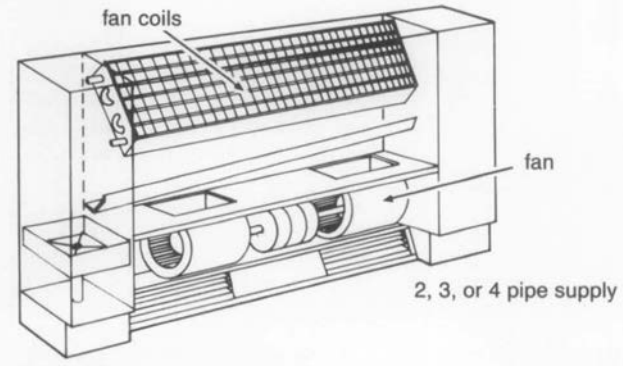


cast iron radiator



cast iron baseboard

Fan Coil Units: Fan coil systems use terminal cabinets in each room serviced by 2, 3, or 4 pipes approximately 1-1/2″ each in diameter. A fan blows air over the coils which are serviced by hot or chilled water. Each fan coil cabinet can be individually controlled. Four-pipe fan coils can provide both heating and cooling all year long. Most piping is steel. Non-cabinet units may be concealed in closets or custom cabinetry, such as benches, can be built.



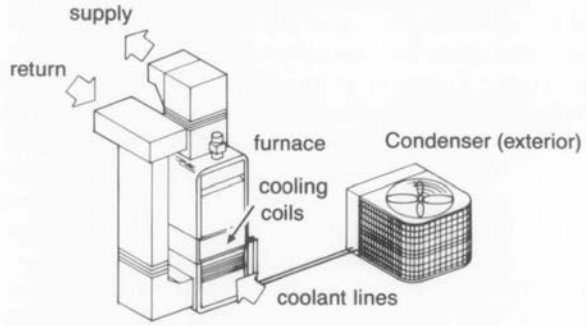
Fan coil unit

CENTRAL AIR SYSTEMS

The basic heating, ventilation and air conditioning (HVAC) system is all-air, single zone fan driven designed for low, medium or high pressure distribution. The system is composed of compressor drives, chillers, condensers, and furnace depending on whether the air is heated, chilled or both. Condensers, generally air cooled, are located outside. The ducts are sheet metal or flexible plastic and can be insulated. Fresh air can be circulated. Registers can be designed for ceilings, floors and walls. The system is controlled by thermostats; one per zone.

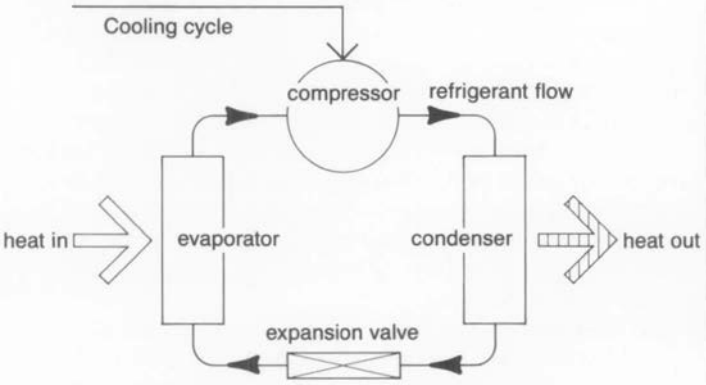
Advantages: Ducted systems offer a high level of control of interior temperature, humidity, and filtration. Zoned units can be relatively small and well concealed.
Disadvantages: The damage from installing a ducted system without adequate space can be serious for a historic building. Systems need constant balancing and can be noisy.

Basic HVAC: Most residential or small commercial systems will consist of a basic furnace with a cooling coil set in the unit and a refrigerant compressor or condenser located outside the building. Heating and cooling ductwork is usually shared. If sophisticated humidification and dehumidification is added to the basic HVAC system, a full climate control system results. This can often double the size of the equipment.



Heating furnace with cooling coil

Basic Heat Pump/Air System: The heat pump is a basic HVAC system as described above except for the method of generating hot and cold air. The system operates on the basic refrigeration cycle where latent heat is extracted from the ambient air and is used to evaporate refrigerant vapor under pressure. Functions of the condenser and evaporator switch when heating is needed. Heat pumps, somewhat less efficient in cold climates, can be fitted with electric resistance coil.



cycle reverses for heating

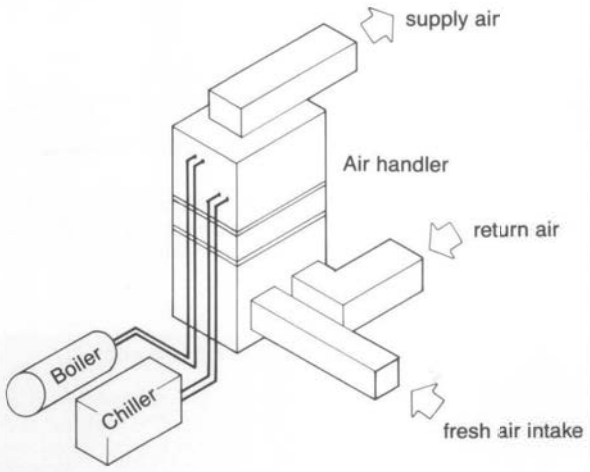
COMBINED AIR AND WATER SYSTEMS

These systems are popular for restoration work because they combine the ease of installation for the piped system with the performance and control of the ducted system. Smaller air handling units, not unlike fan coils, may be located throughout a building with service from a central boiler and chiller. In many cases the water is delivered from a central plant which services a complex of buildings.

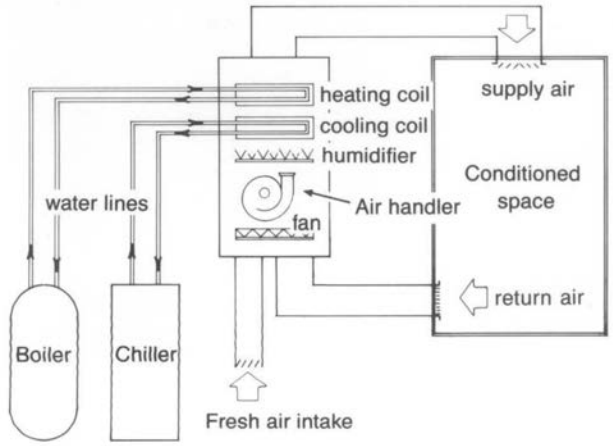
This system overcomes the disadvantages of a central ducted system where there is not adequate horizontal or vertical runs for the ductwork. The equipment, being smaller, may also be quieter and cause less vibration. If only one air handler is being utilized for the building, it is possible to house all the equipment in a vault outside the building and send only conditioned air into the structure.

Advantages: flexibility for installation using greater piping runs with shorter ducted runs; Air handlers can fit into small spaces.
Disadvantages: piping areas may have undetected leaks; air handlers may be noisy.

Water-serviced Air Handlers:



Typical Systems Layout:



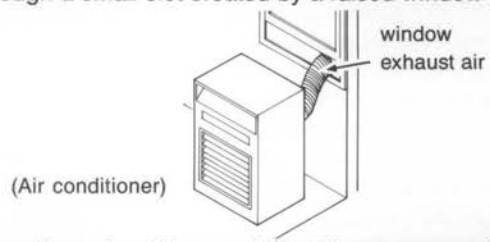
OTHER SYSTEM COMPONENTS

Non-systems components should not be overlooked if they can make a building more comfortable without causing damage to the historic resource or its collection.

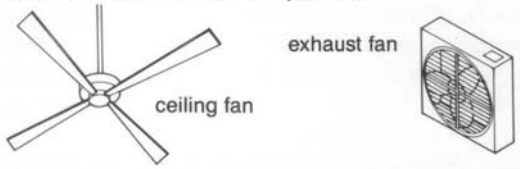
Advantages: components may provide acceptable levels of comfort without the need for an entire system.
Disadvantages: Spot heating, cooling and fluxuations in humidity may harm sensitive collections or furnishings. If an integrated system is desirable, components may provide only a temporary solution.

Portable Air Conditioning:

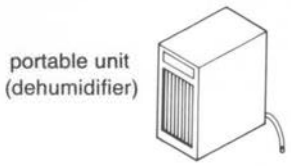
Most individual air conditioners are set in windows or through exterior walls which can be visually as well as physically damaging to historic buildings. Newer portable air conditioners are available which sit in a room and exhaust directly to the exterior through a small slot created by a raised window sash.



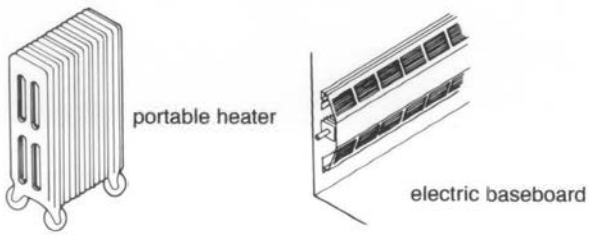
Fans: Fans should be considered in most properties to improve ventilation. Fans can be located in attics, at the top of stairs, or in individual rooms. In moderate climates, fans may eliminate the need to install central air systems.



Dehumidifiers: For houses without central air handling systems, a dehumidifier can resolve problems in humid climates. Seasonal use of dehumidifiers can remove moisture from damp basements and reduce fungal growth.



Heaters: Portable radiant heaters, such as those with water and glycol, may provide temporary heat in buildings used infrequently or during systems breakdowns. Care should be taken not to create a fire hazard with improperly wired units.



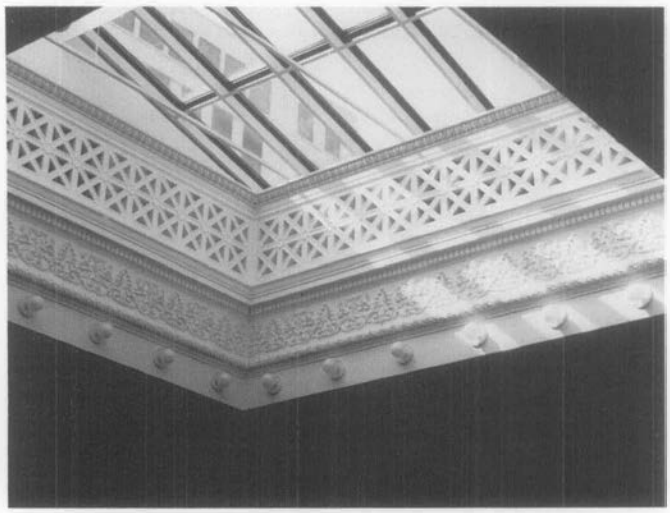
Compiled by Sharon C. Park. Sketches adapted from *Architectural Graphic Standards* with permission from John Wiley and Sons.

4. **Prioritize architecturally significant spaces, finishes, and features to be preserved.** Significant architectural spaces, finishes and features should be identified and evaluated at the outset to ensure their preservation. This includes significant existing mechanical systems or elements such as hot water radiators, decorative grilles, elaborate switchplates, and non-mechanical architectural features such as cupolas, transoms, or porches. Identify non-significant spaces where mechanical equipment can be placed and secondary spaces where equipment and distribution runs on both a horizontal and vertical basis can be located. Appropriate secondary spaces for housing equipment might include attics, basements, penthouses, mezzanines, false ceiling or floor cavities, vertical chases, stair towers, closets, or exterior below-grade vaults (see figure 8).

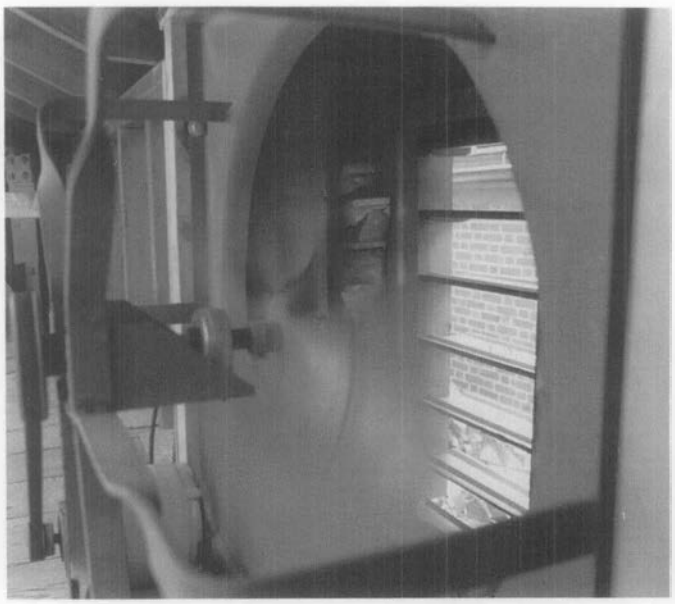
5. **Become familiar with local building and fire codes.** Owners or their representatives should meet early and often with local officials. Legal requirements should be checked; for example, can existing ductwork be reused or modified with dampers? Is asbestos abatement required? What are the energy, fire, and safety codes and standards in place, and how can they be met while maintaining the historic character of the building? How are fire separation walls and rated mechanical systems to be handled between multiple tenants? Is there a requirement for fresh air intake for stair towers that will affect the exterior appearance of the building? Many of the health, energy, and safety code requirements will influence decisions made for mechanical equipment for climate control. It is importance to know what they are before the design phase begins.

6. **Evaluate options for the type and size of systems.** A matrix or feasibility studies should be developed to balance the benefits and drawbacks of various systems. Factors to consider include heating and/or cooling, fuel type, distribution system, control devices, generating equipment and accessories such as filtration, and humidification. What are the initial installation costs, projected fuel costs, long-term maintenance, and life-cycle costs of these components and systems? Are parts of an existing system being reused and upgraded? The benefits of added ventilation should not be overlooked (see figure 9). What are the trade-offs between one large central system and multiple smaller systems? Should there be a forced air ducted system, a 2-pipe fan coil system, or a combined water and air system? What space is available for the equipment and distribution system? Assess the fire-risk levels of various fuels. Understand the advantages and disadvantages of the various types of mechanical systems available. *Then evaluate each of these systems in light of the preservation objectives established during the design phase of planning.*

8. In considering options for new systems, existing spaces should be evaluated for their ability to house new equipment. This sketch shows several areas where new mechanical equipment could be located to avoid damaging significant spaces. Sketch: NPS files



7. Operable skylights and grilles that can be adapted for return air should be identified as part of the planning phase for new or upgraded mechanical systems. Photo: Dianne Pierce, NPS files.



9. Improving ventilation through traditional means should not be overlooked in planning new or upgraded HVAC systems. In mild climates, good exhaust fans can often eliminate the need for air conditioning or can reduce equipment size by reducing cooling loads. Photo: Ernest A. Conrad, P.E.

Designing the new system

In designing a system, it is important to anticipate how it will be installed, how damage to historic materials can be minimized, and how visible the new mechanical system will be within the restored or rehabilitated spaces (see figure 10 a–f). Mechanical equipment space needs are often overwhelming; in some cases, it may be advantageous to look for locations outside of the building, including ground vaults, to house some of the equipment but only if it there is no adverse impact to the historic landscape or adjacent archeological resources. Various means for reducing the heating and cooling loads (and thereby the size of the equipment) should be investigated. This might mean reducing slightly the comfort levels of the interior, increasing the number of climate control zones, or improving the energy efficiency of the building.

The following activities are suggested during the design phase of the new system:

1. Establish specific criteria for the new or upgraded mechanical system. New systems should be *installed with a minimum of damage* to the resource and should be visually *compatible with the architecture* of the building. They should be installed in a way that is *easy to service,* maintain, and upgrade in the future. There should be *safety and back-up monitors in place* if buildings have collections, computer rooms, storage vaults or special conditions that need monitoring. The new *systems should work within the structural limits* of the historic building. They should produce *no undue vibration, no undue noise, no dust or mold,* and *no excess moisture* that could damage the historic building materials. If any equipment is to be located outside of the building, there should be *no impact to the historic appearance of building or site,* and there should be *no impact on archeological resources.*

2. Prioritize the requirements for the new climate control system. The use of the building will determine the level of interior comfort and climate control. Sometimes, various temperature zones may safely be created within a historic building. This zoned approach may be appropriate for buildings with specialized collections storage, for buildings with mixed uses, or for large buildings with different external exposures, occupancy patterns, and delivery schedules for controlled air. Special archives, storage vaults or computer rooms may need a completely different climate control from the rest of the building. Determine temperature and humidity levels for occupants and collections and ventilation requirements between differing zones. Establish if the system is to run 24 hours a day or only during operating or business hours. Determine what controls are optimum (manual, computer, preset automatic, or other). The size and location of the equipment to handle these different situations will ultimately affect the design of the overall system as well.

3. Minimize the impact of the new HVAC on the existing architecture. Design criteria for the new system should be based on the type of architecture of the historic resource. Consideration should be given as to whether or not the delivery system is visible or hidden. Utilitarian and industrial spaces may be capable of accepting a more visible and functional system. More formal, ornate spaces which may be part of an interpretive program may require a less visible or disguised system. A ducted system should be installed without ripping into or boxing out large sections of floors, walls, or ceilings. A wet pipe system should be installed so that hidden leaks will not damage important decorative finishes. In each case, not only the type of system (air, water, combination), but its distribution (duct, pipe) and delivery appearance (grilles, cabinets, or registers) must be evaluated. It may be necessary to use a combination of different systems in order to preserve the historic building. Existing chases should be reused whenever possible.

4. Balance quantitative requirements and preservation objectives. The ideal system may not be achievable for each historic resource due to cost, space limitations, code requirements, or other factors beyond the owner's control. However, significant historic spaces, finishes, and features can be preserved in almost every case, even given these limitations. For example, if some ceiling areas must be slightly lowered to accommodate ductwork or piping, these should be in secondary areas away from decorative ceilings or tall windows. If modern fan coil terminal units are to be visible in historic spaces, consideration should be given to custom designing the cabinets or to using smaller units in more locations to diminish their impact. If grilles and registers are to be located in significant spaces, they should be designed to work within the geometry or placement of decorative elements. All new elements, such as ducts, registers, pipe-runs, and mechanical equipment should be installed in a reversible manner to be removed in the future without further damage to the building (see fig 11).

Systems Performance and Maintenance

Once the system is installed, it will require routine maintenance and balancing to ensure that the proper performance levels are achieved. In some cases, extremely sophisticated, computerized systems have been developed to control interior climates, but these still need monitoring by trained staff. If collection exhibits and archival storage are important to the resource, the climate control system will require constant monitoring and tuning. Back-up systems are also needed to prevent damage when the main system is not working. The owner, manager, or chief of maintenance should be aware of all aspects of the new climate control system and have a plan of action before it is installed.

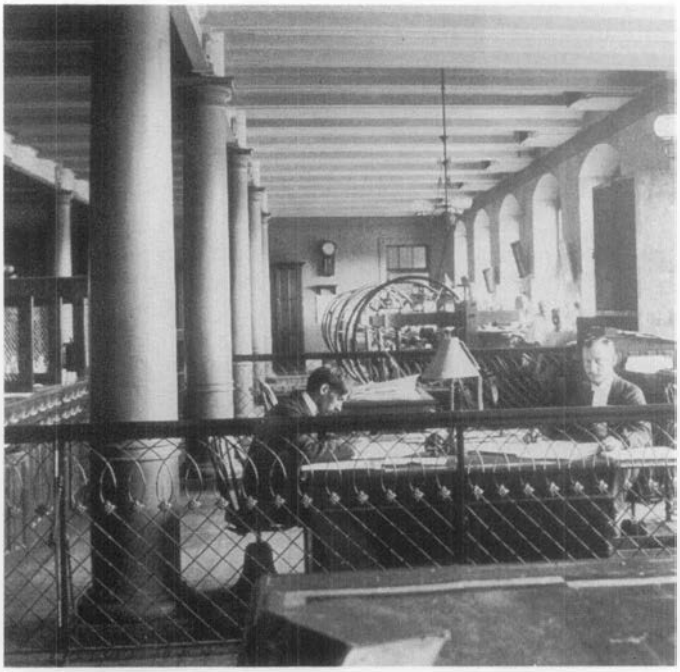
Regular training sessions on operating, monitoring, and maintaining the new system should be held for both curatorial and building maintenance staff. If there are curatorial reasons to maintain constant temperature or humidity levels, only individuals thoroughly trained in how the HVAC systems operates should be able to adjust thermostats. Ill-informed and haphazard attempts to adjust comfort levels, or to save energy over weekends and holidays, can cause great damage.

10. The following photographs illustrate recent preservation projects where careful planning and design retained the historic character of the resources.

before

after

a. Before and after of a circa 1900 school entrance. The radiators have been replaced with a two-pipe fan coil system built into bench seats. The ceiling was preserved and no exposed elements were required to add air conditioning. Piping runs are under the benches and there was no damage to the masonry walls. Photos: Notter Finegold + Alexander Inc. and Lautman Photography, Washington.



historic

after

d. Auditors Buildings, Washington, D.C. This upper floor workspace had been modified over the years with dropped ceilings and partitions. In the recent restoration, the open plan workspace was restored, the false ceiling was removed, and the fireproof construction was exposed. A variable air volume (VAV) system using round double shell exposed ductwork is in keeping with the industrial character of the architectural space. Photo: Kenneth Wyner Photography, courtesy of Notter Finegold + Alexander Inc. Before view provided by Notter Finegold + Alexander/Mariani.

b. Central air conditioning was installed in the corridors of this circa 1900 school building by adding an air handler over the entrance from a vestibule. The custom-designed slot registers provide linear diffusers without detracting from the architecture of the space. Photo: Lautman Photography courtesy of Notter Finegold + Alexander Inc.

c. Conference room, Auditors Building, Washington, D.C. The historic steam radiators were retained for heating. The cast iron ceiling register was retained as a decorative element, but made inoperable to meet fire codes. Photo: Kenneth Wyner Photography courtesy of Notter Finegold + Alexander Inc.

e. Town Hall, Andover, MA. The upstairs auditorium was restored and new mechanical systems were installed. Perimeter baseboard radiation provides heat and air handlers, located in the attic space provide air conditioning. The cast iron ceiling grille was adapted for return air and the supply registers were installed in a symmetrical and regular manner to minimize impact on the historic ceiling. Photo: David Hewitt/Anne Garrison for Ann Beha Associates.

f. Homewood, Baltimore, MD. This elegant circa 1806 residence is now a house museum. The registers for the forced air ducted system seen behind the table legs, are grained to blend with the historic baseboards. The HVAC system uses a water/air system where chilled water and steam heat are converted to conditioned air. Photo: Courtesy Homewood Museum, Johns Hopkins University.

HVAC Do's and Don'ts

DO's:

- Use shutters, operable windows, porches, curtains, awnings, shade trees and other historically appropriate non-mechanical features of historic buildings to reduce the heating and cooling loads. Consider adding sensitively designed storm windows to existing historic windows.
- Retain or upgrade existing mechanical systems whenever possible: for example, reuse radiator systems with new boilers, upgrade ventilation within the building, install proper thermostats or humidistats.
- Improve energy efficiency of existing buildings by installing insulation in attics and basements. Add insulation and vapor barriers to exterior walls *only* when it can be done without further damage to the resource.
- In major spaces, retain decorative elements of the historic system whenever possible. This includes switchplates, grilles and radiators. Be creative in adapting these features to work within the new or upgraded system.
- Use space in existing chases, closets or shafts for new distribution systems.
- Design climate control systems that are compatible with the architecture of the building: hidden system for formal spaces, more exposed systems possible in industrial or secondary spaces. In formal areas, avoid standard commercial registers and use custom slot registers or other less intrusive grilles.
- Size the system to work within the physical constraints of the building. Use multi-zoned smaller units in conjunction with existing vertical shafts, such as stacked closets, or consider locating equipment in vaults underground, if possible.
- Provide adequate ventilation to the mechanical rooms as well as to the entire building. Selectively install air intake grilles in less visible basement, attic, or rear areas.
- Maintain appropriate temperature and humidity levels to meet requirements without accelerating the deterioration of the historic building materials. Set up regular monitoring schedules.
- Design the system for maintenance access and for future systems replacement.
- For highly significant buildings, install safety monitors and backup features, such as double pans, moisture detectors, lined chases, and battery packs to avoid or detect leaks and other damage from system failures.
- Have a regular maintenance program to extend equipment life and to ensure proper performance.
- Train staff to monitor the operation of equipment and to act knowledgeably in emergencies or breakdowns.
- Have an emergency plan for both the building and any curatorial collections in case of serious malfunctions or breakdowns.

DON'TS:

- Don't install a new system if you don't need it.
- Don't switch to a new type of system (e.g. forced air) unless there is sufficient space for the new system or an appropriate place to put it.
- Don't over-design a new system. Don't add air conditioning or climate control if they are not absolutely necessary.
- Don't cut exterior historic building walls to add through-wall heating and air conditioning units. These are visually disfiguring, they destroy historic fabric, and condensation runoff from such units can further damage historic materials.
- Don't damage historic finishes, mask historic features, or alter historic spaces when installing new systems.
- Don't drop ceilings or bulkheads across window openings.
- Don't remove repairable historic windows or replace them with inappropriately designed thermal windows.
- Don't seal operable windows, unless part of a museum where air pollutants and dust are being controlled.
- Don't place condensers, solar panels, chimney stacks, vents or other equipment on visible portions of roofs or at significant locations on the site.
- Don't overload the building structure with the weight of new equipment, particularly in the attic.
- Don't place stress on historic building materials through the vibrations of the new equipment.
- Don't allow condensation on windows or within walls to rot or spall adjacent historic building materials.

Maintenance staff should learn how to operate, monitor, and maintain the mechanical equipment. They must know where the maintenance manuals are kept. Routine maintenance schedules must be developed for changing and cleaning filters, vents, and condensate pans to control fungus, mold, and other organisms that are dangerous to health. Such growths can harm both inhabitants and equipment. (In piped systems, for example, molds in condensate pans can block drainage lines and cause an overflow to leak onto finished surfaces). Maintenance staff should also be able to monitor the appropriate gauges, dials, and thermographs. Staff must be trained to intervene in emergencies, to know where the master controls are, and whom to call in an emergency. As new personnel are hired, they will also require maintenance training.

In addition to regular cyclical maintenance, thorough inspections should be undertaken from time to time to evaluate the continued performance of the climate control system. As the system ages, parts are likely to fail, and signs of trouble may appear. Inadequately ventilated areas may smell musty. Wall surfaces may show staining, wet patches, bubbling or other signs of moisture damage. Routine tests for air quality, humidity, and temperature should indicate if the system is performing properly. If there is damage as a result of the new system, it should be repaired immediately and then closely monitored to ensure complete repair.

Equipment must be accessible for maintenance and should be visible for easy inspection. Moreover, since mechanical systems last only 15–30 years, the system itself must be "reversible." That is, the system must be installed in such a way that later removal will not damage the building. In addition to servicing, the back-up monitors that signal malfunctioning equipment must be routinely checked, adjusted, and maintained. Checklists should be developed to ensure that all aspects of routine maintenance are completed and that data is reported to the building manager.

Conclusion

The successful integration of new systems in historic buildings can be challenging. Meeting modern HVAC requirements for human comfort or installing controlled climates for museum collections or for the operation of complex computer equipment can result in both visual and physical damage to historic resources. Owners of historic buildings must be aware that the final result will involve balancing multiple needs; no perfect heating, ventilating, and air conditioning system exists. In undertaking changes to historic buildings, it is best to have the advice and input of trained professionals who can:

- assess the condition of the historic building,
- evaluate the significant elements that should be preserved or reused,
- prioritize the preservation objectives,
- understand the impact of new interior climate conditions on historic materials,
- integrate preservation with mechanical and code requirements,
- maximize the advantages of various new or upgraded mechanical systems,
- understand the visual and physical impact of various installations,
- identify maintenance and monitoring requirements for new or upgraded systems, and
- plan for the future removal or replacement of the system.

Too often the presumed climate needs of the occupants or collections can be detrimental to the long-term preservation of the building. With a careful balance between the preservation needs of the building and the interior temperature and humidity needs of the occupants, a successful project can result.

a

b

11. During the restoration of this 1806 National Historic Landmark (photo a), a new climate control system was installed. The architects removed all the earlier mechanical equipment from the house and installed new equipment in a 30′ × 40′ concrete vault located underground 150 feet from the house itself (photo b). Only conditioned air is blown into the house reusing much of the circa 1930s ductwork. Photos: Thomas C. Jester.

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cover photo: This historic coal boiler continues in use after its conversion to an oil-fired boiler. Photo: NPS files

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Washington, DC 1991

28 PRESERVATION BRIEFS

Painting Historic Interiors

Sara B. Chase

U.S. Department of the Interior
National Park Service
Cultural Resources
Preservation Assistance

The paint Americans used in the past is undeniably part of a technological and commercial record. But beyond that, the colors we have chosen and continue to select for our interior living and working spaces—bright and exuberant, purposefully somber, or a combination of hues—reflect our nation's cultural influences and our individual and collective spirit (see Figures 1, 2). Paint color is a simple, direct expression of the time, and of taste, values, and mood. To consider paint only as a protective coating is to misunderstand its meaning as an important aspect of America's heritage.

This Brief is about historic interior paints and choosing new paints for historic interiors if repainting is necessary or desirable. It addresses a variety of materials and features: plaster walls and ceilings; wooden doors, molding, and trim; and metal items such as radiators and railings. It provides background information about some of the types of paint which were used in the past, discusses the more common causes and effects of interior paint failure, and explains the principal factors guiding decisions about repainting, including what level of paint investigation may be appropriate. Careful thought should be given to each interior paint project, depending on the history of the building and its painted surfaces. Treatments may range from protecting extant decorative surfaces, to ordering custom-made paint that replicates the original paint color, to using today's paint straight off the shelf and out of the can.

Finally, stripping old paints or applying new oil/alkyd paints poses serious health and safety concerns; the State Historic Preservation Officer should be contacted for current legal and technical information on removal, disposal, and health and safety precautions.

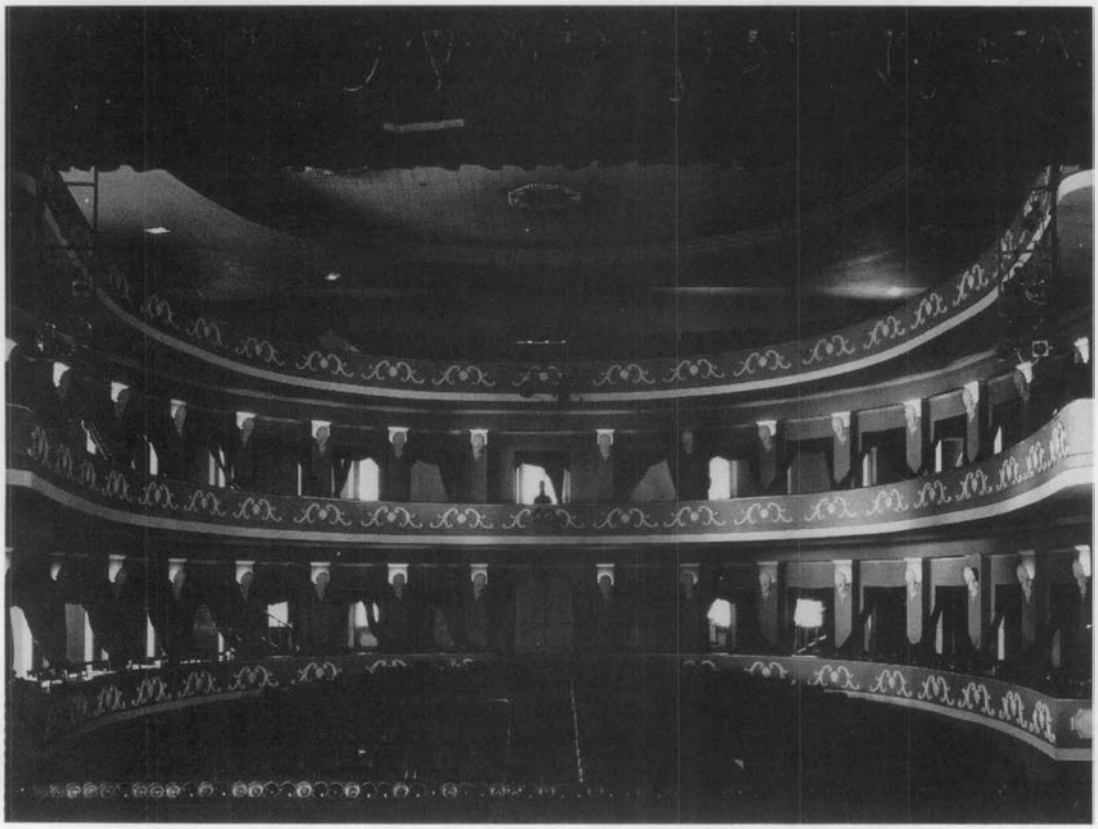
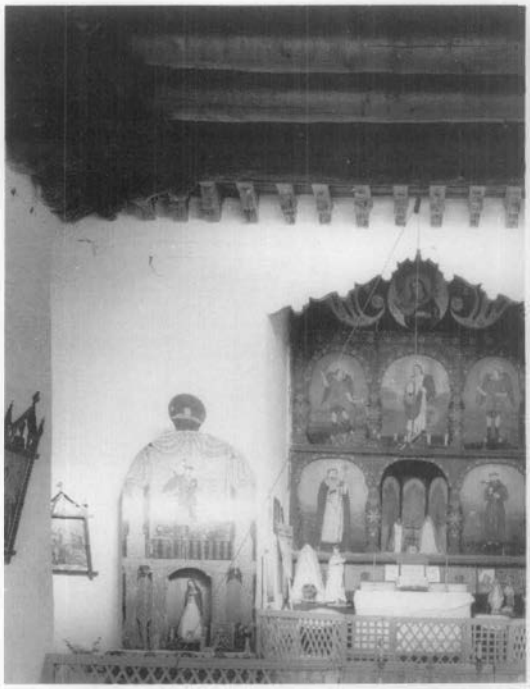


Figure 1. Researching the interior paint history is the key to a successful preservation or restoration project. The decorative detailing can be appreciated in this Puerto Rico theater primarily because of appropriate paint color and paint placement. Photo: Max Toro.

Constituents of Historic Paint: Pigment, Binder, and Vehicle

Paint is a dispersion of small solid particles, usually crystalline, in a liquid



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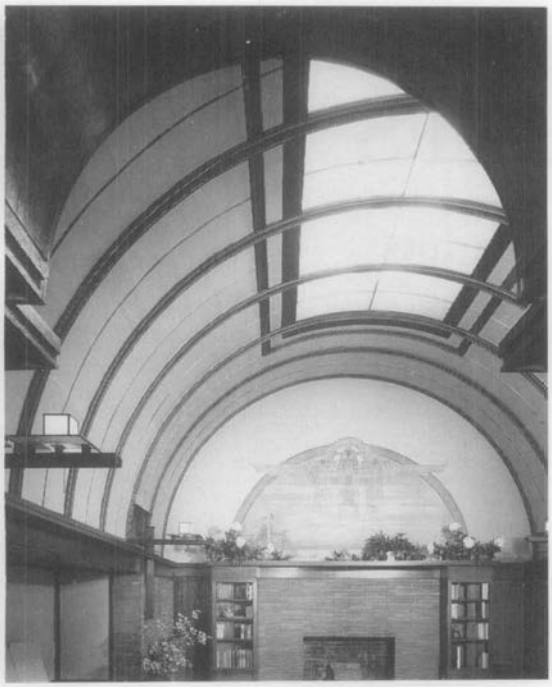

B

C

Figure 2. Paints—plain and colored—have been used throughout our history to define and accent interior spaces. Three examples serve to illustrate a variety of geographical and cultural influences, building types and uses, and interior designs from the 18th to the 20th century. (a) San Jose de Gracia Church, Las Trampas, New Mexico (1760). Photo: Kirk Gittings. (b) Frank Lloyd Wright Home and Studio, Oak Park, Illinois (1889-98). Photo: Philip Turner for HABS. (c) U. S. Customs House, Trading Floor (1908), New York City. Photo: National Park Service files.

medium. Applied to a surface, this liquid has the special quality of becoming a solid, protective film when it dries. Paint also enhances the appearance of surfaces. A late Victorian writer observed that the coming of a painter to a house was cause for celebration. Indeed, these statements not only indicate the chemical and physical complexity of paint, but also its emotional impact.

Pigment. Pigment made the paint opaque, thus preventing deterioration of the substrate caused by ultra-violet light, and added color, thus making the paint attractive. White lead, a whitish corrosion product of lead, was most often used to provide opacity. The white pigment in a colored paint is often called the "hiding" pigment. In addition to preventing the sun's damaging rays from hitting the surface of the substrate, the white lead also helped prevent the growth of mold and mildew. Not until early in the 20th century was a successful substitute, titanium dioxide (TiO2), patented, and even then, it did not come into prevalent use by itself until the mid-20th century (earlier in the century, titanium oxide and white lead were often mixed). Zinc oxide was used briefly as a hiding pigment after 1850 (see Figure 3).

Early tinting pigments for house paints consisted of the earth pigments—ochres, siennas, umbers made from iron-oxide-containing clay—and a few synthesized colorants such as Prussian blue, or mercuric sulfide (crimson). From the early 1800s on more pigments were developed and used to offer a wider and brighter variety of hues.

Binder. The most common binder in interior paints was, and still is, oil. Chalk was sometimes added to water-based paints to help bind the pigment particles together. Other common binders included hide glue and gelatin.

Vehicle. The fluid component was termed the vehicle, or medium, because it carried the pigment. Historically, vehicles included turpentine in oil paints and water in water-based paints, but other vehicles were sometimes used, such as milk in casein paints.

Oil-Based and Water-Based Paints

The two major types of paint are termed oil-based and water-based. For *oil-based paints,* linseed oil was frequently chosen because it is a drying oil. When thinned with an organic solvent such as turpentine for easier spreading, its drying speed was enhanced. To make the drying even faster, drying agents such as cobalt compounds were frequently added. Because the addition of driers was most successfully done in hot or boiling oil, boiled linseed oil was preferable. The drying rate of linseed oil paints was relatively rapid at first, for several days immediately after application, and paint soon felt dry to the touch; it is important to remember, however, that linseed oil paint continues to dry—or more precisely, to cross-link—over decades and thus continues to a point of brittleness as the paint ages. Strong and durable with a surface sheen, oil-based paints were mainly used for wood trim and metal.

Whitewashes and distemper paints differed from oil paints in appearance primarily because the vehicle was water. *Water-based paints* were always flat, having no gloss of their own. Because the paint film dried to the touch as soon as

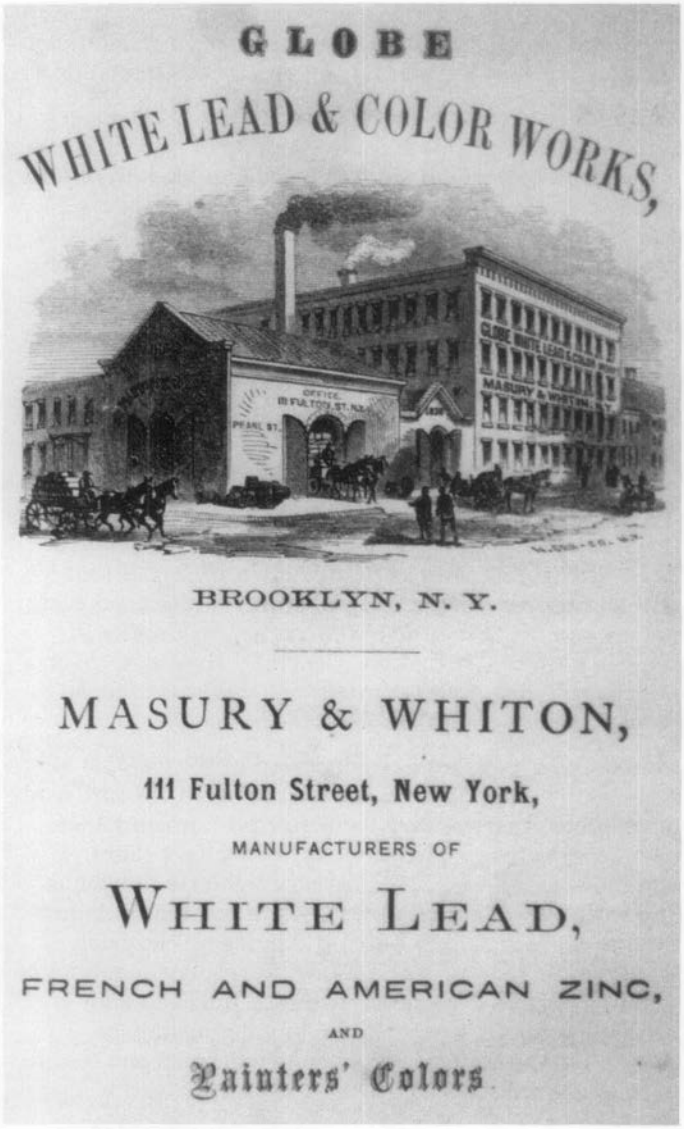

Figure 3. There were numerous companies producing white lead in the United States by mid-19th century. Shown is one manufacturer's trade flyer. Of note, production figures for white lead showed a marked increase after 1850, but a steady decline after 1880. This was, in part, due to a change of taste and style at the end of the 19th century—stains and clear finishes were preferred over opaque paints for interior decorative treatments.

the water evaporated, driers were not needed. Water-base paints were fairly strong, with the pigments well bound as in hide glue distempers, but they did not hold up to abrasion. Wood trim, therefore, was rarely painted with these types of paint historically, though interior plaster surfaces were frequently coated with whitewash and calcimine. Distemper paints were commonly used for decorative work.

Recent Changes to Paint Constituents. Until the mid-20th century, almost all paints used in America could be divided according to the type of binder each had. Chemists sought to improve paints, especially when the two world wars made traditional paint components scarce and expensive. Modern paints are far more complex chemically and physically than early paints. More ingredients have been added to the simple three-part system of pigment, binder, and vehicle. Fillers or extenders such as clay and chalk were put in to make oil paints flow better and to make them cheaper as well. Mildewcides and fungicides were prevalent and popular until their environmental hazards were seen to outweigh their benefits. New formulations which retard the growth of the mildew and fungi are being used. As noted, lead was eliminated after 1950. Most recently, volatile organic solvents in oil paint and thinners have been categorized as environmentally hazardous.

Types of Historic Paints

Historic paints were often made with what was available, rather than adhering to strict formulas. Recipes for successful formulas can be found in historic documents, such as newspapers, illustrating the combinations of ingredients which could be used to produce a paint.

Oil-based paints: Linseed oil, a volatile thinner such as turpentine; a hiding pigment (usually white lead) and coloring pigments.

Enamels: natural resin varnish was added to oil-based paint to provide a hard, more glossy surface.

Glaze: a translucent layer applied to protect the paint and to impart a more uniform gloss surface. Usually made from linseed oil with natural resin varnish added. Some glazes have small quantities of tinting pigments such as verdigris or Prussian blue; some had no pigments added.

Water-based paints: Water, pigment, and a binder, such as hide glue, other natural glues, or gums. Usually used on interior plaster surfaces.

Whitewash: often used on interior plaster surfaces in utilitarian spaces and, at times, used on interior beams; consisted of water, slaked lime, salt, and a variety of other materials. Occasionally a pigment (usually an ochre or other earth pigment) was added to provide tint or color.

Distemper: used for interior applications, were made from water, glues (one or more different natural glues, gelatine, and gums) with whiting as the basic white pigment to which other tinting pigments were added.

Calcimine, or kalsomine: often used on interior surfaces and is another common name for distemper.

Tempera: paint prepared with pigment, egg yolk or white and water; used almost exclusively for decorative treatments.

Gouache: a water-based paint made of whiting, pigment, water, and gum arabic as the binder; used almost exclusively for decorative treatments.

Milk-based paint:

Casein: also called milk paint, was made with hydrated (slaked) lime, pigment, and milk. Most often oil was added, making a strong emulsion paint. Various recipes call for a large variety of additives to increase durability. Casein paints were also used for exterior surfaces.

A major difference in modern paints is the change in binder from the use of natural boiled linseed oil to an alkyd oil which is generally derived from soybean or safflower oil. Use of synthetic resins, such as acrylics and epoxies, has become prevalent in paint manufacture in the last 30 years or so. Acrylic resin emulsions in latex paints, with water thinners, have also become common.

Pre-1875 Paints

Production and Appearance. How were paints made prior to the widespread use of factory-made paint after 1875? How did they look? The answers to these questions are provided more to underscore the differences between early paints and today's paints than for practical purposes. Duplicating the composition and appearance of historic paints, including the unevenness of color, the irregularity of surface texture, the depth provided by a glaze topcoat, and the directional lines of application, can be extremely challenging to a contemporary painter who is using modern materials.

The pigments used in early paints were coarsely and unevenly ground, and they were dispersed in the paint medium by hand; thus, there is a subtle unevenness of color across the surface of many pre-1875 paints (see Figure 4). The dry pigments had to be ground in oil to form a paste and the paste had to be successively thinned with more oil and turpentine before the paint was ready for application. The thickness of the oil medium produced the shiny surface desired in the 18th century. In combination with the cylindrical (or round) shaped brushes with wood handles and boar bristles, it also produced a paint film with a surface texture of brush strokes.

Figure 4. The Boston Stone (1737), a surviving relic of early paint production, was used for pigment grinding in the shop of Thomas Child of Boston, a London-trained painter and stainer. The early paint-grinding tool is the logo of the National Paint and Coatings Association. Photo: Courtesy, SPNEA.

Geographical Variation. The early churches and missions built by the French in Canada and the Spanish in the southwestern United States often had painted decoration on whitewashed plaster walls, done with early water-based paints. By the mid-17th century oil paint was applied to wood trim in many New England houses, and whitewash was applied to walls. These two types of paint, one capable of highly decorative effects such as imitating marble or expensive wood and the other cheap to make and relatively easy to apply, brightened and enhanced American interiors. In cities such as Boston, Philadelphia, New York, and later, Washington, painters and stainers who were trained guildsmen from England practiced their craft and instructed apprentices. The painter's palette of colors included black and white and grays, buffs and tans, ochre yellows and iron oxide reds, and greens (from copper compounds) as well as Prussian blue. That such painting was valued and that a glossy appearance on wood was important are substantiated by evidence of clear and tinted glazes which may be found by microscopic examination.

Brush Marks. Early paints did not dry out to a flat level surface. Leveling, in fact, was a property of paint that was much sought after later, but until well into the 19th century, oil paints and whitewashes showed the signs of brush marks. Application therefore was a matter of stroking the brush in the right direction for the best appearance. The rule of thumb was to draw the brush in its final stokes in the direction of the grain of the wood. Raised-field paneling, then, required that the painter first cover the surface with paint and afterward draw the brush carefully along the vertical areas from bottom to top and along the top and bottom bevels of the panel horizontally from one side to the other.

In the 19th and early 20th centuries, for very fine finishes, several coats were applied with each coat being rubbed down with rotten stone or pumice after drying. A four to five coat application was typical; however nine coats were not uncommon at the end of the century for finishes in some of the grand mansions. Generally, they were given a final glaze finish. Though expensive, this type of finish would last for decades and give a rich, smooth appearance.

Color. Color matching is complicated by the fact that all early paints were made by hand. Each batch of paint, made by painters using books of paint "recipes" or using their own experience and instincts, might well have slight variations in color—a little darker or lighter, a little bluer and so on. The earliest known book of paint formulations by an American painter is the 1812 guide by Hezekiah Reynolds. It gives instructions for the relative quantities of tinting pigments to be added to a base, but even with proportions held constant, the amount of mixing, or dispersion, varied from workman to workman and resulted in color variations.

Knowing all of the facts about early paints can aid in microscopic paint study. For example, finding very finely and evenly ground pigments, equally dispersed throughout the ground or vehicle, is an immediate clue that the paint was not made by hand but, rather, in a factory.

By the first decades of the 19th century more synthetic pigments were available—chrome yellow, chrome green, and shades of red. Discoveries of light, bright, clear colors in the plaster and mosaic decoration of dwellings at Pompeii caught the fancy of many Americans and came together with the technology of paint to make for a new palette of choice, with more delicacy than many of the somewhat greyed-down colors of the 18th century. Of course, the blues which could be produced with Prussian blue in the 18th and 19th centuries were originally often strong in hue. That pigment—as were a number of others—is fugitive, that is, it faded fairly quickly and thus softened in appearance. It should be remembered that high style houses from the mid-17th to late 19th centuries often had wallpaper rather than paint on the walls of the important rooms and hallways.

Glossy/Flat. Another paint innovation of the early 19th century was the use of flatter oil paints achieved by adding more turpentine to the oil, which thus both thinned and flatted them. By the 1830s the velvety look of flat paint was popular. Wherever decorative plaster was present, as it

frequently was during the height of the Federal period, distemper paints were the coating of choice. Being both thin and readily removable with hot water, they permitted the delicate plaster moldings and elaborate floral or botanical elements to be protected and tinted but not obscured by the buildup of many paint layers. (The use of water-based paints on ceilings continued through the Victorian years for the same reasons.)

Unfortunately, flat paints attract dirt, which is less likely to adhere to high gloss surfaces, and are thus harder to wash. Victorians tended to use high gloss clear (or tinted) finishes such as varnish or shellac on much of their wood trim and to use flat or oil paints on walls and ceilings.

Decorative Painting. In interiors, paint could be used creatively and imaginatively, most often to decorate rather than to protect. Decorative forms included stencilling, graining and marbleizing, and *trompe l'oeil* (see Figures 5, 6).

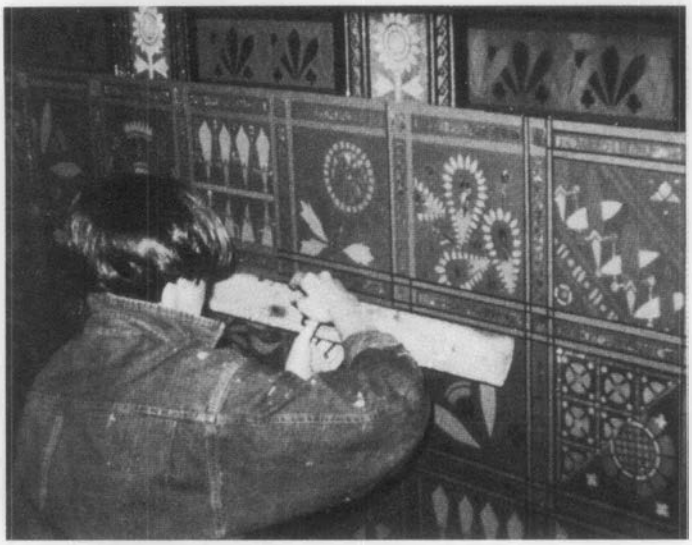

Figure 5. Owners of historic properties often find evidence of decorative painting on interior walls; however, the task of actually preserving or restoring decorative work, such as the complex stencilling pictured here, should only be undertaken by professionals who have specialized training and field experience. Photo: Courtesy, Alexis Elza.

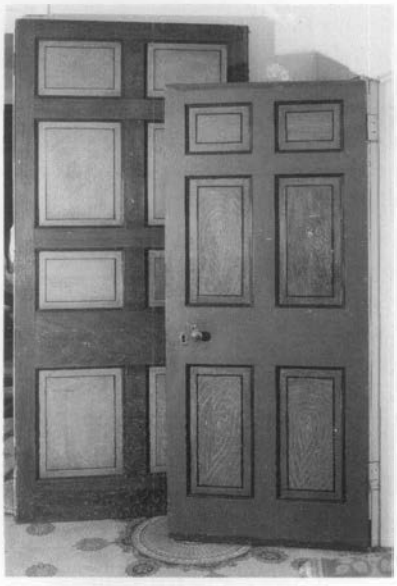

Figure 6. Historic doors may have graining patterns or clear finishes under one or several coats of plain paint, such as these restored 18th and early 19th century doors. Graining may appear even on more vernacular doors of the pre-1850 vintage. Photo: Jack E. Boucher for HABS.

Stencilling. Stencilled designs on walls were often used in the first half of the 19th century in place of wallpaper. Old Sturbridge Village, in Massachusetts, has paintings showing the interiors of a (c. 1815-1820) farmhouse which has both stencilled walls—imitating wallpaper—and painted floors or oiled and painted floor cloths, imitating fine carpets. By 1850 and for the next 60 years thereafter, stencilled and freehand-painted decoration for walls and ceilings became a high as well as a humble art. Owen Jones' ***Grammar of Ornament,*** published in 1859, provided the source for painted decoration from Portland to Peoria, Savannah to San Francisco.

Graining and marbleizing. If floors, walls, and ceilings were decorated by paint in a variety of styles, the wood and stone trim of rooms was not omitted. The use of *faux bois,* that is, painting a plain or common wood such as pine to look like mahogany or some finer wood, or *faux marbre,* painting a wood or plaster surface to look like marble—realistically or fantastically—was common in larger homes of the 18th century. By the early 19th century, both stylized graining and marbleizing adorned the simple rural or small town houses as well. Often baseboards and stair risers were marbleized as were fireplace surrounds. Plain slate was painted to look like fine Italian marble. In many simple buildings, and, later, in the Victorian period, many prominent buildings such as town halls and churches, the wood trim was given a realistic graining to resemble quarter sawn oak, walnut, or a host of other exotic woods.

Trompe L'oeil. Churches, courthouses, and state capitols frequently received yet another remarkable use of paint: *trompe l'oeil* decoration. Applied by skilled artists and artisans, painted designs—most often using distemper paints or oils—could replicate three-dimensional architectural detailing such as ornate molded plaster moldings, medallions, panels, and more.

Factory-Made Paints after 1875

An enormous growth of the paint industry began in the 1860s, stimulated by the invention of a suitable marketing container—the paint can. The first factory-made paints in cans consisted of more finely ground pigments in an oil base; after purchase, additional oil was added to the contents of the can to make up the paint. Such paints saved the time of hand-grinding pigments, and were discussed at length by John Masury in his numerous books. After 1875, factory-made paints were available at a reasonable cost and, as a result, greater numbers of people painted and decorated more of their buildings, and more frequently. The new commercial market created by ready-mixed paint became the cornerstone of our modern paint industry (see Figure 7).

20th Century Paints

By the early decades of the 20th century, popular taste turned away from exuberant colors and decoration. Until the late 1920s both the Colonial Revival and Arts and Crafts styles tended toward more subdued colors and, in the case of Colonial Revival, a more limited palette. The use of *faux* finishes, however, continued. Residential architecture often featured stencilling, such as painted borders above wainscoting or at ceiling and wall edges to imitate decorative wallpaper. Institutional buildings in both cities

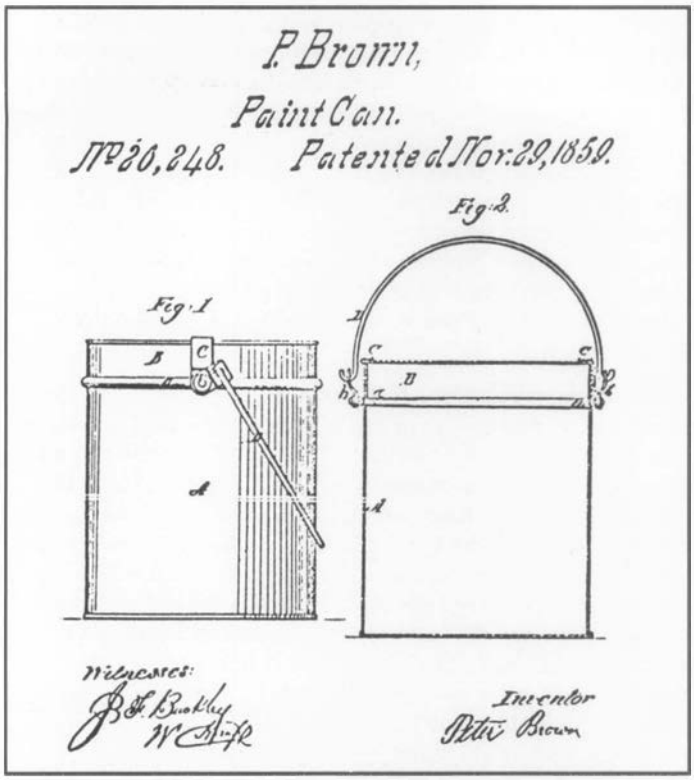

Figure 7. This 1857 patent drawing of a paint can invented by Peter Brown shows a remarkable similarity in design to today's containers. An airtight, carryable container allowed the sale of small amounts of paint. It helped revolutionize the paint industry for typical consumers in the late 19th century because paint was now essentially available to anyone who wanted it.

and small towns used wood graining on metal-clad doors, door and window frames, and staircases, and had stencilled ceilings as well. Many high style public buildings of the 1920s had painted ceilings which imitated the Spanish and Italian late medieval and Renaissance styles.

Although stenciling, gilding, and *faux* finishes can be found, they did not express the modern style of the time. On the other hand, glaze treatments were often used in the early 20th century to "antique" walls and trim that had been painted with neutral colors, especially in Spanish Colonial Revival and Mission architecture. The glazes were applied by ragging, sponging, and other techniques which gave an interesting and uneven surface appearance. Colored plasters were sometimes used, and air brushing employed to give a craftsmanlike appearance to walls, trim, and ceilings. During the same period, Williamsburg paint colors were produced and sold to people who wanted their houses to have a "historic Georgian look." Churches, country clubs, and many private buildings adopted the Williamsburg style from the late 20s onward.

Often decorated with simple molded plaster designs of the Art Deco and Art Moderne styles, interiors of the 1930s and 1940s were frequently accented with metal flake paints in a full range of metallic colors, from copper to bronze (see Figure 8). And enamels, deep but subdued hues, became popular. Paint technology had progressed and varying degrees of gloss were also available, including the mid-range enamels, variously called satin, semi-gloss, or eggshell. In contrast to Victorian paint treatments, this period was characterized by simplicity. To some extent, the

Figure 8. The lobby foyer of the Paramount Theater in Sacramento, California (1931) features painted plaster columns and cornices which have been finished in gold and silver leaf. The theater, a National Historic Landmark, is noted for its Art Deco style. Photo: Gabriel Moulin Studios.

Bauhaus aesthetic influenced taste in the 1950s; interior paints were frequently chosen from a palette limited to a few "earth" colors and a "nearly neutral" palette of off-whites and pale greys.

While the trend in colors and decorative treatments was defined by its simplicity, paint chemists were developing paints of increasing complexity. Experimentation had started early in the 20th century and accelerated greatly after World War II. Of greatest significance was the manufacture of the latex paints for consumer use. Synthetic resin emulsions carried in water offered advantages over the traditional oil paints, and even over the oil/alkyd paints: they did not yellow; they permitted water clean-up until dried; and they emitted no toxic or hazardous fumes from solvent evaporation.

Paint Investigation

Understanding each project's historic preservation goal and knowing what level of information needs to be collected to achieve that goal is an important responsibility of the purchaser of the service. Before someone is hired, the owner or manager needs to decide if a thorough investigation of painted surfaces is actually needed, and *how* to use the results when one is done.

Specialists with both training and field experience conduct paint investigations. These experts use sophisticated instruments and procedures such as field sampling, cross-section analysis, and fluorescent and chemical staining to learn about the components and behaviors of historic paints (see Figure 9). In addition, they utilize written documentation, verbal research, and visual information about past painting in the building in conjunction with findings in the field (Figure 10).

Paint investigation can make several contributions to a project. A complete analysis of the paint layers on surfaces within a structure can tell a great deal about the sequence of alterations that have occurred within a building, as well

A B

Figure 9. Conservators are shown in the two-part process of conducting a complete paint investigation: (a) Paint samples are carefully collected onsite. (b) In the laboratory, an ultra violet light microscope is used to identify pigment and binding media. Paint samples are photographed with the camera mounted on top of the microscope. (right). Photo left: Courtesy, Matthew J. Mosca; Photo right: Courtesy, Andrea M. Gilmore.

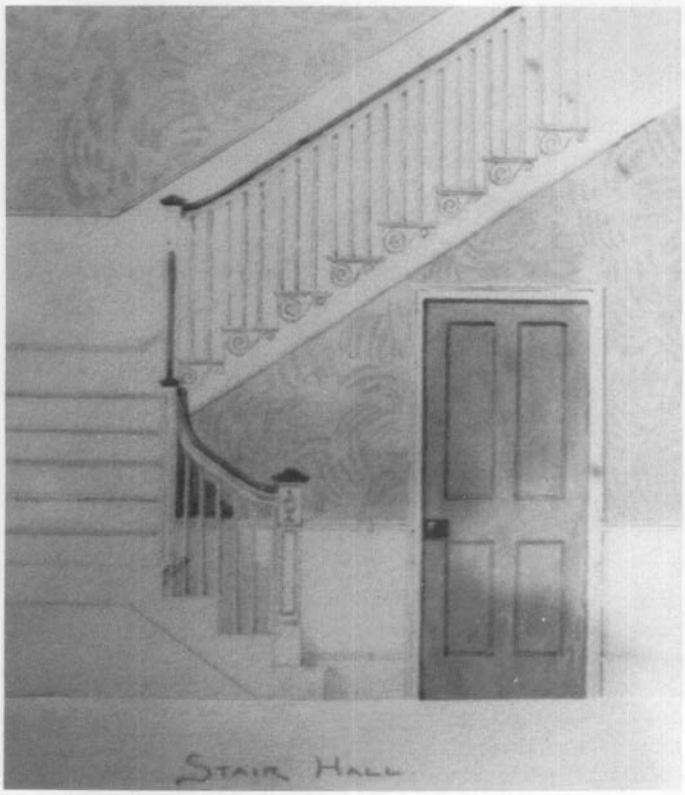

Figure 10. Written, oral, and pictorial documentation—such as this historical rendering—are combined with essential field research to provide the framework for sound historic preservation decisions. Photo: Courtesy, SPNEA.

as potentially providing ranges of dates for some of these changes. By establishing a full sequence of paint layers (termed a *chromochronology*), together with other research, alterations of various building spaces and features can be associated with specific paint layers. It is by establishing this association that the correct layer is identified; when the correct layer has been identified, the color may be matched.

In addition to its archeological value, paint analysis can determine the types and colors of paint on a given surface (identification of thin glazes, decorative paint schemes, binders and pigments). Beyond color identification, then, paint analysis is also recommended to diagnose causes of paint failure. Knowing a paint binder can often explain causes as well as guide appropriate preservation or conservation treatments.

Owners and managers should identify all of these needs before deciding on the extent of analysis. For example, a complete paint investigation is usually recommended as part of an historic structure report. For buildings with little documentation, additions and alterations can often be identified, and possibly dated, through analysis. Often the use of such seemingly expensive techniques can save money in the long run when determining the history of building change.

It is possible to do some analysis on site; this is a much simpler process that can be undertaken for less cost than the complex laboratory procedures described above. However, the usefulness of onsite analysis is limited and the results will not be as precise as results from samples that are analyzed in a laboratory with a good microscope. Any short-cut approaches to paint analysis that do not follow scientific procedures are generally not worth the expense. In summary, if preservation and restoration treatments are being undertaken, a complete investigation is recommended; for a rehabilitation project, onsite analysis and color matching may provide an adequate palette.

Choosing a Treatment

Most projects involve re-painting. It is the historic appearance of the interior and the visual impression that will be created by new paint treatments that must be considered before choosing a particular course of action. The type and colors of paint obviously depend on the type of building and the use and interpretation of its interior spaces (see Figure 11). A consistent approach is best.

Preservation. When the treatment goal is preservation, a building's existing historic features and finishes are maintained and repaired, saving as much of the historic paint as possible. Sometimes, cleaning and washing of

Figure 11. A dark layer can be seen beneath the flaking lighter paint on these raised field panels. Depending on the project work goal and the period of the building's history being interpreted, any one of the paint layers could be duplicated in repainting. National Park Service files.

painted surfaces is all that is needed. Or a coating may be applied to protect important examples of history or art (see Figure 12). If repainting is required, the new paint is matched to existing paint colors using the safer, modern formulations. Re-creating earlier surface colors and treatments is not an objective.

Figure 12. When discovered, important examples of history such as this pencilled Civil War graffiti should be preserved. A conservator can easily clean the area, then apply a protective coating. The history this hand-written message possesses is well worth the sacrifice of surface uniformity, even if it interrupts a freshly painted surface. Photo: Kaye Simonson.

Rehabilitation. In a typical rehabilitation, more latitude exists in choosing both the kind of new paint as well as color because the goal is the efficient re-use of interior spaces. Decisions about new paint often weigh factors such as economy and durability—use of a high quality standard paint from a local or national company and application by a qualified contractor. Color choices may be based on paint research reports prepared for interior rooms of comparable date and style. More often, though, current color values and taste are taken into account. Again, the safer paint formulations are used (see Figure 13).

Figure 13. Part of a historic freight depot, this is not a high-style room and its painted surfaces are obviously in poor condition from long-term neglect. Interior spaces that are being converted for a new use in rehabilitation projects can benefit from being repainted in historic period colors rather than a neutral off-white. Photo: National Park Service files.

Interiors of institutional buildings, such as university buildings, city halls, libraries, and churches often contain rich decorative detailing (Figure 14). During rehabilitation, careful choices should be made to retain or restore selected portions of the decorative work as well as match some of the earlier colors to evoke the historic sense of time and place. At the least, it is important to use period-typical paint color and paint placement.

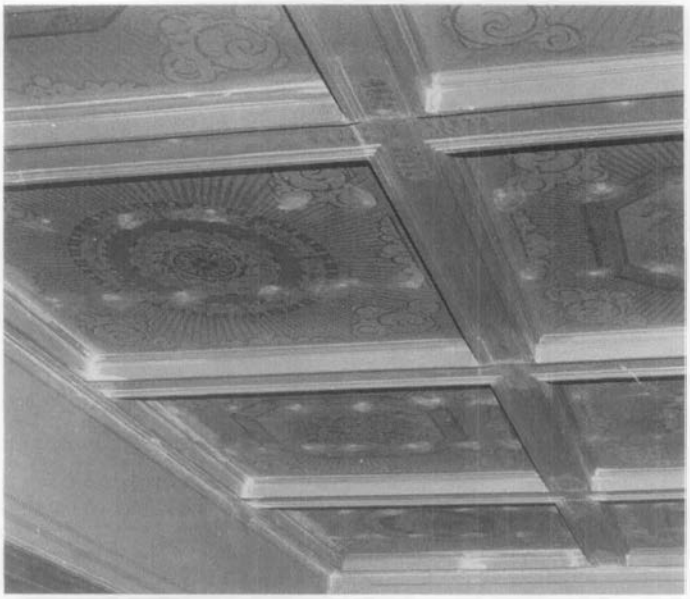

Figure 14. Holes left by insertion of toggle bolts used in the structural strengthening of this ceiling can be seen in the decorative plaster work. Without great expense, a skilled painter can now clean and touch up the damaged areas. This type of targeted repair work can benefit both public and private buildings. Photo: National Park Service files.

Restoration. In a restoration project, the goal is to depict the property as it appeared during its period of greatest significance. This may or may not be the time of its original construction. For example, if a building dated from 1900 but historians deemed its significance to be the 1920s, the appropriate paint color match would be the 1920s layer, not the original 1900 layer.

Based on historical research, onsite collection of paint samples, and laboratory analysis, surface colors and treatments can be re-created to reflect the property at a particular period of time. It should be noted that scholarly findings may yield a color scheme that is not suited to the taste of the contemporary owner, but is nonetheless historically accurate. In restoration, personal taste in color is not at issue; the evidence should be strictly followed.

In the restoration process, colors are custom-matched by professionals to give an accurate representation. If an artist or artisan can be found, the historically replicated paint may be applied using techniques appropriate to the period of the restoration (see Figure 15). Although custom paint manufacture is seldom undertaken, color and glazing are capable of being customized. In some projects, paint may be custom-made using linseed oil and, if building code variances allow it, white lead. For example, the repainting of a number of rooms at Mount Vernon demonstrates that it is possible to replicate historic paints and applications in all aspects; however, as noted, replication of historic paint formulation is not practical for the majority of projects.

Identifying Deteriorated and Damaged Paint Surfaces

Because painted surfaces are subject to abrasion, soiling, water damage, sunlight, and application of incompatible paints they generally need to be repainted or at least reglazed appropriately from time to time.

Abrasion. From the baseboards up to a level of about six feet off the floor, wood trim is constantly subjected to wear

Figure 15. The decorative work on the walls and ceilings of the Senate Chamber, Providence, Rhode Island, City Hall (1875) is a rich combination of paint and gilding on ornate plaster features. It was carefully restored in 1975. Photo: Kate Gilliat. © Providence Preservation Society.

from being touched and inadvertently kicked, and from having furniture pushed against it (see Figure 16). Chair rails were in fact intended to take the wear of having chairs pushed back against them instead of against the more delicate plaster wall or expensive wallpaper. Doors in particular, sometimes beautifully grained, receive extensive handling. Baseboards get scraped by various cleaning devices, and the lower rails of windows, as well as window seats, take abuse. The paint in all of these areas tends to become abraded. Two things are important to bear in mind about areas of abraded paint. Samples taken to determine original paint colors and layer sequences will not be accurate except at undamaged edges. Also, dirt and oil or grease need to be removed before applying any new paint because new paint will not adhere to dirty, greasy surfaces.

Dirt. Soiling is another problem of interior paint (see Figure 17). Fireplaces smoked; early coal-fired furnaces put out oily black soot; gas lights and candles left dark smudges. Sometimes the dirt got deposited on plaster walls or ceilings in a way that makes the pattern of the lath behind the plaster quite clear. Another source of dirt was polluted outside air,

Figure 16. This residential door shows how scuffed and abraded interior painted surfaces can become over time, particularly if the feature is in a high-use area. In the preservation project, the door was simply cleaned and repainted the same color. Photo: Robert M. Smith, Jr.

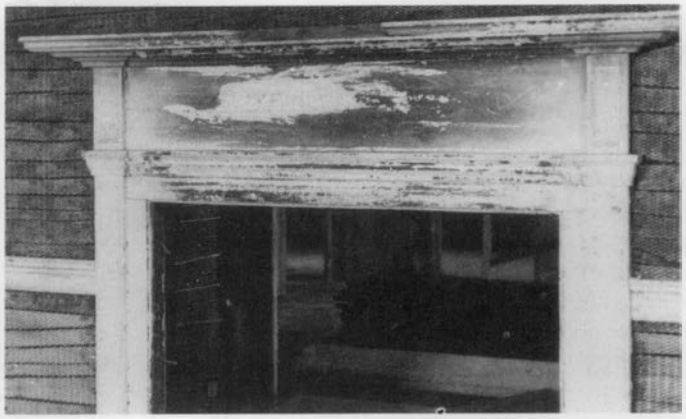

Figure 17. A Federal period fireplace needs careful preparation for repainting. While the soot must obviously be cleaned off, it is important to leave as much of the historic paint intact as possible. Photo: National Park Service files.

from factories or other industries, infiltrating houses and other nearby buildings. Until smokestacks became very high, most air pollution was caused by nearby sources.

In paint investigation, dirt on the surface of paint layers, as seen under the microscope, can be very useful in suggesting the length of time a given paint layer remained exposed, and in distinguishing a finish layer from a prime or undercoat layer. This kind of soiling can happen on any painted surface in a room, but may be slightly heavier in the recesses of moldings and on upward-facing horizontal edges. Using dirt as a sole measure, however, may be misleading if the surfaces have been cleaned. The fracture or bonding between paint layers is often used by professionals as a better means of indicating time differences between layers as well as indicating those layers that are part of a single decoration or painting.

Water. Water, the usual source of deterioration for many kinds of material, is also a prime cause of interior paint failure (see Figure 18). As a liquid, it can come from roof leaks, from faulty plumbing or steam heating systems, or from fire-suppression systems that have misfired. As a vapor, it may come from such human activities as breathing, showering, or cooking. Plaster walls sealed with unpigmented hide-glue are notably susceptible to water damage because it forms a water-soluble layer between the plaster and the paint. This can cause the paint to lose

Figure 18. The major crack along this cornice indicates that there has been long-term moisture problem in this room. Restoring the plaster work and repainting should be done only after the water problem is solved. Photo: Jack E. Boucher for HABS.

adhesion when even small amounts of moisture come into contact with the water-soluble sealer.

Age/Sunlight. Finally, in historic interiors, especially where there is heavy paint build-up, paint can weaken and fail due to chemical or mechanical reasons. For example, the older linseed oil is, the more brittle it is (see Figure 19). It also darkens when it is covered and gets no ultra-violet exposure. In rooms where there is more sunlight on one area than on others, the oil or even oil/alkyd paint will get discernibly darker in the less exposed areas in as short a time as six months. Painted over, the oil medium in older paints gets quite yellow-brown, thus changing the color of the paint. Prussian blue is one of the tinting pigments that is particularly vulnerable to fading.

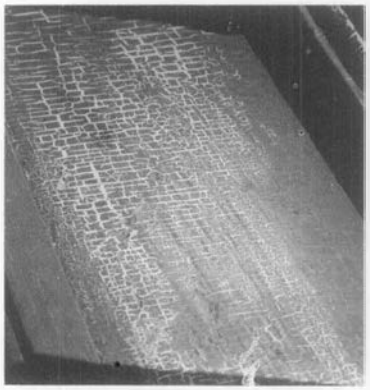

Figure 19. Sunlight typically causes paint deterioration on windows and window sills. This alligatored surface can make paint research difficult, as later paints may have "run in" under earlier ones. This surface should be stripped of all degraded paint prior to repainting. Photo: Richard Graber.

Incompatible Paints. Understanding some basic differences in the strength of various paints helps to explain certain paint problems. Paints that dry to a stronger film are incompatible with those which are weaker. Acrylic latex paints are stronger than oil/alkyd paints. Oil or oil/alkyd paint is stronger than water-based paint such as calcimine. When a stronger paint is applied over a weaker paint, it will tend to pull off any weaker paint which may have begun to lose its bond with its substrate. Thus, on many ceilings of older buildings where oil/alkyd paints have been applied over old calcimine, large strips of paint may be peeling.

Oil or varnish glazes over older paints become brittle with age, and can make removal of later paints rather easy. Sometimes it is possible to take advantage of this characteristic to reveal an earlier decorative treatment such as graining or marbleizing. Getting under the edge of the glaze with a scalpel blade can make the removal of later paints relatively simple, and relatively harmless to the fancier paint treatment. Sometimes, paints separate from each other simply due to poor surface preparation in the past or the hardening of the earlier surface paint. Use of alkaline paint strippers can cause paint to lose adhesion. When insufficiently neutralized, they leave salts in wood which cause oil or oil/alkyd paints to fail to adhere to the surface. If dirt or oily residues are not cleaned from the surfaces to be painted, new paint will not remain well adhered.

Surface Preparation

First, it is important to note that the earlier, linseed oil-based paints were penetrating type paints, forming a bond by absorption into the substrate. Often these thin oil coatings were slightly tinted with an iron-oxide pigment so coverage could be seen; the next coating applied would adhere to this first oil layer. Modern paints, on the other hand, are primarily bonding paints with little ability to penetrate a substrate. For this reason, surface preparation is extremely important for today's paints.

Before preparing the interior for repainting, all moisture penetration from failing roofs or gutters or from faulty plumbing or interior heating elements should be identified and corrected. A paint job is only as good as the preparation that goes before it. The surface to be painted, old or new, wood, plaster, masonry, or metal must be made sound and capable of taking the paint to be applied.

Scraping and Sanding. The first step in preparing interior wood and plaster surfaces which are coherent and sound is to remove any loose paint (see **Paint Hazards** sidebar). Careful hand scraping is always advisable for historic surfaces. Use of mechanical sanders usually leaves traces of the sander's edges, visible through the new paint film. Hand sanding is also necessary to feather the edges of the firmly adhering layers down to the bare areas so that shadow lines are avoided. Preparing previously painted interior masonry for new paint is basically similar to preparing plaster. Metals elements, such as radiators, valences, or firebacks are somewhat different (see Figure 20). In order to get a sound paint job on metal items, the work is primarily that of sanding to remove any rust before repainting. If the existing paint is well adhered over the entire metal surface, then it may be necessary only to sand lightly to roughen the existing paint, thus providing some "tooth" for the primer and new paint layer. On wood, garnet sanding papers work well. Aluminum oxide and silicon carbide sandpapers are effective on other surfaces as well as wood; emery papers should be used on metals.

Paint Removal. When should surfaces be completely stripped? Obviously, new paint is wasted when applied on

Figure 20. Historic metal components, such as this decorative cast-iron radiator, should be preserved during interior work. Following surface preparation, repainting with rust-inhibiting primer and finish coats is recommended. Photo: Jack E. Boucher for HABS.

old paint which is loose, that is, extensively damaged and deteriorated. Sometimes paint on an architectural feature needs to be removed if it obscures delicate detailing (see Figure 21). For the most part, however, if the surface is intact—and the presence of lead paint has been shown to present no health dangers to building occupants—the existing paint can be overpainted.

Well-adhered, intact paint layers (in at least one area of each room) should be covered with a sturdy protective tape, then painted over with the new paint and left in place to inform future research. The next owner may be interested in the building's past history, and methods of gleaning information from old paints grow more sophisticated all the time.

Heat/Scraping. Propane torches should never be used because they can damage historic wood features. Also, charred areas of wood will not hold the new paint. Use of a heat gun or heat plate may be relatively fast, but has both health and safety drawbacks. Heat oxidizes lead paint, causing poisonous fumes. And old walls may contain fine debris which acts like tinder and smolders when heated, bursting into flame hours after the stripping. (Heat methods are best limited to those interior elements that can be safely removed from the building for stripping and re-installed). Finally, scraping to remove heat-loosened paint may gouge and scar the wood or plaster substrate if not done carefully. Rotary wire brushes cut into wood and should be avoided altogether.

Chemical stripping. Removing paint from wood and plaster features can be done with either caustic strippers (potassium or sodium hydroxide) or solvent strippers (organic compounds such as methylene chloride, methanol, or toluol). Caustic strippers are fairly fast acting, but can weaken wood fibers if left on too long, causing them to raise and separate. They also leave alkaline residues which must be neutralized by an acidic wash (usually white vinegar which contains 4% acetic acid). It is difficult to make the neutralizing 100% effective and, when it is not, chemical reactions between the alkaline residues and the new paint may cause the paint to lose adhesion.

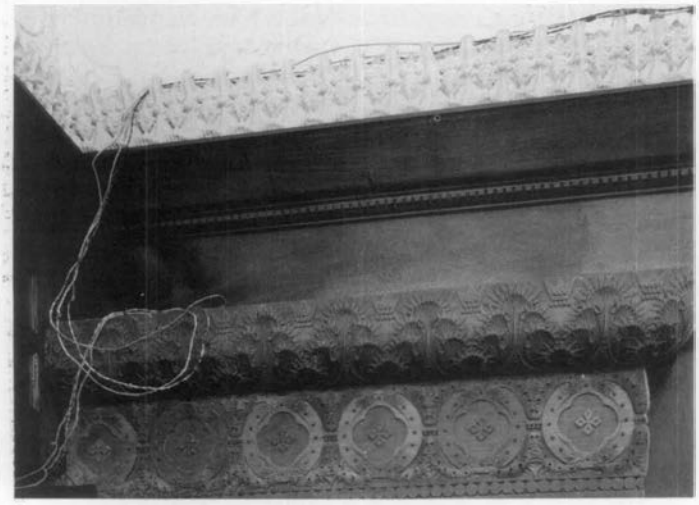

Figure 21. Stripping paint may sometimes be necessary to reveal the delicate detail of an elaborate piece of interior decoration such as this wood column capital. If total paint removal is deemed appropriate, all paint information should be carefully recorded. Photo: National Park Service files.

Methylene chloride and other organic compounds are as effective as caustic strippers, but their fumes may be both flammable and toxic. While they may leave wood and plaster surfaces free from harmful residue, the newly cleaned surface must be washed down with mineral spirits or denatured alcohol before priming in order to remove additives, such as wax, that were put in the stripper to retard its drying. All hazard warnings on the labels of chemical strippers should be heeded.

Detergent or vinegar and water. Water-based paints can usually be scrubbed off with hot water with a detergent added. Calcimine and whitewash are difficult to remove; because of the lime or whiting content (calcium carbonate), however, they can be broken down with acids. While strong acids may work quickly, they are very dangerous. Acetic acid in its most common form, vinegar, (4% acetic acid) is often used instead. In areas where any calcimine remains and is evident as chalk, the area can be coated with white shellac, which provides a stable surface for the new paint.

Air pressure. Air pressure of 200-500 psi is effective for flat surfaces if there is a weak substrate surface bond. A flat nozzle is inserted between the paint layer and substrate, and the air pressure simply lifts the loose paint up for easy removal. When used carefully, this method is fast and causes little damage.

Patching and Repair. Once the substrate and its surface are sound and clean, free from crumbling, loose material or dust, the next step is to undercut and fill any cracks in plaster surfaces. Plaster which has lost its key and is sagging should be re-attached or replaced. Friable plaster and punky wood need to be consolidated. Wood surfaces should be made as smooth as they were historically so that the paint film will cover a relatively uniform surface. Rotted wood must be removed and new wood carefully spliced in. Finally, gypsum plaster finishes can be painted as soon as the water has evaporated; a lime putty coat or traditional finish plaster can be primed almost immediately after drying as well, using alkali-resistant primers such as acrylic latex.

Priming. The importance of a primer can hardly be overstated. It is the intermediary material between the immediate substrate, which may be an old paint layer or may be bare wood, plaster, or metal (rarely stone, as around a fireplace opening), and the fresh paint itself. The primer must be capable of being absorbed to some extent by the material underneath while being compatible and cohesive with the paint to be applied on top. Most paint manufacturers will provide explicit instructions about which primers are most compatible with their paints. Those instructions should be followed.

The question of a primer for latex paint continues to be debated. Traditionalists recommend that the primer between an old oil paint and a new latex paint be an oil primer, but the improvements to latex paint in recent years have led many experts to the conclusion that today's top grade latex primers are best for latex finish paints. If a latex primer is selected, the label on the can should specify clearly that it is one which can bond to an older oil or oil/alkyd paint.

The most important general rule to remember is that softer or weaker paints should always go over harder and

stronger paints. For instance, because latex is stronger than oil, an oil or oil/alkyd paint can go over a well adhered latex, but the reverse will run the risk of failure. Using primer and finish paints by a single company is a good way to guarantee compatibility.

Choosing Modern Paint Types/Finish Coats

Most frequently today, the project goal is preservation or rehabilitation. Because of the impracticality of replicating historic paints, restoration is least often undertaken. Given current laws restricting the use of toxic ingredients, such as lead, solvents, and thinners, contemporary substitute paints using safer ingredients need to be used. Many paint companies make latex paints in colors that are close to historic colors as well as appropriate gloss levels, but contain no white lead and no hazardous volatile organic compounds.

Work on historic properties generally requires the services of a qualified paint contractor who has had at least five years of experience and who can list comparable jobs that a potential client can see. Then, too, getting a sample or a mock-up of any special work may be advisable before the job starts. While less experienced workers may be acceptable for preparing and priming, it is wise to have the most experienced painters on the finish work.

Oil-based/alkyd paints. Today's version of oil paint has a binder that usually contains some linseed oil (read the paint-can label), but also has one of the improved synthesized oils, frequently soy-based, known as alkyds. They dry hard, have flexibility, and discolor far less than linseed oil. They can also be manufactured to dry with a high sheen, and can take enough tinting pigment to create even the very deep Victorian period colors. However, they all contain volatile organic compounds, and thus are forbidden by law in some parts of the United States. They are also less simple and more dangerous to use, as cleaning up involves mineral spirits.

Acrylic water-borne paints (latex). Latex paints are synthetic resins carried in water. Before the paint dries or cross-links, it can be cleaned up with water. Early in the history of latex paints, some contained styrene/butadiene resins. Now nearly all top-grade latex paints contain acrylic resins, which are superior. Also, until fairly recently, the latex paints, while offering great strength, quick drying, and water clean-up, had some disadvantages for jobs which needed to have an historic look. Today, there are latex product lines with better gloss characteristics and more historic colors from which to choose. In addition, latex paints often have excellent color retention with very little fading. Still, it is always a good idea to buy a quart and "test paint" the color chosen for the job on site before making a total commitment.

Calcimine/whitewash. Modern water-based paints such as calcimine can be purchased today and have much the same appearance as the early ones. The same is true of modern whitewash, although today's whitewashes do not leave the same ropy surface texture as the early ones.

Glazes. Glazes were often part of historic paint treatments. Traditionally oil and turpentine, sometimes with a scant amount of pigment, today's glazes can be formulated with a water base and are relatively simple to apply by brush. An experienced decorative painter should be consulted before deciding whether to use a glaze coat rather than a high-gloss enamel. The glaze is capable of providing protection as well as a more accurate historic appearance that includes a greater depth to the finish.

Epoxies/Urethane. These were not available until relatively recently and thus are not appropriate for replication of traditional finishes.

Types of Modern Paint

Oil-based/alkyd: Non-volatile oils and resins, with thinners. (Alkyds are synthetic, gelatinous resins compounded from acids and alcohol.) Accept almost any type of coloring/hiding pigments. For use on interior wood and metal.

Acrylic water-borne paints (latex): Suspension of acrylic or polyvinyl resins in water, with other resins, plus hiding and coloring pigments and extenders. Dries by evaporation. Commercially produced acrylic or latex enamels are also available in a complete range of gloss levels which are produced with the addition of various acrylic polymers. Use on interior plaster especially.

Enamels: Modern alkyd paints are adjusted with the addition of synthetic varnishes to produce a complete range of gloss levels.

Metal finishes: Paints marketed for use on metals, can either be alkyd, latex, or epoxy based, or combinations. The primers used for metals are formulated with rust-inhibiting ingredients.

Special finishes: finishes such as urethane and epoxy-based paints, marketed for very high gloss surface treatments.

Applying Interior Paints

Because flat wall surfaces generally dominate an interior painting job, some flexibility in applicators is suggested below:

Brushes. Natural bristle brushes now have competition from synthetic brushes made of nylon or polyester which work well for applying either oil/alkyd or latex paints. Being harder than natural bristles, they tend to last longer. Since brushes come in a wide and very specific variety of types suited to different types of work, it is important to have a painter who will use the appropriate brush for the paint selected and for each portion of the job. One strong advantage of brushing paint on is that the paint is forced onto the surface and into all of its imperfections. Thus a good brushed-on paint job may last longer if the substrate is sound and the primer and finish coats are compatible and of top quality.

Rollers. There is no harm in using a roller, or even an airless sprayer, to apply a prime coat to a large flat area. Since all contemporary commercial paints dry with a smooth surface anyway, use of a roller or sprayer is acceptable for priming, and even for a first finish coat. However, to get paint well pushed into articulated surfaces and to add some texture to larger flat surfaces, a brush is best.

CAUTION: Before Painting/Know Paint Hazards and Take Action

Before undertaking any project involving paint removal, applicable State and Federal laws on lead paint abatement and disposal must be taken into account and carefully followed. State and Federal requirements may affect options available to owners on both paint removal and repainting. These laws, as well as any requirements prohibiting volatile organic compounds (VOCs), should be requested from the State Historic Preservation Officer in each State.

Below is a summary of the health hazards that owners, managers, and workers need to be aware of before removing paint and repainting:

Lead and other heavy metal compounds. In virtually all paints made before 1950, the white or "hiding" pigment was a lead compound, or more rarely, zinc oxide. Work to remove lead paint such as scraping and dry sanding releases the lead—a highly damaging heavy metal—in dust. Lead dust then enters the human system through pores of the skin and through the lungs. The use of heat for stripping also creates toxic lead fumes which can be inhaled.

To mitigate the hazards of lead paint ingestion, inhalation, or contact, it is extremely important to prevent the dust from circulating by masking room openings and removing all curtains, carpeting, and upholstered furniture. Drop cloths and masking containing lead dust should be carefully enclosed in tight plastic bags before removal. Workers and others in the room should wear High Efficiency Particulate Air (HEPA) filters for lead dust (fume filters if heat stripping is being used), change clothing just outside the room leaving the work clothes inside, and avoid any contact between bare skin (hands) and the paint being removed. Workers should also not eat, drink, or smoke where lead dust is present. Finally, anyone involved in lead paint removal should undergo periodic blood testing. After work, ordinary vacuuming is not enough to remove lead dust; special HEPA vacuums are essential. The surfaces of the room must also be given a final wash with a solution of trisodium phosphate and water, changing the washing solution often and rinsing well.

In addition to lead, early oil paints also had cobalt or other heavy metal compounds in them to accelerate drying. A small amount of mercury is also included in some latex paints to help prevent mildew and mold formation.

Volatile organic compounds (VOCs). Organic paint strippers, such as methylene chloride, and oil/alkyd paints have VOCs as their solvent base. Inhaling these fumes can lead to respiratory and other illnesses, and to cancer. Especially in closed spaces (but in the outdoor environment as well) these compounds pollute the air and can damage health.

Finally, decorative paint work in an historic interior—whether simple or high-style—is well worth preserving or restoring, and when such fancy work is being undertaken, traditional tools should always be used (see Figure 22). To simplify by using short-cut methods or rejecting painted decoration is indeed to dismiss or skew history as well as to lose the enjoyment of a true historic finish.

Figure 22. Traditional water-based paint and artists' brushes are being used to reproduce historic finishes within a restoration project. Photo: Courtesy, Alexis Elza.

Summary

First, it is most important to understand the range of approaches and treatments and to make choices with as much knowledge of the original and subsequent historic paints as possible, using the Secretary of the Interior's Standards for Historic Preservation Projects as a framework.

A paint's patina of age expresses decades or centuries of endurance in the face of changing climate and conditions. Documenting the sequence of interior paint layers and protecting this information for future investigation should be an integral part of any historic preservation project.

Except for the rare, scholarly restorations of historic interiors, most repainting jobs done today will employ modern paint formulations. Modern paints can recreate the appearance of historic colors, gloss and texture in varying degrees, but eliminate earlier toxic components such as white lead and volatile organic compounds.

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Organizations

National Paint and Coatings Association
1500 Rhode Island Ave. N.W.
Washington, D.C. 20005

Painting and Decorating Contractors of America
3913 Old Lee Highway, Suite 33B
Fairfax, VA 22030

Federation of Societies for Coatings Technology
492 Norristown Rd.
Blue Bell, PA 19422-2350

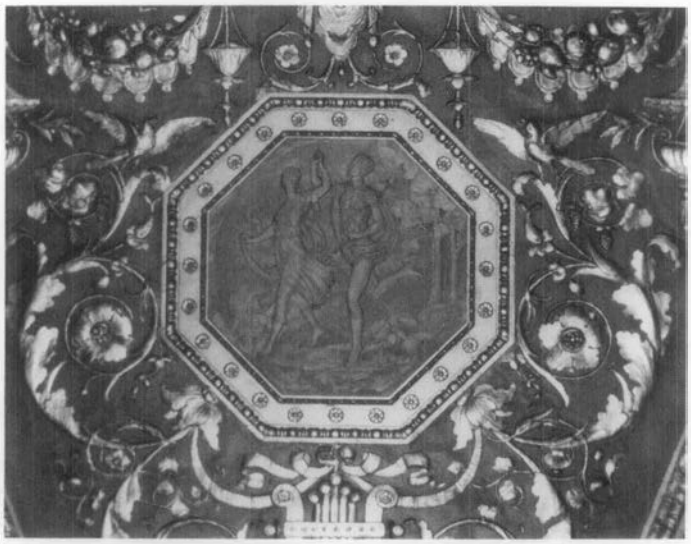

Photo: Matthew J. Mosca

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Kay D. Weeks served as project director and editor of the cooperative publication project.

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29 PRESERVATION BRIEFS

The Repair, Replacement, and Maintenance of Historic Slate Roofs

Jeffrey S. Levine

U.S. Department of the Interior
National Park Service
Cultural Resources
Heritage Preservation Services

Introduction

Slate is one of the most aesthetically pleasing and durable of all roofing materials. It is indicative at once of the awesome powers of nature which have formed it and the expertise and skill of the craftsman in hand-shaping and laying it on the roof. Installed properly, slate roofs require relatively little maintenance and will last 60 to 125 years or longer depending on the type of slate employed, roof configuration, and the geographical location of the property. Some slates have been known to last over 200 years. Found on virtually every class of structure, slate roofs are perhaps most often associated with institutional, ecclesiastical, and government buildings, where longevity is an especially important consideration in material choices. In the slate quarrying regions of the country, where supply is abundant, slate was often used on farm and agricultural buildings as well.

Because the pattern, detailing, and craftsmanship of slate roofs are important design elements of historic buildings, they should be repaired rather than replaced whenever possible. The purpose of this Preservation Brief is to assist property owners, architects, preservationists, and building managers in understanding the causes of slate roof failures and undertaking the repair and replacement of slate roofs. Details contributing to the character of historic slate roofs are described and guidance is offered on maintenance and the degree of intervention required at various levels of deterioration.

The relatively large percentage of historic buildings roofed with slate during the late nineteenth and early twentieth centuries means that many slate roofs, and the 60 to 125 year life span of the slates most commonly used, may be nearing the end of their serviceable lives at the end of the twentieth century. Too often, these roofs are being improperly repaired or replaced with alternative roofing materials, to the detriment of the historic integrity and appearance of the structure. Increased knowledge of the characteristics of slate and its detailing and installation on the roof can lead to more sensitive interventions in which original material is preserved and the building's historic character maintained. Every effort should be made to replace deteriorated slate roofs with new slate and to develop an effective maintenance and repair program for slate roofs that can be retained.

History of Slate Use in the United States

Although slate quarrying was not common in the United States until the latter half of the nineteenth century, slate roofing is known to have been used prior to the Revolution. Archeological excavations at Jamestown, Virginia,have unearthed roofing slate in strata dating from 1625-1650 and 1640-1670. Slate roofs were introduced in Boston as early as 1654 and Philadelphia in 1699. Seventeenth century building ordinances of New York and Boston recommended the use of slate or tile roofs to ensure fireproof construction.

In the early years of the Colonies, nearly all roofing slate was imported from North Wales. It was not until 1785 that the first commercial slate quarry was opened in the United States, by William Docher in Peach Bottom Township, Pennsylvania. Production was limited to that which could be consumed in local markets until the middle of the nineteenth century. Knowledge of the nation's abundant stone resources was given commercial impetus at this time by several forces, including a rapidly growing population that demanded housing, advances in quarrying technology, and extension of the railroad system to previously inaccessible markets. Two additional factors helped push the slate industry to maturity: the immigration of Welsh slate workers to the United States and the introduction of architectural pattern and style books (Figure 1). Slate production increased dramatically in the years following the Civil War as quarries were opened in Vermont, New York, Virginia, and Lehigh and Northampton Counties, Pennsylvania. By 1876, roofing slate imports had all but dried up and the United States became a net exporter of the commodity.

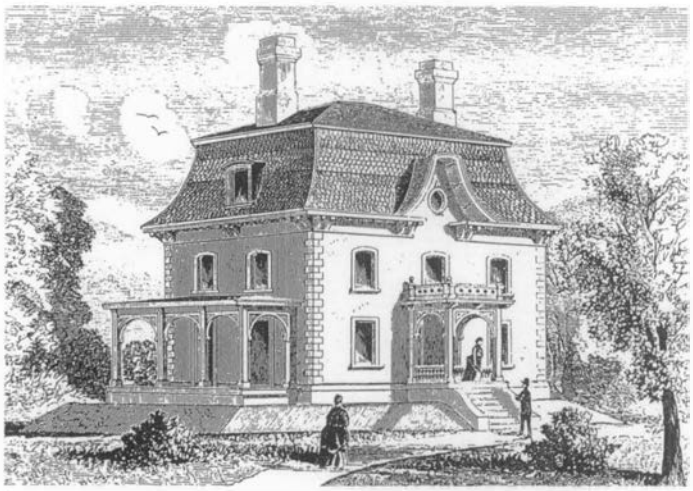


Figure 1. Architectural pattern books of the mid-nineteenth century awakened Americans to the availability and quality of slate for roofing purposes by incorporating slate roofs in their designs. Design XX, "A French Roof House," in A. J. Downing's Victorian Cottage Residences *is shown.*

The U.S. roofing slate industry reached its highest point in both quantity and value of output in the period from 1897 to 1914. In 1899, there were over 200 slate quarries operating in 13 states, Pennsylvania historically being the largest producer of all. The decline of the U.S. roofing slate industry began c.1915 and resulted from several factors, including a decline in skilled labor for both the fabrication and installation of slate and competition from substitute materials, such as asphalt shingles, which could be mass produced, transported and installed at a lower cost than slate. Only recently, with the increasing popularity of historic preservation and the recognition of the superiority of slate over other roofing materials, has slate usage begun to increase.

The Character and Detailing of Historic Slate Roofs

During some periods of architectural history, roof design has gone far beyond the merely functional and contributed much to the character of buildings. Roofs, by their compelling forms, have defined styles and, by their decorative patterns and colors, have imparted both dignity and beauty to buildings. The architectural styles prevalent during the latter half of the nineteenth and early twentieth centuries placed strong emphasis on prominent roof lines and greatly influenced the demand for slate. Slate, laid in multi-colored decorative patterns, was particularly well suited to the Mansard roofs of the Second Empire style, the steeply pitch roofs of the Gothic Revival and High Victorian Gothic styles, and the many prominent roof planes and turrets associated with the Queen Anne style. The Tudor style imitated the quaint appearance of some English slates which, because of their granular cleavage, are thick and irregular. These slates were often laid in a graduated pattern, with the largest slates at the eaves and the courses diminishing in size up the roof slope, or a textural pattern (Figure 2). Collegiate Gothic style buildings, found on many university campuses, were often roofed with slate laid in a graduated pattern.

The configuration, massing, and style of historic slate roofs are important design elements that should be preserved. In addition, several types of historic detailing were often employed to add visual interest to the roof, essentially elevating the roof to the level of an ornamental architectural element. When repairing or replacing a slate roof, original details affecting its visual character should be retained.

Before repairing or replacing an existing slate roof, it is important to document the existing conditions and detailing of the roof using written, visual, and physical evidence so that original features can be identified and preserved. Documentation should continue through the repair or replacement process as significant details, long obscured, are often rediscovered while carrying out these activities. Local histories, building records, old receipts and ledgers, historic photographs, sketches, and paintings, shadow lines and nail hole patterns on the roof deck, and bits of historic material left over from previous interventions (often found in eave cavities) are all useful sources of information which can be of help in piecing together the original appearance of the roof. Size, shape, color, texture, exposure, and coursing are among the most important characteristics of the original slates which should be documented and matched when repairing or replacing an historic slate roof.

Historically, three types of slate roofing—standard, textural, and graduated—were available according to the architectural effect desired. Standard grade slate roofs were most common. These are characterized by their uniform appearance, being composed of slates approximately 3/16″ (0.5cm) thick, of consistent length and width, and having a smooth cleavage surface. Thirty different standard sizes were available, ranging from 10″ (25cm) × 6″ to 24″ × 14″ (15cm × 61cm × 35cm). The slates were laid to break joints and typically had square ends and uniform color and exposure. Patterned and polychromatic roofs were created by laying standard slates of different colors and shapes on the roof in such a way as to create sunbursts, flowers, sawtooth and geometric designs, and even initials and dates (Figure 3). On utilitarian structures, such as barns and sheds, large gaps were sometimes left between each slate within a given course to reduce material and installation costs and provide added ventilation for the interior (Figure 4).

Figure 2. The quaint character of this Tudor style residence is derived, in part, from its textural roof.

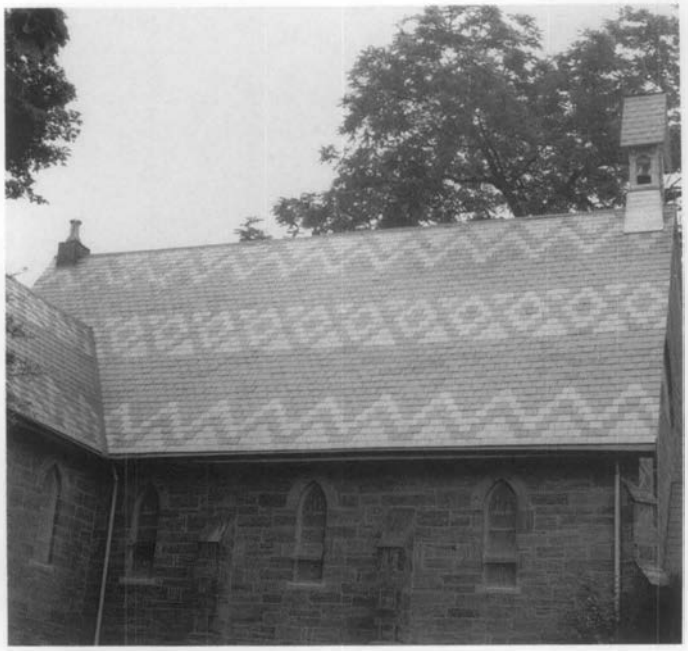


Figure 3. A sawtooth geometric design composed of red, green, and black slates makes this roof the most visually important feature of the building.

Textural slate roofs incorporate slates of different thicknesses, uneven tails, and a rougher texture than standard slates. Textural slate roofs are perhaps most often associated with Tudor style buildings where slates of different colors are used to enhance the effect.

Graduated slate roofs were frequently installed on large institutional and ecclesiastical structures (Figure 5). The slates were graduated according to thickness, size, and exposure, the thickest and largest slates being laid at the eaves and the thinnest and smallest at the ridge. Pleasing architectural effects were achieved by blending sizes and colors.

Detailing at the hips, ridges and valleys provided added opportunity to ornament a slate roof. Hips and ridges can be fashioned out of slate according to various traditional schemes whereby the slates are cut and overlapped to produce a watertight joint of the desired artistic effect. Traditional slate ridge details are the saddle ridge, strip saddle ridge, and comb ridge, and for hips, the saddle hip, mitered hip, Boston hip, and fantail hip (Figure 6). A more linear effect was achieved by covering the ridges and hips with flashing called "cresting" or "ridge roll" formed out of sheet metal, terra cotta, or even slate (Figure 7). Snow guards, snow boards, and various types of gutter and rake treatments also contributed to the character of historic slate roofs (Figure 8).

Two types of valleys were traditionally employed, the open valley and the closed valley. The open valley is lined with metal over which slates lap only at the sides. Closed valleys are covered with slate and have either a continuous metal lining or metal flashing built in with each course. Open valleys are easier to install and maintain, and are generally more watertight than closed valleys. Round valleys are a type of closed valley with a concave rather than V-shaped section (Figure 9). Given the broader sweep of the round valley, it was not uncommon for roofers to interweave asphalt saturated felts rather than copper sheet in the coursing in order to cut costs.

Figure 4. Widely spaced open slating was often used on utilitarian structures where ventilation was desirable. It provided an interesting texture and visual pattern to often plain structures.

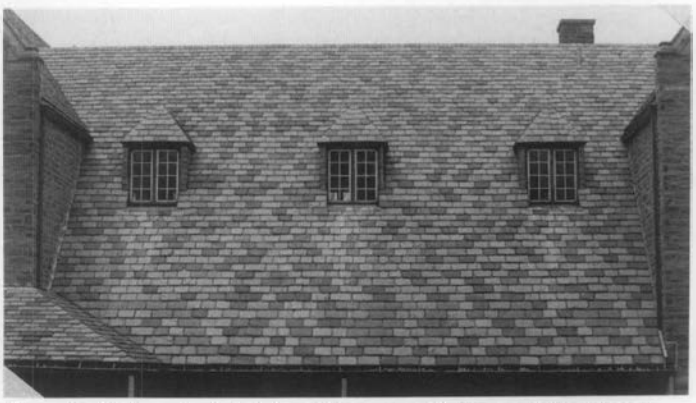


Figure 5. This graduated slate roof is composed of large, thick slates at the eave which are reduced in size and thickness as the slating progresses to the ridge.

Although principally associated with graduated and textural slate roofs, round valleys were infrequently employed due to the difficulty and expense of their installation.

Common types of sheathing used include wood boards, wood battens, and, for fireproof construction on institutional and government buildings, concrete or steel (Figure 10). Solid wood sheathing was typically constructed of tongue and groove, square edged, or shiplapped pine boards of 1″ (2.5 cm) or 1 1/4″ (3 cm) nominal thickness. Boards from 6″ (15 cm) to 8″ (20 cm) wide and tongue and groove boards were generally preferred as they were less likely to warp and curl.

Wood battens, or open wood sheathing, consisted of wood strips, measuring from 2″ (5 cm) to 3″ (7.5 cm) in width, nailed to the roof rafters. Spacing of the battens depended on the length of the slate and equaled the exposure. Slates were nailed to the batten that transected its mid-section. The upper end of the slate rested at least 1/2″ (1.25 cm) on the batten next above. Open wood sheathing was employed primarily on utilitarian, farm, and agricultural structures in the North and on residential buildings in the South where the insulating value of solid wood sheathing was not a strict requirement. To help keep out dust and wind driven rain on residential buildings, mortar was often placed along the top and bottom edge of each batten, a practice sometimes referred to as torching.

Various Roofing Details

Figure 6. Hips are formed at the external angle of two roofing slopes. In (a), the hips at both the roof and the dormer are covered with metal. Note also the open valley and the built-in gutter. In (b), the dormer hip slates have been laid in a fantail pattern to help shed water. Note also the metal ridge cap.

Figure 7. Ridge caps and cresting can be elaborate. Ridges are formed at the long horizontal juncture of two roofing slopes and capping protects this joint from moisture. In (a), a terra cotta capping with a decorative profile complements the finial over the various roof peaks. In (b), the mansard roof has a decorative iron cresting at the break between the lower and the upper roof slopes.

Figure 8. Eave details include snow guards, snow boards, gutter treatments. Snow guards are generally used in areas where ice and snow accumulate to avoid dangerous slides from the roof. In (a) the snow guards are set in two staggered rows above a pole gutter. In (b), the copper wire snow guards are set more frequently up a very steep gable.

Figure 9. Valleys are formed at the internal angle of two roofing slopes. Flashing is often placed under the slate to increase moisture protect at this vulnerable joint. Shown in (a) is a closed valley where the slates are held tight to the valley line. (b) illustrates of a round valley where the transition between the two slopes is a continuous curve. It requires careful workmanship and an experienced roofer.

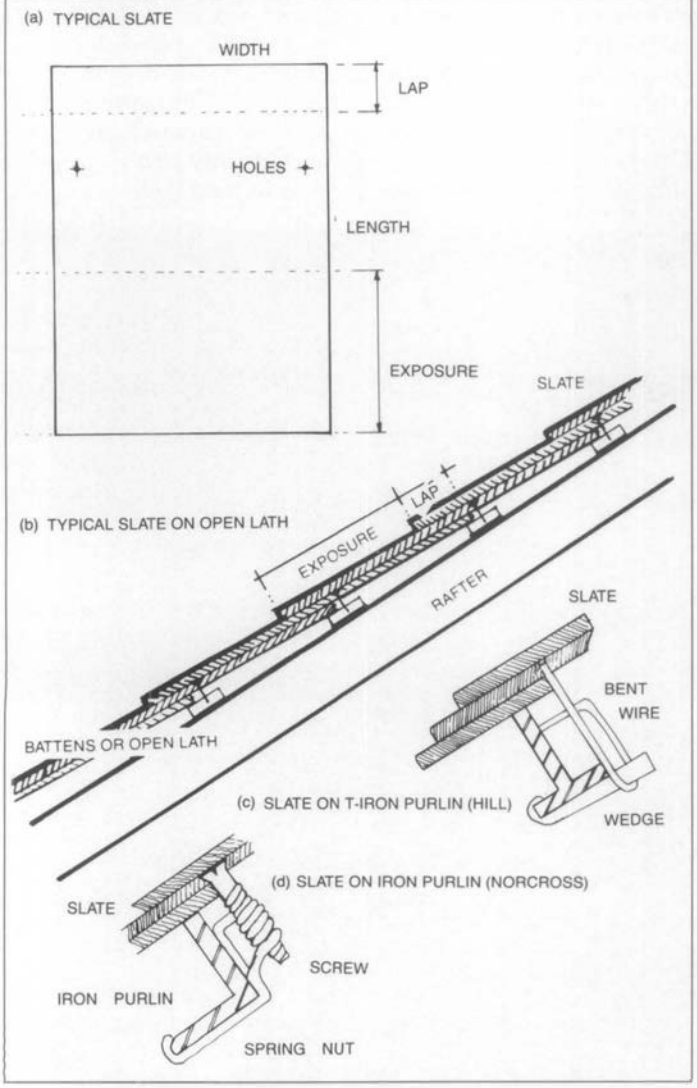


Figure 10. (a) shows a typical slate; exposure may be calculated by subtracting the headlap from the total length of the slate and dividing by two. Slates were typically nailed either to closed wooden decking or to open laths (b). In the late 19th century, with the concern for fireproof construction, special fasteners were developed to secure slate to steel purlins (c) 1881 patent to James G. Hill; (d) 1889 patent to Orlando W. Norcross).

Steel angles substituted for the wood battens in fireproof construction. The slates were secured using wire wrapped around the steel angle, where it was twisted-off tight. Alternately, any of a variety of special fasteners patented over the years could have been used to attach the slate to the steel angle (Figure 10). On roofs with concrete decks, slates were typically nailed to wood nailing strips embedded in the concrete.

Beginning in the late nineteenth century, asphalt saturated roofing felt was installed atop solid wood sheathing. The felt provided a temporary, watertight roof until the slate could be installed atop it. Felt also served to cushion the slates, exclude wind driven rain and dust, and ease slight unevenness between the sheathing boards.

Slate was typically laid in horizontal courses starting at the eaves with a standard headlap of 3″ (7.5 cm) (Figure 10). Headlap was generally reduced to 2″ (5 cm) on Mansard roofs and on particularly steep slopes with more than 20″ (50 cm) of rise per 12″ (30 cm) of run. Conversely, headlap was increased to 4″ (10 cm) or more on low pitched roofs with a rise of 8″ (20 cm) or less per 12″ (30 cm) of horizontal run. The minimum roof slope necessary for a slate roof was 4″ (10 cm) of rise per 12″ (30 cm) of run.

Where Does Slate Come From?

Slate is a fine grained, crystalline rock derived from sediments of clay and fine silt which were deposited on ancient sea bottoms. Superimposed materials gradually consolidated the sedimentary particles into bedded deposits of shale. Mountain building forces subsequently folded, crumpled, and compressed the shale. At the same time, intense heat and pressure changed the original clays into new minerals such as mica, chlorite, and quartz. By such mechanical and chemical processes bedded clays were transformed, or metamorphosed, into slate, whole

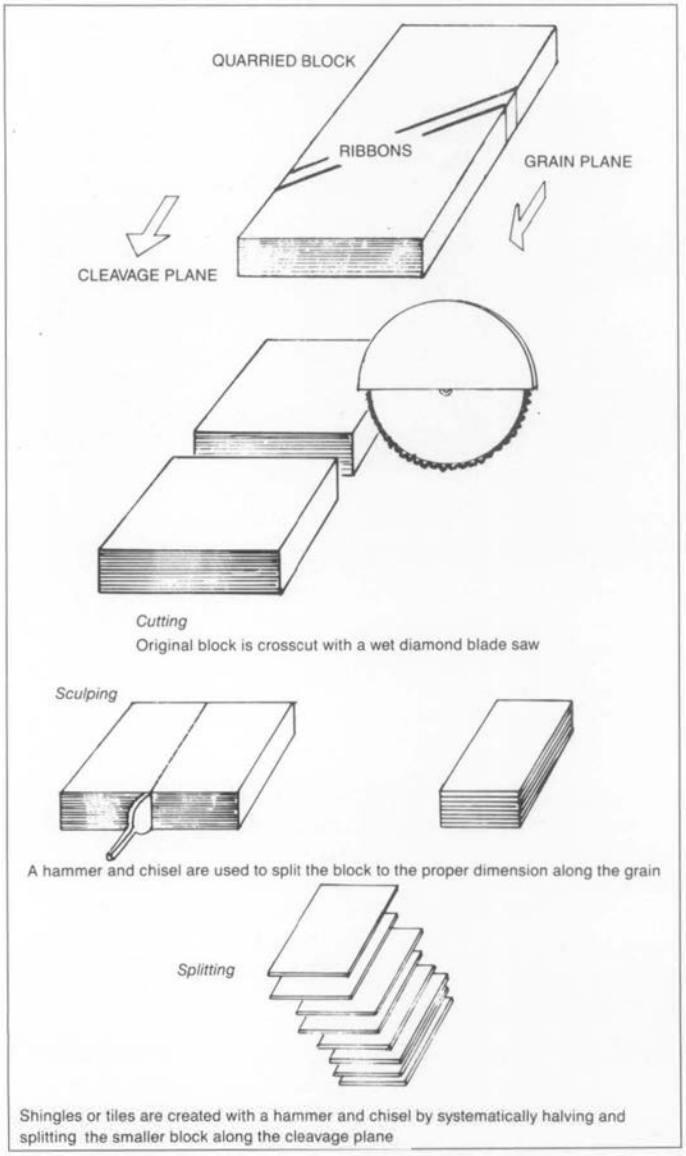


Figure 11. Slate roofing tiles or shingles are still manufactured using traditional methods brought to this country by Welsh immigrants in the nineteenth century. Shown above are the first 3 steps of cutting, sculping and splitting. Once the rough slate tile is made it is trimmed and punched for holes.

geologic ages being consumed in the process. Slates vary in composition, structure, and durability because the degree to which their determinant minerals have been altered is neither uniform nor consistent.

The adaptation of slate for roofing purposes is inextricably linked to its genesis. The manufacturing processes of nature have endowed slate with certain commercially amenable properties which have had a profound influence on the methods by which slate is quarried and fabricated (Figure 11), as well as its suitability for use as a roofing tile.

Slate roofing tiles are still manufactured by hand using traditional methods in a five step process: cutting, sculping, splitting, trimming, and hole punching. In the manufacturing process, large, irregular blocks taken from the quarry are first cut with a saw across the grain in sections slightly longer than the length of the finished roofing slate. The blocks are next sculped, or split along the grain of the slate, to widths slightly larger than the widths of finished slates. Sculping is generally accomplished with a mallet and a broad-faced chisel, although some types of slate must be cut along their grain. In the splitting area, the slightly oversized blocks are split along their cleavage planes to the desired shingle thickness. The splitter's tools consist of a wooden mallet and two splitting chisels used for prying the block into halves and repeating this process until the desired thinness is reached (Figure 12). The last two steps involve trimming the tile to the desired size and then punching two nail holes toward the top of the slate using a formula based on the size and exposure of the slate.

Minerals, the building blocks of rocks, through their characteristic crystalline structures define the physical properties of the rocks which they compose. Slate consists of minerals that are stable and resistant to weathering and is, therefore, generally of high strength, low porosity, and low absorption. The low porosity and low absorption of slate mitigate the deleterious action of frost on the stone and make it well adapted for roofing purposes. The two most important structural properties of slate are cleavage and grain.

The metamorphic processes of geologic change necessary to produce slate are dependent upon movements in the earth's crust and the heat and pressure generated thereby. For this reason, slate is found only in certain mountainous regions. The most economically important slate deposits in this country lie in the Mid-Atlantic and Northeastern states transversed by or bordering on the Appalachian Mountain chain. Variations in local chemistry and conditions under which the slate was formed have

Figure 12. In the splitting area, the slightly oversized blocks are split along their cleavage planes. The splitter's tools consist of a wooden mallet and splitting chisels. The process of halving the split portions is repeated until a tile or shingle of appropriate thinness is obtained.

Figure 13. Paper thin lamination can be seen flaking off of this weathered, 120 year piece of Pennsylvania Hard-Vein slate.

produced a wide range of colors and qualities and ultimately determine the character of the slate found in these areas.

Slate is available in a variety of colors. The most common are grey, blue-grey, black, various shades of green, deep purple, brick red, and mottled varieties. The presence of carbonaceous matter, derived from the decay of marine organisms on ancient sea floors, gives rise to the black colored slates. Compounds of iron generate the red, purple, and green colored slates.

Generally, the slates of Maine, Virginia, and the Peach Bottom district of York County, Pennsylvania are deep blue-black in color. Those of Virginia have a distinctive lustrous appearance as well due to their high mica content. The slates of Lehigh and Northampton Counties, Pennsylvania, are grayish-black in color. Green, red, purple, and mottled slates derive from the New York-Vermont district. The slate producing region of New York, which centers around Granville and Middle Granville, is particularly important because it contains one of the few commercial deposits of red slate in the world.

Slates are also classified as fading or unfading according to their color stability. Fading slates change to new shades or may streak within a short time after exposure to the atmosphere due to the presence of fine-grained disseminated pyrite. For example, the "weathering green" or "sea-green" slates of New York and Vermont are grayish green when freshly quarried. Upon exposure, from 20% to 60% of the slates typically weather to soft tones of orange-brown, buff, and gray while the others retain their original shade. Slates designated as unfading maintain their original colors for many years.

Color permanence generally provides no indication of the durability of slate. Rather, time has shown that the Vermont and New York slates will last about 125 years; Buckingham Virginia slates 175 years or more; and Pennsylvania Soft-Vein slates in excess of 60 years; Pennsylvania Hard-Vein slates and Peach Bottom slates, neither of which is still quarried, had life spans of roughly 100 and at least 200 years respectively. The life spans provided should be used only as a general guide in determining whether or not an existing slate roof is nearing the end of its serviceable life.

Ribbons are visible as bands on the cleavage face of slate and represent geologic periods during which greater amounts of carbonaceous matter, calcite, or coarse quartz particles were present in the sediment from which the slate was formed. Ribbons typically weather more and were most common in Pennsylvania slate quarries. As they were not as durable as clear slates, ribbon slate is no longer manufactured for roofing purposes. Mottled grey slates from Vermont are the closest match for Pennsylvania ribbon slate available today.

In recent years, slates from China, Africa, Spain and other countries have begun to be imported into the United States, primarily for distribution on the West Coast. The use of imported slates should probably be limited to new construction since their colors and textures often do not match those of U.S. slate.

Deterioration of Slate and Slate Roofs

The durability of a slate roof depends primarily on four factors: the physical and mineralogical properties of the slate; the way in which it is fabricated; installation techniques employed; and, regular and timely maintenance. The first three of these factors are examined below. The maintenance and repair of slate roofs are discussed in later sections of this Brief.

The natural weathering of roofing slate manifests itself as a slow process of chipping and scaling along the cleavage planes (Figure 13). Paper thin laminations flake off the surface of the slate and the slate becomes soft and spongy as the inner layers begin to come apart, or delaminate. The nature of the sound given off by a slate when tapped with one's knuckles or slating hammer is a fair indication of its condition. High-grade slate, when poised upon the fingertips and struck, will emit a clear, solid sound. Severely weathered slates are much less sonorous, and give off a dull thud when tapped.

The weathering of slate is chiefly due to mineral impurities (primarily calcite and iron sulfides) in the slate which, in concert with alternating wet/dry and hot/cold cycles, react to form gypsum (Figure 14). Because gypsum

Figure 14. The white blotches on these Pennsylvania Soft-Vein slates indicate areas where gypsum is leaching out onto the surface of the slates.

Figure 15. View of the underside of slates laid on open sheathing shows that delamination and flaking is just as bad or worse on the underside of slates as on the exposed surface. This is why most slates cannot be flipped over for reuse.

molecules take up about twice as much volume as calcite molecules, internal stresses result from the reaction, causing the slate to delaminate. This type of deterioration is as prominent on the underside of the roof as on the exposed surface due to the leaching and subsequent concentration of gypsum in this area (Figure 15). Consequently, deteriorated roofing slates typically cannot be flipped over and re-used.

The chemical and physical changes which accompany slate weathering cause an increase in absorption and a decrease in both strength and toughness. The tendency of old, weathered slates to absorb and hold moisture can lead to rot in underlying areas of wood sheathing. Such rot can go undetected for long periods of time since, often, there is no accompanying leak. Due to their loss of strength, weathered slates are more prone to breakage, loss of corners, and cracking.

Slates with low calcite content tend to weather slowly. Dense slates, with low porosity, likewise decay slower than slates with equal calcite, but with a greater porosity. The pitch of a roof can also affect its longevity. The steeper the pitch, the longer the slate can be expected to last as water will run off faster and will be less likely to be drawn under the slates by capillary action or driven under by wind forces. Spires and the steep slopes of Mansard roofs often retain their original slate long after other portions of the roof have been replaced. Areas of a roof subject to concentrated water flows and ice damming, such as along eaves and valleys, also tend to deteriorate more rapidly than other areas of the roof.

Mechanical agents, such as thermal expansion and contraction and the action of frost, are subordinate in the weathering of slate, coming into play only after the slate has been materially altered from its original state by the chemical transformation of calcite to gypsum. The more rapid deterioration of slates found on roof slopes with the most severe exposure to the sun, wind, and rain (typically, but not always, a southern exposure) may be attributable to the combined result of the deleterious effects of impurities in the slate and mechanical agents. Atmospheric acids produce only negligible deterioration in roofing slate.

It is difficult to assess the procedures by which a piece of slate has been fabricated without visiting the quarry and observing the process first hand. The location and size of nail holes, grain orientation, the condition of corners, and the number of broken pieces are all things which may be observed in a shipment of slate to judge the quality of its fabrication. Nail holes should be clean and with a shallow countersink on the face of the slate for the nail head; grain oriented along the length of the slate; and, corners left whole. An allowance for 10% breakage in shipment is typically provided for by the quarry.

Installation problems often involve the improper nailing and lapping of slates. The nailing of slates differs from that of other roofing materials. Slate nails should not be driven tight as is the case with asphalt and wood shingles. Rather, they should be set such that the slate is permitted to hang freely on the nail shank. Nails driven too far will crack the slate and those left projecting will puncture the overlying slate (Figure 16). Nail heads left exposed accelerate roof deterioration by providing a point for water entry. Non-ferrous slater's nails, such as solid copper or stainless steel, should always be used since plain steel and galvanized nails will usually rust out long before the slate itself begins to deteriorate. The rusting of nineteenth century cut nails is a common cause of slate loss on historic roofs.

When joints are improperly broken (i.e., when slates lap the joints in the course below by less than 3″ [7.5 cm]), it is possible for water to pass between the joints, through the nail holes and ultimately to the underlying felt, where it will cause deterioration and leaks to develop. Insufficient headlap can also result in leaks as water entering the joints between slates may have a greater tendency to be wind blown beyond the heads of the slates in the course below.

Occasionally, individual slates are damaged. This may be caused by falling tree limbs, ice dams in gutters, valleys, and chimney crickets, the weight of a workman walking on the roof, or a naturally occurring fault in the slate unit. Whatever the form of damage, if it is caught soon enough, the roof can usually be repaired or selectively replaced and deterioration mitigated.

The ability to lay slate properly so as to produce a water-tight and aesthetically pleasing roof requires training, much practice, and the right tools (Figure 17). The

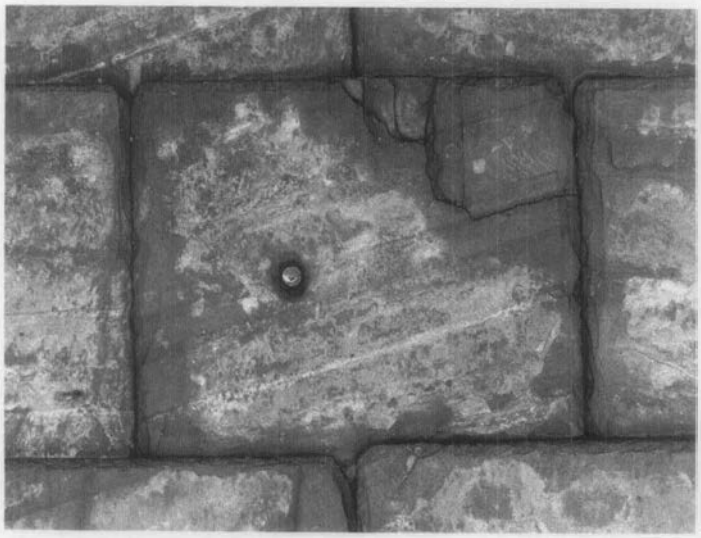


Figure 16. Detail view of a slate which has been punctured by the head of a nail used to secure the slate in the course below. Likely, the nail was not hammered in far enough when originally installed.

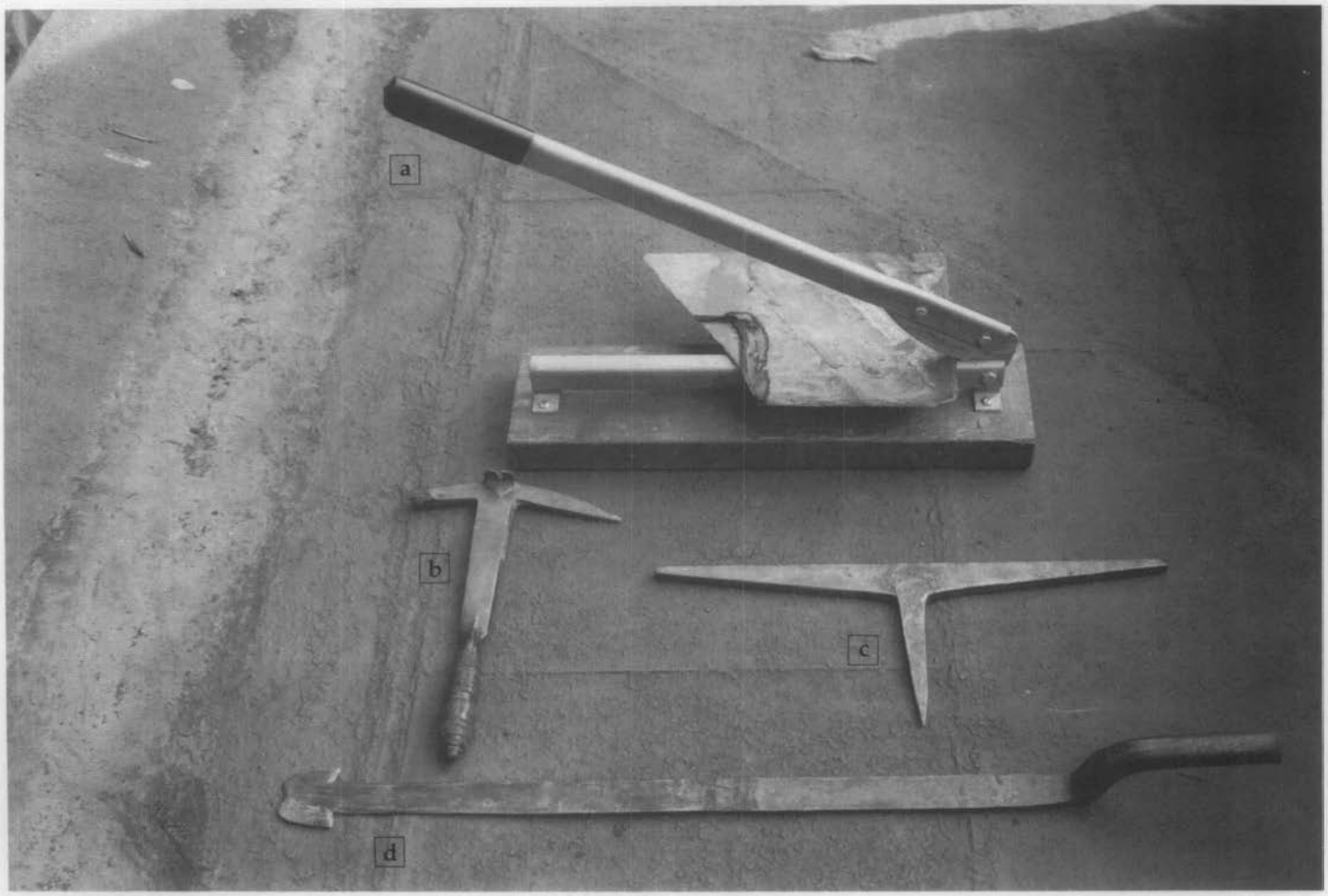


Figure 17. Slater's Tools. The cutter (a) is used to trim slate edges; the slate hammer (b) is used for hammering nails, trimming, cutting and punching holes in slates, and pulling roofing nails; the steak (c) is a T-shaped piece of iron upon which the slater places the edge of a slate to be trimmed; and the ripper (d) is slid under the slates to pull out the nails.

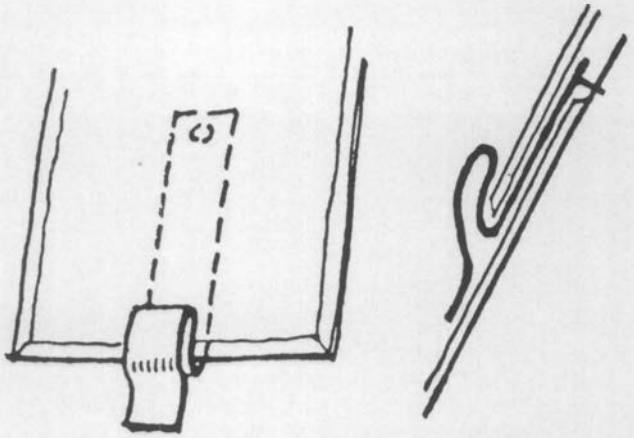
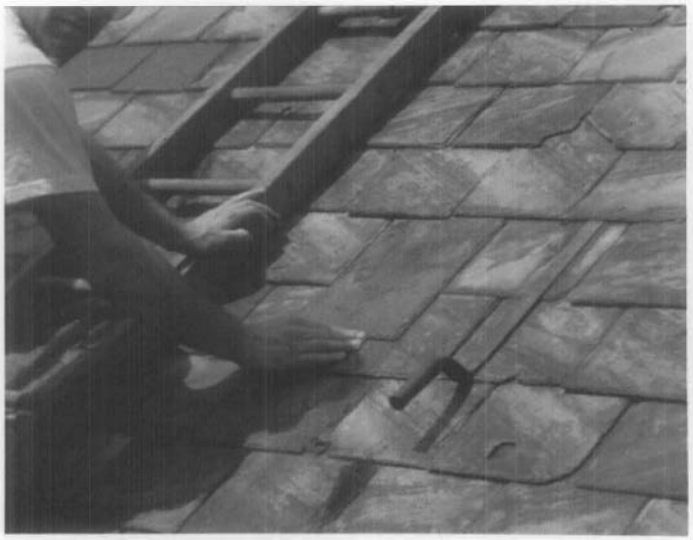


Figure 18. A method of securing replacement slates is shown. The copper strip is nailed to the roof sheathing just above the head of the slate in the course below. The replacement slate is then inserted and the copper tab folded over its tail. This type of repair is not recommended for northern climates where snow and ice can cause the copper tab to fold over, allowing the replacement slate to slide out of position as occurred here on the left.

Repair Sequence

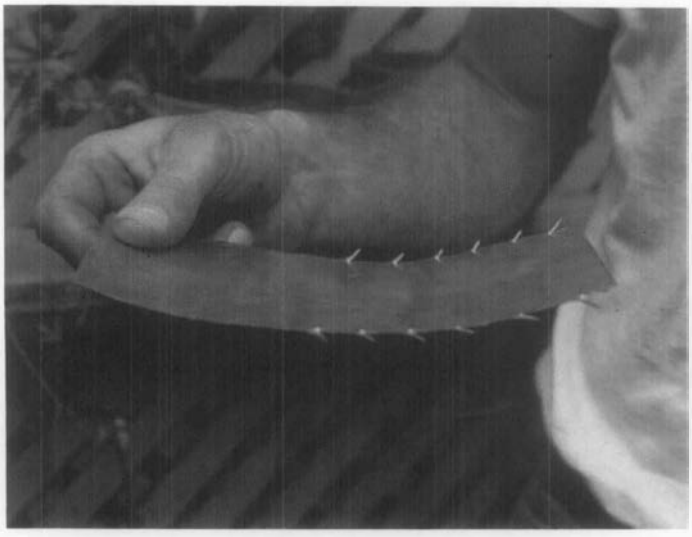
(a) A ripper is used to remove the nails from the deteriorated slate.



(b) A replacement slate is slid into place.

(c) A new slate is secured in place with a copper nail.

(d) A copper bib is formed to protect the newly created nail hole.



(e) The bib is cut along its edges and bent into a concave shape to create a friction fit.

(f) The slate hammer is used to push the bib in place over the nail head.

Figure 19. Above is a repair sequence for replacing a damaged slate.

The installation and repair of slate roofs should be entrusted only to experienced slaters.

Repairing Slate Roofs

Broken, cracked, and missing slates should be repaired promptly by an experienced slater in order to prevent water damage to interior finishes, accelerated deterioration of the roof and roof sheathing, and possible structural degradation to framing members (Figures 18 and 19).

The damaged slate is first removed by cutting or pulling out its nails with a ripper. If steel cut nails, rather than copper nails, were used in laying the roof, adjacent slates may be inadvertently damaged or displaced in the ripping process, and these, too, will have to be repaired. If the slate does not slide out by itself, the pointed end of the slate hammer can be punched into the slate and the slate dragged out. A new slate, or salvaged slate, which should match the size, shape, texture, and weathered color of the old slate, is then slid into place and held in position by one nail inserted through the vertical joint between the slates in the course above and approximately one inch below the tail of the slate two courses above. To prevent water penetration through the newly created nail hole, a piece of copper with a friction fit, measuring roughly 3″ (7.5 cm) in width and 8″ (20 cm) in length, is slid lengthwise under the joint between the two slates located directly above the new slate and over the nail. Alternate methods for securing the replacement slate include the use of metal hooks, clips, and straps that are bent over the tail end of the slate. The application of roofing mastic or sealants to damaged slates should *not* be considered a viable repair alternative because these materials, though effective at first, will eventually harden and crack, thereby allowing water to enter (Figure 20). Mastic also makes future repairs more difficult to execute, is unsightly, and, when applied to metal flashings, accelerates their corrosion.

When two or more broken slates lie adjacent to each other in the same course, or when replacing leaky valley flashings, it is best to form pyramids (i.e., to remove a diminishing number of slates from higher courses) to keep the number of bibs required to a minimum. When re-installing the slates, only the top slate in each pyramid will need a bib. Slates along the sides of the pyramid will receive two nails, one above the other, along the upper part of its exposed edge.

When many slates must be removed to effect a repair, the sheathing should be checked for rotted areas and projecting nails. Plywood is generally not a good replacement material for deteriorated wood sheathing due to the relative difficulty of driving a nail through it (the bounce produced can loosen adjacent slates). Instead, new wood boards of similar width and thickness to those being replaced should be used. Because the nominal thickness of today's dimension lumber is slightly thinner than that produced in the past, it may be necessary to shim the new wood boards so that they lie flush with the top surface of adjacent existing sheathing boards. Pressure treated lumber is not recommended due to its tendency to shrink. This can cause the slates to crack and become displaced.

To permit proper re-laying of the slate, the new roof sheathing must be of smooth and solid construction. At least two nails should be placed through the new boards at every rafter and joints between the ends of the boards should occur over rafters. Insufficient nailing will cause the boards to be springy, making nailing of the slates difficult and causing adjacent slates to loosen in the process. Unevenness in the sheathing will show in the finished roof surface and may cause premature cracking of the slate. Roof sheathing in valleys and along hips, ridges, and eaves may be covered with waterproof membrane underlayment rather than roofing felt for added protection against leakage.

In emergency situations, such as when severe hurricanes or tornadoes blow numerous slates off the roof, a temporary roof covering should be installed immediately after the storm to prevent further water damage to the interior of the building and to permit the drying out process to begin. Heavy gauge plastic and vinyl tarpaulins are often used for this purpose, though they are difficult to secure in place and can be blown off in high winds. Roll roofing, carefully stitched in to areas of the remaining roof, is a somewhat more functional solution that will allow sufficient time to document the existing roof conditions, plan repairs, and order materials (Figure 21).

Slate roof repair is viable for localized problems and damaged roofs with reasonably long serviceable lives remaining. If 20% or more of the slates on a roof or roof slope are broken, cracked, missing, or sliding out of position, it is usually less expensive to replace the roof than to execute individual repairs. This is especially true of older roofs nearing the end of their serviceable lives

Figure 20. This roof has been poorly repaired numerous times in the past. The installation of mastic to seal out moisture has only exacerbated the problem. A timely repair and good maintenance could have extended the life of this roof.

Figure 21. As a result of hurricanes and other disasters, it may be necessary to temporarily stabilize a roof until materials can be obtained and a qualified roofing contractor hired. Heavy roofing felt was stitched into this slate roof to stop moisture penetration until matching slate was obtained for repair. Significant slate roofs should not be stripped off and replaced with asphalt shingles. Photograph courtesy of the National Park Service.

because even the most experienced slater will likely damage additional slates while attempting repairs. Depending on the age of the slate, its expected serviceable life, and the cause(s) of deterioration, it may or may not be cost effective to salvage slates. Where deteriorated nails or flashings are the cause of the roof failure, salvage of at least some slates should be possible for use in repairs. When salvaging slates, each must be sounded to discover cracks and faults and the degree to which it has weathered. It is usually wise to salvage slates when only a portion of the roof is to be replaced. In this way, the salvaged slates may be used for future repairs to the remaining sections of the roof.

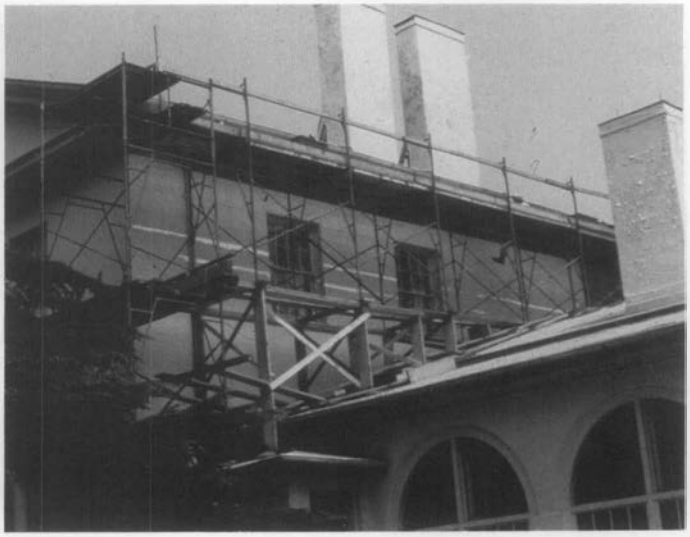
The Replacement of Deteriorated Roofs

Historic slate roofs should be repaired rather than replaced whenever possible. Before replacing a slate roof, check for isolated damage, corroded and worn flashings, leaky gutters, poor ventilation in the attic, and other possible sources of moisture. All too often slate roofs are mistakenly replaced when, in fact, they could have been effectively repaired. Deciding whether an historic slate roof should be repaired or replaced can be difficult and each roof must be judged separately (see guidance in shaded box on page 16).

If repair is not possible and a new slate roof must be installed, it is important to remember that more than just the replacement of the slate is involved (Figure 22). The old slate should be removed to prevent overloading of the roof timbers. Stripping should be done in sections, with felt installed, to avoid exposing the entire sub-roof to the weather. In the process, rotted wood sheathing should be replaced and the roof timbers checked for signs of stress, including deflection, cracking, and twisting. If such conditions are found, a structural engineer experienced in working with older buildings should be consulted. Other repairs, such as chimney repointing, which may require access to the roof should be completed before the new roof is put on.

Drawings and specifications for a new slate roof should be prepared by a restoration architect, especially if the project is going to be competitively bid or if the roof is particularly complex. Standard specifications, like those published in 1926 by the National Slate Association may be used as a basis for developing specifications appropriate for a particular project. The specifications and drawings should contain all the information necessary to replicate the original appearance of the roof as closely as possible. Certain changes may have to be accepted, however, since several types of slate once prominent in this country, such as ribbon slate, are no longer quarried. It is wise to

(a) Historic documentation was necessary to determine the historic configuration.

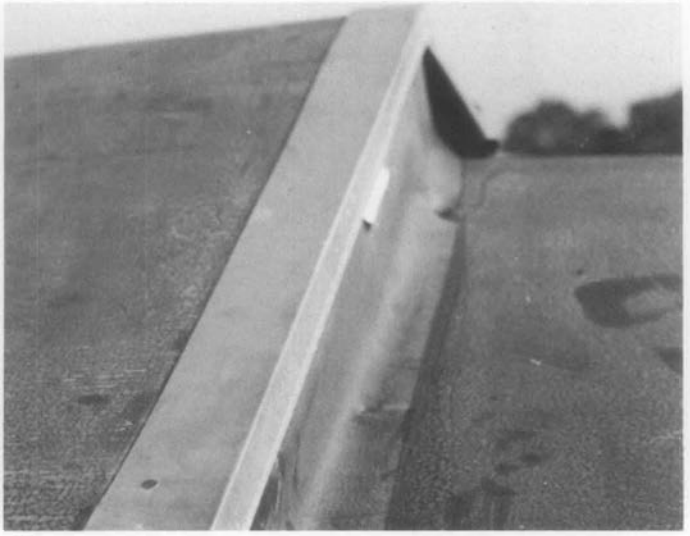


(b) Scaffolding was installed early to document existing conditions to determine extent of work.

(c) Slate was removed in sections to avoid stress on timber framing.

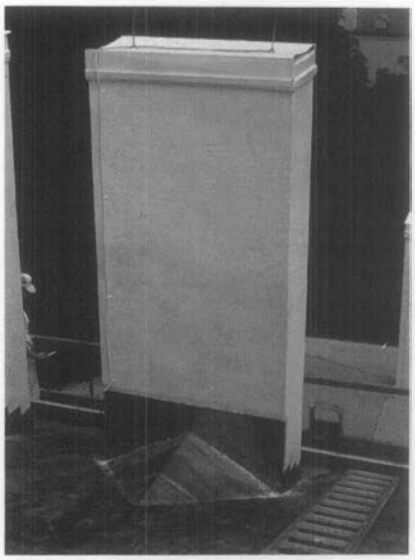
(d) Deteriorated sheathing was replaced and rafter tails were reinforced.

(e) Roofing felt was installed over decking; a rubberized membrane was used selectively at the eaves and under some flashing.

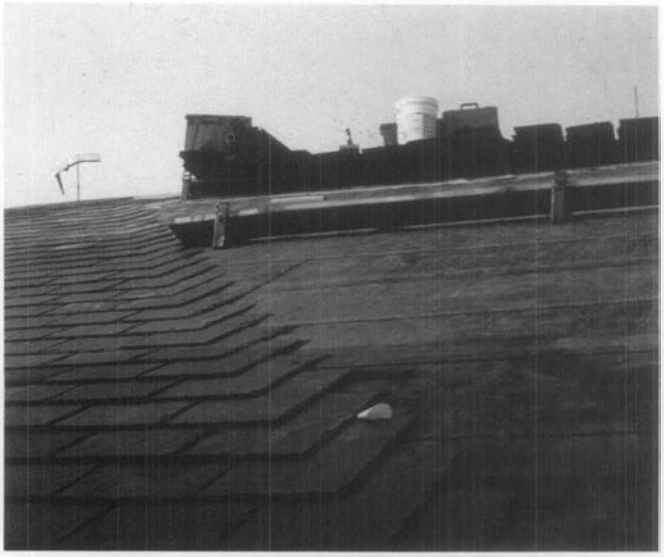


(f) Lead coated copper flashing was installed throughout. Seen is the offset between the portico roof and the main roof in progress.

Figure 22. Installing a new roof involves more than just slate. Above is a sequence of views of the roof replacement at Arlington House. Photographs courtesy of the National Park Service. *(Sequence continued on page 14.)*



(g) Masonry chimneys were repaired and metal crickets were fabricated at the chimneys.



(h) This installation pattern allows the slates to be laid in courses leaving a temporary path of travel to avoid stepping on installed slates.

(i) Although the gutters and snow boards were the last elements installed, their support brackets were installed as the slates were laid.

anticipate the replacement of older roofs so that proper planning can be undertaken and financial resources set aside, thereby, reducing the likelihood of rash last minute decisions.

Roofing slate is sold by the square in the United States. One square is enough to cover 100 square feet (13.3 square meters) of plain roof surface when laid with a standard headlap of 3" (7.5cm). When ordering slate, considerable lead time should be allowed as delivery may take anywhere from 4 to 12 weeks and even as long as 1 year for special orders. Orders for random widths of a particular slate can generally be filled more quickly than orders for fixed widths. Once on site, slates should be stored on edge, under cover on pallets.

A roof and its associated flashings, gutters, and downspouts function as a system to shed water. Material choices should be made with this in mind. For example, use a single type of metal for all flashings and the rainwater conductor system to avoid galvanic action. Choose materials with life spans comparable to that of the slate, such as non-ferrous nails. Use heavier gauge flashings or sacrificial flashings in areas that are difficult to access or subject to concentrated water flows.

Flashings are the weakest point in any roof. Given the permanence of slate, it is poor economy to use anything but the most durable of metals and the best workmanship for installing flashings. Copper is one of the best flashing materials, and along with terne, is most often associated with historic slate roofs. Copper is extremely durable, easily worked and soldered, and requires little maintenance. Sixteen-ounce copper sheet is the minimum weight recommended for flashings. Lighter weights will not endure the erosive action of dust and grit carried over the roof by rain water. Heavier weight, 20 oz. (565 grams) or 24 oz. (680 grams), copper should be used in gutters, valleys, and areas with limited accessibility. Lead coated copper has properties similar to copper and is even more durable due to its additional lead coating. Lead coated copper is often used in restoration work.

Terne is a less desirable flashing material since it must be painted periodically. Terne coated stainless steel (TCS) is a modern-day substitute for terne. Although more difficult to work than terne, TCS will not corrode if left unpainted; a great advantage, especially in areas that are difficult to access.

Once a metal is chosen, it is important to use it throughout for all flashings, gutters, downspouts, and metal roofs. Mixing of dissimilar metals can lead to rapid corrosion of the more electronegative metal by galvanic action. Where flashings turn up a vertical surface, they should be covered with a cap flashing. Slates which overlap metal flashings should be nailed in such a manner as to avoid puncturing the metal. This may be accomplished by punching a second hole about 2" (5cm) above the existing hole on the side of the slate not overlapping the metal flashing. It is important that holes be punched from the back side of the slate. In this way, a shallow countersink is created on the face of the slate in which the head of the nail may sit.

◄ *Continuation of the roof repair sequence of Arlington House from page 13.*

Figure 23. Slate roofs should not be walked on if at all possible. For large projects, lifts can be used to inspect roofs periodically to assess maintenance needs. Photograph courtesy of the National Park Service.

The use of artificial, mineral fiber slate is not recommended for restoration work since its rigid appearance is that of a man-made material and not one of nature. Artificial slates may also have a tendency to fade over time. And, although artificial slate costs less than natural slate, the total initial cost of an artificial slate roof is only marginally less than a natural slate roof. This is because all the other costs associated with replacing a slate roof, such as the cost of labor, flashings, and tearing-off the old roof, are equal in both cases. Over the long term, natural slate tends to be a better investment because several artificial slate roofs will have to be installed during the life span of one natural slate roof.

Clear roof expanses can be covered by an experienced slater and one helper at the rate of about two to three squares per day. More complex roofs and the presence of chimneys, dormers, and valleys can bring this rate down to below one square per day. One square per day is a good average rate to use in figuring how long a job will take to complete. This takes into account the installation of flashings and gutters and the set-up and break-down of scaffolding. Tear-off of the existing roof will require additional time.

Maintenance

Given the relatively high initial cost of installing a new slate roof, it pays to inspect its overall condition annually and after severe storms. For safety reasons, it is recommended that building owners and maintenance personnel carry out roof surveys from the ground using binoculars or from a cherry picker (Figure 23). Cracked, broken, misaligned, and missing slates and the degree to which delamination has occurred should be noted, along with failed flashings (pin holes, open seams, loose and misaligned elements, etc.) and broken or clogged downspouts. A roof plan or sketch and a camera can aid in recording problems and discussing them with contractors. In the attic, wood rafters and sheathing should be checked for water stains and rot. Critical areas are typically near the roof plate and at the intersection of roof planes, such as at valleys and hips. Regular maintenance should include cleaning gutters at least twice during the fall and once in early spring, and replacing damaged slates promptly. Every five to seven years inspections should be conducted by professionals experienced in working with slate and steep slopes. Good record keeping, in the form of a log book and the systematic filing of all bills and samples, can help in piecing together a roof's repair history and is an important part of maintenance.

As part of regular maintenance, an attempt should be made to keep foot traffic off the roof. If maintenance personnel, chimney sweeps, painters, or others must walk on the roof, it is recommended that ladders be hooked over the ridge and that the workmen walk on the ladders to better distribute their weight. If slates are to be walked on, it is best to wear soft soled shoes and to step on the lower-middle of the exposed portion of the slate unit.

Conclusion

Slate roofs are a critical design feature of many historic buildings that cannot be duplicated using substitute materials (Figure 24). Slate roofs can, and should be, maintained and repaired to effectively extend their serviceable lives. When replacement is necessary, details contributing to the appearance of the roof should be retained. High quality slate is still available from reputable quarries and, while a significant investment, can be a cost effective solution over the long term.

Further Reading

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Repair/Replacement Guideline

The following guideline is provided to assist in the repair/replace decision making process:

1. Consider the age and condition of the roof versus its expected serviceable life given the type of slate employed.

2. Calculate the number of damaged and missing slates. Is the number less than about 20%? Is the roof generally in good condition? If so, the roof should be evaluated for repair rather than replacement. Also, keep in mind that the older a roof becomes, the more maintenance it will likely require.

3. Determine if there are active leaks and what their source may be. Do not assume the slates are leaking. Gutters, valleys and flashings are more likely candidates. "False leaks" can be caused by moisture condensation in the attic due to improper ventilation.

4. Check the roof rafters and sheathing for moisture stains. Poke an awl into the wood to determine if it is rotted. Remember that very old, delaminating slates will hold moisture and cause adjacent wood members to deteriorate even if there are no apparent leaks.

5. Are many slates sliding out of position? If so, it may be that ferrous metal fasteners were used and that these are corroding, while the slates are still in good condition. Salvage the slates and re-lay them on the roof. If the slates have worn around the nails holes, it may be necessary to punch new holes before re-laying them.

6. Consider the condition of the roof's flashings. Because slate is so durable, metal flashings often wear out before the slate does. Examine the flashings carefully. Even the smallest pinhole can permit large quantities of water to enter the building.

7. Is the deterioration of the slate uniform? Often this is not the case. It may be that only one slope needs replacement and the other slopes can be repaired. In this way, the cost of replacement can be spread over many years.

8. Press down hard on the slates with your hand. Sound slates will be unaffected by the pressure. Deteriorated slates will feel brittle and will crack. Tap on slates that have fallen out or been removed. A full, deep sound indicates a slate in good condition, while a dull thud suggests a slate in poor condition.

9. Are new slates readily available? Even if replacement is determined to be necessary, the existing roof may have to be repaired to allow time for documentation and the ordering of appropriate replacement slates.

Figure 24. Although slate replacement roofs are expensive, the superiority of materials and craftsmanship will give years of continued service. If amortized over the life of the roof, the replacement cost can be very reasonable. Photograph courtesy of the National Park Service.

Note: measurements in this publication are given in both U.S. Customary System and International (Metric) System for comparative purposes. Metric conversions are in some cases approximate and should not be relied upon in preparing technical specifications.

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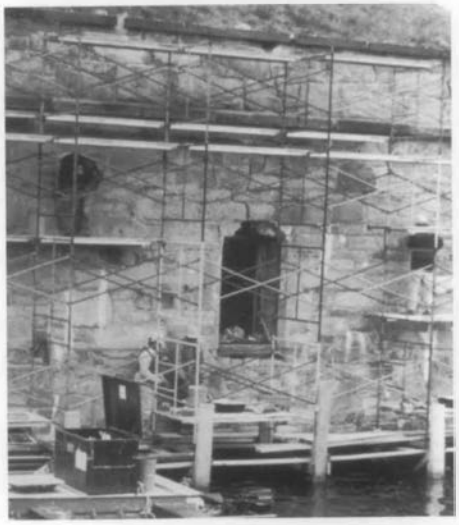
Cover Photograph: A portion of an advertisement for Slatington-Bangor Slate Syndicate (Slatington, PA) which appeared in the July 1910 issue of Building Age *(Vol.32 No.7).*

39 PRESERVATION BRIEFS



Holding the Line: Controlling Unwanted Moisture in Historic Buildings

Sharon C. Park, AIA

U.S. Department of the Interior
National Park Service
Cultural Resources
Heritage Preservation Services

Uncontrolled moisture is the most prevalent cause of deterioration in older and historic buildings. It leads to erosion, corrosion, rot, and ultimately the destruction of materials, finishes, and eventually structural components. Ever-present in our environment, moisture can be *controlled* to provide the differing *levels* of moisture necessary for human comfort as well as the longevity of historic building materials, furnishings, and museum collections. The challenge to building owners and preservation professionals alike is to understand the patterns of moisture movement in order to better manage it — not to eliminate it. There is never a single answer to a moisture problem. Diagnosis and treatment will always differ depending on where the building is located, climatic and soil conditions, ground water effects, and local traditions in building construction.

Remedial Actions within an Historic Preservation Context

In this Brief, advice about controlling the sources of unwanted moisture is provided within a preservation context based on philosophical principles contained in the *Secretary of the Interior's Standards for the Treatment of Historic Properties.* Following the Standards means significant materials and features that contribute to the historic character of the building should be preserved, not damaged during remedial treatment (see fig.1). It also means that physical treatments should be reversible, whenever possible. The majority of treatments for moisture management in this Brief stress preservation maintenance for materials, effective drainage of troublesome ground moisture, and improved interior ventilation.

The Brief encourages a systematic approach for evaluating moisture problems which, in some cases, can be undertaken by a building owner. Because the source of moisture can be elusive, it may be necessary to consult with historic preservation professionals prior to starting work that would affect historic materials. Architects, engineers, conservators, preservation contractors, and staff of State Historic Preservation Offices (SHPOs) can provide such advice.

Regardless of who does the work, however, these are the principles that should guide treatment decisions:

- Avoid remedial treatments without prior careful diagnosis.
- Undertake treatments that protect the historical significance of the resource.
- Address issues of ground-related moisture and rain run-off thoroughly.
- Manage existing moisture conditions before introducing humidified / dehumidified mechanical systems.
- Implement a program of ongoing monitoring and maintenance once moisture is controlled or managed.
- Be aware of significant landscape and archeological resources in areas to be excavated.

Finally, mitigating the effects of catastrophic moisture, such as floods, requires a different approach and will not be addressed fully in this Brief.

Fig. 1. Moisture problems, if not properly corrected, will increase damage to historic buildings. This waterproof coating trapped moisture from the leaking roof, causing portions of the masonry parapet to fail. Photo: NPS Files.

How and Where to Look for Damaging Moisture

Finding, treating, and managing the sources of damaging moisture requires a systematic approach that takes time, patience, and a thorough examination of all aspects of the problem—including a series of variable conditions (See this page). Moisture problems may be a direct result of one of these factors or may be attributable to a combination of interdependent variables.

Factors Contributing to Moisture Problems

A variety of simultaneously existing conditions contribute to moisture problems in old buildings. For recurring moisture problems, it may be necessary for the owner or preservation professional to address many, if not all, of the following variables:

- Types of building materials and construction systems
- Type and condition of roof and site drainage systems and their rates of discharge
- Type of soil, moisture content, and surface /subsurface water flow adjacent to building
- Building usage and moisture generated by occupancy
- Condition and absorption rates of materials
- Type, operation, and condition of heating, ventilating, cooling, humidification/ dehumidification, and plumbing systems
- Daily and seasonal changes in sun, prevailing winds, rain, temperature, and relative humidity (inside and outside), as well as seasonal or tidal variations in groundwater levels
- Unusual site conditions or irregularities of construction
- Conditions in affected wall cavities, temperature and relative humidity, and dewpoints
- Amount of air infiltration present in a building
- Adjacent landscape and planting materials

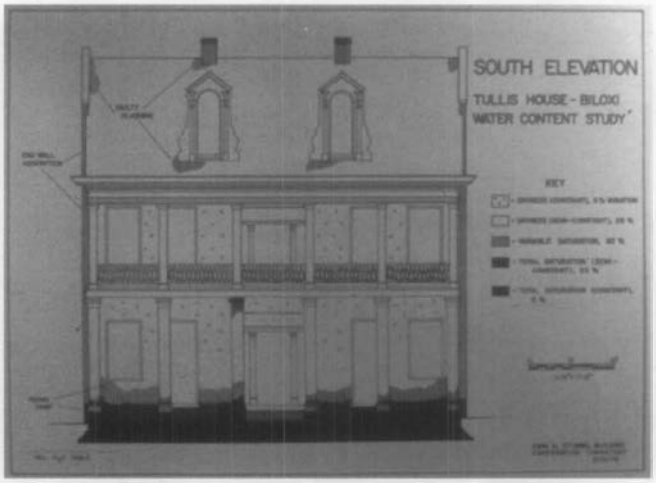


Fig. 2. Historic buildings plagued by dampness problems will benefit from systematic documentation to set a baseline against which moisture changes can be measured. Exterior areas with higher moisture levels may have algae growth or discoloration stains. Drawing: John H. Stubbs.

Diagnosing and treating the cause of moisture problems requires looking at both the localized decay, as well as understanding the performance of the entire building and site. Moisture is notorious for traveling far from the source, and moisture movement within concealed areas of the building construction make accurate diagnosis of the source and path difficult. Obvious deficiencies, such as broken pipes, clogged gutters, or cracked walls that contribute to moisture damage, should always be corrected promptly.

For more complicated problems, it may take several months or up to four seasons of monitoring and evaluation to complete a full diagnosis. Rushing to a solution without adequate documentation can often result in the unnecessary removal of historic materials—and worse—the creation of long-term problems associated with an increase, rather than a decrease, in the unwanted moisture.

Looking for Signs

Identifying the type of moisture damage and discovering its source or sources usually involves the human senses of sight, smell, hearing, touch, and taste combined with intuition. Some of the more common signs of visible as well as hidden moisture damage (see fig. 2, 3) include:

- Presence of standing water, mold, fungus, or mildew
- Wet stains, eroding surfaces, or efflorescence (salt deposits) on interior and exterior surfaces
- Flaking paint and plaster, peeling wallpaper, or moisture blisters on finished surfaces
- Dank, musty smells in areas of high humidity or poorly ventilated spaces
- Rust and corrosion stains on metal elements, such as anchorage systems and protruding roof nails in the attic
- Cupped, warped, cracked, or rotted wood
- Spalled, cracked masonry or eroded mortar joints
- Faulty roofs and gutters including missing roofing slates, tiles, or shingles and poor condition of flashing or gutters
- Condensation on window and wall surfaces
- Ice dams in gutters, on roofs, or moisture in attics

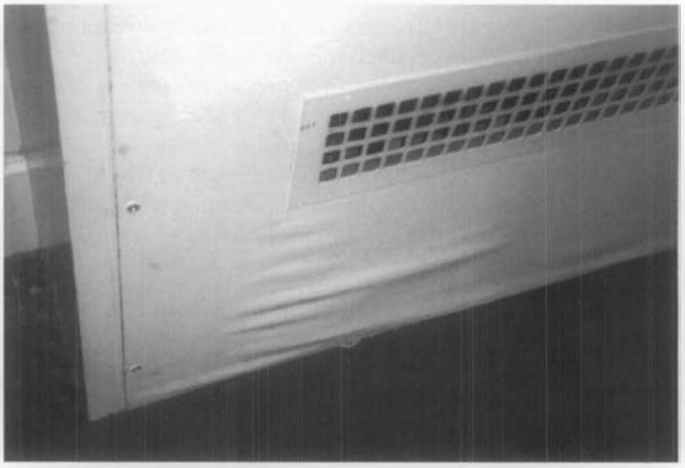


Fig. 3. The deterioration of this wooden cover was a sign that water was leaking from the fan coil unit behind. Photo: author.

Uncovering and Analyzing Moisture Problems

Moisture comes from a variety of external sources. Most problems begin as a result of the weather in the form of rain or snow, from high ambient relative humidity, or from high water tables. But some of the most troublesome moisture damage in older buildings may be from internal sources, such as leaking plumbing pipes, components of heating, cooling, and climate control systems, as well as sources related to use or occupancy of the building. In some cases, moisture damage may be the result of poorly designed original details, such as projecting outriggers in rustic structures that are vulnerable to rotting, and may require special treatment.

The five most common sources of unwanted moisture include:

- Above grade exterior moisture entering the building
- Below grade ground moisture entering the building
- Leaking plumbing pipes and mechanical equipment
- Interior moisture from household use and climate control systems
- Water used in maintenance and construction materials.

Above grade exterior moisture generally results from weather related moisture entering through deteriorating materials as a result of deferred maintenance, structural settlement cracks, or damage from high winds or storms (see fig. 4). Such sources as faulty roofs, cracks in walls, and open joints around window and door openings can be corrected through either repair or limited replacement. Due to their age, historic buildings are notoriously "drafty," allowing rain, wind, and damp air to enter through missing mortar joints; around cracks in windows, doors, and wood siding; and into uninsulated attics. In some cases, excessively absorbent materials, such as soft sandstone, become saturated from rain or gutter overflows, and can allow moisture to dampen interior surfaces. Vines or other vegetative materials allowed to grow directly on building materials without trellis or other framework can cause damage from roots eroding mortar joints and foundations as well as dampness being held against surfaces. In most cases, keeping vegetation off buildings, repairing damaged materials, replacing flashings, rehanging gutters, repairing downspouts, repointing mortar, caulking perimeter joints around windows and doors, and repainting surfaces can alleviate most sources of unwanted exterior moisture from entering a building above grade.

Below grade ground moisture is a major source of unwanted moisture for historic and older buildings. *Proper handling of surface rain run-off is one of the most important measures of controlling unwanted ground moisture.* Rain water is often referred to as "bulk moisture" in areas that receive significant annual rainfalls or infrequent, but heavy, precipitation. For example, a heavy rain of 2" per hour can produce 200 gallons of water from downspout discharge alone for a house during a one hour period. When soil is saturated at the base of the building, the moisture will wet footings and crawl spaces or find its way through cracks in foundation walls and enter into basements (see fig. 5). Moisture in saturated basement or foundation walls—also exacerbated by high water tables—will generally rise up within a wall and eventually cause deterioration of the masonry and adjacent wooden structural elements.

Builders traditionally left a working area, known as a builder's trench, around the exterior of a foundation wall. These trenches have been known to increase moisture problems if the infill soil is less than fully compacted or includes rubble backfill, which, in some cases, may act as a reservoir holding damp materials against masonry walls. Broken subsurface pipes or downspout drainage can leak into the builder's trench and dampen walls some distance from the source. Any subsurface penetration of the foundation wall for sewer, water, or other piping also can act as a direct conduit of ground moisture unless these holes are well sealed. A frequently unsuspected, but serious, modern source of ground moisture is a landscape irrigation system set too close to the building. Incorrect placement of sprinkler heads can add a tremendous amount of moisture at the foundation level and on wall surfaces.

Fig. 4. Deferred maintenance often leads to blocked gutters and downspouts. This cracked gutter system allowed moisture to penetrate the upper exterior wall, erode mortar joints, and rot fascia boards. Photo: NPS files.

Fig. 5. Excavating this foundation revealed that the downspout pipe had corroded at the " u-trap" and was leaking moisture into the soil. Openings around the horizontal water supply line and cracks in the wall allowed moisture to penetrate the basement in multiple locations. Photo: author.

The ground, and subsequently the building, will stay much drier by 1) re-directing rain water away from the foundation through sloping grades, 2) capturing and disposing downspout water well away from the building, 3) developing a controlled ground gutter or effective drainage for buildings historically without gutters and downspouts, and 4) reducing splash-back of moisture onto foundation walls. The excavation of foundations and the use of dampproof coatings and footing drains should only be used after the measures of reducing ground moisture listed above have been implemented.

Leaking plumbing pipes and mechanical equipment can cause immediate or long-term damage to historic building interiors. Routine maintenance, repair, or, if necessary, replacement of older plumbing and mechanical equipment are common solutions. Older water and sewer pipes are subject to corrosion over time. Slow leaks at plumbing joints hidden within walls and ceilings can ultimately rot floor boards, stain ceiling plaster, and lead to decay of structural members. Frozen pipes that crack can damage interior finishes (see fig. 6). In addition to leaking plumbing pipes, old radiators in some historic buildings have been replaced with water-supplied fan coil units which tend to leak. These heating and cooling units, as well as central air equipment, have overflow and condensation pans that require cyclical maintenance to avoid mold and mildew growth and corrosion blockage of drainage channels. Uninsulated forced-air sheet metal ductwork and cold water pipes in walls and ceilings often allow condensation to form on the cold metal, which then drips and causes bubbling plaster and peeling paint. Careful design and vigilant maintenance, as well as repair and insulating pipes or ductwork, will generally rid the building of these common sources of moisture.

Fig. 6. Uninsulated plumbing pipes close to the exterior wall froze and cracked, wetting this ornamental plaster ceiling before the water supply line could be shut off. As a result, limited portions of the ceiling needed reattaching. Photo: author.

Interior moisture from building use and modern humidified heating and cooling systems can create serious problems. In northern U.S. climates, heated buildings will have winter-time relative humidity levels ranging from 10%-35% Relative Humidity (RH). A house with four occupants generates between 10 and 16 pounds of water a day (approximately 1 – 2 gallons) from human residents. Moisture from food preparation, showering, or laundry use will produce condensation on windows in winter climates. When one area or floor of a building is air-conditioned and another area is not, there is the chance for condensation to occur between the two areas. Most periodic condensation does not create a long-term problem.

Humidified climate control systems are generally a major problem in museums housed within historic buildings. They produce between 35%-55% RH on average which, as a vapor, will seek to dissipate and equalize with adjacent spaces (see fig. 7). Moisture can form on single-glazed windows in winter with exterior temperatures below 30 F and interior temperatures at 70 F with as little as 35% RH. Frequent condensation on interior window surfaces is an indication that moisture is migrating into exterior walls, which can cause long-term damage to historic materials. Materials and wall systems around climate controlled areas may need to be made of moisture resistant finishes in order to handle the additional moisture in the air. Moist interior conditions in hot and humid climates will generate mold and fungal growth. Unvented mechanical equipment, such as gas stoves, driers, and kerosene heaters, generate large quantities of moisture. It is important to provide adequate ventilation and find a balance between interior temperature, relative humidity, and airflow to avoid interior moisture that can damage historic buildings.

Fig. 7. Condensation dripping from the large overhead courtyard skylight was damaging the masonry in this museum. A new skylight with thermal glazing was installed, replacing the deteriorated single-glazed unit. A new climate control system monitors interior temperature and humidity. Photo: © Isabella Stewart Gardner Museum, Boston.

Moisture from maintenance and construction materials can cause damage to adjacent historic materials. Careless use of liquids to wash floors can lead to water seepage through cracks and dislodge adhesives or cup and curl materials. High-pressure power washing of exterior walls and roofing materials can force water into construction joints where it can dislodge mortar, lift roofing tiles, and saturate frame walls and masonry. Replastered or newly

plastered interior walls or the construction of new additions attached to historic buildings may hold moisture for months; new plaster, mortar, or concrete should be fully cured before they are painted or finished. The use of materials in projects that have been damaged by moisture prior to installation or have too high a moisture content may cause concealed damage (see fig. 8).

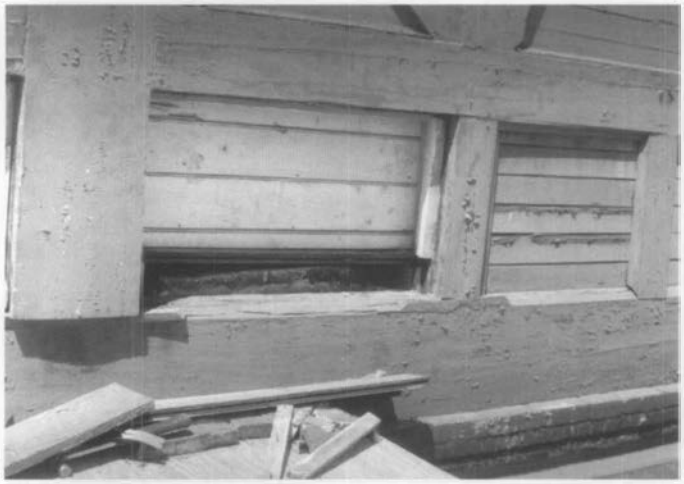


Fig. 8. Damaging moisture conditions can occur during construction. Peeling paint on this newly rehabilitated frame wall was attributed to wall insulation that had become wet during the project and was not discovered. Photo: NPS Files.

Transport or Movement of Moisture

Knowing the five most common sources of moisture that cause damage to building materials is the first step in diagnosing moisture problems. But it is also important to understand the basic mechanisms that affect moisture movement in buildings. Moisture transport, or movement, occurs in two states: liquid and vapor. It is directly related to pressure differentials. For example, water in a gaseous or vapor state, as warm moist air, will move from its high pressure area to a lower pressure area where the air is cooler and drier. Liquid water will move as a result of differences in hydrostatic pressure or wind pressure. *It is the pressure differentials that drive the rate of moisture migration in either state.* Because the building materials themselves resist this moisture movement, the rate of movement will depend on two factors: the permeability of the materials when affected by vapor and the absorption rates of materials in contact with liquid.

The mechanics, or physics, of moisture movement is complex, but if the driving force is difference in pressure, then an approach to reducing moisture movement and its damage is to reduce the difference in pressure, not to increase it. That is why the treatments discussed in this Brief will look at *managing moisture by draining bulk moisture and ventilating vapor moisture* before setting up new barriers with impermeable coatings or over-pressurized new climate control systems that threaten aging building materials and archaic construction systems.

Three forms of moisture transport are particularly important to understand in regards to historic buildings — *infiltration, capillary action, and vapor diffusion* —remembering, at the same time, that the subject is infinitely complex and, thus, one of continuing scientific study (see fig. 9). Buildings were traditionally designed to deal with the movement of air. For example, cupolas and roof lanterns allowed hot air to rise and provided a natural draft to pull air through buildings. Cavity walls in both frame and masonry buildings were constructed to allow moisture to dissipate in the air space between external and internal walls. Radiators were placed in front of windows to keep cold surfaces warm, thereby reducing condensation on these surfaces. Many of these features, however, have been altered over time in an effort to modernize appearances, improve energy efficiency, or accommodate changes in use. The change in use will also affect moisture movement, particularly in commercial and industrial buildings with modern mechanical systems. Therefore, the way a building handles air and moisture today may be different from that intended by the original builder or architect, and poorly conceived changes may be partially responsible for chronic moisture conditions.

Moisture moves into and through materials as both a visible liquid (capillary action) and as a gaseous vapor (infiltration and vapor diffusion). Moisture from leaks, saturation, rising damp, and condensation can lead to the deterioration of materials and cause an unhealthy environment. Moisture in its solid form, ice, can also cause damage from frozen, cracked water pipes, or split gutter seams or spalled masonry from freeze-thaw action. Moisture from melting ice dams, leaks, and condensation often can travel great distances down walls and along construction surfaces, pipes, or conduits. The amount of moisture and how it deteriorates materials is dependent upon complex forces and variables that must be considered for each situation.

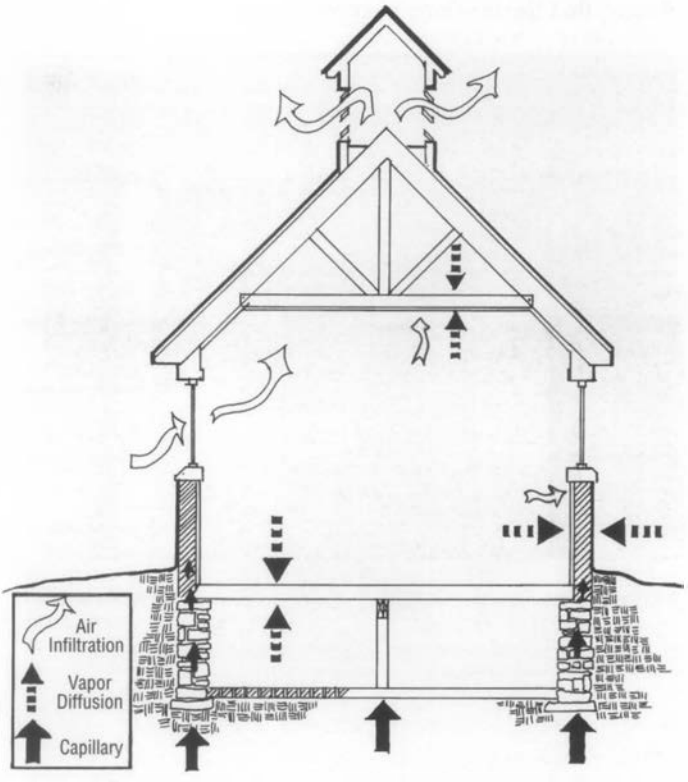


Fig. 9. The dynamic forces that move air and moisture through a building are important to understand particularlly when selecting a treatment to correct a moisture problem. Air infiltration, capillary action, and vapor diffusion all affect the wetting and drying of materials. Drawing; NPS Files.

Determining the way moisture is handled by the building is further complicated because each building and site is unique. Water damage from blocked gutters and downspouts can saturate materials on the outside, and high levels of interior moisture can saturate interior materials. Difficult cases may call for technical evaluation by consultants specializing in moisture monitoring and diagnostic evaluation. In other words, it may take a team to effectively evaluate a situation and determine a proper approach to controlling moisture damage in old buildings.

Infiltration is created by wind, temperature gradients (hot air rising), ventilation fan action, and the stack or chimney effect that draws air up into tall vertical spaces. Infiltration as a dynamic force does not actually move liquid water, but is the vehicle by which dampness, as a component of air, finds its way into building materials. Older buildings have a natural air exchange, generally from 1 to 4 changes per hour, which, in turn, may help control moisture by diluting moisture within a building. The tighter the building construction, however, the lower will be the infiltration rate and the natural circulation of air. In the process of infiltration, however, moisture that has entered the building and saturated materials can be drawn in and out of materials, thereby adding to the dampness in the air (see fig. 10). Inadequate air circulation where there is excessive moisture (i.e., in a damp basement), accelerates the deterioration of historic materials. To reduce the unwanted moisture that accompanies infiltration, it is best to incorporate maintenance and repair treatments to close joints and weatherstrip windows, while providing controlled air exchanges elsewhere. The worst approach is to seal the building so completely, while limiting fresh air intake, that the building cannot breathe.

Fig. 10. Infiltration of damp air can occur around loose-fitting or deteriorated window sash and through cracks or open joints in building exteriors. Photo: Ann Brooks Prueher.

Capillary action occurs when moisture in saturated porous building materials, such as masonry, wicks up or travels vertically as it evaporates to the surface. In capillary attraction, liquid in the material is attracted to the solid surface of the pore structure causing it to rise vertically; thus, it is often called "rising damp," particularly when found in conjunction with ground moisture. It should not, however, be confused with moisture that laterally penetrates a foundation wall through cracks and settles in the basement. Not easily controlled, most rising damp comes from high water tables or a constant source under the footing. In cases of damp masonry walls with capillary action, there is usually a whitish stain or horizontal tide mark of efflorescence that seasonally fluctuates about 1- 3 feet above grade where the excess moisture evaporates from the wall (see fig. 11). This tide mark is full of salt crystals, that have been drawn from the ground and building materials along with the water, making the masonry even more sensitive to additional moisture absorption from the surrounding air. Capillary migration of moisture may occur in any material with a pore structure where there is a constant or recurring source of moisture.

Fig. 11. Capillary rise of moisture in masonry is often accompanied with a horizontal tide-mark line several feet above the grade, as seen here. Removing or redirecting as much ground moisture as possible usually helps reduce moisture within a wall. Photo: NPS Files.

The best approach for dealing with capillary rise in building materials is to reduce the amount of water in contact with historic materials. If that is not possible due to chronically high water tables, it may be necessary to introduce a horizontal damp-proof barrier, such as slate course or a lead or plastic sheet, to stop the vertical rise of moisture. Moisture should not be sealed into the wall with a waterproof coating, such as cement parging or vinyl wall coverings, applied to the inside of damp walls. This will only increase the pressure differential as a vertical barrier and force the capillary action, and its destruction of materials, higher up the wall.

Vapor diffusion is the natural movement of pressurized moisture vapor through porous materials. It is most readily apparent as humidified interior air moves out through walls to a cooler exterior. In a hot and humid climate, the reverse will happen as moist hot air moves into cooler, dryer, air-conditioned, interiors. The movement of the moisture vapor is not a serious problem until the dewpoint temperature is reached and the vapor changes into liquid moisture known as *condensation*. This can occur within a wall or on interior surfaces. Vapor diffusion will be more of

a problem for a frame structure with several layers of infill materials within the frame cavity than a dense masonry structure. Condensation as a result of vapor migration usually takes place on a surface or film, such as paint, where there is a change in permeability.

The installation of climate control systems in historic buildings (mostly museums) that have *not* been properly designed or regulated and that force pressurized damp air to diffuse into perimeter walls is an ongoing concern. These newer systems take constant monitoring and back-up warning systems to avoid moisture damage.

Long-term and undetected condensation or high moisture content can cause serious structural damage as well as an unhealthy environment, heavy with mold and mildew spores. Reducing the interior/exterior pressure differential and the difference between interior and exterior temperature and relative humidity helps control unwanted vapor diffusion. This can sometimes be achieved by reducing interior relative humidity. In some instances, using vapor barriers, such as heavy plastic sheeting laid over damp crawl spaces, can have remarkable success in stopping vapor diffusion from damp ground into buildings. Yet, knowledgeable experts in the field differ regarding the appropriateness of vapor barriers and when and where to use them, as well as the best way to handle natural diffusion in insulated walls.

Adding insulation to historic buildings, particularly in walls of wooden frame structures, has been a standard modern weatherization treatment, but it can have a disastrous effect on historic buildings. The process of installing the insulation destroys historic siding or plaster, and it is very difficult to establish a tight vapor barrier. While insulation has the benefit of increasing the efficiency of heating and cooling by containing temperature controlled air, it does not eliminate surfaces on which damaging moisture can condense. For insulated residential frame structures, the most obvious sign of a moisture

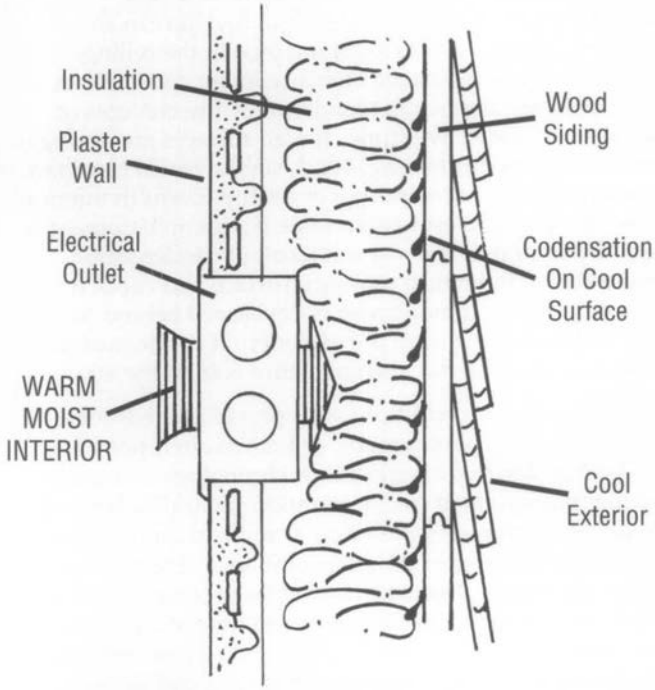


Fig. 12. Vapor diffusion can result in damp air migrating into absorbent materials and condensing on colder surfaces, thereby wetting insulation, damaging electrical conduits, and causing deterioration of the wooden framing. Drawing: NPS Files.

diffusion problem is peeling paint on wooden siding, even after careful surface preparation and repainting. Vapor impermeable barriers such as plastic sheeting, or more accurately, *vapor retarders,* in cold and moderate climates generally help slow vapor diffusion where it is not wanted.

In regions where *humidified* climate control systems are installed into insulated frame buildings, it is important to stop *interstitial*, or in-wall, dewpoint condensation. This is very difficult because humidified air can penetrate breaches in the vapor barrier, particularly around electrical outlets (see fig. 12). Improperly or incompletely installed retrofit vapor barriers will cause extensive damage to the building, just in the installation process, and will allow trapped condensation to wet the insulation and sheathing boards, corrode metal elements such as wiring cables and metal anchors, and blister paint finishes. Providing a tight wall vapor barrier, as well as a ventilated cavity behind wooden clapboards or siding appears to help insulated frame walls, if the interior relative humidity can be adjusted or monitored to avoid condensation. Correct placement of vapor retarders within building construction will vary by region, building construction, and type of climate control system.

Surveying and Diagnosing Moisture Damage: Key Questions to Ask

It is important for the building to be surveyed first and the evidence and location of suspected moisture damage systematically recorded before undertaking any major work to correct the problem. This will give a baseline from which relative changes in condition can be noted.

When materials become wet, there are specific physical changes that can be detected and noted in a record book or on survey sheets. Every time there is a heavy rain, snow storm, water in the basement, or mechanical systems failure, the owner or consultant should note and record the way moisture is moving, its appearance, and what variables might contribute to the cause. *Standing outside to observe a building in the rain may answer many questions and help trace the movement of water into the building.* Evidence of deteriorating materials that cover more serious moisture damage should also be noted, even if it is not immediately clear what is causing the damage. (For example, water stains on the ceiling may be from leaking pipes, blocked fan coil drainage pans above, or from moisture which has penetrated around a poorly sloped window sill above.) Don't jump to conclusions, but use a systematic approach to help establish an educated theory — or hypothesis — of what is causing the moisture problem or what areas need further investigation.

Surveying moisture damage must be systematic so that relative changes can be noted. Tools for investigating can be as simple as a notebook, sketch plans, binoculars, camera, aluminum foil, smoke pencil, and flashlight. The systematic approach involves looking at buildings from the top down and from the outside to the inside. Photographs, floor plans, site plan, and exterior elevations — even roughly sketched — should be used to indicate all evidence of damp or damaged materials, with notations for musty or poorly ventilated areas. Information might be needed on the absorption and permeability characteristics of the building materials and soils. Exterior drainage patterns should be noted and these base plans referred to on a regular basis in different seasons and in differing types of weather (see fig. 13).

Glossary:

Air flow/ infiltration: The movement that carries moist air into and through materials. Air flow depends on the difference between indoor and outdoor pressures, wind speed and direction as well as the permeability of materials.

Bulk water: The large quantity of moisture from roof and ground run-off that can enter into a building either above grade or below grade.

Capillary action: The force that moves moisture through the pore structure of materials. Generally referred to as rising damp, moisture at or below the foundation level will rise vertically in a wall to a height at which the rate of evaporation balances the rate at which it can be drawn up by capillary forces.

Condensation: The physical process by which water vapor is transformed into a liquid when the relative humidity of the air reaches 100% and the excess water vapor forms, generally as droplets, on the colder adjacent surface.

Convection: Heat transfer through the atmosphere by a difference in force or air pressure is one type of air transport. Sometimes referred to as the "stack effect," hotter less dense air will rise, colder dense air will fall creating movement of air within a building.

Dewpoint: The temperature at which water vapor condenses when the air is cooled at a constant pressure and constant moisture content.

Diffusion: The movement of water vapor through a material. Diffusion depends on vapor pressure, temperature, relative humidity, and the permeability of a material.

Evaporation: The transformation of liquid into a vapor, generally as a result of rise of temperature, is the opposite of condensation. Moisture in damp soil, such as in a crawl space, can evaporate into the air, raise the relative humidity in that space, and enter the building as a vapor.

Ground moisture: The saturated moisture in the ground as a result of surface run-off and naturally occuring water tables. Ground moisture can penetrate through cracks and holes in foundation walls or can migrate up from moisture under the foundation base.

Monitoring instrumentation: These devices are generally used for long term diagnostic analysis of a problem, or to measure the preformance of a treatment, or to measure changes of conditions or environment. In-wall probes or sensors are often attached to data-loggers which can be down-loaded into computers.

Permeability: A characteristic of porosity of a material generally listed as the rate of diffusion of a pressurized gas through a material. The pore structure of some materials allows them to absorb or adsorb more moisture than other materials. Limestones are generally more permeable than granites.

Relative humidity (RH): Dampness in the air is measured as the percent of water vapor in the air at a specific temperature relative to the amount of water vapor that can be held in a vapor form at that specific temperature.

Survey instrumentation: technical instrumentation that is used on-site to provide quick readings of specific physical conditions. Generally these are hand-held survey instruments, such as moisture, temperature and relative humidity readers, dewpoint sensors, and fiber optic boroscopes.

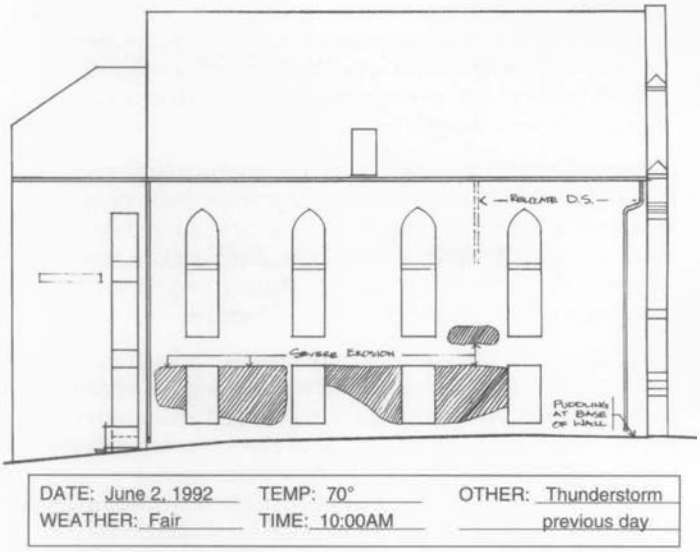


Fig. 13. Using sketch plans and elevation drawings to record the moisture damage along with the date, time, and weather conditions will show how moisture is affecting buildings over time. Drawing: Courtesy, Quinn Evans Architects.

It is best to start with one method of periodic documentation and to use this same method each time. Because moisture is affected by gravity, many surveys start with the roof and guttering systems and work down through the exterior walls. Any obvious areas of water penetration, damaged surfaces, or staining should be noted. Any recurring damp or stain patterns, both exterior and interior, should also be noted with a commentary on the temperature, weather, and any other facts that may be relevant (driving rains, saturated soil, high interior humidity, recent washing of the building, presence of a lawn watering system, etc.).

The interior should be recorded as well, beginning with the attic and working down to the basement and crawl space. It may be necessary to remove damaged materials selectively in order to trace the path of moisture or to pinpoint a source, such as a leaking pipe in the ceiling. The use of a basic resistance moisture meter, available in many hardware stores, can identify moisture contents of materials and show, over time, if wall surfaces are drying or becoming damper (see fig. 14). A smoke pencil can chart air infiltration around windows or draft patterns in interior spaces. For a quick test to determine if a damp basement is caused by saturated walls or is a result of condensation, tape a piece of foil onto a masonry surface and check it after a day or two; if moisture has developed behind the foil, then it is coming from the masonry. If condensation is on the surface of the foil, then moisture is from the air.

Comparing current conditions with previous conditions, historic drawings, photographs, or known alterations may also assist in the final diagnosis. A chronological record, showing improvement or deterioration, should be backed up with photographs or notations as to the changing size, condition, or features of the deterioration and how these changes have been affected by variables of temperature and rainfall. If a condition can be related in time to a particular event, such as efflorescence developing on a chimney after the building is no longer heated, it may be possible to isolate a cause, develop a hypothesis, and then test the hypothesis (by adding some temporary heat), before applying a remedial treatment.

Fig. 14. Using instruments in this damp-check kit can help determine the relative change in wet conditions over time. This involves readings of air temperature, computing dewpoint temperatures, and tracking the moisture content of materials to indicate if they are drying properly. Photo: Dell Corporation.

If the owner or consultant has access to moisture survey and monitoring equipment such as resistance moisture meters, dewpoint indicators, salt detectors, infrared thermography systems, psychrometer, fiber-optic boroscopes, and miniaturized video cameras, additional quantified data can be incorporated into the survey (see fig. 15). If it is necessary to track the wetting and drying of walls over a period of time, deep probes set into walls and in the soil with connector cables to computerized data loggers or the use of long-term recording of hygrothermographs may require a trained specialist. Miniaturized fiber-optic video cameras can record the condition of subsurface drain lines without excavation (see fig. 16). It should be noted, however, that *instrumentation, while extremely useful, cannot take the place of careful personal observation and analysis.* Relying on instrumentation alone rarely will give the owner the information needed to fully diagnose a moisture problem.

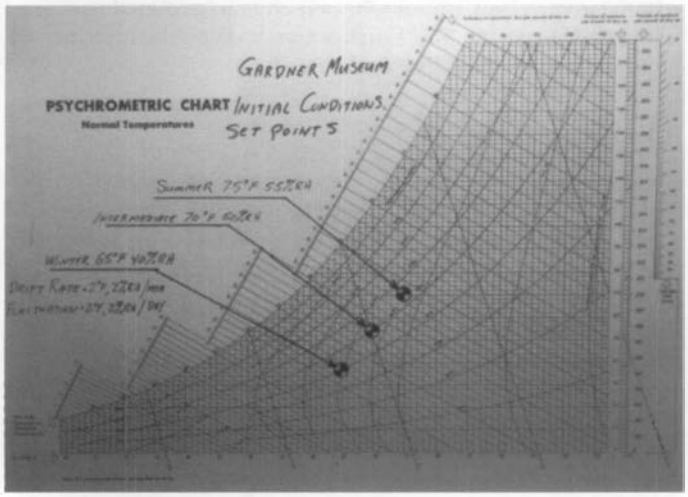


Fig. 15. Psychrometric charts quantify the amount of relative humidity a building can tolerate before dewpoint condensation occurs. This is important when the range of temperature and humidity are critical to both collections management and historic building preservation. Chart: Landmark Facilities Group.

Fig. 16. Contractors specializing in building diagnostics often have video cameras or fiber optic equipment that allow the viewing of inaccessible areas. This is particularly helpful in chimney flues or subsurface drains, as shown here. In the past, these areas would need to be excavated for visual inspection. Photo: author.

To avoid jumping to a quick—potentially erroneous—conclusion, a series of questions should be asked first. This will help establish a theory or hypothesis that can be tested to increase the chances that a remedial treatment will control or manage existing moisture.

How is water draining around building and site? What is the effectiveness of gutters and downspouts? Are the slopes or grading around foundations adequate? What are the locations of subsurface features such as wells, cisterns, or drainage fields? Are there subsurface drainage pipes (or drainage boots) attached to the downspouts and are they in good working condition? Does the soil retain moisture or allow it to drain freely? Where is the water table? Are there window wells holding rain water? What is the flow rate of area drains around the site (can be tested with a hose for several minutes)? Is the storm piping out to the street sufficient for heavy rains, or does water chronically back up on the site? Has adjacent new construction affected site drainage or water table levels?

How does water/moisture appear to be entering the building? Have all five primary sources of moisture been evaluated? What is the condition of construction materials and are there any obvious areas of deterioration? Did this building have a builder's trench around the foundation that could be holding water against the exterior walls? Are the interior bearing walls as well as the exterior walls showing evidence of rising damp? Is there evidence of hydrostatic pressure under the basement floor such as water percolating up through cracks? Has there been moisture damage from an ice dam in the last several months? Is damage localized, on one side of the building only, or over a large area?

What are the principal moisture dynamics? Is the moisture condition from liquid or vapor sources? Is the attic moisture a result of vapor diffusion as damp air comes up through the cavity walls from the crawl space or is it from a leaking roof? Is the exterior wall moisture from rising damp with a tide mark or are there uneven spots of dampness from foundation splash back, or other ground

moisture conditions? Is there adequate air exchange in the building, particularly in damp areas, such as the basement? Has the height of the water table been established by inserting a long pipe into the ground in order to record the water levels?

How is the interior climate handling moisture? Are there areas in the building that do not appear to be ventilating well and where mold is growing? Are there historic features that once helped the building control air and moisture that can be reactivated, such as operable skylights or windows? Could dewpoint condensation be occurring behind surfaces, since there is often condensation on the windows? Does the building feel unusually damp or smell in an unusual way that suggest the need for further study? Is there evidence of termites, carpenter ants, or other pests attracted to moist conditions? Is a dehumidifier keeping the air dry or is it, in fact, creating a cycle where it is actually drawing moisture through the foundation wall?

Does the moisture problem appear to be intermittent, chronic, or tied to specific events? Are damp conditions occuring within two hours of a heavy rain or is there a delayed reaction? Does rust on most nail heads in the attic indicate a condensation problem? What are the wet patterns that appear on a building wall during and after a rain storm? Is it localized or in large areas? Can these rain patterns be tied to gutter over-flows, faulty flashing, or saturation of absorbent materials? Is a repaired area holding up well over time or is there evidence that moisture is returning? Do moisture meter readings of wall cavities indicate they are wet, suggesting leaks or condensation in the wall?

Once a hypothesis of the source or sources of the moisture has been developed from observation and recording of data, it is often useful to prove or disprove this hypothesis with interim treatments, and, if necessary, the additional use of instrumentation to verify conditions. For damp basements, test solutions can help determine the cause. For example, surface moisture in low spots should be redirected away from the foundation wall with regrading to determine if basement dampness improves. If there is still a problem, determine if subsurface downspout collection pipes or cast iron boots are not functioning properly. The above grade downspouts can be disconnected and attached to long, flexible extender pipes and redirected away from the foundation (see fig. 17). If, after a heavy rain or a simulation using a hose, there is no improvement, look for additional ground moisture sources such as high water tables, hidden cisterns, or leaking water service lines as a cause of moisture in the basement. New data will lead to a new hypothesis that should be tested and verified. *The process of elimination can be frustrating, but is required if a systematic method of diagnosis is to be successful.*

Selecting an Appropriate Level of Treatment

The treatments in chart format at the back of this publication are divided into levels based on the degree of moisture problems. Level I covers preservation maintenance; Level II focuses on repair using historically compatible materials and essentially mitigating damaging moisture conditions; and Level III discusses replacement and alteration of materials that permit continued use in a chronically moist environment. It is important to begin

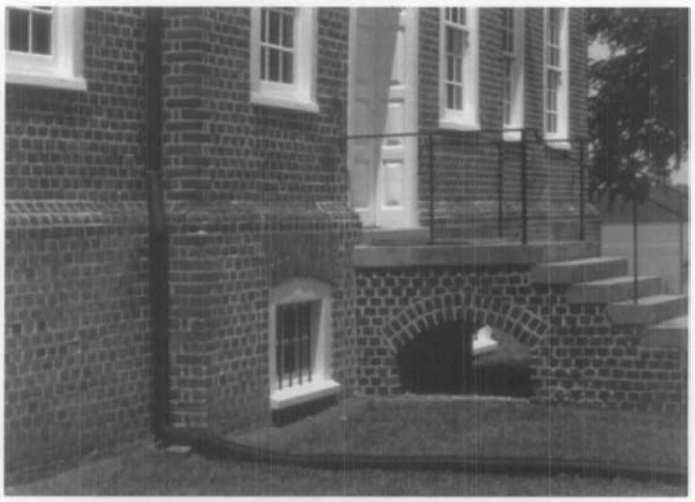


Fig. 17. In testing a theory for the cause of basement wetness, the owner used long black extender pipes to direct roof run-off away from the foundation. This test established that the owner did not need expensive waterproofing of the foundation, but a better drainage system. Photo: Baird M. Smith.

with Level I and work through to a manageable treatment as part of the control of moisture problems. Buildings in serious decay will require treatments in Level II, and difficult or unusual site conditions may require more aggressive treatments in Level III. Caution should always be exercised when selecting a treatment. The treatments listed are a guide and not intended to be recommendations for specific projects as the key is always proper diagnosis.

Start with the repair of any obvious deficiencies using sound preservation maintenance. If moisture cannot be managed by maintenance alone, it is important to reduce it by mitigating problems *before* deteriorated historic materials are replaced (see fig. 18). Treatments should not remove materials that can be preserved; should not involve extensive excavation unless there is a documented need; and should not include coating buildings with waterproof sealers that can exacerbate an existing problem. Some alteration to historic materials, structural systems, mechanical systems, windows, or finishes may be needed when excessive site moisture cannot be controlled by drainage systems, or in areas prone to floods. These changes, however, should, be sensitive to preserving those materials, features, and finishes that convey the historic character of the building and site.

Ongoing Care

Once the building has been repaired and the larger moisture issues addressed, it is important to keep a record of additional evidence of moisture problems and *to protect the historic or old building through proper cyclical maintenance* (see fig. 19) In some cases, particularly in museum environments, it is critical to monitor areas vulnerable to moisture damage. In a number of historic buildings, in-wall moisture monitors are used to ensure that the moisture purposely generated to keep relative humidity at ranges appropriate to a museum collection does not migrate into walls and cause deterioration. The potential problem with all systems is the failure of controls, valves, and panels over time. Back-up systems, warning devices, properly trained staff and an emergency plan will help control damage if there is a system failure.

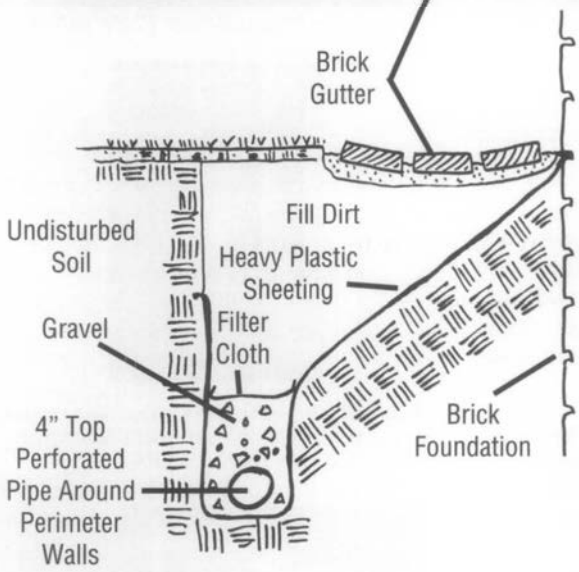


Fig. 18. This detail drawing shows a sub-surface perimeter drain in conjunction with a historic brick ground gutter system to help control roof run-off moisture from entering the historic foundation. Detail: Courtesy, Gunston Hall Plantation. Photo: Elizabeth Sasser.

Fig. 19. Maintaining gutters and downspouts in good operable condition, repairing exteriors to keep water out, redirecting damaging moisture away from foundations and controlling interior moisture and condensation are all important when holding the line on moisture deterioration. Photo: Nebraska State Historical Society.

Ongoing maintenance and vigilance to situations that could potentially cause moisture damage must become a routine part of the everyday life of a building. The owner or staff responsible for the upkeep of the building should inspect the property weekly and note any leaks, mustiness, or blocked drains. Again, observing the building during a rain will test whether ground and gutter drainage are working well.

For some buildings a back-up power system may be necessary to keep sump pumps working during storms when electrical power may be lost. For mechanical equipment rooms, condensation pans, basement floors, and laundry areas where early detection of water is important, there are alarms that sound when their sensors come into contact with moisture.

Conclusion

Moisture in old and historic buildings, though difficult to evaluate, can be systematically studied and the appropriate protective measures taken. Much of the documentation and evaluation is based on common sense combined with an understanding of historic building materials, construction technology, and the basics of moisture and air movement. Variables can be evaluated step by step and situations creating direct or secondary moisture damage can generally be corrected. The majority of moisture problems can be mitigated with maintenance, repair, control of ground and roof moisture, and improved ventilation. For more complex situations, however, a thorough diagnosis and an understanding of how the building handles moisture at present, can lead to a treatment that solves the problem without damaging the historic resource.

It is usually advantageous to eliminate one potential source of moisture at a time. Simultaneous treatments may set up a new dynamic in the building with its own set of moisture problems. Implementing changes sequentially will allow the owner or preservation professional to track the success of each treatment.

Moisture problems can be intimidating to a building owner who has diligently tried to control them. Keeping a record of evidence of moisture damage, results of diagnostic tests, and remedial treatments, is beneficial to a building's long-term care. The more complete a survey and evaluation, the greater the success in controlling unwanted moisture now and in the future.

Holding the line on unwanted moisture in buildings will be successful if 1) there is constant concern for signs of problems and 2) there is ongoing physical care provided by those who understand the building, site, mechanical systems, and the previous efforts to deal with moisture. For properties with major or difficult-to-diagnose problems, a team approach is often most effective. The owner working with properly trained staff, contractors and consultants can monitor, select, and implement treatments within a preservation context in order to manage moisture and to protect the historic resource.

MOISTURE: LEVEL I PRESERVATION MAINTENANCE

Exterior: Apply cyclical maintenance procedures to eliminate rain and moisture infiltration.

Roofing/ guttering: Make weather-tight and operational; inspect and clean gutters as necessary depending on number of nearby trees, but at least twice a year; inspect roofing at least once a year, preferably spring; replace missing or damaged roofing shingles, slates, or tiles; repair flashing; repair or replace cracked downspouts.

Walls: Repair damaged surface materials; repoint masonry with appropriately formulated mortar; prime and repaint wooden, metal, or masonry elements or surfaces; remove efflorescence from masonry with non-metallic bristle brushes.

Window and door openings: Eliminate cracks or open joints; caulk or repoint around openings or steps; repair or reset weatherstripping; check flashing; repaint, as necessary.

Ground: Apply regular maintenance procedures to eliminate standing water and vegetative threats to building/site.

Grade: Eliminate low spots around building foundations; clean out existing downspout boots twice a year or add extension to leaders to carry moisture away from foundation; do a hose test to verify that surface drains are functioning; reduce moisture used to clean steps and walks; eliminate the use of chlorides to melt ice which can increase freeze/thaw spalling of masonry; check operation of irrigation systems, hose bib leaks, and clearance of air conditioning condensate drain outlets.

Crawl space: Check crawl space for animal infestation, termites, ponding moisture, or high moisture content; check foundation grilles for adequate ventilation; seasonally close grilles when appropriate — in winter, if not needed, or in summer if hot humid air is diffusing into air conditioned space.

Foliage: Keep foliage and vines off buildings; trim overhanging trees to keep debris from gutters and limbs from rubbing against building; remove moisture retaining elements, such as firewood, from foundations.

Basements and foundations: Increase ventilation and maintain surfaces to avoid moisture.

Equipment: Check dehumidifiers, sump pump, vent fans, and water detection or alarm systems for proper maintenance as required; check battery back-up twice a year.

Piping/ductwork: Check for condensation on pipes and insulate/seal joints, if necessary.

Interior: Maintain equipment to reduce leaks and interior moisture.

Plumbing pipes: Add insulation to plumbing or radiator pipes located in areas subject to freezing, such as along outside walls, in attics, or in unheated basements.

Mechanical equipment: Check condensation pans and drain lines to keep clear; insulate and seal joints in exposed metal ductwork to avoid drawing in moist air.

Cleaning: Routinely dust and clean surfaces to reduce the amount of water or moist chemicals used to clean building; caulk around tile floor and wall connections; and maintain floor grouts in good condition.

Ventilation: Reduce household-produced moisture, if a problem, by increasing ventilation; vent clothes driers to the outside; install and always use exhaust fans in restrooms, bathrooms, showers, and kitchens, when in use.

A. Inspecting the overall building on at least an annual basis will identify areas needing maintenance. A bucket lift is helpful for large buildings. Photo: author.

B. Repair exterior surfaces, paint, and recaulk as needed. Photo: Williamsport Preservation Training Center (WPTC), NPS.

C. Cleaning out gutters and downspouts should be done at least twice a year. Photo: WPTC, NPS.

D. Protect the building from damage by maintaining equipment and using alarms, like this floor water sensor. Photo: Dell Corporation.

MOISTURE: LEVEL II REPAIR AND CORRECTIVE ACTION

Exterior: Repair features that have been damaged. Replace an extensively deteriorated feature with a new feature that matches in design, color, texture, and where possible, materials.

Roofing: Repair roofing, parapets and overhangs that have allowed moisture to enter; add ice and water shield membrane to lower 3-4 feet or roofing in cold climates to limit damage from ice dams; increase attic ventilation, if heat and humidity build-up is a problem. Make gutters slope @ 1/8" to the foot. Use professional handbooks to size gutters and reposition, if necessary and appropriate to historic architecture. Add ventilated chimney caps to unused chimneys that collect rain water.

Walls: Repair spalled masonry, terra cotta, etc. by selectively installing new masonry units to match; replace rotted clapboards too close to grade and adjust grade or clapboards to achieve adequate clearance; protect or cover open window wells.

A. Mitigate poor drainage with gravel, filter cloth, or the use of subsurface drainage mats under finished paving. Photo: Larry D. Dermody.

Ground: Correct serious ground water problems; capture and dispose of downspout water away from foundation; and control vapor diffusion of crawlspace moisture.

Grade: Re-establish positive sloping of grade; try to obtain 6" of fall in the first 10' surrounding building foundation; for buildings without gutter systems, regrade and install a positive subsurface collection system with gravel, or waterproof sheeting and perimeter drains; adjust pitch or slope of eave line grade drains or French drains to reduce splash back onto foundation walls; add subsurface drainage boots or extension pipes to take existing downspout water away from building foundation to the greatest extent feasible.

Crawl space: Add polyethylene vapor barrier (heavy construction grade or Mylar) to exposed dirt in crawlspace if monitoring indicates it is needed and there is no rising damp; add ventilation grilles for additional cross ventilation, if determined advisable.

B. Repair roofs and add ice and water shields at eaves and under valleys in cold climates. Photo: Larry D. Dermody.

Foundations and Basements: Correct existing high moisture levels, if other means of controlling ground moisture are inadequate.

Mechanical devices: Add interior perimeter drains and sump pump; add dehumidifiers for seasonal control of humidity in confined, unventilated space (but don't create a problem with pulling dampness out of walls); add ventilator fans to improve air flow, but don't use both the dehumidifier and ventilator fan at the same time.

Walls: Remove commentates coatings, if holding rising damp in walls; coat walls with vapor permeable lime based rendering plaster, if damp walls need a sacrificial coating to protect mortar from erosion; add termite shields, if evidence of termites and dampness cannot be controlled.

Framing: Reinforce existing floor framing weakened by moisture by adding lolly column support and reinforcing joist ends with sistered or parallel supports. Add a vapor impermeable shield, preferably non-ferrous metal, under wood joists coming into contact with moist masonry.

C. Develop new drainage systems for roof run-off that remove moisture from the base of the building. Photo: WPTC, NPS.

Interior: Eliminate areas where moisture is leaking or causing a problem.

Plumbing: Replace older pipes and fixtures subject to leaking or overflowing; insulate water pipes subject to condensation.

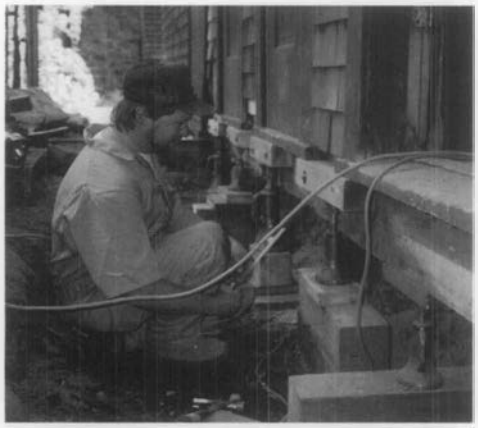
Ventilation: Add exhaust fans and whole house fans to increase air flow through buildings, if areas are damp or need more ventilation to control mold and mildew.

Climate: Adjust temperature and relative humidity to manage interior humidity; Correct areas of improperly balanced pressure for HVAC systems that may be causing a moisture problem.

D. Install ventilating fans when additional air circulation will improve damp conditions in buildings or reduce cooling loads. Photo: Ernest A. Conrad, P. E.

MOISTURE: LEVEL III REPLACEMENT / ALTERATIONS — —

A. This lead sheet was installed at the base of the replacement column to stop rising damp. Photo: Bryan Blundell.



B. Wood sills set on grade were replaced with concrete pier foundation and new wooden sill plates. Changes were not visible on the exterior (see C). Photo: WPTC, NPS.

Exterior: Undertake exterior rehabilitation work that follows professional repair practices —i.e., replace a deteriorated feature with a new feature to match the existing in design, color, texture, and when possible, materials. In some limited situations, non-historic materials may be necessary in unusually wet areas.

Roofs: Add ventilator fans to exhaust roofs but avoid large projecting features whose designs might negatively affect the appearance of the historic roof. When replacing roofs, correct conditions that have caused moisture problems, but keep the overall appearance of the roof; for example, ventilate under wooden shingles, or detail standing seams to avoid buckling and cracking. Be attentive to provide extra protection for internal or built-in gutters by using the best quality materials, flashing, and vapor impermeable connection details.

Walls: If insulation and vapor barriers are added to frame walls, consider maintaining a ventilation channel behind the exterior cladding to avoid peeling and blistering paint occurrences.

Windows: Consider removable exterior storm windows, but allow operation of windows for periodic ventilation of cavity between exterior storm and historic sash. For stained glass windows using protective glazing, use only ventilated storms to avoid condensation as well as heat build-up.

Ground: Control excessive ground moisture. This may require extensive excavations, new drainage systems, and the use of substitute materials. These may include concrete or new sustainable recycled materials for wood in damp areas when they do not impact the historic appearance of the building.

Grade: Excavate and install water collection systems to assist with positive run-off of low lying or difficult areas of moisture drainage; use drainage mats under finished grade to improve run-off control; consider the use of column plinth blocks or bases that are ventilated or constructed of non-absorbent substitute materials in chronically damp areas. Replace improperly sloped walks; repair non-functioning catch basins and site drains; repair settled areas around steps and other features at grade.

C. The new ground gutter gravel base helps drainage around the concrete foundation (see B above) which is not visible behind the replaced wooden wall shingles. Photo: WPTC, NPS.

D. In a flood plain, rotted joists were replaced with a concrete slab and sleepers designed to drain water. Spaced flooring allowed drainage and room for damp wood to swell without buckling. Harper's Ferry Center, NPS.

E. Mechanical systems on the lower level were placed on platforms above the flood line. Harper's Ferry Center, NPS.

— — FOR CHRONICALLY DAMP CONDITIONS

Foundations: Improve performance of foundation walls with damp-proof treatments to stop infiltration or damp course layers to stop rising damp. Some substitute materials may need to be selectively integrated into new features.

Walls: excavate, repoint masonry walls, add footing drains, and waterproof exterior subsurface walls; replace wood sill plates and deteriorated structural foundations with new materials, such as pressure treated wood, to withstand chronic moisture conditions; materials may change, but overall appearance should remain similar. Add dampcourse layer to stop rising damp; avoid chemical injections as these are rarely totally effective, are not reversible, and are often visually intrusive.

Interior: Control the amount of moisture and condensation on the interiors of historic buildings. Most designs for new HVAC systems will be undertaken by mechanical engineers, but systems should be selected that are appropriate to the resource and intended use.

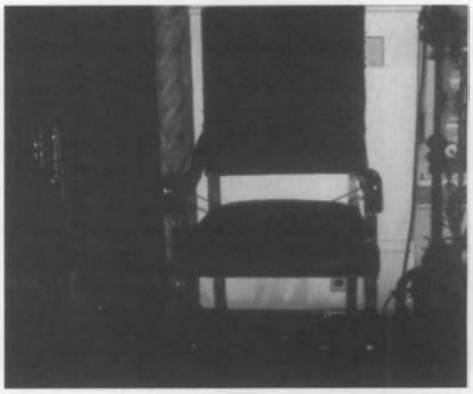
Windows, skylights: Add double and triple glazing, where necessary to control condensation. Avoid new metal sashes or use thermal breaks where prone to heavy condensation.

Mechanical systems: Design new systems to reduce stress on building exterior. This might require insulating and tightening up the building exterior, but provisions must be made for adequate air flow. A new zoned system, with appropriate transition insulation, may be effective in areas with differing climatic needs.

Control devices/Interior spaces: If new climate control systems are added design back-up controls and monitoring systems to protect from interior moisture damage.

Walls: If partition walls sit on floors that periodically flood, consider spacers or isolation membranes behind baseboards to stop moisture from wicking up through absorbent materials.

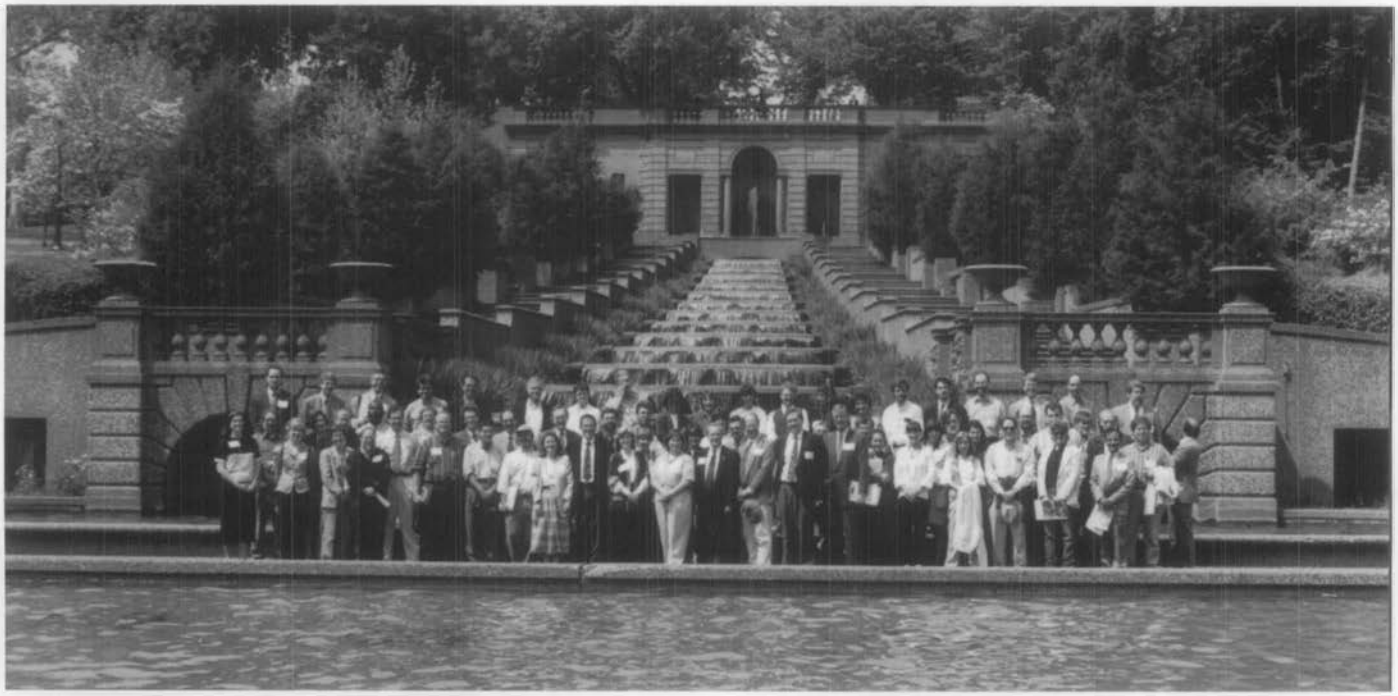
F. Triple glazed windows replaced the originals to control condensation. Photo: © Isabella Stewart Gardner Museum, Boston.



G. New sensors which monitor temperature and relative humidity are located throughout this museum and tied to a computer that controls the climate control system. Photo: © Isabella Stewart Gardner Museum, Boston.

I. Critically damp foundation walls were protected with a layer of bentonite clay to reduce moisture penetration. This work was in combination with new downspouts that were connected to drainage boots that deposited captures roof run-off away from the foundation. Photo: Courtesy, Larry D. Dermody and the National Trust for Historic Preservation.

H. New computers tie a variety of monitoring and security features into a comprehensive system which provides warning and backup alerts when any of the system components are not functioning properly. Photo: © Isabella Stewart Gardner Museum, Boston.



Back Cover: The Diagnosing Moisture in Historic Building Symposium held in Washington, DC, May, 1996, brought together practitioners in the field of historic preservation to discuss the issues contained in this Preservation Brief. Attendees are standing in front of the cascading fountains at Meridian Hill Park, a National Historic Landmark. Photo: Eric Avner.

Reading List

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This publication has been prepared pursuant to the National Historic Preservation Act, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Comments about this publication should be directed to de Teel Patterson Tiller, Acting Manager, Heritage Preservation Services Program, National Park Service, P.O. Box 37127, Washington, DC 20013-7127. This publication is not copyrighted and can be reproduced without penalty. Copyright photographs included in this publication may not be used to illustrate publications other than as a reference to this Preservation Brief, without permission of the owners. Normal procedures for credit to the authors and the National Park Service are appreciated.

Cover Photo: Masonry repointing in a wet environment. Photo: Williamsport Preservation Training Center, NPS.

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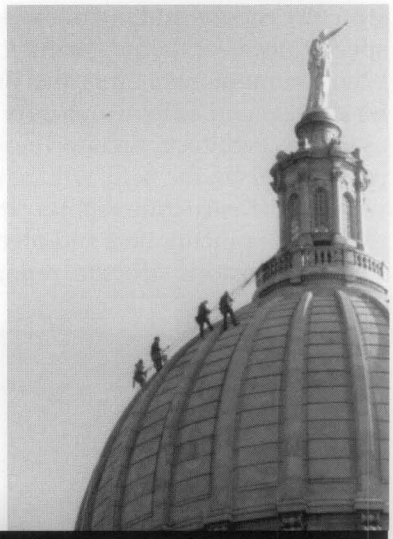
43 PRESERVATION BRIEFS

The Preparation and Use of Historic Structure Reports

Deborah Slaton

National Park Service
U.S. Department of the Interior
Heritage Preservation Services



A historic structure report provides documentary, graphic, and physical information about a property's history and existing condition. Broadly recognized as an effective part of preservation planning, a historic structure report also addresses management or owner goals for the use or re-use of the property. It provides a thoughtfully considered argument for selecting the most appropriate approach to treatment, *prior* to the commencement of work, and outlines a scope of recommended work. The report serves as an important guide for *all* changes made to a historic property during a project—repair, rehabilitation, or restoration—and can also provide information for maintenance procedures. Finally, it records the findings of research and investigation, as well as the processes of physical work, for future researchers.

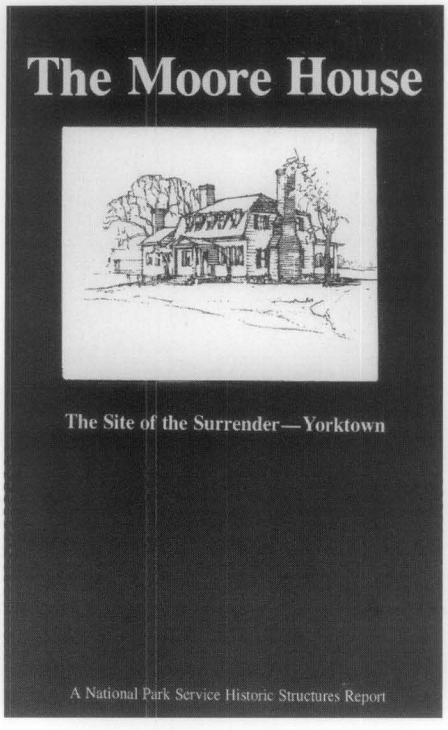


Figure 1. In the introduction to the first historic structure report in this country, Charles E. Peterson of the National Park Service wrote in 1935 "any architect who undertakes the responsibility of working over a fine old building should feel obligated to prepare a detailed report of his findings for the information of those who will come to study the structure in future years." Since then, thousands of historic structure reports (HSRs) have been prepared to help guide work on historic properties. Photo: National Parks and Conservation Association.

A historical "first." The first historic structure report prepared in the United States, *The Moore House: The Site of the Surrender—Yorktown*, was written by Charles E. Peterson of the National Park Service in the early 1930s (Fig. 1). In the decades since the Moore House report was completed, preservation specialists commissioned by owners and managers of historic properties have prepared thousands of reports of this type. Similar studies have also been used for many years as planning tools in France, Canada, Australia, and other countries, as well as in the United States. Although historic structure reports may differ in format depending upon the client, the producer of the report, the significance of the structure, treatment requirements, and budgetary and time restrictions, the essential historic preservation goal is the same.

> *Just as an art conservator would not intervene in the life of an artistic artifact before obtaining a thorough knowledge of its history, significance, and composition, so those engaged in the preservation of buildings . . . should proceed only from a basis of knowledge. Too often in the past, the cultural integrity of countless buildings . . . has been compromised by approaches to restorations grounded on personal whim, willful romanticism, and expedient notions of repair . . . . The preparation of a historic structure report is the first step in adopting a disciplined approach to the care of a historic building.*[1]

In response to the many inquires received on the subject, this Preservation Brief will explain the purpose of historic structure reports, describe their value to the preservation of significant historic properties, outline how reports are commissioned and prepared, and recommend an organizational format. The National Park Service acknowledges the variations that exist in historic

structure reports and in how these reports address the specific needs of the properties for which they have been commissioned. Thus, this Brief is written primarily for owners and administrators of historic properties, as well as architects, architectural historians, and other practitioners in the field, who have limited experience with historic structure reports. It also responds to the requests of practitioners and owners to help define the scope of a historic structure report study.

Guiding the Treatment of Significant Historic Properties

A historic structure report is generally commissioned by a property owner for an individual building and its site that has been designated as historically or architecturally significant, particularly buildings open to the public, such as state capitols, city halls, courthouses, libraries, hotels, theaters, churches, and house museums (Fig. 2). It is certainly possible, but is less common, to prepare a historic structure report for a privately owned residence.

Besides the building itself, a historic structure report may address immediate site or landscape features, as well as items that are attached to the building, such as murals, bas reliefs, decorative metalwork, wood paneling, and attached floor coverings. Non-attached items, including furniture or artwork, may be discussed in the historic structure report, but usually receive in-depth coverage in a separate report or inventory. One significant property may include multiple buildings, for example, a house, barn, and outbuildings; thus, a single historic structure report may be prepared for several related buildings and their site.

Historic structure reports can be prepared for other historic resource types as well, including bridges, canals, ships, mines, and locomotives, which are categorized as structures by the National Register of Historic Places; sculpture and monuments, which are categorized as objects; and college campuses and industrial complexes, which are categorized as districts (Fig. 3). For battlefields, gardens, designed landscapes, and cemeteries, which are categorized as sites, parallel evaluation and investigation is usually undertaken through a separate document called a cultural landscape report.

Figure 2. Historic structure reports are prepared for many types of structures with various intended uses. Examples include courthouses and state capitols still serving their historic function (upper left, Wisconsin State Capitol, Madison); significant properties that are to be rehabilitated and adaptively reused (center left, New York Merchants' Exhange, from former bank headquarters to hotel); and properties that are to be restored as house museums (lower left, Willa Cather Childhood Home, Red Cloud, Nebraska). The scope of such studies includes the interior as well as exterior of the historic structure (lower right, Stanley Field Hall, Field Museum, Chicago). Photos: upper and lower left, Wiss, Janney, Elstner Associates, Inc.; center left, Jan Hird Pokorny Associates, Inc.; lower right, McGuire Igleski & Associates, Inc.

Figure 3. The University of Vermont has more than thirty contributing buildings in four historic districts listed in the National Register of Historic Places. The Campus Master Plan recognizes a commitment to respect and maintain the historic integrity of these facilities. Historic structure reports are available for many of the University's historic structures. Photo: University of Vermont Historic Preservation Program.

A team approach. With such an array of subject matter, it is not surprising that preparation of a historic structure report is almost always a multi-disciplinary task. For a small or simple project, the project team may include only one or two specialists. For a complex project, a team may involve historians, architectural historians, archeologists, architects, structural engineers, mechanical engineers, electrical engineers, landscape architects, conservators, curators, materials scientists, building code consultants, photographers, and other specialists. The disciplines involved in a specific historic structure report reflect the key areas or issues to be addressed for the particular property. The project leader or designated principal author for the report is responsible for coordinating and integrating the information generated by the various disciplines. Designation of a principal author may depend on the goals of the historic structure report and on which disciplines are emphasized in the study.

Figure 4. For small or simple projects, the project team may include only one or two specialists while complex projects may involve a large number of investigators and specialists. For example, evaluation of this barn may primarily involve a historian, an architectural conservator, and a structural engineer. Photo: Wiss, Janney, Elstner Associates, Inc.

Value of the Historic Structure Report

The completed historic structure report is of value in many ways. It provides:

- A primary planning document for decision-making about preservation, rehabilitation, restoration, or reconstruction treatments
- Documentation to help establish significant dates or periods of construction
- A guide for budget and schedule planning for work on the historic structure
- A basis for design of recommended work
- A compilation of key information on the history, significance, and existing condition of the historic structure
- A summary of information known and conditions observed at the time of the survey
- A readily accessible reference document for owners, managers, staff, committees, and professionals working on or using the historic structure
- A tool for use in interpretation of the structure based on historical and physical evidence
- A bibliography of archival documentation relevant to the structure
- A resource for further research and investigation
- A record of completed work

Benefits for large-scale and long-term projects. In the development of any historic structure report, the scope of work and level of detail are necessarily adjusted to meet the requirements of a particular project, taking into account the property's significance, condition, intended use, and available funding. This does not mean that every significant historic property requires—or receives—a comprehensive investigation and detailed report. Some historic structure reports are of very limited scope. It may be necessary for a project to proceed without a historic structure report, either because of the cost of the report or a perceived need to expedite the work.

Most large-scale or long-term work projects would benefit greatly from the preparation of such a report—and not only from the value of the report as an efficient planning tool. (See box above.) If work proceeds without a historic structure report to guide it, it is possible that physical evidence important to understanding the history and construction of the structure may be destroyed or that inappropriate changes may be made. The preparation of a report prior to initiation of work preserves such information for future researchers. Even more importantly, prior

Figure 5. At the Hudson Opera House, a multi-arts center in Hudson, New York, the historic structure report was prepared incrementally. The first phase of the report focused on assessment and recommendations for repair of the roofing, the most critical issue in preservation of the building. Photo: Gary Schiro.

preparation of a report helps ensure that the history, significance, and condition of the property are thoroughly understood and taken into consideration in the selection of a treatment approach and development of work recommendations. One of the goals of a historic structure report is to reduce the loss of historic fabric or significance and to ensure the preservation of the historic character of the resource.

When to Prepare the Report

Optimal first phase. The historic structure report is an optimal first phase of historic preservation efforts for a significant building or structure, preceding design and implementation of preservation, rehabilitation, restoration, or reconstruction work. Information contained in the report documents existing conditions and serves as a basis for proposing physical changes. As additional information is learned relevant to the history of the building, and as work on the historic structure is implemented, the report can be amended and supplemented.

The length of time required to prepare a historic structure report and the budget established for its development will vary, depending on the complexity of the project, the extent and availability of archival documentation, and to what extent work has already been performed on the building. If the scope of a historic structure report for a simple building is limited to a brief overview of historic significance, a walk-through condition assessment, and general treatment, the study and report may be completed within a few months' time by an experienced investigator. On the other hand, a historic structure report for a larger building with numerous past alterations and substantive problems will require extensive research and on-site study by a multidisciplinary team. This type of report can often take up to two years to complete.

Determining the Scope of Work

The following questions should be answered to determine the scope of work required for the study:

- Is the building's history well understood?
- Has the period of significance been established?
- Does the building represent a variety of periods of construction, additions, and modifications, not all of which may be significant?
- What archival documentation is available?
- Does the building have physical problems that require repair? What construction materials and systems are known to exhibit distress or deterioration?
- Does the building have code or functional problems that interfere with its use?
- Is the building in use? Is a new or more intensive use planned?
- Is funding available to commission the report needed to address these requirements? If not, can the scope of the report be reduced to answer critical questions in a limited report?
- Has the time frame for the overall project been established?

Incremental preparation. If budgetary constraints preclude completing the historic structure report as one project, it can be prepared incrementally (Fig. 5). The work recommendations should not be developed or implemented prior to completion of research and investigation, except for emergency stabilization to prevent immediate failure or damage, or temporary measures to address critical health and safety issues. A partial historic structure report can be completed in preparation for anticipated work that must be initiated to preserve or protect the building. This type of report includes analysis of only those building elements and systems that may be affected by the proposed work, and involves only the specialists needed to address the types of investigation and work planned. For example, research and documentation of existing interior finishes may be required before undertaking localized structural stabilization that will require removal of interior materials.

In undertaking such work prior to the completion of a historic structure report, caution should be taken not to alter or unnecessarily remove changes to the building that had occurred over time. The completed report may conclude that such changes to the building may have acquired significance in their own right and therefore merit preservation.

Documenting past work. Sometimes a historic structure report is initiated when repair or restoration work on the historic building has already been completed. Although it is always recommended that the study be done prior to new work, in this case, the report needs

to document—as fully as possible—the condition and appearance of materials, elements, and spaces as they existed *prior* to the work performed. The extent to which this can be achieved depends on the quality of archival documentation available and physical recording undertaken prior to the completed work. The report should describe the nature and extent of the past repair or restoration work, and, if possible, should also document research performed, reasons for design decisions made, and the construction process for the work already completed on the structures.

Commissioning a Report

Commissioning a historic structure report requires answering a series of questions to establish the scope of work. (See sidebar.) The goals of the report need to be defined and the report should be designed to support planning for the future of the historic structure. This effort may involve gathering information to answer questions about what is significant about the building and site; what uses are appropriate for the building, or whether existing uses need to be modified; what known conditions require repair and whether those repairs are urgent; and what short-term and long-term goals need to be addressed. Finally the available budget for the historic structure report project should be established before a request for proposals is issued.

The procedures for preparing a historic structure report and the outline of report content and organization can serve as the basis to develop a scope of work for the study and also to solicit proposals for a report that reflects the requirements of the specific structure, and, of course, the available budget. Although the request for proposals should always establish such a scope of work, firms may be invited to suggest adjustments to the scope of work based on their past experience. The request for proposals should require a qualifications submittal from each proposer. This submittal should include resumes for the principal investigators and a description of experience in preparing historic structure reports or similar studies, as well as experience with buildings of similar type, age, and construction to the subject of the study. References and samples of work may be requested from the proposer as part of this submittal. An interview with one or more candidates is highly recommended, both so that the proposers can present their project approach and qualifications, and so that the client can ask questions in response to the submitted proposal.

How Much Will It Cost?

The cost of undertaking a historic structure report is determined by numerous factors, some of which may be unique to a particular property. Common to most projects, however, are seven factors that help determine the cost of a report:

1. The *level of significance* of the property will certainly influence the cost. That is, a property that is nationally significant would likely require a greater effort than a property that is only locally significant.

Figure 6. Historical photographs are an invaluable aid and time saver in establishing a building's original construction and evolution; in guiding the replication of missing features; and even in understanding existing material deterioration. The availability of information, such as archival photographs, surviving original architectural drawings, or HABS documentation, has a direct bearing on the cost of preparing a historic structure report. In this circa 1890 photo of the Rancho San Andrés Castro Adobe, the "lumbering up" on the south end is a character-defining feature of adobe construction, rarely seen today. Photo: Historic photograph from the Historic Structure Report for Rancho San Andrés Adobe by Edna Kimbro, State Historian, California State Parks, Monterey District.

2. The *treatment and use* for which the historic structure report information provides a basis is an important cost consideration. If the decision is reached to maintain a building in its current form, the level of effort required in preparing a historic structure report would be less than where the intended treatment is a comprehensive restoration. A change in building use likewise may increase the level of effort; for example, the additional work involved in addressing different building code provisions.

3. The *availability of information* about the historic resource has a direct bearing on costs. Some historic structures are well researched, and drawings may have been prepared to exacting standards, while others may require considerable original research and investigation to establish the evolution of the structure (Fig. 6). On occasion, a property owner's in-house staff or volunteers may undertake further research in advance of a contracted study as a way to reduce the cost of the report.

4. The *location of and access to a historic building* is a cost factor for some studies. A property in a remote mountain location can involve high travel costs relative to properties in or near an urban area. A structure requiring special techniques for exterior physical inspection would involve higher access costs than a small residential structure (Fig. 7).

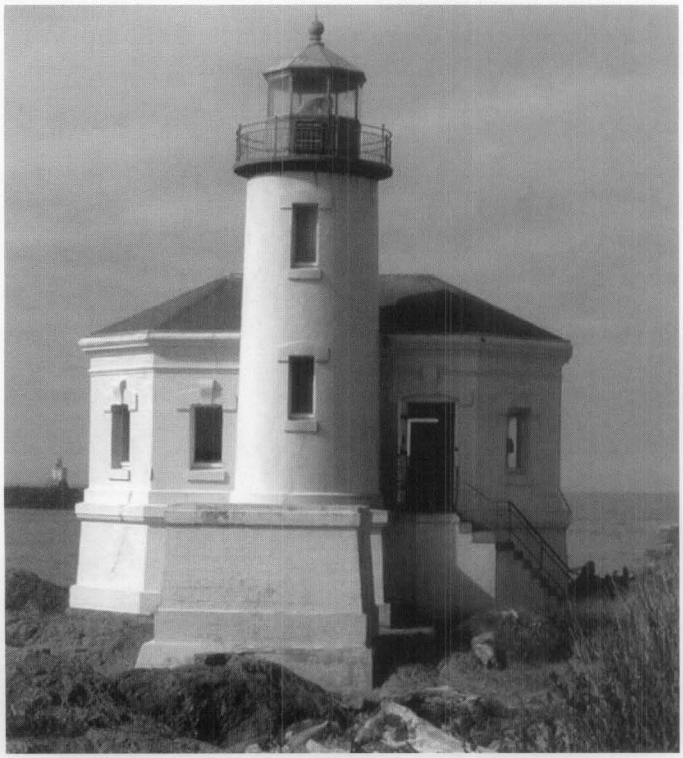


Figure 7. Numerous factors influence the cost of preparing a historic structure report including the level of significance, size, and complexity of the property; required treatment and use; existing condition; and the location and access to the structure. Historic structure reports were prepared for several small lighthouses along the Oregon coast, including the Coquille River Lighthouse, shown here. Photo: Wiss, Janney, Elstner Associates, Inc.

Collecting Information for the Report

A typical study involves:

- Preliminary walk through
- Research and review of archival documentation
- Oral histories
- An existing condition survey (including exterior and interior architectural elements, structural systems, mechanical and electrical systems, etc.)
- Measured drawings following the *Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation*
- Record photography
- Selected materials studies (e.g., mortar analysis, finishes analysis, etc.)
- Evaluation of significance
- Discussion with the owner and users about current and future intended uses for the structure
- Selection and rationale for the most appropriate treatment approach (preservation, rehabilitation, restoration, or reconstruction)
- Development of specific work recommendations

5. The *size and architectural character* of a property affect the time required to prepare a historic structure report. A simple four-room vernacular structure would usually involve less effort than a complicated high-style courthouse with many significant spaces.

6. The *physical condition of the structure* and also the *extent of physical fabric that is accessible for study* will be cost determinants as well. Obviously, a property in good condition is usually less problematic than one in a deteriorated state. For a structure that was continuously occupied and where alterations cover earlier fabric, the opportunity to extract information from physical fabric dating to early periods may be limited without extensive removals that are usually beyond the scope of the historic structure report study. Even where buildings are vacant, there are instances where certain physical investigations may need to be limited because of the destructive impact that will occur to historic fabric.

7. The *type of final report* that is required can significantly affect the cost of the project, but is an area where costs can readily be controlled. Historic structure reports do not necessarily need to be professionally bound and printed. In-house desktop publishing has become commonplace, and a formal work product can often be obtained without excessive costs. Overly sophisticated printing and binding efforts represent a misplaced funding allocation for most historic

properties. There are distinct advantages to having a report prepared in an appropriate electronic form, thus reducing the number of hard copies and facilitating future updates and additions to the report. For most properties where historic structure reports are prepared, ten or so hard copies should suffice. Providing one copy of the report in a three-ring binder is a helpful and inexpensive way to furnish the owner with a "working" copy of the document.

Suggested steps for collecting information prior to configuring the data into the actual report are as follows:

Preliminary walk through. A preliminary walk through of the building and its site with the owner or site manager, appropriate building staff representatives, and key members of the historic structure report team is important to review the project scope of work. During the walk through, a brief review of existing conditions can be performed to highlight user concerns and gather information about distress and deterioration observed. Building staff may also be able to provide information on recent repairs, current maintenance procedures, and specific areas of active deterioration. A brief review of existing documentation available on site is also useful. Site personnel may be able to recommend additional archival resources.

Historical research. Archival research should be directed toward gathering information on the building's history, original construction and later modifications, occupancies, and uses over time (Fig. 8). Research for the report is not intended to produce a large compendium of historical and genealogical material, but rather selected information necessary to understand the evolution of the structure, its significance, and justification for the treatment selected. For significant sites where other types of studies such as archeological investigations or a cultural landscape report have been completed or are underway, coordination is required to ensure that research information is shared and that the research effort is not duplicated.

If a National Register nomination or other inventory has already been completed for the building and its site, the bibliography of that document may suggest possible sources for further research. In addition, a completed National Register nomination can serve as a starting point for development of the historic structure report sections on history and significance, and can be included in the appendix of the report.

Public and university libraries, and state and local historical societies, are likely sources of relevant materials. Municipal records collections often contain deed and building permit information that is useful in developing a chronology of ownership and construction. Architectural, engineering, and construction documents, shop drawings, repair documents, and maintenance records are valuable sources of information. The original

Figure 8. Historical research is directed toward gathering information on a structure's history, original construction and later modifications, occupancies, and uses over time. Research may range from national repositories such as the Library of Congress to local collections or private family records. Old newspapers, architectural journals, and even manufacturing trade catalogs can be surprising sources of historical accounts and illustrations. This circa 1902 photograph of New York's Flatiron Building is of the construction in progress; such photographs are useful in understanding building chronology as well as concealed conditions of as-built construction such as building framing. Photo: Library of Congress, LC-D401-14278. The interior photograph of the former Bemir Drug Store in Rochester, New York, showcases a rubber tile floor as illustrated in a 1925 publication by the United States Rubber Company.

drawings and specifications, if extant, may be kept at the archives of the historic building but may also have been retained by the firm that designed the building or successor firms. Building records and other archival documentation may have remained with the structure or site, with previous owners, or with related properties.

Historic photographs are invaluable in developing a chronology of building changes and in determining the character and detailing of missing elements (Fig 9). Photographs in private collections, not intended as formal documentation, can often be useful. For example, family photographs taken outdoors can document a building that appears in the background. Renderings and paintings can also be useful, but these images must be carefully analyzed and compared with other information to ensure accurate interpretation. Correspondence and oral histories can be important additions to the overall information, but may be unreliable and should be confirmed, when possible, by comparison with photographic documentation and physical evidence.

Fire insurance maps, such as Sanborn maps, can provide information on type of construction materials. When maps from different years are available, these can be useful in developing a chronology of additions and other changes to the structure.

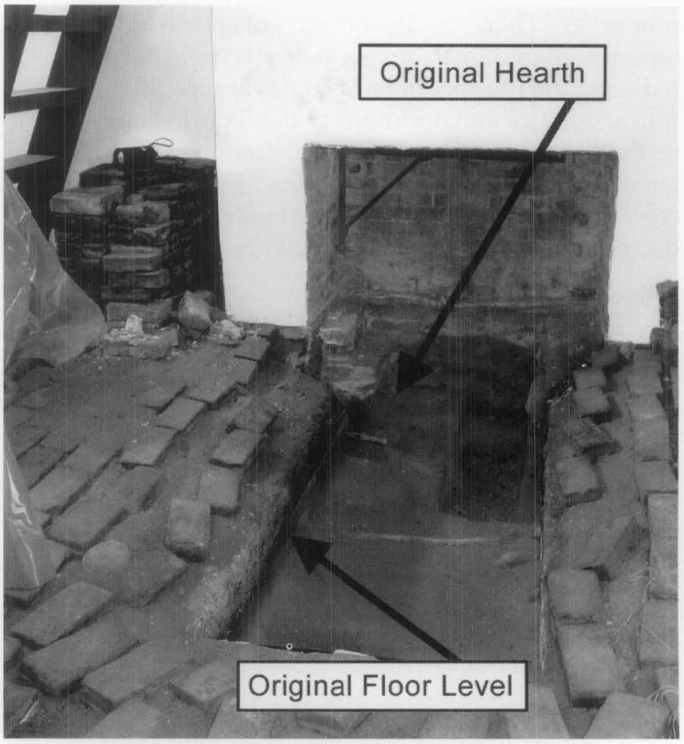


Figure 10. Archeological studies may be valuable in uncovering important evidence of changes to a historic structure. Following historical research and after several archeological soil probes, a decision was made to excavate an area in front of a mid-nineteenth century fireplace, revealing the original dirt floor and hearth undetected by earlier restoration efforts. Photo: Kaaren Staveteig, National Park Service.

Existing condition survey. A survey is performed to document physical spaces and elements, and to assess the current condition of building materials and systems. In conjunction with historical research, the condition survey helps determine the historic integrity of a structure. The survey and inspection should address the building's exterior and interior materials, features and finishes; structural systems; interior spaces; mechanical, electrical, and plumbing systems; and fire detection and security systems. Further study may be required such as non-intrusive or intrusive investigation, field testing, sample removal, and laboratory testing and analysis of materials.

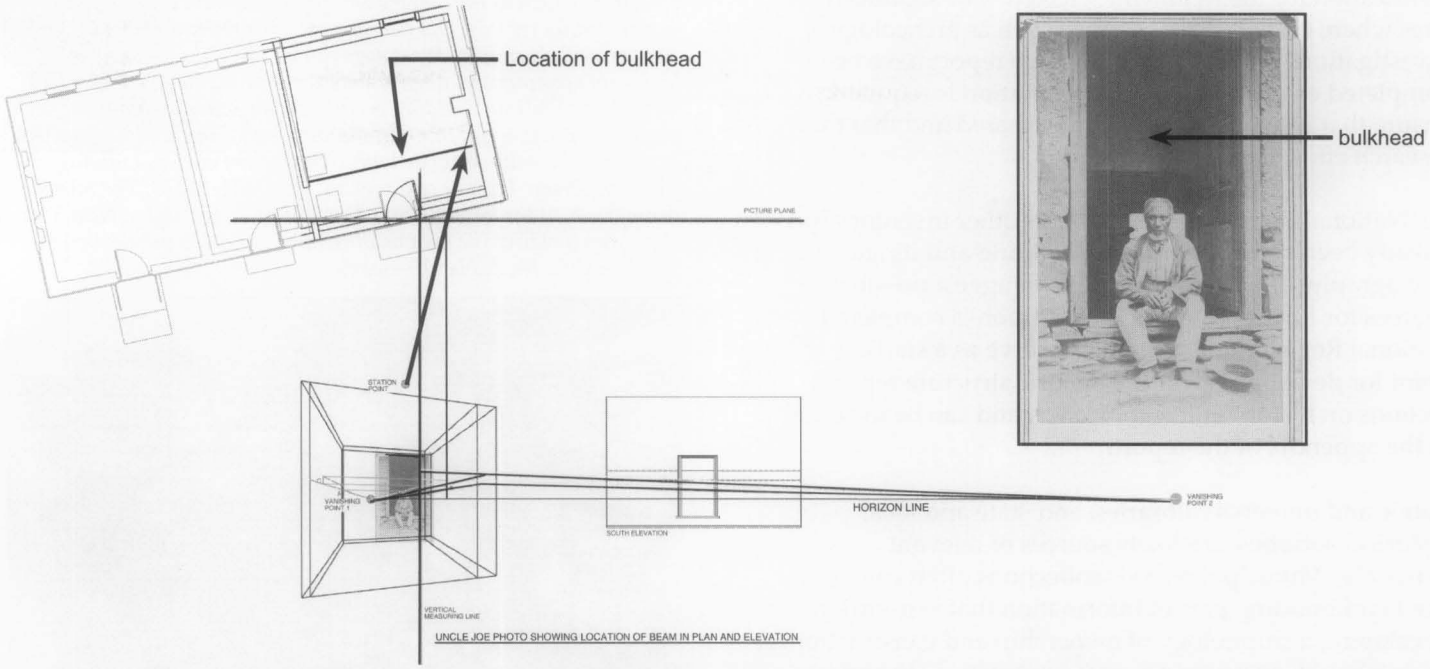


Figure 9. A CADD perspective analysis facilitated study of the location of a long removed interior bulkhead wall. The bulkhead appears in a historic exterior photograph of a man seated in the door entrance to a mid-nineteenth century plantation dependency. Drawing: John Volz & Associates, Inc.; historic photo: National Park Service files.

Archeological investigations can provide information on the locations of building foundations and other sub-grade building elements, and can also assist in developing information on the function of adjacent site areas, building elements, and previously unfinished floor spaces (Fig. 10). The survey may also address the immediate site landscape, if this is not covered in a separate cultural landscape report.

Information gathered during the survey can be documented with field notes on baseline drawings consisting of field sketches or measured drawings. In addition, documentation can include photographs (35-mm, large format, digital, perspective-corrected, and scale-rectified photographs; photogrammetry; and laser techniques), sketches and measured drawings, computer-aided design and drafting (CADD), video records, and written notes and field measurements. Depending upon project requirements, documentation may need to be prepared to archival standards regarding paper, photographs and negatives, electronic records, and backup data.

Measured drawings and record photography. The collection of the Historic American Building Survey/ Historic American Engineering Record (HABS/HAER) archive at the Library of Congress should be searched in case the property has been previously documented through drawings and photographs. While many historic properties have been documented since the start of this invaluable collection in the 1930s, it is still more likely that this type of documentation does not exist for a property for which a historic structure report is being undertaken. Preparation of such documentation to portray the current condition of a property can be an invaluable addition to the historic structure report. Besides serving as a documentary record of a structure, the recording documents can serve another purpose such as an easement document, information for catastrophic loss protection, interpretive drawings, or baseline drawings for proposed work. If undertaken as part of the current building study, the measured drawings and record photography should follow the *Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation.*

Materials investigation and testing. Field examination and testing of building material may include non-destructive (non-intrusive) or, where necessary, destructive (intrusive) examination and/or testing of materials, components, and systems (Fig. 11). Examples of non-destructive methods of field examination and testing include field microscopy, the use of a metal detector to locate concealed metal elements, and X-ray techniques to assess concealed conditions. Some examples of destructive methods of field examination and testing include structural testing, strain relief testing, and inspection openings (probes). Instruments such as a borescope, through which concealed conditions can be viewed through a small hole, permit

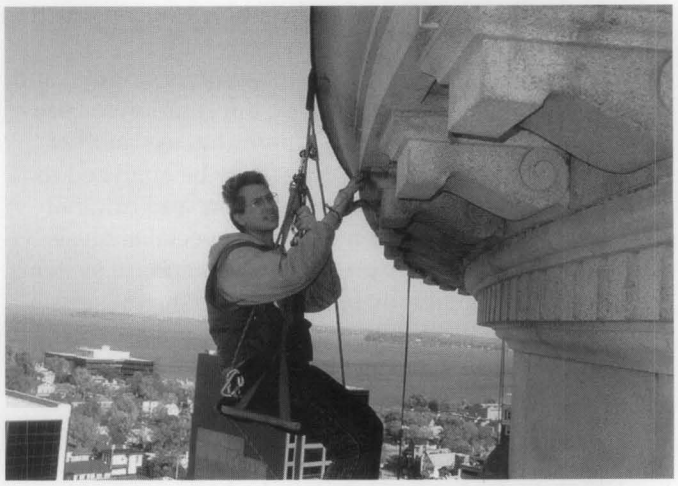
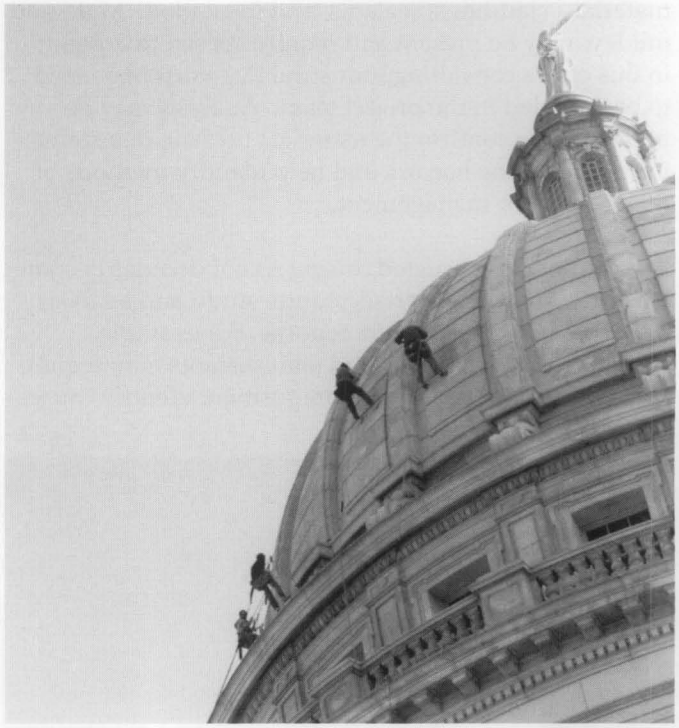


Figure 11. The use of special access methods may be necessary for close-up investigation of building elements. At the Wisconsin State Capitol, project architects and engineers used rappelling techniques. Photo: Wiss, Janney, Elstner Associates, Inc.



enhanced examination while limiting damage to the existing building fabric.

Depending upon existing conditions and the results of the site inspection, field monitoring may be required. Field monitoring can include humidity and temperature monitoring, documentation of structural movement and vibrations, light level monitoring, and other environmental monitoring.

In addition, materials samples may be removed for laboratory studies. A wide range of laboratory testing may be appropriate to establish the composition of various construction materials, determine causes of deterioration, and identify and assess appropriate conservation and repair measures (Fig. 12). Materials analysis may also be helpful in dating changes to the

structure and in developing a chronology of construction (Fig. 13). For example, mortar analysis may be performed to determine the composition of original and repointing mortars and to provide information for use in designing a mortar mix for repointing. As another example, paint and other coatings may be analyzed to determine finish types and composition, and original and subsequent color schemes, using special analysis techniques and comparison with color standard systems. Samples should generally be returned to the owner and retained in case future testing is required. In some cases, it may be appropriate to reinstall the samples after materials studies have been completed.

Sample removal and analysis may also be required to identify hazardous materials, which are present in many historic buildings. For example, lead and other heavy metals are components of many older paints and coatings, and asbestos is a constituent of some roofing materials, claddings, sealants, and insulation. Mold and mildew may be present and require special treatment; in this case a consulting industrial hygienist may need to be included in the project team. Analysis may be performed to confirm the materials present, determine the nature of the hazard, and help identify methods of remediation or management.

As buildings constructed during recent decades become "historic," newer materials require study and analysis as part of historic structure reports. For example, curtain wall components and joint sealants may require analysis to determine their composition, identify causes

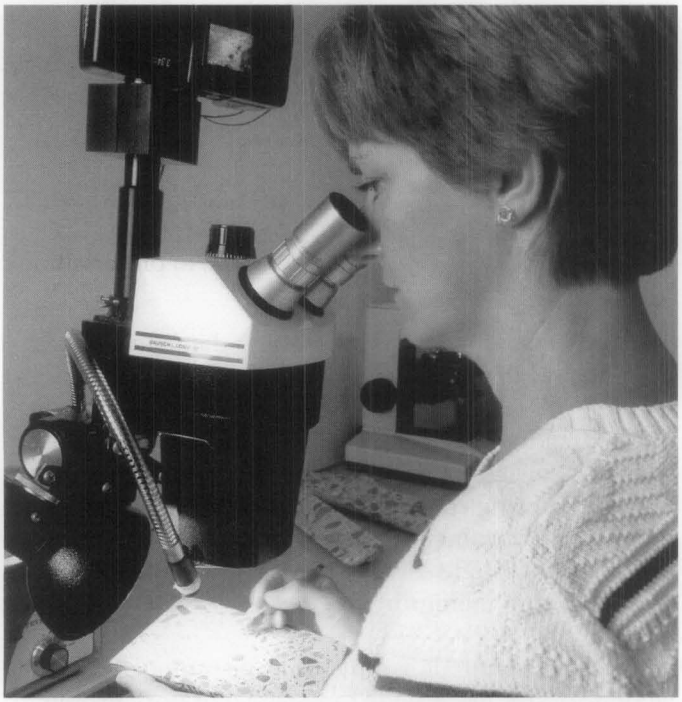


Figure 12. Field and laboratory studies of construction materials may be performed as part of a historic structure report. Laboratory studies of samples removed from the building may include a range of chemical and physical testing and evaluation. Here, a petrographer uses a stereomicroscope to examine concrete specimens. Photo: Wiss, Janney, Elstner Associates, Inc.

Figure 13. Paint studies may not only help establish the chronology of paints and paint colors used on a building but also may aid in the dating of existing architectural features. Examination of the paint layers on these modillions utilizing a hand-held microscope enabled an investigating team to confirm in the field which modillions were original and which were later replacements. Photo: Charles Fisher, National Park Service.

of deterioration, and select appropriate replacement sealants. Composite materials and plastics, present in post-World War II buildings, may also require special effort to determine repair techniques or appropriate materials for replacement.

All of the information gathered during the physical investigation, and through field testing and laboratory analysis, should be documented in field notes, sketches, photographs, and test reports. This information is incorporated in the historic structure report and provides a basis for the development of treatment recommendations.

Evaluation of significance. The process of evaluation occurs throughout the study of the historic structure as information is gathered, compared, and reviewed. Historical data and physical evidence are reviewed to help evaluate the historical, architectural, engineering, and cultural significance of the property, its construction and use, and occupants or other persons associated with its history and development. This evaluation includes determination of the period(s) of primary significance. An overview of the building's history and an assessment of its significance are included in the report.

Depending on the historical significance of the property, and whether a detailed history has already been written,

The Secretary of the Interior provides four distinct but interrelated approaches to the treatment of historic properties.

Preservation focuses on the maintenance and repair of existing historic materials and retention of a property's form as it has evolved over time.

Rehabilitation acknowledges the need to alter or add to a historic property to meet continuing or changing uses while retaining the property's historic character.

Restoration is undertaken to depict a property at a particular period of time in its history, while removing evidence of other periods.

Reconstruction re-creates vanished or non-surviving portions of a property for interpretive purposes.

a brief or more detailed history may be appropriate. A chronology of construction and changes to the building, developed through historic and physical research, is an effective approach to identifying original building elements, as well as modifications that have occurred over time. If a comprehensive National Register nomination or other inventory has been prepared, the significance may already be defined. In other cases, the significance of a building and even its treatment may have been established through authorizing legislation or through the charter of an organization or foundation that owns the historic property. Where appropriate, however, the building's significance should be re-evaluated in light of research performed for the historic structure report.

The results of the research, investigation, and field and laboratory testing are reviewed as a basis for developing specific work recommendations. The history and significance of the building and its site are evaluated to understand what spaces, elements, and finishes are of architectural or historical importance, and to confirm the overall project goals and treatment direction. The physical condition of the building and its systems is evaluated with regard to existing deterioration and distress, and needed repairs, as well as changes required to meet treatment goals. Attention is given to identification of life safety issues and code considerations. Conditions are also identified that could lead to future safety risks, loss of historic fabric, or loss of performance.

Selection of a treatment approach. Once the building's history, significance, and physical condition have been researched and investigated, an appropriate treatment is usually selected (Fig. 14). Depending upon the intended use of a property, funding prospects, and the findings of the investigation, it may be necessary in some cases to identify and discuss an alternate treatment as well. For example, a building currently occupied by caretakers that is a candidate for restoration and use as a museum may require such ambitious funding support that, for the foreseeable future, a more practical treatment could be to preserve the building and retain the caretakers. In this case, the treatment recommendation would be to restore the property and project work relevant to the restoration would be described. However, the alternate treatment (in this instance an interim one) of preserving the building in its current form would also be described, including discussion of work appropriate to preservation such as repairing the existing roof and installing a monitored fire detection system.

Figure 14. The treatment approach selected for a building usually is determined by the intended use of a property, funding prospects, and the findings of an investigation. The Wolf Creek Inn, operated by the Oregon Parks and Recreation Department, is among the most intact and oldest active travelers' inns in Oregon. The historic structure report outlined a rehabilitation treatment which included such work recommendations as repairs to specific historic fabric, landscape restoration and site improvements, and upgrading of the building's mechanical and electrical systems. Photo: Historic American Building Survey, 1934.

In selecting an appropriate treatment, the Secretary of the Interior's Standards for the Treatment of Historic Properties can be particularly helpful. (See sidebar.) In use for more than twenty-five years, the Standards are a widely accepted means of planning for and undertaking project work in a manner that preserves historic materials and elements. The Secretary's Standards have been adopted by many state and local review

entities for review of work proposals on historic structures.

The Standards and their accompanying Guidelines describe four different options for treatment and list recommended techniques for exterior and interior work consistent with each option. One treatment (preservation, rehabilitation, restoration, or reconstruction) is usually selected and followed throughout the course of a project involving a particular building. Application of a single treatment approach helps to avoid inappropriate combinations of work, such as restoring a building's appearance to an earlier time in history while simultaneously constructing a new addition.

Figure 15. The historic structure report for the Hotel Florence, shown here in 1886 (upper), 1963 (center), and 2004 (lower) views, provided a basis for stabilization and repair work which has been completed. Initial phases of work addressed preservation of the building envelope, structural repairs, and limited mechanical and electrical improvements. The report also provided recommendations for future rehabilitation work that will be implemented in phases as funding becomes available. Photos: upper and center, Historic American Building Survey; lower, Wiss, Janney, Elstner Associates, Inc.

Development of work recommendations. The work recommendations are a central feature of the report. They are developed only after the research and investigation has been completed and the overall project goal established as to whether a particular building should be preserved, rehabilitated, restored, or reconstructed. The specific work recommendations need to be consistent with the selected treatment. If analysis performed during the study suggests that the approach or use initially proposed would adversely affect the materials, character, and significance of the historic building, then an alternate approach with a different scope of work or different use may need to be developed. The process of developing work recommendations also needs to take into account applicable laws, regulations, codes, and functional requirements with specific attention to life safety, fire protection, energy conservation, abatement of hazardous materials, and accessibility for persons with disabilities.

In addition to project goals, the proposed work is also guided by the building's condition. The scope of recommended work may range from minor repairs to structural stabilization to extensive restoration. In addition, the scope of work may be very narrow (e.g., priming and painting of woodwork and repair of deteriorated roof flashings), or very extensive (e.g., stabilization of timber framing or major repair and repointing of exterior masonry walls). The result of implementing (or not implementing) the recommended work needs to be considered as the recommendations are developed.

Of course, the available project budget is also a factor in determining the extent of recommended work and whether it must be accomplished in several phases or projects. Whether or not available budget is the primary factor in determining the extent of work that can be performed, it is often useful to prioritize recommended work items. The recommended tasks can be examined in terms of relative importance and the time required for implementation. Prioritizing repairs can be critical where immediate or short-term work is needed to stabilize a building or structure, eliminate safety hazards, make the building weather tight, and protect it against further deterioration (Fig. 15).

Appropriate procedures for undertaking the recommended work items are described in the historic structure report and are intended to serve as a basis for planning the repair, rehabilitation, or restoration design. The level of detail to which the work items are defined should be limited in the historic structure report, as these

recommendations serve as the foundation for, rather than in place of, design and construction documents for the work. For example, baseline drawings annotated with existing condition notes can later serve as a starting place for development of construction drawings. Outline procedures provided in the report for recommended work items can be used later to develop specifications for the work. Finally, a general opinion of probable costs associated with the recommended work is often prepared. A cost estimate is useful to building owners and managers in budget planning and also assists in prioritizing the work. For large or complex projects, the services of a professional cost estimator may be helpful in this effort.

Report Preparation. Upon completion of the research, physical investigation, evaluation, and work recommendations, the historic structure report is compiled. The principal investigator may submit an outline of the report for owner review at the beginning of the report preparation. A draft report may also be submitted for review when the report is partially complete, especially if there are many new research findings, significant physical distress conditions to be addressed, or complicated choices to be made in determining the treatment.

The report should be prepared in a style and format that is readily accessible and user-friendly; however, it is not essential that a standardized method or format be followed for all historic structure reports. The report can be primarily narrative or graphic, but is most typically a combination of these formats. Ease and economy of report preparation should be considered but should not take precedence over clarity and thoroughness of documentation.

Meetings and presentations. In addition to meetings with site personnel early in the study process, it is helpful for the project team to meet at key points during the research, investigation, and development of the historic structure report. For example, it is useful for the project team members performing archival research to meet with site personnel to review documents and findings, and to help ensure that important archival sources have not been overlooked. Project team members may also walk through the building with site personnel during the investigation phase to review and discuss existing conditions and possible recommendation approaches. When the report is in draft form, a meeting of the project team with those personnel who will be reviewing and using the report is useful to discuss overall goals, treatments, and recommendations as these are being developed. Finally, when the study is complete, a presentation of the completed study by the project team helps to familiarize the owner and building personnel with the report, highlight key issues, answer questions, and provide a transition to the use of the report as a working document by the building's caretakers.

Report Organization

The scope of the study—historical research, condition survey, investigation and testing, evaluation, selection of appropriate treatment, and development of specific work recommendations—generates a wealth of information about the history and condition of the building and the specific work needed to preserve, rehabilitate, restore, or reconstruct it. This information is typically a combination of historical and technical data obtained by different members of the project team and presented as an integrated report in text, photographs, drawings, and tables (Fig.16). The project leader or principal author must guide the development of the report so that key issues are addressed, information is

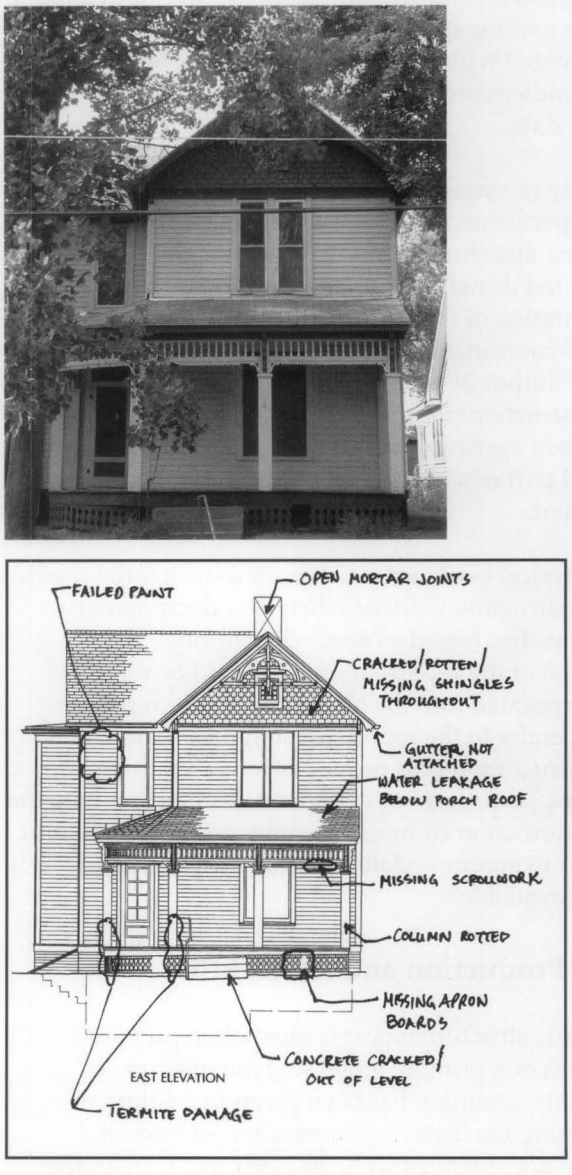


Figure 16. The historic structure report for the Noland House in Independence, Missouri, a vernacular house that is significant as part of the context of Harry S Truman's life and family in Independence, Missouri, includes photographs and measured drawings to record existing features and conditions of the building. The measured drawings will also provide a basis for construction documents for future preservation work. This photograph and drawing illustrate the front elevation of the house. Photo and drawing: Bahr Vermeer Haecker Architects.

documented and assimilated in the report findings and discussion, recommendations are clearly presented, and no information is lost or misinterpreted in the compilation process.

In order to integrate the many pieces of information into a coherent and comprehensive whole, the historic structure report is generally organized into two principal sections preceded by a brief introduction that summarizes overall findings and recommendations and provides project administrative data. The main sections of the report consist of (1) a narrative that documents the evolution of the building, its physical description, existing condition, and an evaluation of significance; and (2) a discussion of historic preservation objectives, together with recommendations for an overall treatment approach and for specific work. The report is usually supplemented with footnotes or endnotes, bibliography, and appendices of historical documentation and technical data.

It is highly recommended that a post project record of all work performed later be added as a supplement to the historic structure report. This record may consist of annotated drawings, photographs, and other documentation of the work performed. Site personnel may help coordinate this supplement or record if the principal author of the report is not involved in the later construction phase. Some organizations and government agencies consider the post project record to be a third part of a historic structure report and not just a supplement.

When physical evidence is discovered during the course of the construction work or when new documentary evidence is discovered as research continues after completion of the report, this also should be recorded and incorporated into the historic structure report or in an appendix to the report. An important goal of the historic structure report process is to maintain the report as an active and working document, both to facilitate the use of information compiled in the report and to permit the report to accommodate new information readily as it becomes available.

Report Production and Availability

The historic structure report is most often prepared in the form of a printed, illustrated manuscript. In recent years, attention has been given to creating or transforming the historic structure report into an electronic document as well. In electronic format, the report can easily be shared with interested parties and is readily updated.

However, because historic structure reports are still mostly produced in printed format (although sometimes concurrently with an electronic document), it is important that, after production, one or more copies be provided to the property owner and also made available to the project team. As the basis for design and construction documents, the historic structure report needs to be readily available and extensively used during implementation of the work. At least one site copy should be maintained in a physical format that can be readily updated, such as a three-ring notebook to which additional documentation can easily be added. Field documentation materials, including photographs and negatives, measured field drawings, condition reports and surveys, materials test reports, and other information gathered during the study can be stored in an archive by the building owner for future reference.

An archival copy should also be provided to the owner, and a minimum of one archival copy kept at the project site and at an appropriate local or regional archive, such as a state historical library. Copies of the historic structure report may also be provided to a local historical organization or university and the state historic preservation agency or historical society. In addition, a copy may be given to the National Trust for Historic Preservation Library at the University of Maryland at College Park, which has established a reference collection of historic structure reports.

Summary

Various agencies and organizations have employed historic structure reports as planning tools for many years, for example, the National Park Service, General Services Administration, New York State Office of Parks, Recreation and Historic Preservation, and the Society for the Preservation of New England Antiquities. These and other agencies and organizations may have specific requirements and procedures for reports prepared for properties under their stewardship that differ from those described in this Preservation Brief. All historic structure reports, however, share a common goal—the careful documentation and appropriate treatment of significant historic structures.

The historic structure report is an optimal first phase of historic preservation efforts for a significant building, preceding design and implementation of its preservation, rehabilitation, restoration, or reconstruction. If work proceeds without a historic structure report as a guide, physical evidence important to understanding the history and construction of the building may be destroyed. The preparation of a report prior to initiation of work provides documentation for future researchers. Even more importantly, prior preparation of a report helps ensure that the history, significance, and condition of the property are thoroughly understood and taken into consideration in the selection of an appropriate treatment and in the development of work recommendations. A well prepared historic structure report is an invaluable preservation guide.

Content and Organization of Report

Cover Page
Table of Contents
Introduction
    Study Summary
    Project Data
Part 1 - Developmental History
    Historical Background and Context
    Chronology of Development and Use
    Physical Description
    Evaluation of Significance
    Condition Assessment
Part 2 - Treatment and Work Recommendations
    Historic Preservation Objectives
    Requirements for Work
    Work Recommendations and Alternatives
Bibliography
Appendices
Supplemental Record of Work Performed
(section often added later)
    Completion Report
    Technical Data (on work completed)

Introduction. This section includes a concise account of research and investigation findings and recommendations for treatment and use, and a record of project administrative data.

- *Study Summary* - a brief statement of the purpose, findings, and recommendations of the study, including major research findings, key issues addressed by the study, and a summary of recommendations for treatment and use.
- *Project Data* - a summary of project administrative data (e.g., location, ownership, and landmark status of property) and the methodology and project participants.

Part 1 Developmental History. This section consists of a narrative report based on historical research and physical examination documenting the evolution of the building, its current condition and causes of deterioration, and its significance.

- *Historical Background and Context* - a brief history of the building and its context, its designers and builders, and persons associated with its history and development.
- *Chronology of Development and Use* - a description of original construction, modifications, and uses, based on historical documentation and physical evidence.
- *Physical Description* - a description of elements, materials, and spaces of the building, including significant and non-significant features of the building.
- *Evaluation of Significance* - a discussion of significant features, original and non-original materials and elements, and identification of the period(s) of significance (if appropriate).
- *Condition Assessment* - a description of the condition of building materials, elements, and systems and causes of deterioration, and discussion of materials testing and analysis (if performed as part of this study).

Part 2 Treatment and Work Recommendations. This section presents the historic preservation objective and selected treatment (preservation, rehabilitation, restoration, or reconstruction), requirements for work, and recommended work that corresponds with the defined treatment goal.

- *Historic Preservation Objectives* - a description and rationale for the recommended treatment and how it meets the project goals for use of the building, e.g., rehabilitation for a new use, restoration for interpretive purposes, etc.
- *Requirements for Work* - an outline of the laws, regulations, and functional requirements that are applicable to the recommended work areas (e.g., life safety, fire protection, energy conservation, hazardous materials abatement, and handicapped accessibility).
- *Work Recommendations and Alternatives* - a presentation of tasks recommended to realize the proposed treatment approach; evaluation of proposed solutions; and description of specific recommendations for work, including alternate solutions, if appropriate.

Notes, Bibliography and Appendices

- Footnotes or endnotes
- Bibliography, annotated if possible
- List of sources of information (e.g., archives, photograph collections)
- Appendices (e.g., figures, tables, drawings, historic and current photographs, reference documents, materials analysis reports, etc.)
- Index (if the report is particularly long or complex)

Supplemental Record of Work Performed. This section documents work performed, which may include planning studies, technical studies such as laboratory testing or structural analysis, or other investigation work that was not part of the scope of the original historic structure report, and records physical work on the building (construction documents, annotated drawings, photographs). The section is usually added later to update the report, as most historic structure reports are issued prior to implementation of the recommended treatment approach and specific work. It is sometimes referred to as Part 3 of the report.

- *Completion Report* - a record of the work accomplished, physical evidence discovered during construction, and how findings affect interpretation of the building.
- *Technical Data* - a collection of field reports, material data sheets, field notes, correspondence, and construction documents.

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[1] From the introduction to the *University of Virginia, Pavilion 1, Historic Structure Report*, Mesick Cohen Waite Hall Architects, 1988.

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47 PRESERVATION BRIEFS

Maintaining the Exteriors of Small and Medium Size Historic Buildings

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U.S. Department of the Interior

Heritage Preservation Services

Preservation is defined as "the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the *ongoing maintenance and repair* of historic materials and features rather than extensive replacement and new construction."[1]

Maintenance helps preserve the integrity of historic structures. If existing materials are regularly maintained and deterioration is significantly reduced or prevented, the integrity of materials and workmanship of the building is protected. Proper maintenance is the most cost effective method of extending the life of a building. As soon as a building is constructed, restored, or rehabilitated, physical care is needed to slow the natural process of deterioration. An older building has already experienced years of normal weathering and may have suffered from neglect or inappropriate work as well.

Decay is inevitable but deterioration can accelerate when the building envelope is not maintained on a regular basis. Surfaces and parts that were seamlessly joined when the building was constructed may gradually become loose or disconnected; materials that were once sound begin to show signs of weathering. If maintenance is deferred, a typical response is to rush in to fix what has been ignored, creating additional problems. Work done on a crisis level can favor inappropriate treatments that alter or damage historic material.

There are rewards for undertaking certain repetitive tasks consistently according to a set schedule. Routine and preventive care of building materials is the most effective way of slowing the natural process of deterioration. The survival of historic buildings in good condition is primarily due to regular upkeep and the preservation of historic materials.

Well-maintained properties tend to suffer less damage from storms, high winds, and even small earthquakes. Keeping the roof sound, armatures and attachments such as shutters tightened and secured, and having joints and connections functioning well, strengthens the ability of older buildings to withstand natural occurrences.

Over time, the cost of maintenance is substantially less than the replacement of deteriorated historic features and involves considerably less disruption. Stopping decay before it is widespread helps keep the scale and complexity of work manageable for the owner.

This *Preservation Brief* is designed for those responsible for the care of small and medium size historic buildings, including owners, property administrators, in-house maintenance staff, volunteers, architects, and maintenance contractors. The Brief discusses the benefits of regular inspections, monitoring, and seasonal maintenance work; provides general guidance on maintenance treatments for historic building exteriors; and emphasizes the importance of keeping a written record of completed work.

Getting Started

Understanding how building materials and construction details function will help avoid treatments that are made in an attempt to simplify maintenance but which may also result in long-term damage. It is enticing to read about "maintenance free" products and systems, particularly waterproof sealers, rubberized paints, and synthetic siding, but there is no such thing as maintenance free when it comes to caring for historic buildings. Some approaches that initially seem to reduce maintenance requirements may over time actually accelerate deterioration.

Exterior building components, such as roofs, walls, openings, projections, and foundations, were often constructed with a variety of functional features, such as overhangs, trim pieces, drip edges, ventilated cavities, and painted surfaces, to protect against water infiltration, ultraviolet deterioration, air infiltration, and

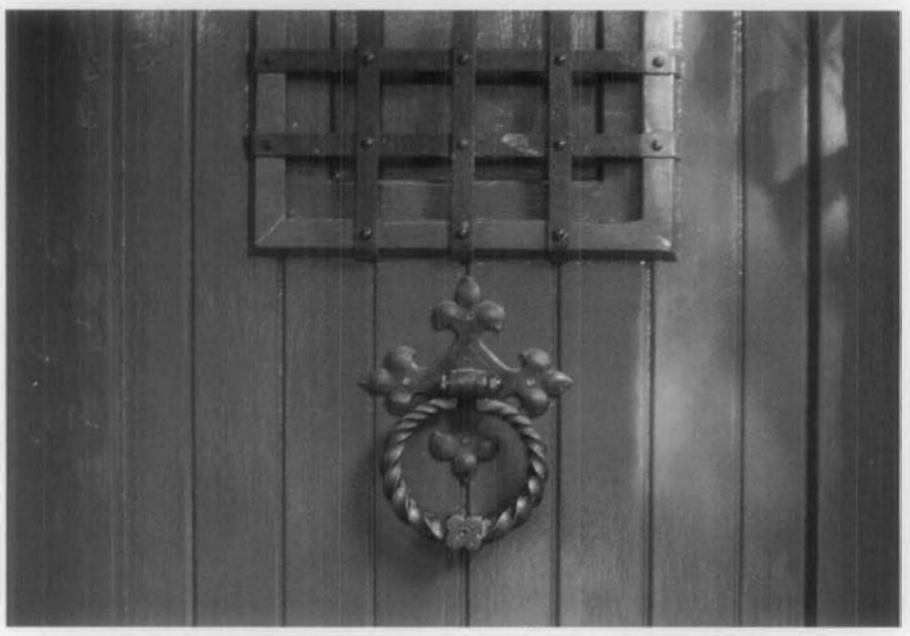

Figure 1. Maintenance involves selecting the proper treatment and protecting adjacent surfaces. Using painter's tape to mask around a brass doorknocker protects the painted door surface from damage when polishing with chemical compounds. On the other hand, hardware with a patinated finish was not intended to be polished and should simply be cleaned with a damp cloth.

Cautions During Maintenance Work

All maintenance work requires attention to safety of the workers and protection of the historic structure. Examples include the following:

• Care should be taken when working with historic materials containing lead-based paint. For example, damp methods may be used for sanding and removal to minimize air-borne particles. Special protection is required for workers and appropriate safety measures should be followed.

• Materials encountered during maintenance work, such as droppings from pigeons and mice, can cause serious illnesses. Appropriate safety precautions need to be followed. Services of a licensed contractor should be obtained to remove large deposits from attics and crawlspaces.

• Heat removal of paint involves several potential safety concerns. First, heating of lead-containing paint requires special safety precautions for workers. Second, even at low temperature levels, heat removal of paint runs the risk of igniting debris in walls. Heat should be used only with great caution with sufficient coverage by smoke detectors in work areas. Work periods need to be timed to allow monitoring after completion of paint removal each day, since debris will most often smolder for a length of time before breaking out into open flame. The use of torches, open flames, or high heat should be avoided.

• Many chemical products are hazardous and volatile organic compounds (VOC) are banned in many areas. If allowed, appropriate respirators and other safety precautions are essential for use.

• Personal protection is importan and may require the use of goggles, gloves, mask, closed-toed shoes, and a hard hat.

• Electrical service should be turned off before inspecting a basement after a flood or heavy rain, where there is high standing water.

pest infestation. Construction assemblies and joints between materials allow for expansion and contraction and the diffusion of moisture vapor, while keeping water from penetrating the building envelope. Older buildings use such features effectively and care must be taken to retain them, avoiding the temptation to reduce air infiltration or otherwise alter them.

Monitoring, inspections, and maintenance should all be undertaken with safety in mind. Besides normal safety procedures, it is important to be cognizant of health issues more commonly encountered with older buildings, such as lead-based paint, asbestos, and bird droppings, and to know when it is necessary to seek professional services (see sidebar).

Original building features and examples of special craftsmanship should be afforded extra care. The patina or aging of historic materials is often part of the charm and character of historic buildings. In such cases, maintenance should avoid attempts to make finishes look new by over-cleaning or cladding existing materials. As with any product that has the potential to harm historic materials, the selection of a cleaning procedure should always involve testing in a discreet location on the building to ensure that it will not abrade, fade, streak, or otherwise damage the substrate (Fig 1).

Maintenance Plan, Schedules and Inspection

Organizing related work into a written set of procedures, or a Maintenance Plan, helps eliminate duplication, makes it easier to coordinate work effort, and creates a system for prioritizing maintenance tasks that takes into account the most vulnerable and character-defining elements.

The first time a property owner or manager establishes a maintenance plan or program, it is advisable to have help from a preservation architect, preservation consultant, and/or experienced contractor. Written procedures should outline step-by-step approaches that are custom- tailored to a building. No matter how small the property, every historic site should have a written guide for maintenance that can be as simple as:

1) Schedules and checklists for inspections;
2) Forms for recording work, blank base plans and elevations to be filled in during inspections and upon completion of work;
3) A set of base-line photographs to be augmented over time;
4) Current lists of contractors for help with complex issues or in case of emergencies;
5) Written procedures for the appropriate care of specific materials, including housekeeping, routine care, and preventive measures;
6) Record-keeping sections for work completed, costs, warranty cards, sample paint colors, and other pertinent material.

This information can be kept in one or more formats, such as a three-ring binder, file folders, or a computer database. It is important to keep the files current with completed work forms to facilitate long-term evaluations and planning for future work (Fig 2).

Proper maintenance depends on an organized plan with work prescribed in manageable components. Regular maintenance needs to be considered a priority both in terms of time allotted for inspections and for allocation of funding.

Maintenance work scheduling is generally based on a variety of factors, including the seriousness of the problem, type of work involved, seasonal appropriateness, product manufacturer's recommendations, and staff availability. There are other variables as well. For example, building materials and finishes on southern and western exposures will often weather faster than those on northern or eastern exposures. Horizontal surfaces facing skyward usually require greater maintenance than vertical ones; in regions with moderate or heavy rainfall, wood and other materials in prolonged shadow are subject to more rapid decay.

Maintenance costs can be controlled, in part, through careful planning, identification of the amount of labor required, and thoughtful scheduling of work. Maintenance schedules should take into account daily and seasonal activities of the property in order to maximize the uninterrupted time necessary to complete the work. Institutions generally need to budget annually between 2 and 4 percent of the replacement value of the building to underwrite the expense of full building maintenance.[2] Use of trained volunteers to undertake maintenance can help reduce costs.

Exterior inspections usually proceed from the roof down to the foundation, working on one elevation at

Cyclic Building Inspection Checklist: Horse Stable			**Inspection date: 04/24/05**	
Building Feature	*Material(s)*	*Condition Description*	*Maintenance Action Required*	*Work Done*
ROOF:				
Covering	Clay tile	Two slipped tiles	Reattach tiles	5/4/05
	Painted metal standing seam	Slight corrosion; blistering paint on metal roof section	Sand and repaint area that is peeling	6/8/05
Flashing	Painted metal	Flashing in good condition	N/A	N/A
Gutters/ Downspouts	6" half round galvanized metal	Gutter sagging; downspouts OK	Realign gutter and put on new hanger strap	5/4/05
			Flush out downspouts	5/5/05
Chimneys	No masonry chimney	N/A	N/A	N/A
Attachments/ Penetrations	Metal vent stack and weathervane	Vent stack hood has some peeling paint; vane OK	Sand and repaint vent stack	6/8/05

Figure 2. All personnel associated with a historic structure need to become acquainted with how existing building features should appear and during their daily or weekly routines look for changes that may occur. This will help augment the regular maintenance inspection that will occur at specified intervals based on seasonal changes, use, and other factors. A segment of an inspection form showing the roof elements of a horse stable is shown. The inspection report should be kept along with the maintenance plan and other material in notebook, file or electronic form.

a time, moving around the building in a consistent direction. On the interior, the attic, inside surfaces of exterior walls, and crawlspaces or basements should be examined for signs of potential or existing problems with the building envelope.

The following chart lists suggested inspection frequencies for major features associated with the building's exterior, based on a temperate four-season climate and moderate levels of annual rainfall. For areas of different climate conditions and rainfall, such as in the more arid southwest, the nature of building decay and frequency of inspections will vary. For buildings with certain inherent conditions, heavy use patterns, or locations with more extreme weather conditions, the frequency of inspections should be altered accordingly.

Note: All building features should be inspected after any significant weather event such as a severe rainstorm or unusually high winds.

INSPECTION FREQUENCY CHART		
Feature	Minimum Inspection Frequency	Season
Roof	Annually	Spring or fall; every 5 years by roofer
Chimneys	Annually	Fall, prior to heating season; every 5 years by mason
Roof Drainage	6 months; more frequently as needed	Before and after wet season, during heavy rain
Exterior Walls and Porches	Annually	Spring, prior to summer/fall painting season
Windows	Annually	Spring, prior to summer/fall painting season
Foundation and Grade	Annually	Spring or during wet season
Building Perimeter	Annually	Winter, after leaves have dropped off trees
Entryways	Annually; heavily used entries may merit greater frequency	Spring, prior to summer/fall painting season
Doors	6 months; heavily used entry doors may merit greater frequency	Spring and fall; prior to heating/ cooling seasons
Attic	4 months, or after a major storm	Before, during and after wet season
Basement/ Crawlspace	4 months, or after a major storm	Before, during and after rain season

Survey observations can be recorded on a standardized report form and photographs taken as a visual record. All deficient conditions should be recorded and placed on a written schedule to be corrected or monitored.

BUILDING COMPONENTS

For purposes of this discussion, the principal exterior surface areas have been divided into five components and are presented in order from the roof down to grade. While guidance for inspection and maintenance is provided for each component, this information is very general in nature and is not indeed to be comprehensive in scope. Examples have been selected to address some typical maintenance needs and to help the reader avoid common mistakes.

Roofs/chimneys

The roof is designed to keep water out of a building. Thus one of the principal maintenance objectives is to ensure water flows off the roof and into functional gutters and downspouts directly to grade and away from the building—and to prevent water from penetrating the attic, exterior walls, and basement of a building. (Note: Some buildings were designed without gutters and thus assessments must be made as to whether rain water is being properly addressed at the foundation and perimeter grade.) Keeping gutters and downspouts cleared of debris is usually high on the list of regular maintenance activities (Fig 3). Flashing around chimneys, parapets, dormers, and other appendages to the roof also merit regular inspection and appropriate maintenance when needed. The material covering the roof—wood shingles, slate, tile, asphalt, sheet metal, rolled roofing—requires maintenance both to ensure a watertight seal and to lengthen its service life; the type and frequency of maintenance varies with the roofing material. Older chimneys and parapets also require inspection and maintenance. With the exception of cleaning and minor repairs to gutters and downspouts, most roof maintenance work will necessitate use of an outside contractor.

Inspection:

The functioning of gutters and downspouts can be safely observed from the ground during rainy weather and when winter ice has collected. Binoculars are a useful tool in helping to identify potential roofing problems from the same safe vantage point. Careful observation from grade helps to identify maintenance needs between close-up inspections by an experienced roofer. Observation from the building interior is also important to identify possible leak locations. When access can be safely gained to the roof, it is important to wear shoes with slip-resistant soles and to use safety ropes.

Figure 3. Keeping gutters clean of debris can be one of the most important cyclical maintenance activities. On this small one-story addition, a garden hose is being used to flush out the trough to ensure that the gutter and downspouts are unobstructed. Gutters on most small and medium size buildings can be reached with an extension ladder and a garden hose. Photo: Bryan Blundell.

Depending on the nature of the roof, some common conditions of concern to look for are:

- sagging gutters and split downspouts;
- debris accumulating in gutters and valleys;
- overhanging branches rubbing against the roof or gutters
- plant shoots growing out of chimneys;
- slipped, missing, cracked, bucking, delaminating, peeling, or broken roof coverings;
- deteriorated flashing and failing connections at any intersection of roof areas or of roof and adjacent wall;
- bubbled surfaces and moisture ponding on flat or low sloped roofs;
- evidence of water leaks in the attic;
- misaligned or damaged elements, such as decorative cresting, lightning rods, or antennas; and
- cracked masonry or dislodged chimney caps.

Maintenance:

• Remove leaves and other debris from gutters and downspouts. Utilize a ladder with a brace device, if necessary, to keep the ladder from crushing the gutter. Use a garden hose to flush out troughs and downspouts. Patch or repair holes in gutters using products such as fiberglass tape and epoxy adhesive in metal gutters. Avoid asphalt compounds since acidic material can cause further deterioration of metal gutters.

• Correct misaligned gutters and adjust, if necessary, so that water flows to drains and does not pond. If gutter edges sag, consider inserting wooden wedges between the fascia board and the back of the gutter to add support. Seal leaking seams or pinholes in gutters and elbows.

• Broom sweep branch or leaf debris away from shingles, valleys, and crickets, particularly around chimneys and dormers.

• Where mechanical equipment is mounted on flat or low-sloped roofs, ensure that access for maintenance can be provided without damaging the roof. Clean out trapped leaves and debris from around equipment base and consider adding a protective walkway for access.

• Remove biological growth where it is causing erosion or exfoliation of roofing. Use low-pressure garden hose water and a natural or nylon scrubbing brush to remove such growth, scraping with a plastic putty knife or similar wood or plastic tool as needed on heavier buildup. Most growth is acidic and while there are products designed to kill spores, such as diluted chlorine bleach, they should be avoided. Even fairly weak formulas can still cause unexpected color changes, efflorescence, or over-splash damage to plantings or surfaces below the roof. Where appropriate, trim adjacent tree branches to increase sunlight on the roof since sunlight will deter further biological growth.

• Re-secure loose flashing at the dormers, chimneys or parapets. Clean out old mortar, lead, lead wool, or fastening material and make sure that flashing is properly inserted into reglet (slot) joints, taking care not to damage the substrate. Avoid installing new step flashing as a single metal component where multiple pieces are required to provide proper waterproofing. Also avoid attaching step flashing with mastic or sealant. Properly re-bed all step flashing. Use appropriate non-ferrous flashing metal or painted metal if needed. Since cap, step, valley, cricket, and apron flashings each have specific overlap and extension requirements, replacement flashing should match the existing material unless there has been a proven deficiency.

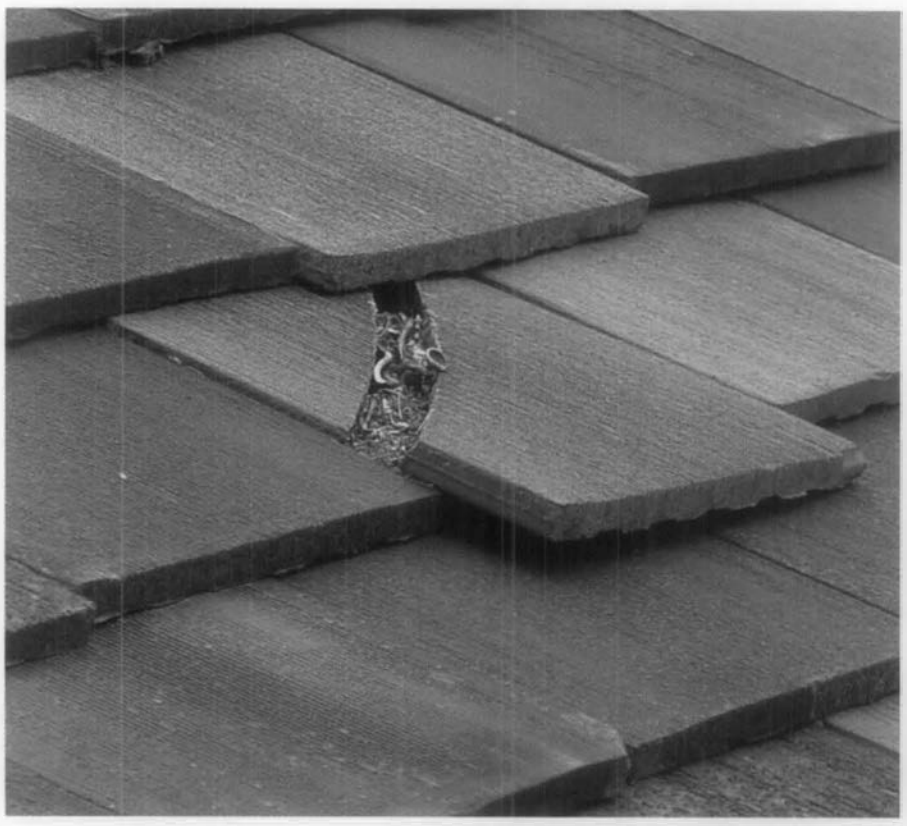

Figure 4. Damage to roofs often requires immediate attention. As a temporary measure, this damaged roof tile could be replaced with a brown aluminum sheet wedged between the existing tiles. Photo: Chad Randl.

Figure 5. The use of a sealant to close an exposed joint is not always an effective long-term solution. Where this decorative wood element connects to the slate roof, the sealant has failed within a short time and a proper metal flashing collar is being fitted instead. Photo: Bryan Blundell.

• Repoint joints in chimneys, parapet, or balustrade capping stones using a hydraulic lime mortar or other suitable mortar where the existing mortar has eroded or cracked, allowing moisture penetration. In general, a mortar that is slightly weaker than the adjacent masonry should be used. This allows trapped moisture in the masonry to migrate out through the mortar and not the masonry. Spalled masonry is often evidence of the previous use of a mortar mix that was too hard.

• Use professional services to repair chimneys and caps. Avoid the use of mortar washes on masonry since they tend to crack, allowing moisture to penetrate and promoting masonry spalling. Repoint masonry with a durable mortar that is slightly weaker than the adjacent masonry. Slope the masonry mortar cap to insure drainage away from the flue. If a chimney rain cap is installed, ensure adequate venting and exhaust.

• As a temporary measure, slip pieces of non-corrosive metal flashing under or between damaged and missing roofing units until new slate, shingles, or tile can be attached. Repair broken, missing or damaged roofing units with ones that match. Follow roofing supplier and industry guidance on inserting and attaching replacement units (Fig 4). Avoid using temporary asphalt patches as it makes a proper repair difficult later on.

• For long-term preservation of wooden shingle roofs coated with a preservative, recoat every few years following the manufacturer's recommendations. Be aware of environmental considerations.

• Scrape and repaint selected areas of coated ferrous metal roofing as needed; repaint on a regularly scheduled basis. Ferrous metal roofs can last a long time if painted regularly. Alkyd coatings are generally used on metal roofs; be sure to wash and properly prepare the area beforehand. Environmental regulations may restrict the use of certain types of paints. Apply the coating system in accordance with manufacturer's recommendations. Prepare the surface prior to application to obtain good adhesion with the prime coat. Apply both a prime coat and a topcoat for good bonding and coverage; select primer and topcoat products from the same manufacturer.

• Re-secure loose decorative elements, such as finials and weathervanes. Seek professional advice if decorative elements exhibit considerable corrosion, wood rot, or structural instability. Small surface cracks may benefit from a flexible sealant to keep moisture out; sealants have a limited life and require careful inspection and periodic replacement (Fig 5).

Exterior Walls

Exterior walls are designed to help prevent water infiltration, control air infiltration, and serve as a barrier for unwanted animals, birds and insects. The primary maintenance objective is to keep walls in sound condition and to prevent water penetration, insect infestation, and needless decay (Fig 6). Depending on the materials and construction methods, walls should have an even appearance, free from unwanted cracks, and should be able to shed excess moisture. Where surfaces are significantly misaligned or where there are bulging wall sections

or cracks indicative of potential structural problems, seek professional guidance as to the cause of distress and appropriate corrective measures. Wood-frame construction generally will require more frequent maintenance than buildings constructed of brick, stone, or terra cotta (Fig 7).

Inspections:

It is best to inspect walls during dry as well as wet weather. Look for moisture patterns that may appear on the walls after a heavy or sustained rainfall or snow, recording any patterns on elevation drawings or standard recording forms. Monitoring the interior wall for moisture or other potential problems is important as well. Look for movement in cracks, joints, and around windows and doors and try to establish whether movement is seasonal in nature (such as related to shrinkage of wood during dry weather) or signs of an ongoing problem. For moderate size buildings, a ladder or mechanical lift may be necessary, though in some cases the use of binoculars and observations made from windows and other openings will be sufficient. When examining the walls, some common conditions of concern to look for are:

- Misaligned surfaces, bulging wall sections, cracks in masonry units, diagonal cracks in masonry joints, spalling masonry, open joints, and nail popping;
- Evidence of wood rot, insect infestation, and potentially damaging vegetative growth;
- Deficiencies in the attachment of wall mounted lamps, flag pole brackets, signs, and similar items;
- Potential problems with penetrating features such as water spigots, electrical outlets, and vents;
- Excessive damp spots, often accompanied by staining, peeling paint, moss, or mold; and
- General paint problems (Fig 8).

Maintenance:

• Trim tree branches away from walls. Remove ivy and tendrils of climbing plants by first cutting at the base of the vine to allow tendrils to die back, and later using a plastic scraper to dislodge debris and an appropriate digging tool to dislodge and remove root systems. Be cautious if using a commercial chemical to accelerate root decay; follow safety directions and avoid contact of chemicals with workers and wall materials.

• Wash exterior wall surfaces if dirt or other deposits are causing damage or hiding deterioration; extend

Figure 6. Stucco applied to an exterior wall or foundation was intended to function as a watertight surface. Unless maintained, rainwater will penetrate open joints and cracks that may occur over time. A spalled section of stucco indicates some damage has occurred and a wooden mallet is being used to tap the surface to determine whether the immediate stucco has lost adhesion. Photo: Bryan Blundell.

Figure 7. One of the advantages of wood shingles as a wall covering is that individual shingles that are damaged can easily be replaced. On this highly exposed corner, worn shingles have been selectively replaced to help safeguard against water damage. The new shingles will be stained to match the existing shingles.

Figure 8. The paint on the siding of this south-facing wall needs to be scraped, sanded, primed and repainted. Postponing such work will lead to further paint failure, require greater preparatory costs, and could even result in the need to replace some siding. Photo: Charles Fisher.

Figure 9. To help extend a repainting cycle, dirt and spider webs should be removed before permanent staining occurs. In this case, a natural bristle brush and a soft damp cloth are being used to remove insect debris and refresh the surface appearance.

scheduled times for cleaning for cosmetic purposes to reduce frequency (Fig 9). When cleaning, use the gentlest means possible; start with natural bristle brushes and water and only add a mild phosphate-free detergent if necessary. Use non-abrasive cleaning methods and low-pressure water from a garden hose. For most building materials, such as wood and brick, avoid abrasive methods such as mechanical scrapers and high-pressure water or air and such additives as sand, natural soda, ice crystals, or rubber products. All abrasives remove some portion of the surface and power-washing drives excessive moisture into wall materials and even into wall cavities and interior walls. If using a mild detergent, two people are recommended, one to brush and one to prewet and rinse. When graffiti or stains are present, consult a preservation specialist who may use poultices or mild chemicals to remove the stain. If the entire building needs cleaning other than described above, consult a specialist.

• Repoint masonry in areas where mortar is loose or where masonry units have settled. Resolve cause of cracks or failure before resetting units and repointing. Rake out joints by hand, generally avoiding rotary saws or drills, to a depth of 2 ½ times the width of the joint (or until sound mortar is encountered), to make sure that fresh mortar will not pop out. Repointing mortar should be lime-rich and formulated to be slightly weaker than the masonry units and to match the historic mortar in color, width, appearance, and tooling. Off-the-shelf pre-mixed cement mortars are not appropriate for most historic buildings. Avoid use of joint sealants in place of mortar on vertical masonry wall surfaces, as they are not breathable and can lead to moisture-related damage of the adjacent masonry (Fig 10).

• Correct areas that trap unwanted moisture. Damaged bricks or stone units can sometimes be removed, turned around, and reset, or replaced with salvaged units. When using traditional or contemporary materials for patching wood, masonry, metal, or other materials, ensure that the materials are compatible with the substrate; evaluate strength, vapor permeability, and thermal expansion, as well as appearance.

• When patching is required, select a compatible patch material. Prepare substrate and install patch material according to manufacturer's recommendations; respect existing joints. Small or shallow surface defects may not require patching; large or deep surface defects may be better addressed by installation of a dutchman unit than by patching.

• Where a damaged area is too large to patch, consider replacing the section with in-kind material. For stucco and adobe materials, traditional patching formulas are recommended.

• When temporarily removing wood siding to repair framing or to tighten corner boards and loose trim, reuse the existing siding where possible. Consider using stainless steel or high strength aluminum nails as appropriate. Putty or fill nail holes flush with siding prior to repainting. Back-prime any installed wood with

Figure 10. Repointing of masonry should usually be approached as repair rather than maintenance work in part because of the need for a skilled mason familiar with historic mortar. In this case, a moisture condition was not corrected and the use of a waterproof coating and off-the-shelf Portland cement mortar trapped water and resulted in further damage to these 19th century bricks. Photo: NPS files.

one coat of primer and coat end grain that might be exposed with two coats of primer.

• Prepare, prime, and spot paint areas needing repainting. Remember that preparation is the key to a successful long lasting paint job. Ensure beforehand the compatibility of new and existing paints to avoid premature paint failure. Remove loose paint to a sound substrate; sand or gently rough surface if needed for a good paint bond; wipe clean; and repaint with appropriate primer and topcoats. Follow manufacturer's recommendations for application of coatings, including temperature parameters for paint application. Use top quality coating materials. Generally paint when sun is not shining directly onto surfaces to be painted.

• Remove deteriorated caulks and sealants, clean, and reapply appropriate caulks and sealants using backer rods as necessary. Follow manufacturer's instructions regarding preparation and installation.

• Correct deficiencies in any wall attachments such as awning and flag pole anchors, improperly installed electrical outlets, or loose water spigots.

Openings

Exterior wall openings primarily consist of doors, windows, storefronts, and passageways. The major maintenance objectives are to retain the functioning nature of the opening and to keep in sound condition the connection between the opening and the wall in order to reduce air and water infiltration.

Inspection:

Wall openings are typically inspected from inside as well as out. Examinations should include the overall material condition; a check for unwanted water penetration, insect infiltration, or animal entry; and identification of where openings may not be properly functioning. Frames should be checked to make sure they are not loose and to ascertain whether the intersection between the wall and the frame is properly sealed. Secure connections of glazing to sash and between sash and frames are also important. Particular attention should be placed on exposed horizontal surfaces of storefronts and window frames as they tend to deteriorate much faster than vertical surfaces. Inspections should identify:

- loose frames, doors, sash, shutters, screens, storefront components, and signs that present safety hazards;
- slipped sills and tipped or cupped thresholds;
- poorly fitting units and storm assemblies, misaligned frames, drag marks on thresholds from sagging doors and storm doors;
- loose, open, or decayed joints in door and window frames, doors and sash, shutters, and storefronts;
- loose hardware, broken sash cords/chains, worn sash pulleys, cracked awning, shutter and window hardware, locking difficulties, and deteriorated weatherstripping and flashing;
- broken/cracked glass, loose or missing glazing and putty;
- peeling paint, corrosion or rust stains; and
- window well debris accumulation, heavy bird droppings, and termite and carpenter ant damage.

Maintenance:

• Replace broken or missing glass as soon as possible; in some cases cracked glass may be repaired using specialty glues. For historic crown glass and early cylinder glass, a conservation approach should be considered to repair limited cracks. Where panes with a distinct appearance are missing, specialty glass should be obtained to match, with sufficient inventory kept for future needs. Avoid using mechanical devices to remove old putty and match historic putty bevels or details when undertaking work.

• Reputty window glazing where putty is deteriorated or missing. Take care in removing putty so as not to crack or break old glass or damage muntins and sash frames. Re-glaze with either traditionally formulated

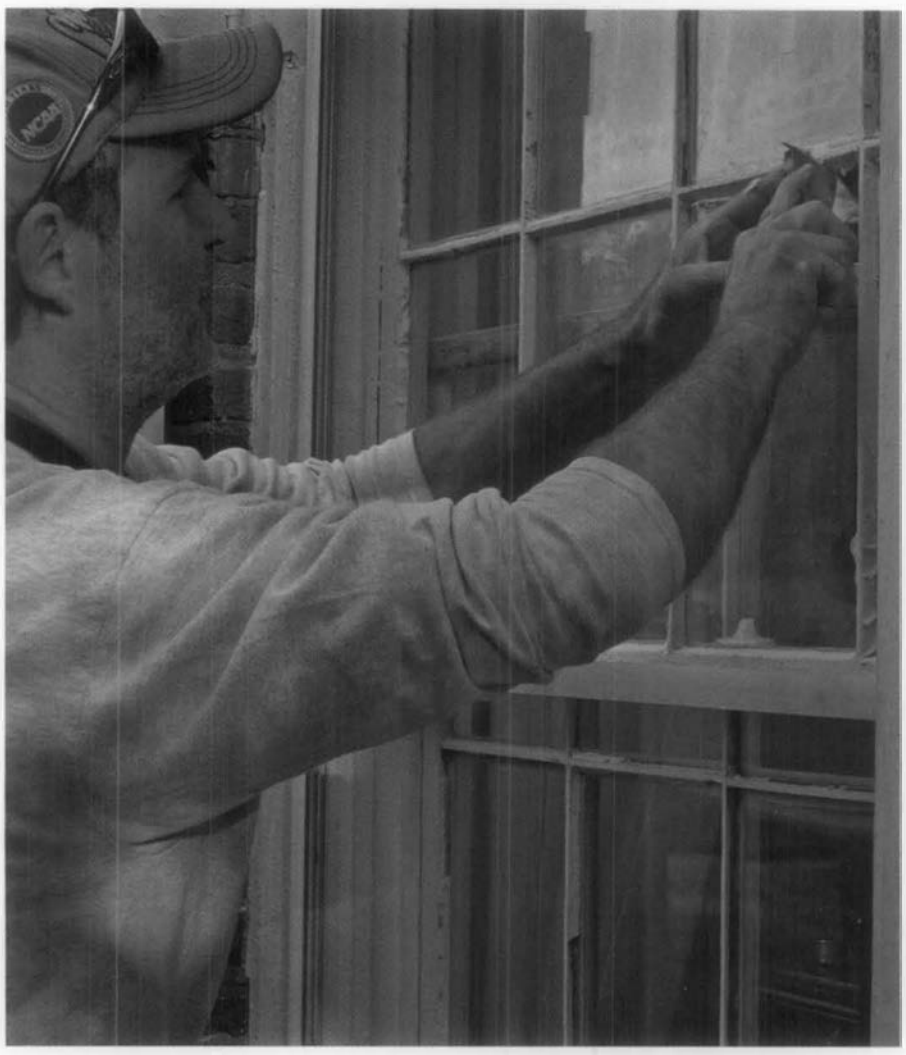

Figure 11. Glazing putty should be maintained in sound condition to prevent unwanted air infiltration and water damage. New glazing putty should be pulled tight to the glass and edge of the wood, creating a clean bevel that matches the historic glazing.

oil putties or modern synthetic ones, making sure to properly bed the glass and secure with glazing points (Fig 11).

• Clean window glass, door glazing, storefronts, transom prism lights, garage doors, and storm panels using a mild vinegar and water mixture or a non-alkaline commercial window cleaner. Be cautious with compounds that contain ammonia as they may stain brass or bronze hardware elements if not totally removed. When using a squeegee blade or sponge, wipe wet corners with a soft dry cloth. Avoid high-pressure washes.

• Clean handles, locks and similar hardware with a soft, damp cloth. Use mineral spirits or commercial cleaners very sparingly, as repeated use may remove original finishes. Most metal cleaners include ammonia that can streak and stain metal, so it is important to remove all cleaning residue. Polished hardware subject to tarnishing or oxidation, particularly doorknobs, often benefits from a thin coat of paste wax (carnauba), hand buffed to remove extra residue. Avoid lacquer finishes for high use areas, as they require more extensive maintenance. Patinated finishes should not be cleaned with any chemicals, since the subtle aged appearance contributes to the building's character.

• Remove and clean hardware before painting doors and windows; reinstall after the paint has dried.

• Tighten screws in doorframes and lubricate door hinges, awning hardware, garage door mechanisms, window sash chains, and pulleys using a graphite or silicone type lubricant.

Contracting Maintenance and Repair Work

Many contractors are very proficient in using modern construction methods and materials; however, they may not have the experience or skill required to carry out maintenance on historic buildings. The following are tips to use when selecting a contractor to work on your historic building:

1. Become familiar with work done on similar historic properties in your area so that you can obtain names of possible preservation contractors.

2. Be as specific as possible in defining the scope of work you expect to undertake.

3. Ask potential contractors for multiple references (three to five) and visit previous work sites. Contact the building owner or manager and ask how the job proceeded; if the same work crew was retained from start to finish; if the workers were of a consistent skill level; whether the project was completed in a reasonable time; and whether the person would use the contractor again.

4. Be familiar with the preservation context of the work to be undertaken. Use the written procedures in your maintenance plan to help define the scope of work in accordance with preservation standards and guidelines. Always request that the gentlest method possible be used. Use a preservation consultant if necessary to ensure that the work is performed in an appropriate manner.

5. Request in the contract proposal a detailed cost estimate that clearly defines the work to be executed, establishes the precautions that will be used to protect adjoining materials, and lists specific qualified subcontractors, if any, to be used.

6. Insure that the contractor has all necessary business licenses and carries worker compensation.

• Check weather stripping on doors and windows and adjust or replace as necessary. Use a durable type of weather stripping, such as spring metal or high quality synthetic material, avoiding common brush and bulb or pile weather stripping that require more frequent replacement.

• Adjust steel casement windows as needed for proper alignment and tight fit. Avoid additional weather stripping as this may lead to further misalignment, creating pathways for air and water infiltration.

• Check window sills for proper drainage. Fill cracks in wood sills with a wood filler or epoxy. Follow manufacturer's instructions for preparation and installation. Do not cover over a wood sill with metal panning, as it may trap moisture and promote decay.

• Repair, prime, and repaint windows, doors, frames, and sills when needed. Clean out putty debris and paint chips from windows using a wet paper towel and dispose of debris prior to repair or repainting. Take appropriate additional precautions when removing lead-based paint. Sand and prepare surfaces and use material-specific patching compounds to fill any holes or areas collecting moisture (Fig 12). Avoid leaving exposed wood unpainted for any length of time, as light will degrade the wood surface and lead to premature failure of subsequent paint applications. Immediately prime steel sash after paint is removed and the substrate prepared for repainting.

• Adjust wood sash that bind when operated. Apply beeswax, paraffin, or similar material to tracks or sash runs for ease of movement. If sash are loose, replace worn parting beads. Sash runs traditionally were unpainted between the stop and parting bead; removing subsequent paint applications will often help improve sash operation.

• Correct perimeter cracks around windows and doors to prevent water and air infiltration. Use traditional material or modern sealants as appropriate. If fillers such as lead wool have been used, new wool can be inserted with a thin blade tool, taking care to avoid damage to adjacent trim. Reduce excess air infiltration around windows by repairing and lubricating sash locks so that windows close tightly.

Figure 12. Good surface preparation is essential for long lasting paint. Scraping loose paint, filling nail holes and cracks, sanding, and wiping with a damp cloth prior to repainting are all important steps whether touching up small areas or repainting an entire feature. Always use a manufacturer's best quality paint. Windows and shutters may need repainting every five to seven years, depending on exposure and climate.

Figure 13. Window air conditioning units can cause damage to surfaces below when condensation drips in an uncontrolled manner. Drip extension tubes can sometimes be added to direct the discharge.

• Remove debris beneath window air conditioning units and ensure that water from units does not drain onto sills or wall surfaces below (Fig 13). Removal of air conditioning units when not in season is recommended.

• Adjust storm panels and clean weep holes; check that weep holes at the bottom of the panels are open so water will not be trapped on the sill. Exterior applied storm windows are best attached using screws and not tightly adhered with sealant. Use of sealant makes storm units difficult to remove for maintenance and can contribute to moisture entrapment if weep holes become clogged.

• Remove weakened or loose shutters and store for later repair. Consider adding a zinc or painted metal top to shutters as a protective cap to cover the wood's exposed end grain. This will extend the life of the shutters.

Figure 14. When inspecting connections between projections and the main building, look for areas where birds, bees and pests may enter or nest. Birds have been nesting in this porch roof and the area is being cleaned of their debris. Where an opening exists, it may be necessary to cover it with a trim piece, screening, or sealant. Photo: Bryan Blundell.

Projections

Numerous projections may exist on a historic building, such as porches, dormers, skylights, balconies, fire escapes, and breezeways. They are often composed of several different materials and may include an independent roof. Principal maintenance objectives include directing moisture off these features and keeping weathered surfaces in good condition. Secondary projections may include brackets, lamps, hanging signs, and similar items that tend to be exposed to the elements.

Inspection:

In some cases, projections are essentially independent units of a building and so must be evaluated carefully for possible settlement, separation from the main body of the building, and materials deterioration. Some electrical features may require inspection by a electrician or service technician. Common conditions of concern to look for are:

- damaged flashing or tie-in connections of projecting elements;
- misaligned posts and railings;
- deteriorated finishes and materials, including peeling paint, cupped and warped decking, wood deterioration, and hazardous steps;
- evidence of termites, carpenter ants, bees, or animal pests (Fig 14);
- damaged lamps, unsafe electrical outlets or deteriorated seals around connections;
- loose marker plaques, sign, or mail boxes; and
- rust and excessive wear of structural, anchorage, and safety features of balconies and fire escapes.

Maintenance:

• Selectively repair or replace damaged roofing units on porches and other projections. Ensure adequate drainage away from the building. Repair flashing connections as needed; clean and seal open joints as appropriate.

• Secure any loose connections, such as on porch rails or fire escapes.

• Maintain ferrous metal components by following manufacturer's recommendation for cleaning and repainting. Remove rust and corrosion from porch handrails, balconies, fire escapes, and other metal features; prepare, prime, and repaint using a corrosion-inhibitive coating system. Apply new primer before new corrosion sets in, followed by new topcoat. Take appropriate safety measures when dealing with existing lead-based paint and in using corrosion-removal products (Fig 15).

• Reattach loose brackets, lamps, or signs. With electrical boxes for outlets or lighting devices, ensure that cover plates are properly sealed. Prime and paint metal elements as needed.

• Keep porch decks and steps free from dust, dirt, leaf debris, and snow as soon at it accumulates using a broom or plastic blade shovel.

• Repair areas of wood decay or other damage to railings, posts, and decorative elements. Repair with wood dutchman, wood putty, or epoxy filler, as appropriate; replace individual elements as needed.

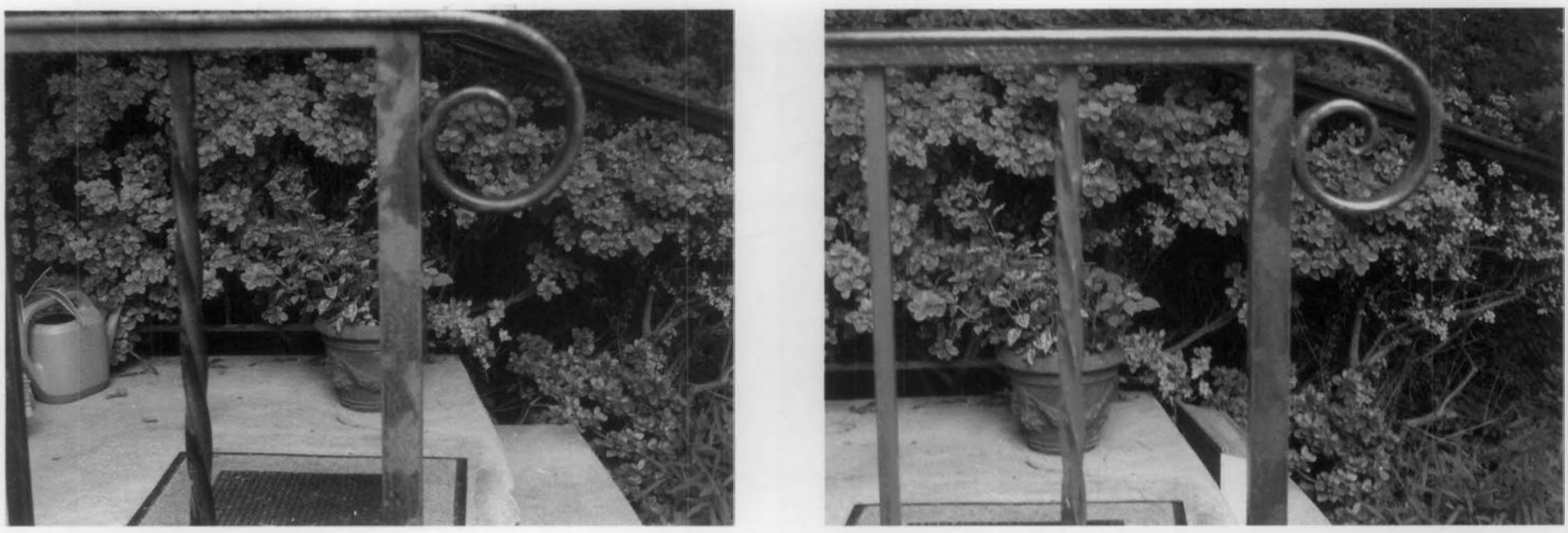

Figure 15. Metal projecting elements on a building, such as sign armatures and railings, are easily subject to rust and decay. Proper surface preparation to remove rust is essential. Special metal primers and topcoats should be used.

Prime and repaint features when necessary and repaint horizontal surfaces on a more frequent basis.

• Sand and repaint porch floorboards to keep weather surfaces protected. The exposed ends of porch floorboards are especially susceptible to decay and may need to be treated every year or two.

• Carefully cut out damaged or buckled porch flooring and replace with wood to match. Back-prime new wood that is being installed; treat end grain with wood preservative and paint primer. Ensure that new wood is adequately kiln or air-dried to avoid shrinkage and problems with paint adherence.

• Repair rotted stair stringers; adjust grade or add stone pavers at stair base to keep wooden elements from coming into direct contact with soil.

• Consider durable hardwoods for replacement material where beading, chamfering, or other decorative work is required in order to match existing features being replaced. Although appropriate for certain applications, pressure treated lumber is hard to tool and may inhibit paint adherence if not allowed to weather prior to coating application.

• Clean out any debris from carpenter bees, ants, termites, and rodents, particularly from under porches. Replace damaged wood and add screening or lattice to discourage rodents. Consider treating above ground features with a borate solution to deter termites and wood rot and repaint exposed surfaces.

Foundations and Perimeter Grades

The foundation walls that penetrate into the ground, the piers that support raised structures, and the ground immediately around a foundation (known as grade) serve important structural functions. To help sustain these functions, it is important that there is good drainage around and away from the building. The maintenance goal is to prevent moisture from entering foundations and crawl spaces and damaging materials close to the grade, and to provide ventilation in damp areas.

Inspection:

Inspections at the foundation should be done in conjunction with the inspection of the downspouts to ensure that water is being discharged a sufficient distance from the building perimeter to avoid excessive dampness in basements or crawl spaces. In addition, crawl spaces should be adequately vented to deter mold and decay and should be screened or otherwise secured against animals. Look for:

- depressions or grade sloping toward the foundation; standing water after a storm;

Figure 16. This chronically wet area has a mildew bloom brought on by heat generated from the air-conditioning condenser unit. The dampness could be caused be a clogged roof gutter, improper grading, or a leaking hose bibb.

Sealants and Caulks

Using sealants and caulks has become a familiar part of exterior maintenance today. As the use of precision joinery and certain traditional materials to render joints more weathertight has waned in recent years, caulks and more often elastomeric sealants are used to seal cracks and joints to keep out moisture and reduce air infiltration. Where cracks and failing joints are indicators of a serious problem, sealants and caulks may be used as a temporary measure. In some cases they may actually exacerbate the existing problem, such as by trapping moisture in adjacent masonry, and lead to more costly repairs.

Manufacturer's recommendations provide instructions on the proper application of caulks and sealants. Special attention should be placed on ensuring that the subsurface or joint is properly prepared and cleaned. Backer rods may be necessary for joints or cracks. Tooling of the caulk or sealant is usually necessary to ensure contact with all edge surfaces and for a clean and consistent appearance.

Caulks generally refer to older oil resin-based products, which have relatively limited life span and limited flexibility. Contemporary elastomeric sealants are composed of polymer synthetics. Elastomeric sealants are more durable than caulks and have greater flexibility and wider application. Caulks and sealants can become maintenance problems, as they tend to deteriorate faster than their substrates and must be replaced periodically as a part of cyclical maintenance of the structure.

The selection criteria for caulks and sealants include type of substrate, adhesion properties, size and configuration of joint, intended appearance/color and paintability, movement characteristics, and service life. Both one-part and two-part sealants are available; the latter require mixing as part of the application process. Sealants are commonly used for a variety of places on the exterior of a building such as around windows and doors, at interfaces between masonry and wood, between various wood features or elements, and at attachments to or through walls or roofs, such as with lamps, signs, or exterior plumbing fixtures. Their effectiveness depends on numerous factors including proper surface preparation and application. Applications of sealants and caulks should be examined as part of routine maintenance inspection, irrespective of their projected life expectancy.

Installation of caulks and sealants often can be undertaken by site personnel. For large and more complex projects, a contactor experienced in sealant installation may be needed. In either case, the sealant manufacturer should be consulted on proper sealant selection, preparation, and installation procedures.

- material deterioration at or near the foundation, including loss of mortar in masonry, rotting wood clapboards, or settlement cracks in the lower sections of wall;
- evidence of animal or pest infestation;
- vegetation growing close to the foundation, including trees, shrubs and planting beds;
- evidence of moisture damage from lawn and garden in-ground sprinkler systems;
- evidence of moss or mold from damp conditions or poorly situated downspout splash blocks (Fig 16); and
- blocked downspout drainage boots or clogged areaway grates.

Maintenance:

• Remove leaves and other debris from drains to prevent accumulation. Detach drain grates from paved areas and extract clogged debris. Flush with a hose to ensure that there is no blockage. Use a professional drain service to clear obstructions if necessary.

• Conduct annual termite inspections. Promptly address termite and other insect infestations. Use only licensed company for treatment where needed.

• Keep the grade around the foundation sloping away from the building. Add soil to fill depressions particularly around downspouts and splash blocks. Make sure that soil does not come too close to wooden or metal elements. A 6" separation between wooden siding and the grade is usually recommended.

• Avoid use of mulching material immediately around foundations as such material may promote termite infestation, retain moisture or change existing grade slope.

• Reset splash blocks at the end of downspouts or add extender tubes to the end of downspouts as necessary (Fig 17).

• Lubricate operable foundation vent grilles to facilitate seasonal use; paint as needed.

• Manage vegetation around foundations to allow sufficient air movement for wall surfaces to dry out during damp periods. Trim plantings and remove weeds and climbing vine roots. Be careful not to scar foundations or porch piers with grass or weed cutting equipment. If tree roots appear to be damaging a foundation wall, consult an engineer as well as a tree company.

• Wash off discoloration on foundations caused by splash-back, algae, or mildew. Use plain water and a soft natural or nylon bristle brush. Unless thoroughly researched and tested beforehand on a discreet area of the wall, avoid chemical products that may discolor certain types of stone. If cleaning products are used, test beforehand in a discreet area; and avoid over splash to plantings and adjacent building materials.

• Selectively repoint unit masonry as needed. Follow guidance under the wall section in regard to compatible mix, appearance, and texture for pointing mortar.

• Avoid using salts for de-icing and fertilizers with a high acid or petro-chemical content around foundations, as these materials can cause salt contamination of masonry. Use sand or organic materials without chloride additives that can damage masonry. Where salt is used on icy walks, distribute it sparingly and sweep up residual salt after walks have dried.

• Use snow shovels and brooms to clean snow from historic paths and walkways. Avoid blade-type snow removers as they may chip or abrade cobblestones, brick, or stone paving. Note that use of steel snow removal tools in areas where salt-containing snow melters are used may result in rust staining from steel fragments left on the paving.

Figure 17. Extending downspouts at their base is one of the basic steps to reduce dampness in basements, crawl spaces and around foundations. Extensions should be buried, if possible, for aesthetics, ease of lawn care, and to avoid creating a tripping hazard. Photo: NPS files.

Conclusion

Maintenance is the most important preservation treatment for extending the life of a historic property. It is also the most cost effective. Understanding the construction techniques of the original builders and the performance qualities of older building materials, using traditional maintenance and repair methods, and selecting in-kind materials where replacements are needed will help preserve the building and its historic character.

Maintenance can be managed in small distinct components, coordinated with other work, and scheduled over many years to ensure that materials are properly cared for and their life span maximized. A written maintenance plan is the most effective way to organize, schedule, and guide the work necessary to properly care for a historic building. The maintenance plan should include a description of the materials and methods required for each task, as well as a schedule for work required for maintenance of different building materials and components.

Historic house journals, maintenance guides for older buildings, preservation consultants, and preservation maintenance firms can assist with writing appropriate procedures for specific properties. Priorities should be established for intervening when unexpected damage occurs such as from broken water pipes or high winds.

Worker safety should always be paramount. When work is beyond the capabilities of in-house personnel and must be contracted, special efforts should be made to ensure that a contractor is both experienced in working with historic buildings and utilizes appropriate preservation treatments.

A well-maintained property is a more valuable property and one that will survive as a legacy for generations to come.

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Acknowledgements

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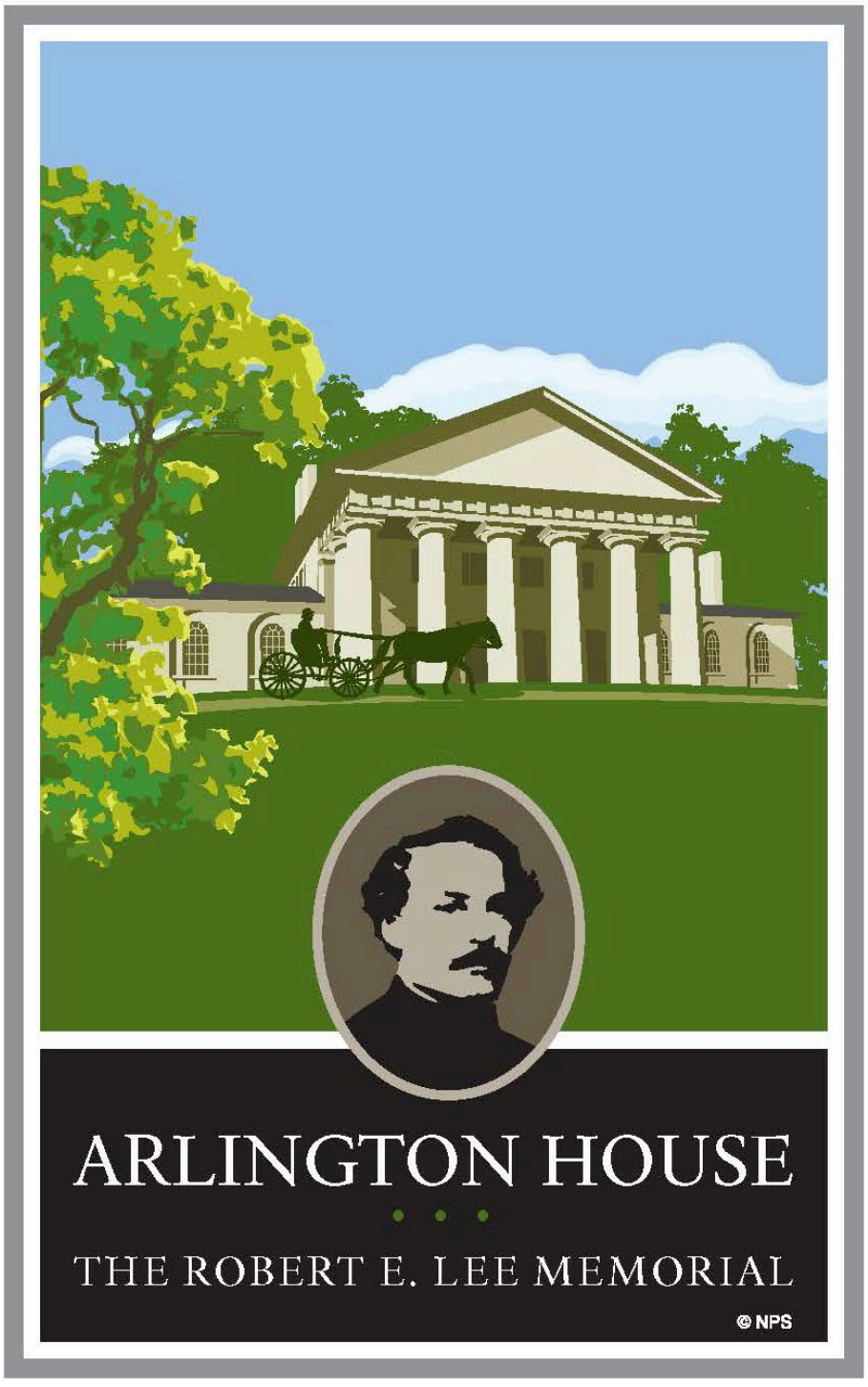
George Washington Memorial Parkway
Landscape Management Plan



CONTENTS

Introduction …….. page 3

Site Map ……...……...…….. page 5

Zones

Zone 1 General Site Maintenance ……..……. page 6

Zone 2 South Flower Garden ……..……..… page 11

Zone 3 Kitchen Garden Vegetable Beds …..……. page 15

Zone 4 Arlington Woods ……..……. page 18

Appendix A. Responsibility Matrix …… page 20

Appendix B. Maintenance Calendar……..……...……. page 21

Appendix C. South Flower Garden Planting Plan …….. page 22

Appendix D. Kitchen Garden: Period Appropriate Plantings

……..... page 23

Appendix E. Kitchen Garden: Planting Calendar ……... page 25

References and Additional Resources ……..……. page 27

INTRODUCTION

History

Originally constructed between 1802 and 1818, Arlington House was built to be both the residence of George Washington Parke Custis and as the nation's first memorial to his adopted grandfather, George Washington. The home became the repository of hundreds of relics and artifacts that once belonged to George and Martha Washington at Mount Vernon. Custis' daughter Mary Anna Randolph Custis would then marry a young Robert E. Lee in the house in 1831. This house became the residence of Robert E. Lee and his family before the Civil War. During the American Civil War, the house was seized by the Union Army who proceeded to turn the plantation into a military cemetery that is now known as Arlington National Cemetery.

In 1925, the United States designated Arlington House as a National Memorial to Robert E. Lee. This designation was the result of the respect he earned from the North and South in advocating for reconciliation after the Civil War.

Arlington House is a Greek revival style mansion located in Arlington, Virginia and is part of the George Washington Memorial Parkway (GWMP). The house overlooks the Potomac River and the National Mall in Washington, D.C. Today, the National Park Service serves as the steward of this important resource to ensure its preservation for future generations.

Statement of Purpose

Maintaining the Arlington House landscape is an integral part of GWMP's preservation stewardship along with restoring key landscape elements lost over time. The Landscape Management Plan is a detailed roadmap that outlines the goals and priorities of site maintenance along with long term care and future projects. The Plan's goal is to maintain a high standard of horticultural care and management that provides optimal growing conditions for the site's plant material, enhances the ecological health of the site's environment, and presents a landscape of high quality for visitors.

Management Approach

A holistic management approach is best applied to the site so that all aspects of the landscape are addressed, and the highly visible site is maintained to an exemplary standard. There are four primary landscape zones each requiring its own management strategy addressing annual maintenance, priorities, challenges, and long-term care.

Zone 1 – General Site Maintenance

Zone 2 – South Flower Garden

Zone 3 – Kitchen Garden Vegetable Beds

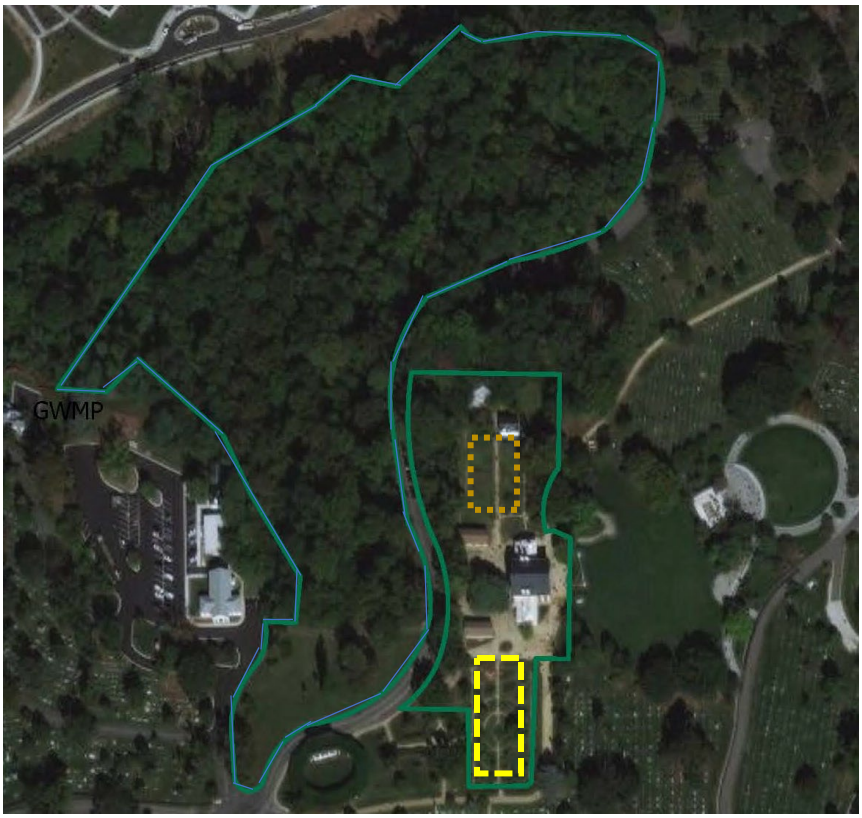
Zone 4 – Arlington Woods

Each section includes a profile of the area along with an annual care plan broken down by season and arboriculture needs for that zone. Priorities and long-term projects are included for future planning purposes.

Beyond general landscape maintenance, Arlington House grounds require a higher level of horticulture maintenance on par with neighboring public gardens to preserve the site. Integrated pest management protocols, where plant material is scouted and treated as needed, need to be instituted to support the long-term maintenance of the site. Currently these tasks are dependent on funding availability, however when pest problems are identified early, the financial burden of correcting issues shrinks.

It would be advisable to enlarge the existing Kitchen Garden volunteer group at Arlington House to build a more diverse garden volunteer program. A dedicated group of volunteers who work across the site including the South Flower Garden will be able to help support the basic landscape contract work while funding is sought for horticulture maintenance.

ARLINGTON HOUSE MAINTENANCE ZONES



Zone 1 …… General Site Maintenance, GWMP Maintenance Contract

Zone 2 …… South Flower Garden, GWMP Maintenance Contract

Zone 3 …… Kitchen Garden Vegetable Beds, Kitchen Garden Volunteers

Zone 4 …… Arlington Woods, GWMP Natural Resources/Maintenance Staff

ZONE 1 – General Site Maintenance

Profile

Arlington House consists of 4 acres of landscaped planting beds, paved walkways, and natural areas needing ongoing landscape maintenance. The Sherman Drive entrance landscape serves as the principal gateway to the historic site for arriving visitors and is the first impression of many first-time visitors. Because of its importance, this area will receive the highest standard of maintenance along with the iconic east façade landscape. The care and presentation demands of its diverse landscape areas—South Flower Garden, Kitchen Garden, and East Façade require constant diligence.

The general maintenance of the site is achieved through contracted mowing and landscape services managed by GWMP Division of Maintenance with a detailed general scope of work. Supplemental work including turf renovation, turf fertilization, plant health care and replacement plants is dependent on available funding.

Contract Scope of Work Specifications:

Turf	2.86 A
String Trimming	2520 linear feet
Holly Hedge (8')	350 linear feet (2100 sf.)
Shrub Hedge	80 linear feet (240 sf.)
Paved Surfaces	10,798 square feet
Annual Floral Display	4,000 square feet
Perennial Beds	8,534 square feet
Tree and Shrub Beds	2,340 square feet
Historic Roses	137 plants

Priorities

Most visitors approach the site from Sherman Drive by foot or by tram so front beds and walkways must be completely free of litter. Daily sweeps through the area must be completed prior to the site opening to the public at 9 am. Weed control around the steps, ramp, and mulch beds facing the road is essential. Provide supplemental irrigation as needed to establish new shrub and turf plantings along frontage facing road. Turf should be maintained to the GWMP's highest standard, Class A, given the site's visitation and visibility. Ensure pruning tools are cleaned before working onsite so diseases like fire blight, rose rosette disease, etc. are not introduced into or spread through the garden.

Arboriculture

Due to the site's proximity to Sherman Drive and Arlington National Cemetery, this zone has a high management intensity level. Frequent visits throughout the year will be necessary to maintain the high standard of maintenance this zone warrants, especially the magnolias in the South Flower Garden and Deodar Cedar located in the west yard. Because several specimen trees are of advanced age or otherwise in decline, frequent visits will be required to remove dead or dying branches while due to the numerous newly installed trees' smaller caliper, visits to structurally prune them should begin after establishment. Watering will be necessary for young trees during times of drought.

Hardscape

As part of the Arlington House renovation project, pathways were updated from the previous gravel surface to a new bonded aggregate surface in high traffic areas. This update improves

traffic flow and visitor safety however it requires a higher level of maintenance to ensure the pathway's permeability and long-term viability.

All bonded aggregate pavements require regular inspection and periodic removal of accumulated sediment from the surface. Clogging typically occurs near the pavement surface. If the surface is slow draining, high performance vacuum equipment (It is recommended that regenerative air vacuum equipment be used annually to clean the pavement surface) may restore the permeability and should be tried first. The primary maintenance requirement for bonded aggregate paving is to clean the surface drainage voids. Fine debris and dirt accumulate in the drainage openings and reduce the pavement's flow capacity. It is natural for clogging to occur over time, but routine maintenance will reduce this problem.

During snow removal snow plowing is allowed using shovels or blades with plastic/rubber blades. The use of de-icing chemicals is allowed, as well, if the materials applied do not damage existing plant material, CMA based is preferred.

For more information regarding the bonded aggregate pavement, please refer to the Arlington House Product Maintenance Manual.

Additional areas in the kitchen garden and south flower garden remain crushed stone. These paths will require periodic maintenance including weed eradication, raking, and additional stone to level walkways due to normal wear and tear or weather events.

Annual Care Plan

ALL SEASONS
• Remove weeds from all display beds and mulched areas around trees. Also keep pavement cracks and edges weed-free.
• Maintain uniform weed-free turf at a height of at least 3".
• Maintain clean edge to turf along walkways.
• Provide supplemental irrigation, as needed, to all plantings.
• Monitor newly planted materials, investigate problems, and take appropriate action.
• Remove downed limbs and dead material.
• Monitor plants for insects and disease symptoms. Treat as needed.
• Apply herbicides around walkways and edges as needed.
• Prune all dead wood within 8'.
• Keep fence areas and trees free of weed vines.

• Remove all spontaneous woody weeds from shrub beds and around base of trees.
• Report potential disease or pest issues to NPS staff.
• Report replacement material needs to NPS staff.
SPRING
• Aerate all grass areas (or in Fall).
• Apply soil amendments, if needed.
• Remove leaf litter from shrub beds.
• Edge and apply double-ground mulch to shrub beds providing uniform coverage at a consistent depth of 2”.
• Create mulch rings around trees. Apply double-ground mulch at a consistent depth of 2” to all trees.
• Top dress and seed lawn areas where needed.
• String trim grass from edges of pavement every two weeks.
• Aerate and de-thatch all grass areas, as needed.
SUMMER
• Edge and reapply double-ground mulch to shrub beds providing uniform coverage at a consistent depth of 2” as needed.
• Create mulch rings around trees. Apply double-ground mulch at a consistent depth of 2” to all trees.
• Monitor soils for moisture. Pre-empt drought stress with hand watering, if necessary.
• String-trim grass from edges of pavement every two weeks.
• Prune vines trained on pillars of the comfort station.
FALL
• Aerate all grass areas (or in Spring).
• Apply soil amendments, if needed.
• Fertilize turf.
• Remove leaf litter from shrub beds and lawn.
• Top dress and seed lawn areas where needed.
• Install pathway stakes for snow removal.
• String trim grass from edges of pavement every two weeks.
• Prune vines trained on pillars of the comfort station.
WINTER
• Remove all woody weeds from shrub beds, around base of trees, and signage.
• Remove basal sprouts from trees, as appropriate.
• Structurally prune young trees, as needed.

Long-term Projects

Every 2 years, or as needed

• Prune shrubs to rejuvenate.
• Prune trees and shrubs for dead, diseased, broken and weak attachments.
• Monitor herbaceous layer performance, add and/ or replace herbaceous material does not thrive.
Every 3 years, or as needed
• Replant shrub beds as needed to maintain bed density.
• Monitor herbaceous layer, maintain balance between perennial species.
• Thin old wood from flowering shrubs.

Additional Projects

- Replace North Garden (Kitchen Garden) holly hedge.
- Install gravel border around structures to prevent damage from landscape equipment.
- Install site-wide irrigation system.

ZONE 2 – South Flower Garden

Profile

Arlington House South Flower Garden consists of .5 acre of landscaped planting beds and paved walkways needing ongoing landscape maintenance. The flower garden is an interpreted design based on existing descriptions of the Lee family's garden. Plants mentioned by the family were incorporated into the planting palate to allow visitors to experience a garden similar to what the Lee's might have had on the site while the iconic East Façade provides visitors a sense of place. The garden can be viewed from Sherman Drive and is adjacent to the principal site entrance for arriving visitors and is the first impression of many first-time visitors. Because of its importance, this area will receive the highest standard of maintenance. The care and presentation demands of its diverse planting areas require constant diligence.

The general maintenance of the site is achieved through contracted maintenance while detail work may be achieved through the generous donation of volunteer labor.

Priorities

Most visitors approach the South Flower Garden from the house, site entrance or from the Civil War Unknowns Memorial so the fence line beds and walkways must be completely free of litter and weeds. Daily sweeps through the area must be completed prior to the site opening to the public at 9 am. Weed control around the perimeter is essential. Provide supplemental irrigation as needed to establish new plantings throughout the garden and during times of drought. Turf should be maintained to the GWMP's highest standard, Class A, mostly free of broadleaf weeds and reseeded as needed. Ensure pruning tools are cleaned before working onsite so diseases like fire blight, rose rosette disease, etc. are not introduced into or spread through the garden.

Arboriculture

Due to the area's high traffic, this zone has a high management intensity level. Arboriculture needs will be completed by NPS staff or by a tree service contract if work cannot be completed from the ground. The magnolias, pear, and elm tree adjacent to the garden gate require monitoring and pruning for dead, water sprouts, and basal suckers.

Annual Care Plan

ALL SEASONS
• Remove weeds from all planting beds and mulched areas including around trees.
• Maintain clean edge along walkways.
• Provide supplemental watering, as needed, to all plantings.
• Remove weeds from gravel pathways.
• Monitor newly planted materials, investigate problems, and report issues.
• Remove downed limbs and dead material.
• Monitor plants for insects and disease symptoms. Treat as needed.
• Prune all dead wood within 8'.
• Keep fence areas and trees free of weed vines.
• Report potential disease or pest problems to NPS staff.
• Report replacement material needs to NPS staff.
SPRING
• Remove spent blooms from herbaceous material and flowering shrubs.
• Remove leaf litter from shrub beds.

• Stake plant material such as peonies.
• Thin seedlings to provide room for growth.
• Install summer annuals.
SUMMER
• Remove spent blooms from reblooming roses.
• Once blooming roses will be left to set hips.
• Monitor soils for moisture. Pre-empt drought stress with hand watering, if necessary.
• Remove all vines from trees and shrubs keeping a 12” radius clear around plant base.
• Monitor for insects and disease symptoms.
FALL
• Divide plant colonies such as iris, as needed.
• Plant new divisions to fill in open bed areas.
• Install bulbs.
• Remove leaf litter from shrub beds and lawn.
• Cut back herbaceous material not left to seed.
WINTER
• Remove all woody weeds from shrub beds and around base of trees.
• Remove basal and water sprouts from trees, as appropriate.
• Structure prune shrubs and young trees, as needed after establishment.
• Remove dead herbaceous growth at end of season prior to the emergence of new spring growth.

Long-term Projects

Every 2 years, or as needed
• Prune shrubs to rejuvenate.
• Prune trees and shrubs for dead, diseased, broken and weak attachments.
• Monitor herbaceous layer performance, add and/ or replace herbaceous material that does not thrive.
Every 3 years, or as needed
• Thin boxwood hedges. Shear boxwood hedges once they are established.
• Monitor herbaceous layer, maintain balance between perennial species.
• Thin old wood from flowering shrubs.
• Add supplemental gravel to areas showing wear.

Recommended Additional Projects

- Restore missing gazebo in center of garden.

- Restore garden layout and plantings to 1860 design.
- Add growing structures for climbing vines.

ZONE 3 – Kitchen Garden Vegetable Beds

Profile

The North Garden or Kitchen Garden consists of .25 acre of planting beds dedicated to organically producing historically appropriate 19th century vegetables, herbs, and fruits that would have been familiar to the Lee family. Produce from the garden is donated to the Arlington Food Assistance Center or used for interpretive activities. Due to its importance and high visibility, this area will receive the highest standard of maintenance. The care and presentation demands of the vegetable beds require constant diligence.

The general maintenance of the vegetable beds is achieved through the donated labor of generous volunteers managed by GWMP staff. The surrounding plantings are maintained through contracted mowing and landscape services managed by GWMP Division of Maintenance with a detailed general scope of work. Supplemental work including turf renovation, turf fertilization, and replacement trees and shrubs is dependent on available funding.

Priorities

Visitors approach the site from the west yard so the fence line and walkway must be completely free of litter. The center pathway leads through the garden to the museum, comfort station, and bookstore making this a high traffic area. Daily sweeps through the area must be completed prior to the site opening to the public at 9 am. Weed control around the fence line, signage and planting beds is essential. Provide supplemental irrigation as needed to support plantings including new tree and turf plantings along center walkway. Turf should be maintained to the GWMP's highest standard, Class A, mostly free of broadleaf weeds and reseeded as needed. Ensure pruning tools are cleaned before working onsite so diseases like fire blight, rose rosette disease, etc. are not introduced into or spread through the garden.

Arboriculture

Due to the area's lack of mature trees, this zone has a low management intensity level. Structural pruning of apple trees may be completed by volunteers overseen by GWMP staff.

Annual Care Plan

ALL SEASONS
• Remove weeds from all planting beds and mulched areas around trees.
• Maintain clean edge to turf along walkways.
• Provide supplemental irrigation, as needed, to all plantings.
• Remove weeds from gravel walkways.
• Monitor newly planted materials, investigate problems, and report issues. Take appropriate action if possible.
• Remove downed limbs and dead material.
• Monitor plants for insects and disease symptoms. Treat as needed.
• Prune all dead wood within 8'.
• Keep fence areas and trees free of weed vines.
• Remove all spontaneous woody weeds from planting beds and around base of trees.
• Report replacement material needs to NPS staff.
• Monitor plants for herbivore damage.
SPRING
• Mark bed placements.

• Turn over soil as needed.
• Install spring crops following planting schedule including vegetables under cover if necessary.
• Apply soil amendments, if needed.
• Remove leaf litter from beds.
• Sow seeds after last frost.
• Thin seedlings as needed.
• Harvest produce as needed.
• Install summer crops following planting schedule.
• Water as needed.
SUMMER
•
• Monitor soils for moisture. Pre-empt drought stress with hand watering, if necessary.
• Remove dead as necessary from plant material.
• Harvest produce as needed.
• Install fall crops following planting schedule.
FALL
• Harvest remaining vegetables and herbs.
• Apply soil amendments, if needed.
• Sow winter cover crop.
• Remove litter from beds and lawn.
• Cut back herbaceous material.
• Clean & sharpen tools. (or Early Spring)
• Store hoses and tools for winter.
WINTER
• Remove all woody weeds from beds and around base of trees.
• Remove basal sprouts from trees, as appropriate.
• Structure prune young trees, as needed.
• Review past year's planting results to create new planting plan.
• Review planting calendar to plan out new planting schedule.
• Sow seeds indoors for spring crops following planting schedule.

Additional Projects

- Establishment of small fruiting shrubs.
- Addition of period appropriate growing structures.
- Replace apple trees with period appropriate fruit trees as described by the garden's oral history.

ZONE 4 – Arlington Woods

Profile

Arlington Woods consists of 12 acres of natural woodland needing periodic maintenance to remove invasive species infiltrating this natural area as well as road clearance so as not to block Sherman Drive. Dead wood is generally left onsite to decay naturally and provide wildlife habitat.

The general maintenance of the site is achieved through a partnership between the GWMP Divisions of Maintenance and Resource Management.

Priorities

Most visitors do not realize the forested area along Sherman Drive is a natural woodland and a remnant of the original forested tract. The woodland is kept as a natural area and only requires periodic sweeps along the perimeter adjacent to the paved roads and pedestrian walkways to ensure there is no encroachment.

Arboriculture

Due to the area's natural appearance and habitat, this zone has a low management intensity level. Arboriculture needs will be completed by NPS staff or by a tree service contract only when necessary.

Annual Care Plan

ALL SEASONS

• Leave downed limbs and dead material in forested area.
• Prune all dead wood within 8’ of roadway and pedestrian walkways.
• Remove invasive species from forest floor concentrating on perimeter.

Long-term Projects

Every 2 years, or as needed
• Monitor interior for erosion and ravine degradation.
• Monitor woodland for native plant populations especially rare or endangered species.
Every 3 years, or as needed
• Monitor and assess health of mature trees.

Additional Projects

MAINTENANCE RESPONSIBILITY MATRIX

Zone	Site	Responsible Party
1	General Maintenance	Mowing & Landscape Services Contract managed by Division of Maintenance
2	South Flower Garden - supplemental	Volunteer group or supplemental maintenance contract if funding is available
3	Kitchen Garden – vegetable beds	Kitchen Garden Volunteers managed by GWMP Horticulturist
4	Arlington Woods	NPS staff (Divs. Of Maintenance and Resource Management)

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LANDSCAPE MAINTENANCE SCHEDULE

January	February	March	April	May	June	July	August	September	October	November	December
	Spring Clean Up										
		Mulching									
			Mowing								
		Pre Emergent Application									
		Spring Fertilization									
		Spring Broadleaf Application									
				Summer Annual Flower Rotation							
								Fall Flower Rotation			
						IPM Inspections					
Tree Pruning										Tree Pruning	
						Pruning					
								Fall/ Winter Turf Fertilization			
								Fall Broadleaf Application			
										Fall Leaf Removal	
								Fall Seeding/ Aeration			
				Irrigation Start Up							
					Irrigation Inspections						
									Irrigation Winterization		

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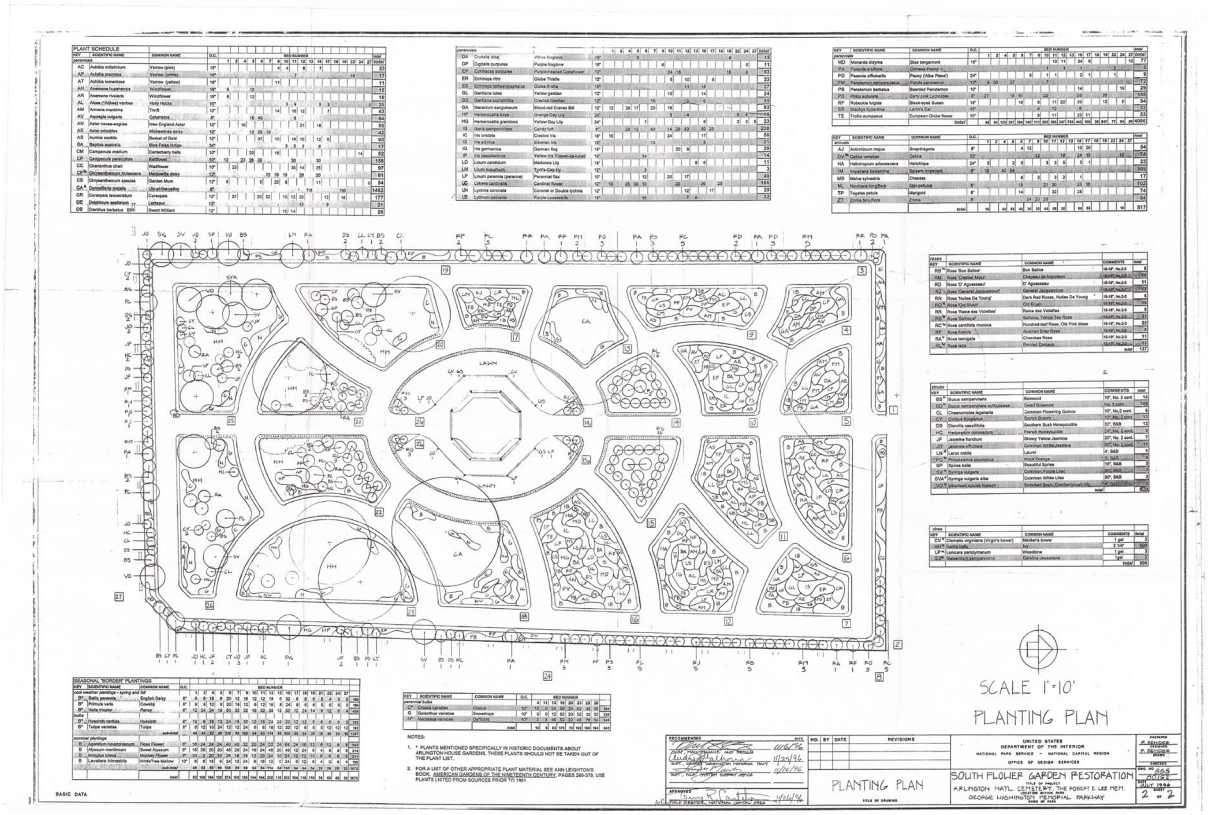
Landscape Management Plan

SOUTH FLOWER GARDEN PLANTING PLAN



Renovated in Summer 2020 using existing 1996 plan. Bed layout was replicated however many plant species were substituted due to lack of availability or are now considered invasive. Plant numbers were modified for spacing and fall annuals were installed.

KITCHEN GARDEN:
PERIOD APPRORIATE PLANTS

Vegetables/Fruits	Herbs
Peas	Angelica
Cabbage	Coriander
Gooseberries	Horehound
Beans	Southernwood
Celery	Anise
Beets	Clary
Raspberries	Liquorice
Irish Potatoes	Spearmint**
Turnips	Borage
Carrots	Dill
Currants	Peppermint**
Corn	Sage
Asparagus	Balm
Strawberries	Elecampane*
Tomatoes	Pennyroyal
Kale	Thistle
Cherries	Blessed Thoroughwort
Blackberries	Chamomile
Grapes	Fennel
Pears	Rosemary
Squash	Lavender
Apricots	Boneset
Lettuce	Caraway
Radishes	Hyssop
Onions	Rue
Okra	Tansy
Brussel Sprouts	Wormwood
Rhubarb	Thyme

Sweet Potatoes	Rampion
Cauliflower	Basil
Broccoli	Parsley
Artichoke	Cress
Cardoon	
Mangel-Wurzel	
Peppers	
Spinach	
Apples	
Elderberry	
Lemons	
Oranges	
Pineapple	
Coconut	
Eggplant	

*mentioned in historic references however now invasive. Do not plant. Replace with *Helianthus* species.
***Mentha* species are aggressive and control measures need to be put in place to restrain them in the garden.

Plants specifically mentioned by Lee family and ARHO visitors.
Plants exhibited at the Columbian Horticultural Society in 1835, 1836, and 1840.
Period appropriate plants not specifically mentioned at ARHO.

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Kitchen Garden: Planting Calendar

Planting and Harvest Dates **Hardiness Zone 7a**

Refer to the legend at the bottom of the chart to determine when it is appropriate to plant and harvest each vegetable, based on the last and first killing frost date for your region. Actual last and first killing frost dates will vary due to local conditions and yearly temperature fluctuations. Planting and harvest periods are represented as a 10-day range. You may wish to favor earlier or later planting dates within the given range based on local data or experience.
Note: The use of row cover fabric and cold frames may extend the expected planting and harvest window by two to four weeks in the spring and fall.

| | Last Spring Frost: 4/15 - 4/25 | | | | | | | | | | | | | | | | | | First Fall Frost: 10/15 - 10/25 | | | | | | | | | | | | | | | | | |

| | | |

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Photos

George Washington Memorial Parkway, National Park Service

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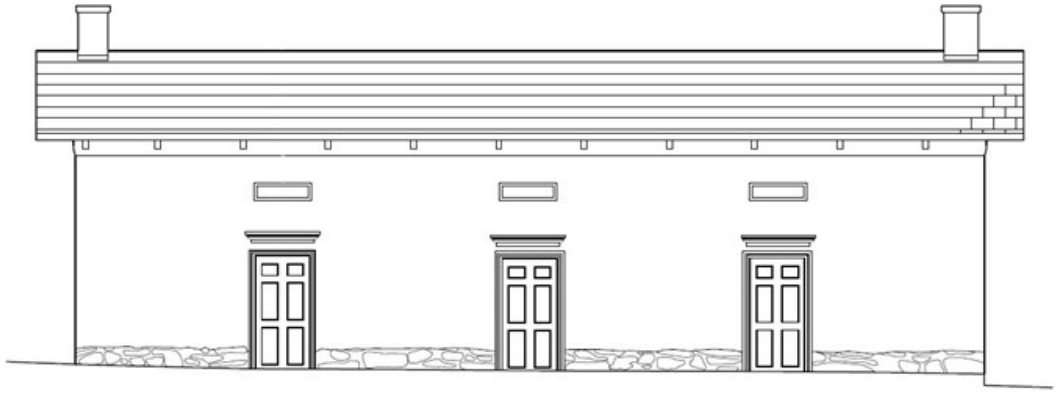

South Slave Quarters
Arlington House, The Robert E. Lee Memorial
Historic Structure Report Part 3 and Preservation Maintenance Plan
1985 - 2021

Appendix D:
LiDAR Documentation

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SECTION A

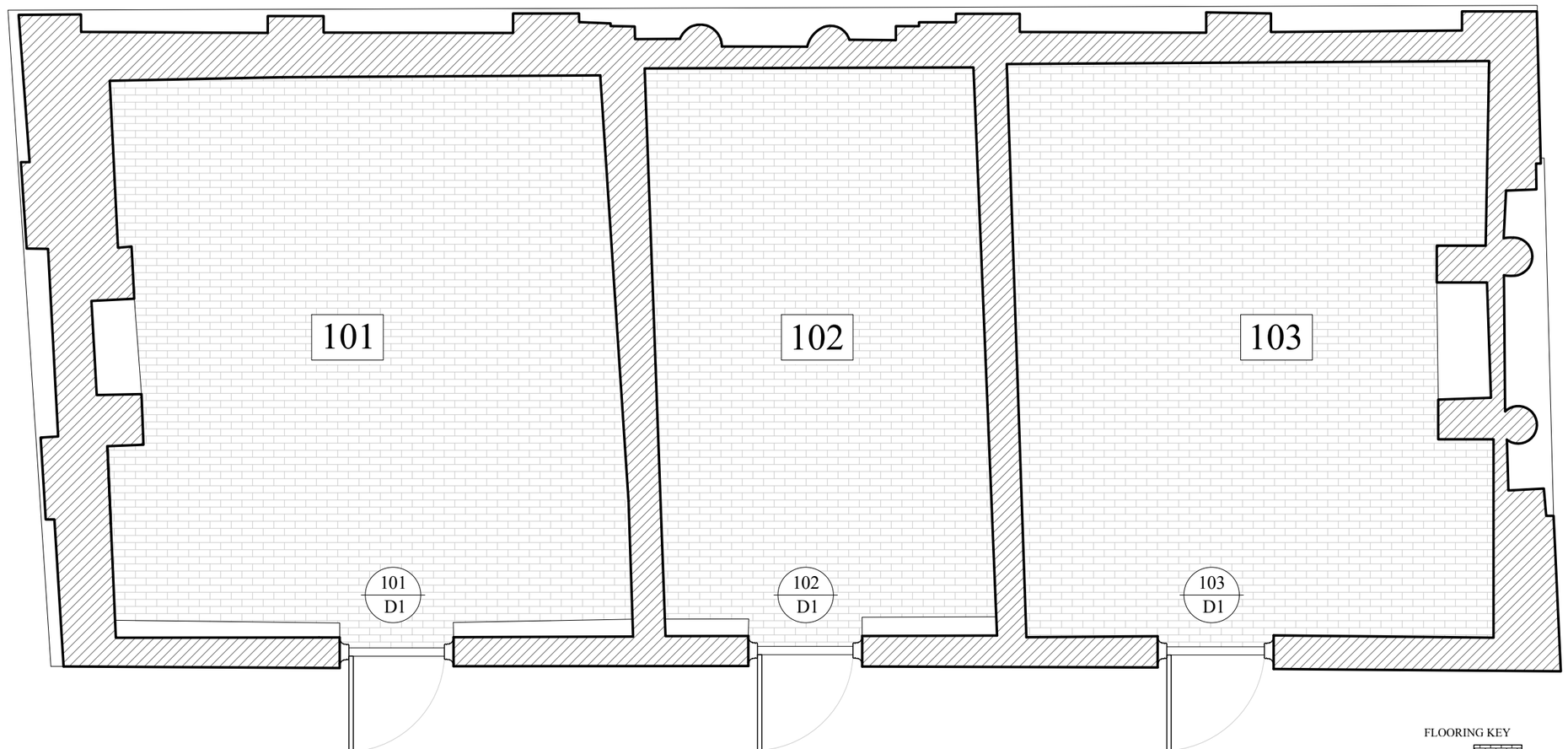
SECTION B

47'-6 1/2"

1'-11 3/8" | 5'-10 1/8" | 1'-9" | 5'-11 1/8" | 3'-9 7/8" | 8'-2" | 1'-10 5/8" | 2'-0" | 5'-10" | 8'-0 1/8" | 2'-4 1/8"

20'-4 5/8"

4'-7 3/8" | 2'-8 1/2" | 5'-11" | 2'-6 3/4" | 4'-7 1/4"



4'-9 1/8" | 11'-0 1/4" | 4'-10 3/8"

20'-7 3/4"

FLOORING KEY

Brick

8'-7 3/4" | 3'-6 3/4" | 9'-2 3/4" | 3'-6 3/4" | 9'-3" | 3'-7 5/8" | 8'-11 7/8"

46'-10 5/8"

0 1 2 3 4 5 10 15

FEET 1/4"=1'-0"

GROUND FLOOR PLAN

1/4"=1'-0" 1:48

0 1 2 3 4 5

METERS 1:48

SHEET 1 OF 8 SHEETS

Arlington House, The Robert E. Lee Memorial - South Slave Quarters

Lee Drive, Arlington National Cemetery, Arlington, Arlington County, VA

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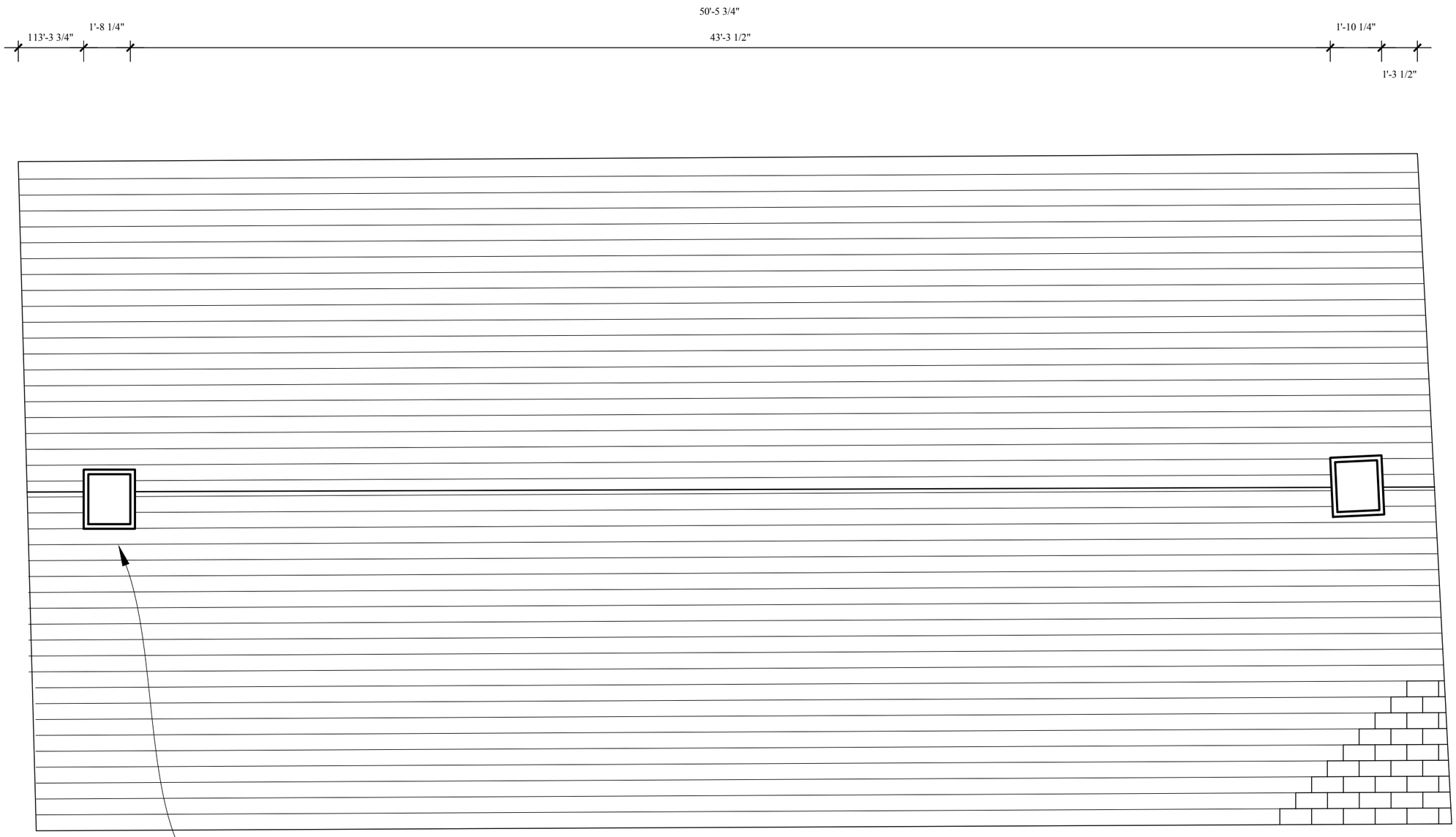

0 1 2 3 4 5 10 15

FEET 1/4"=1'-0"

ROOF PLAN

1/4"=1'-0" 1:48

0 1 2 3 4 5

METERS 1:48

SHEET 2 OF 8 SHEETS

Arlington House, The Robert E. Lee Memorial - South Slave Quarters

Lee Drive, Arlington National Cemetery, Arlington, Arlington County, VA

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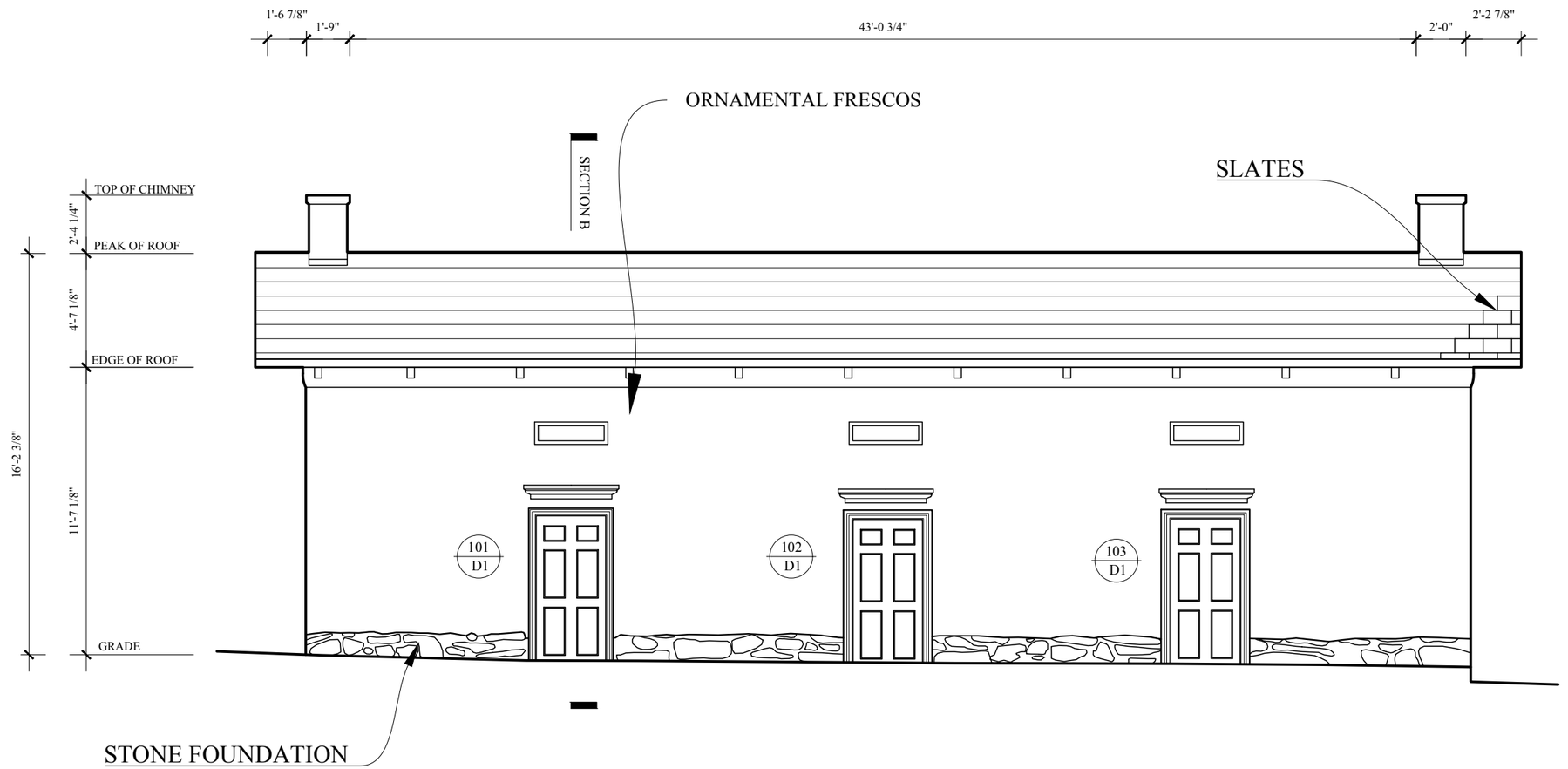

NORTH ELEVATION

3/16"=1'-0" 1:64

0 1 2 4 6 8 10 20

FEET 3/16"=1'-0"

0 1 2 4 6

METERS 1:64

1'-10 7/8"
1'-10 1/8"
43'-1 7/8"
1'-9"
2'-5 5/8"

SHEET 5 OF 8 SHEETS

Arlington House, The Robert E. Lee Memorial - South Slave Quarters

Lee Drive, Arlington National Cemetery, Arlington, Arlington County, VA

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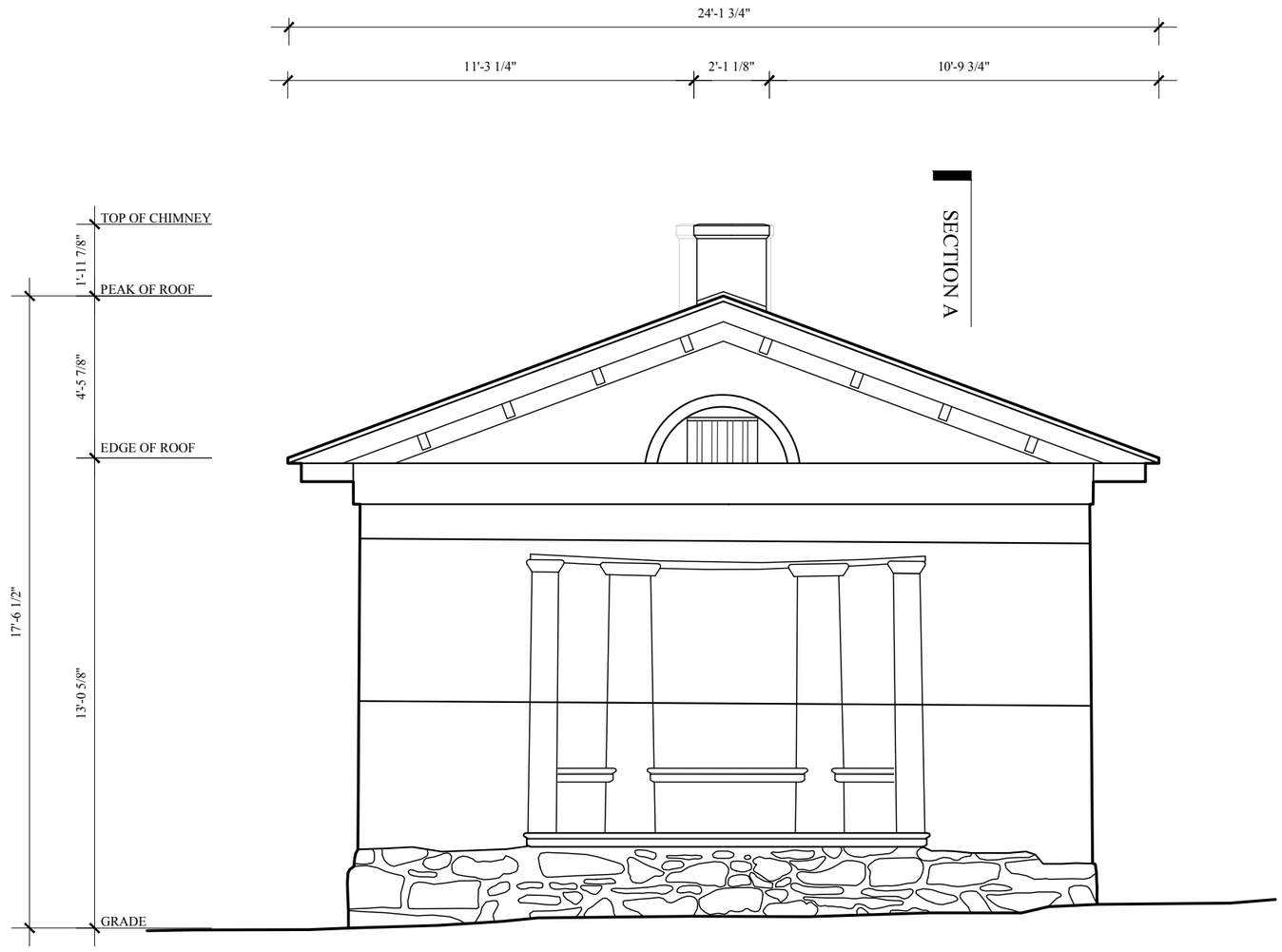

0 1 2 3 4 5 10 15

FEET 1/4"=1'-0"

EAST ELEVATION

1/4"=1'-0" 1:48

0 1 2 3 4 5

METERS 1:48

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Arlington House, The Robert E. Lee Memorial - South Slave Quarters
Lee Drive, Arlington National Cemetery, Arlington County, VA

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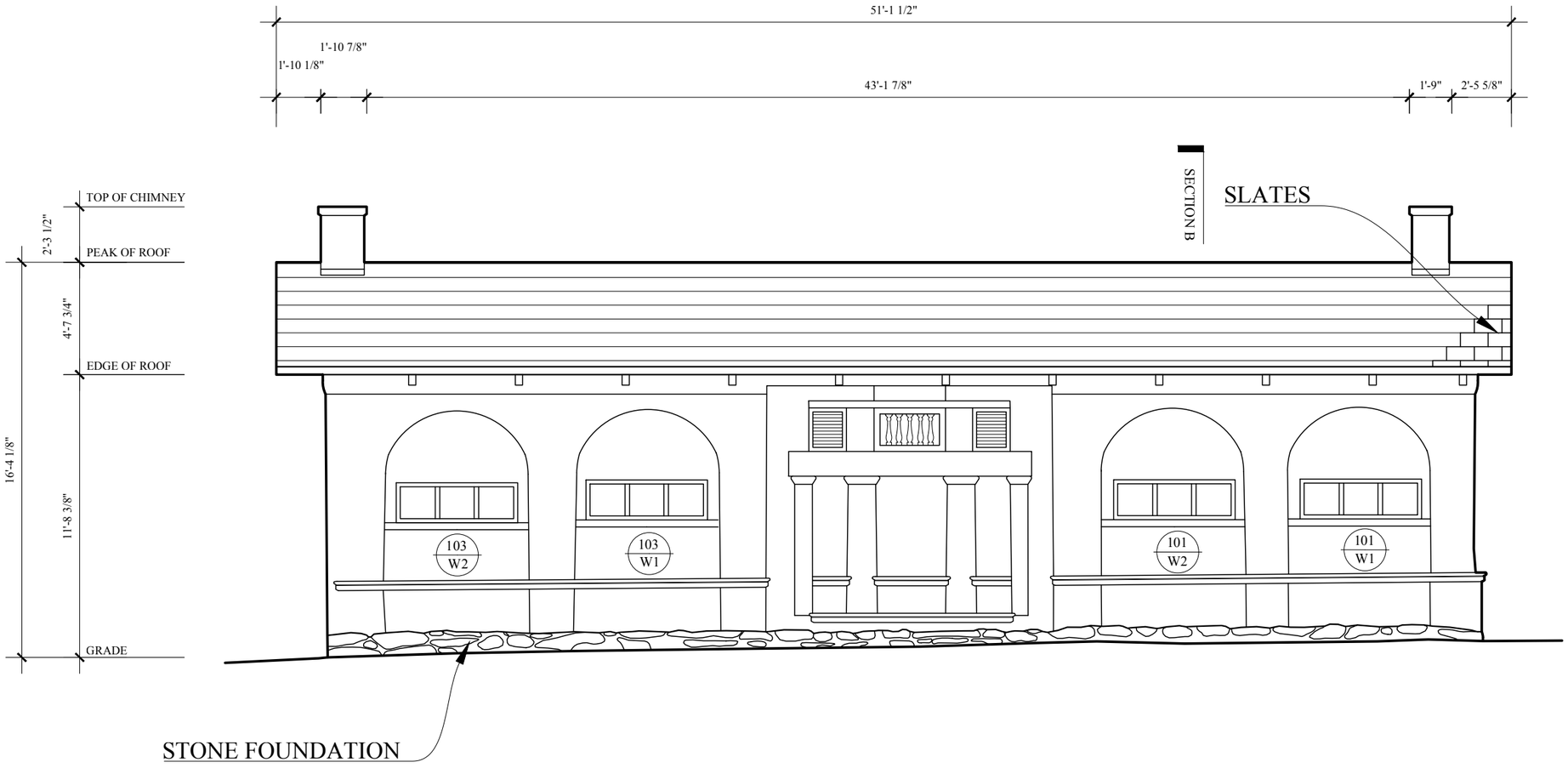

SOUTH ELEVATION

3/16"=1'-0" 1:64

0 1 2 4 6 8 10 20

FEET 3/16"=1'-0"

0 1 2 4 6

METERS 1:64

SHEET 5 OF 8 SHEETS

Arlington House, The Robert E. Lee Memorial - South Slave Quarters

Lee Drive, Arlington National Cemetery, Arlington, Arlington County, VA

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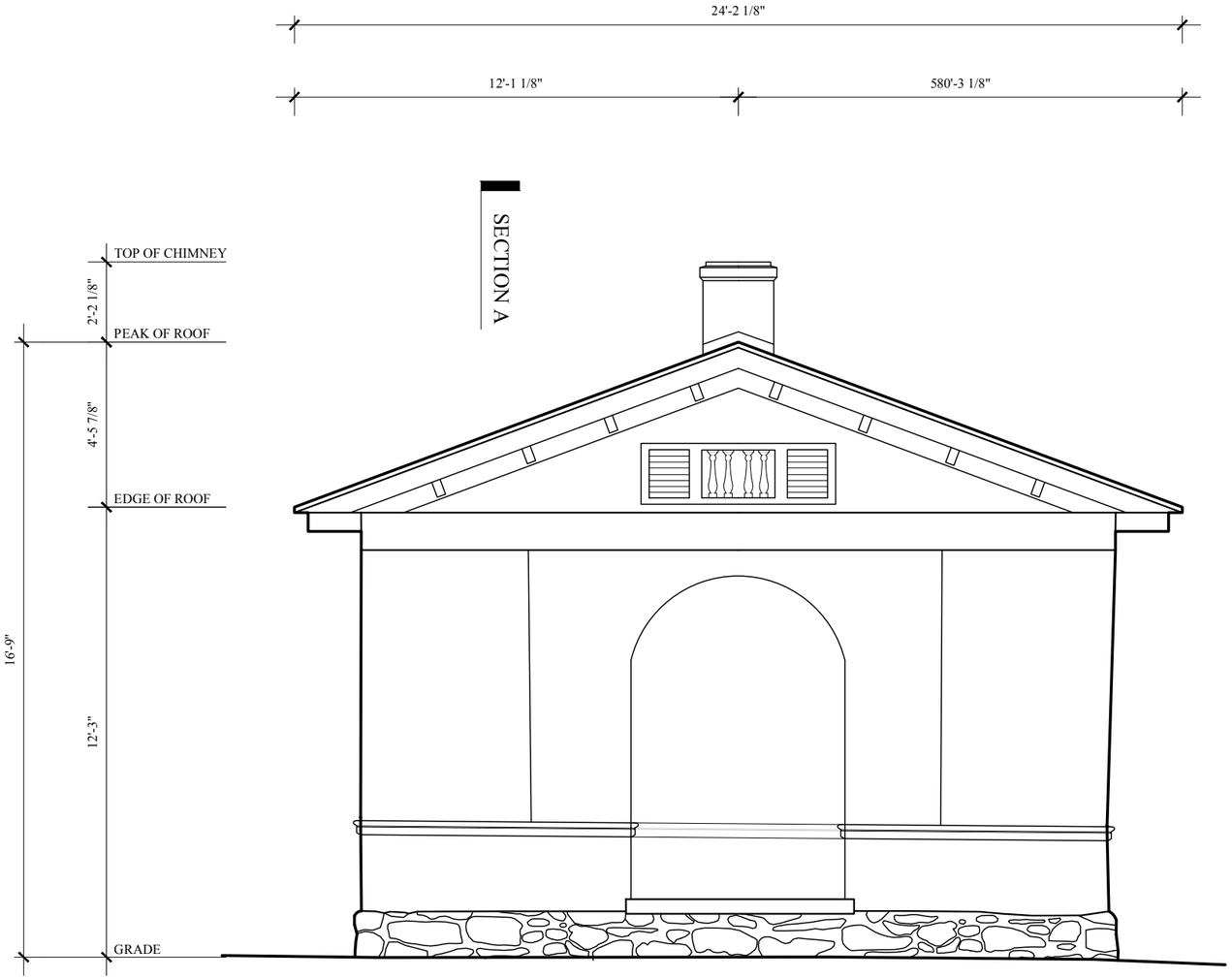

0 1 2 3 4 5 10 15

FEET 1/4"=1'-0"

WEST ELEVATION

1/4"=1'-0" 1:48

0 1 2 3 4 5

METERS 1:48

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Arlington House, The Robert E. Lee Memorial - South Slave Quarters

Lee Drive, Arlington National Cemetery, Arlington, Arlington County, VA

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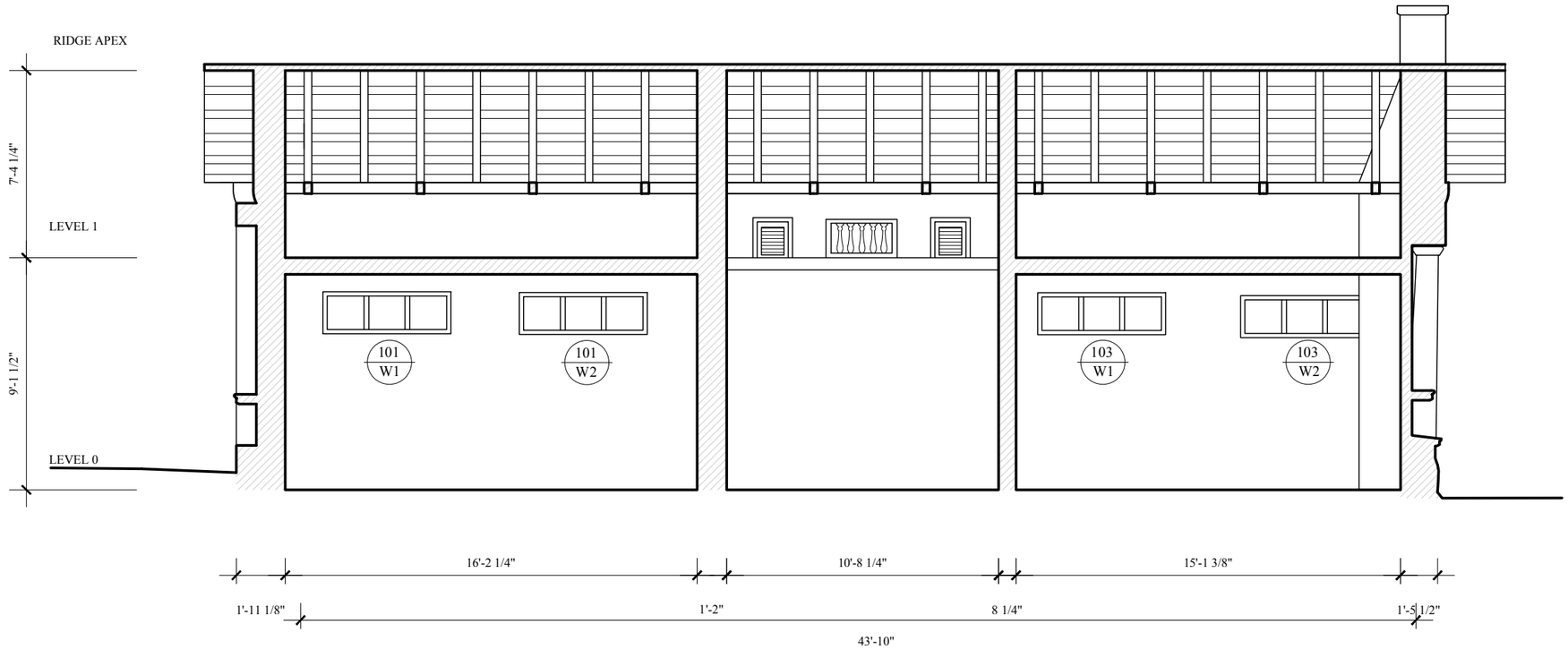

LONGITUDINAL SECTION

3/16"=1'-0" 1:64

0 1 2 4 6 8 10 20

FEET 3/16"=1'-0"

0 1 2 4 6

METERS 1:64

SHEET 7 OF 8 SHEETS

Arlington House, The Robert E. Lee Memorial - South Slave Quarters

Lee Drive, Arlington National Cemetery, Arlington, Arlington County, VA

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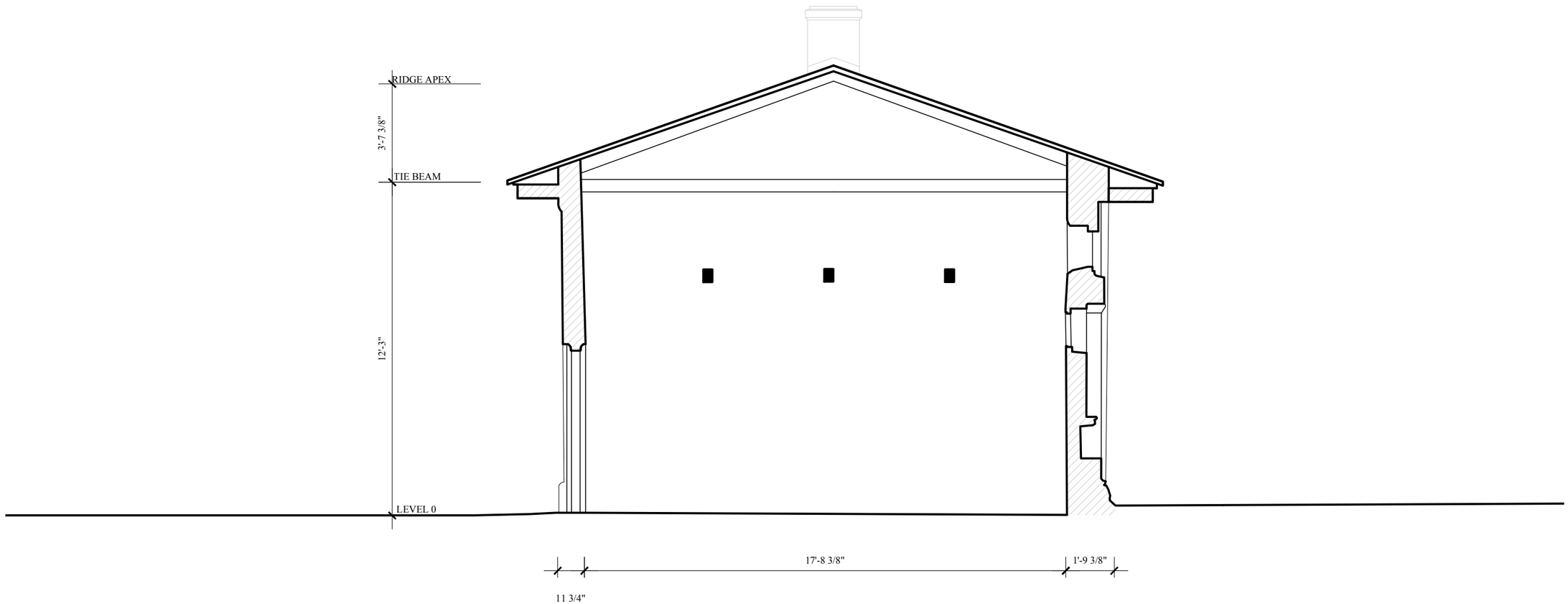

TRANSVERSE SECTION

1/4"=1'-0" 1:48

0 1 2 3 4 5 10 15
FEET 1/4"=1'-0"

0 1 2 3 4 5
METERS 1:48

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Lee Drive, Arlington National Cemetery, Arlington County, VA

SHEET 8 OF 8 SHEETS

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