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Burgess-Capps Cabin

Historic Context, Maintenance Issues, and Measured Drawings

August S. Fuelberth, James Wilcoski, Peter B. Stynoski,
Carey L. Baxter, Madison L. Story, Adam D. Smith, and
Joseph S. Murphey

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Abstract

The Burgess-Capps Cabin is located on the US Air Force Academy (USAFA), Colorado, and was placed on the National Register of Historic Places (NRHP) in 1975 under the name of “Pioneer Cabin.” The building is currently not occupied but used as a history interpretive site. It is one of the few log cabins that remain in this part of Colorado from the time of European settlement. All buildings, especially historic ones, require regular planned maintenance and repair. The most notable cause of historic building element failure or decay is not the fact that the historic building is old, but rather, it is caused by incorrect or inappropriate repair or basic neglect of the historic building fabric. This document is a maintenance manual compiled with as-is conditions of construction materials of the cabin. The secretary of interior’s guidelines on rehabilitation and repair per material are discussed to provide the cultural resources manager at USAFA a guide to maintain this historic building. Additional chapters include information regarding the historic materials and a structural analysis. This report satisfies Section 110 of the National Historic Preservation Act (NHPA) of 1966 as amended and will help USAFA’s Cultural Resources Management Office to manage this historic building.

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Preface

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Section 4 reprints and modifies portions of Adam Smith and Marcia Harris, *Fort Leonard Wood Maintenance and Repair Manual: Black Officer’s Club*, ERDC/CERL SR-05-41 (Champaign, IL: ERDC-CERL, 2005). Public domain.

COL Christian Patterson was commander of ERDC, and Dr. David W. Pittman was the director.

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1 Introduction

1.1 Background

The US Congress codified the National Historic Preservation Act of 1966 (NHPA), the nation’s most effective cultural resources legislation to date, in order to provide guidelines and requirements for identifying tangible elements of our nation’s past. This legislative requirement was met through creation of the National Register of Historic Places (NRHP). Contained within this piece of legislation (NHPA Sections 110 and 106) are requirements for federal agencies to address their cultural resources, defined as any prehistoric or historic district, site, building, structure, or object. Section 110 requires federal agencies to inventory and evaluate their cultural resources. Section 106 requires the determination of effect of federal undertakings on properties deemed eligible or potentially eligible for the NRHP.¹

1.2 Objective

The objective of this work was to gather building data through field inspections, archival research, and 3D scanning of the Burgess-Capps Cabin located at the US Air Force Academy (USAFA) and to compile this data to help manage this historic building and site by prioritizing appropriate reconstruction, repair, and maintenance tasks.²

1.3 Approach

The Burgess-Capps Cabin’s historical information, evaluation, site location and information, and feature evaluation report are based on four successive steps—Stages I, II, III, and IV—with each step providing a foundation for the next level. Carey L. Baxter, August S. Fuelberth, Adam D. Smith, Peter B. Stynoski, and James Wilcoski gathered building and site data

1. National Historic Preservation Act, Pub. L. No. 89-665, as amended by Pub. L. No. 96-515, Sections 110, 106 (1966).

² Note that the Colorado State Historic Preservation Office was not able to review the report prior to its finalization, and if it is needed for future, presently unknown Section 106 needs, USAFA understands that the report’s findings and recommendations will need to be considered by the Colorado State Historic Preservation Office at that time for specific needs on concurrence or nonconcurrence regarding undertakings.

through field inspections, archival research, and 3D scanning. The researchers then compiled this data into the four stages described below.

- Stage I is the identification and documentation of the historic building and classification of the building. This stage produces general identification information, including the background material necessary to establish a frame of reference for the building's history, architecture, and construction techniques and materials. Stage I includes an up-to-date historic context utilizing recently gathered material from repositories at USAFA and in Colorado Springs.³
- Stage II includes the site location and general site information, as well as an architectural description of the Burgess-Capps Cabin.
- Stage III allows for the organization of the building into one or more zones or areas of varying historical and architectural importance. This section contains descriptive information and photographs, drawings, and keys to identify the areas.
- Stage IV contains the identification, evaluation, and descriptions of individual architectural features (both building and site) or elements within each zone that were established in Stage III (referred to as the "Element Report"). Stage IV also identifies deficient elements and provides work recommendations and cost estimates to correct these deficiencies. The elements are organized into divisions such as exterior and interior. The data in Stage IV is most applicable to reconstruction, repair, and maintenance.

1.4 Scope

The data collected for work related to this report for the Burgess-Capps Cabin is organized into two parts: graphic documentation and written information.

The graphic portion consists of historical photographs of Burgess-Capps Cabin, historical maps and aerials, and current condition drawings based on 3D scan data.

3. Some oral histories and other sources are not easily vetted, so dates and timelines may not correlate across the historic context.

The written portion consists of the various elements of the building and potential repair or replacement options guided by the “Secretary of the Interior’s Standards.”⁴

1.5 Researchers

This project was conducted by the US Army Corps of Engineers, Engineering Research Development Center, Construction and Engineering Research Laboratory (ERDC-CERL) in Champaign, Illinois. The research team included Adam D. Smith, master of architecture, as project manager with 25 years of experience in military architectural history; Carey L. Baxter, archeologist and 3D scanning expert with 22 years of experience; Peter B. Stynoski for the materials analysis; James Wilcoski for the structural analysis; Madison L. Story, master of science in historic preservation, preservation professional with 2 years of experience; and August S. Fuelberth, student intern (architecture), with 3 years of experience, supervised by Joseph S. Murphey, master of architecture, historical architect with 42 years of experience, registered architect, Texas #12533.

1.6 Site visits

ERDC-CERL personnel made three trips to USAFA, first in August 2021 to 3D scan the Burgess-Capps Cabin and to evaluate, photograph, and gather information at USAFA’s Cultural Resources Management (CRM) Office. The second and third trips were completed in November 2021 to gather historical information, specimens for the materials analysis, additional photographs, and data for the structural assessment.

Throughout 2021 and 2022, USAFA CRM staff assisted with the gathering of additional photographs and information in consultation with ERDC-CERL personnel upon our site visits as well as via phone and email.

4. National Park Service, “The Secretary of the Interior’s Standards for the Treatment of Historic Properties: Rehabilitation as a Treatment and Standards for Rehabilitation,” Technical Preservation Services, last updated October 26, 2022, <https://www.nps.gov/articles/000/treatment-standards-rehabilitation.htm>.

2 Stage I: History

The first Euro-Americans passed through the Colorado Springs area in the early to mid-1800s; however, Euro-American settlement did not begin in earnest until the passage of the Homestead Act of 1862, which allowed prospective settlers to obtain a 160-acre parcel for a dwelling and homestead. The earliest Euro-American settlers in the area were William Lennox, Aaron Blodgett, Charles Schubarth, Harlow Teachout, and William Burgess;⁵ however, the region was utilized by the Arapahos, Cheyenne, and Utes before Euro-American settlement.⁶

Euro-American settlement of the Colorado Springs area was largely incited by the discovery of gold in Colorado in 1859. In 1861, a stage road was established between Colorado City and Denver City, and settlers quickly began homesteading or purchasing land in the area that would later become USAFA.⁷ At this time, the land in the area was government land, often referred to as “offered land,” which was open to private entry. Government regulations provided that surveyed land that had been open to preemption and homestead for five years but had not been occupied could be purchased in unlimited acreage at \$1.25 per acre. Most of the Colorado Springs area was “offered land” in the 1860s and 1870s, but settlers primarily homesteaded in the Shooks Run and Monument Creek valleys.⁸ Much of the land that would later become USAFA was purchased by General Palmer, the founder of the Denver and Rio Grande Western Railroad, and his backers. By 1871, the railroad ran from Colorado Springs to Denver along Monument Creek.⁹

5. HMdb.org, “Before the Academy: United States Air Force Academy,” The Historical Marker Database, October 20, 2020, <https://www.hmdb.org/m.asp?m=158304>.

6 E.S. Cassells, *The Archaeology of Colorado* (Boulder, CO: Johnson Publishing Company, 1983). For a full list of the spelled-out forms of the units of measure used in this document and their conversions, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 248–52 and 345–47, <https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf>.

7. Versar, Inc., National Register Eligibility Evaluation of Archaeological Site 5EP1619, United States Air Force Academy, El Paso County, Colorado (Colorado Springs, CO: United States Air Force Academy, 2007), 7.

8 I. Howbert, *Memories of a Lifetime in the Pikes Peak Region* (New York, NY: G.P. Putnam’s Sons, 1925).

9. Bernard Schriever, personal communication with Adam Smith, April 25, 2023; Bill Eckert, “A USAFA Nearby Neighborhood History,” Air Force Academy Class of 1968 (website), October 27, 2015, <http://www.usafa68.org/Bulletins/Eckert/bu35.htm>.

Harlow Teachout was the first major settler in the area, and he constructed a two-story, eight-bedroom home in what is now Pine Valley in the late 1860s.¹⁰ In 1872, David Edgerton purchased a 160-acre tract of land adjacent to Harlow Teachout's homestead.¹¹ Edgerton, though, may have started inhabiting this land on 27 July 1869.¹² Soon after, an area hotel—located, according to oral histories, in Harlow Teachout's two-story home—known as Edgerton House came to house people traveling between Denver and Pueblo. By 1878, a small community had formed on Edgerton's homestead, and it served as a station on the Denver and Rio Grande Railroad (Figure 1).¹³

Figure 1. Edgerton shown in red box on a c. 1890 map. ("El Paso County Colorado map," after 1882 about 1890, Wikipedia, https://en.wikipedia.org/wiki/Edgerton,_Colorado. Edited by the Engineer Research and Development Center, Construction Engineering Research Laboratory [ERDC-CERL], 2022. Public domain.)



2.1 The Burgesses and the Capps

In the early to mid-1870s, the Capps and Burgess families settled on land north and northwest of Edgerton. After moving from Ohio, Leonard Capps

10. Jill R. Trout, "Communities of Yesterday," July 19, 1988, MSS 0126 SC, Special Collections, Pikes Peak Library District, Penrose Library, Colorado Springs, CO, 2.

11. Danny Summers, "A Look Back at Edgerton," *Douglas County News-Press*, March 26, 2011, <https://douglascountynewspress.net/stories/a-look-back-at-edgerton,89732>.

12. Trout, "Communities of Yesterday," 2.

13. Trout, "Communities of Yesterday," 2–4.

likely settled in the area first, building a cabin around what is now Falcon Stadium circa 1869.¹⁴

Approximately one mile to the east of the Capps cabin, William “Bill” Alexander (alternatively spelled Alexsander) Burgess (Figure 2) built a 288 sq ft cabin beginning in 1875.¹⁵ Bill Burgess was born in Cleveland, Ohio, on 20 February 1854. Following the death of his father, he and his mother moved west in 1859 in a covered wagon pulled by a yoke of eight oxen. They stopped in Lawrence, Kansas, and Denver, Colorado, before arriving to Keystone, Colorado, in 1862.¹⁶ Bill Burgess and his mother, Isabelle, remained in Keystone, Colorado, from 1862 until 1870.¹⁷ Bill, reportedly without his mother, came to Douglass Valley in the early 1870s.¹⁸

14. Census records show that the Capps family occupied the cabin in 1870; George V. Fagan, “The Air Force Academy Site and the Pikes Peak Region,” 1962, 4489.13, Special Collections, Pikes Peak Library District, Penrose Library, Colorado Springs, CO, 4; Terry Aretz, “Students Discover Pioneer Cabin,” *Falcon Flyer*, October 10, 1996, C: Environmental & CATCODE Documentation, XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

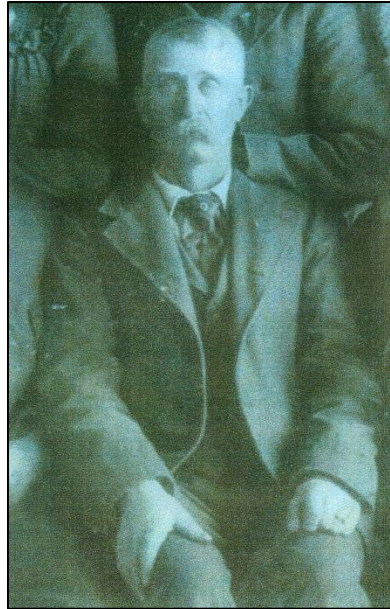
15. “Academy Goes Up on Land Rich in Pioneer History,” *Gazette Telegraph*, May 12, 1957, 125.3.21, RG 120, Series 15, Box 5, folder 4, US Air Force Academy Library, Colorado Springs, CO; Sarah M. Scalise, “Physical Inspection Checklist,” A: Asset review/Inventory (Facility Inspection/Inventory, Appraisals), XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO; Aretz, “Students Discover Pioneer Cabin;” Hal M. Brewer, “Pioneer Cabin,” National Register of Historic Places Nomination Form, January 27, 1975, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO; Marion G. (Burgess) Jaloma, “‘The Lonely Burgess Cabin’ by Dave Hughes corrected by Marion G. (Burgess) Jaloma,” personal collection of Jack Anthony.

16. Marion G. (Burgess) Jaloma, “‘The People Story Behind the Pioneer Cabin’ by Bill Hemingway corrected by Marion G. (Burgess) Jaloma,” personal collection of Jack Anthony.

17. Jaloma, “‘The People Story Behind the Pioneer Cabin’ by Bill Hemingway corrected by Marion G. (Burgess) Jaloma.”

18. Jaloma, “‘The Lonely Burgess Cabin’ by Dave Hughes corrected by Marion G. (Burgess) Jaloma.”

Figure 2. William Alexander “Bill” Burgess, 1901. (Personal collection of Jack Anthony. Reprinted with permission of Jack Anthony.)



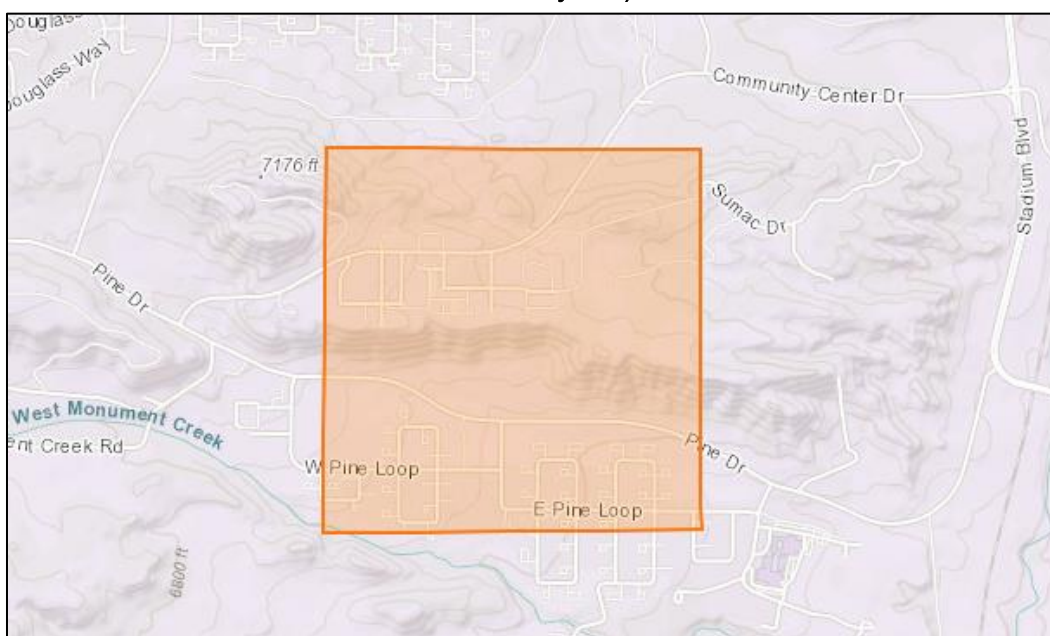
In 1861, a man named William W. Burgess filed a homestead for a 160-acre parcel of land in Douglass Valley; however, according to a Burgess descendant, this was not the same William “Bill” Alexander Burgess who built the cabin, as Bill was too young to file a land claim, and his father William had passed away in Ohio prior to Bill and his mother’s arrival in Colorado.¹⁹

There are numerous varying reports regarding how William “Bill” Alexander Burgess acquired his homestead north of Colorado Springs (Figure 3). Per the chain of title, Burgess borrowed \$200 from J. B. Kilbourn, the receiver against the property, in 1887; however, the transaction was not recorded until 1889, and Burgess did not receive the patent until 1891. He

19. Notably, there is no land patent accessible via the Bureau of Land Management’s online General Land Office Records for a William Burgess or William W. Burgess in 1861. There are patents for a William Burgess, no middle name, in 1884 and William A. Burgess in 1891; Jaloma, “‘The People Story Behind the Pioneer Cabin’ by Bill Hemingway corrected by Marion G. (Burgess) Jaloma”; William Burgess (Pueblo, CO) state volume patent No. 1768, Land Patent Search (database), General Land Office Records, Bureau of Land Management, accessed September 2, 2022, <https://glorerecords.blm.gov/search/default.aspx>; William A. Burgess (Pueblo, CO) state volume patent No. 4761, Land Patent Search (database), General Land Office Records, Bureau of Land Management, accessed September 2, 2022, <https://glorerecords.blm.gov/search/default.aspx>.

also did not record the patent with the county until 1911.²⁰ Other reports state that he filed to purchase the homestead on 14 February 1871, when he was a few days shy of his 17th birthday, or that he traveled to Pueblo, Colorado, with Timothy Kenneth Capps to pay a \$6.00 fee to the financial receiver for a homestead parcel on 16 January 1884 (Timothy K. Capps reportedly already lived on the adjacent land, as his father, Leonard, had homesteaded it in 1886).²¹ Given these conflicting reports, it is possible that Burgess arrived and began inhabiting the land in the decade prior to his pursuit of legal ownership of the land.

Figure 3. Bill Burgess's parcel shown on a contemporary map of the US Air Force Academy (USAFA), 2022. (William A. Burgess [Pueblo, CO] state volume patent No. 4761. Map data: Powered by Esri.)



Bill initially lived in a slab shack west of where he would later build his cabin as, according to a descendant, he had a mine claim in the hills.²² He cut logs and ties for the Denver and Rio Grande Western Railroad to earn money. He reportedly began building the cabin that is now known as the

20. William A. Burgess (Pueblo, CO), The Security Abstract and Title Company, abstract of title no. 84011, RG 120, US Air Force Academy Library, Colorado Springs, CO.

21. William's move to his own property was reportedly the result of cruelty from his stepfather, Bill Jones; [The story of William Alexander Burgess], F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO; Marion Gene (Burgess) Jaloma and R. Steve Andrews, "Burgess Homestead Cabin," 2005, personal collection of Jack Anthony; Marion G. (Burgess) Jaloma, "Leonard Kenneth Capps Family," personal collection of Jack Anthony.

22. No record of this mine claim was found by researchers; Jaloma, "The Lonely Burgess Cabin" by Dave Hughes corrected by Marion G. (Burgess) Jaloma."

Burgess-Capps cabin in 1875, though this date may be inaccurate.²³ Upon completion, it had a sod roof and dirt floor; Bill laid the plank floor and shake roof after beginning a family. The loft and porch were also later additions to the cabin.²⁴

In 1880, Bill, then 26, married Adaline (alternatively spelled Adayline) Layton, who had moved to Colorado from Illinois. The pair went on to have five children: Henry Alexander, born 1881; Oscar Allen, 1882; Elizabeth Mary, 1884; Emma, 1886; and Olive Camilla, 1888.²⁵

Adaline reportedly aided in the ongoing construction of the cabin, collecting rock for the exterior chimney and digging a cellar on the north elevation of the cabin. This cellar was likely a root cellar, as there is no evidence of a subsurface room next to the cabin.²⁶ Adaline also reportedly installed a comb-cleaning device consisting of a corn cob with horsehair by drilling a hole in the wood and pushing the corn cob into the hole to hang it.²⁷

The Burgesses most consistently earned money through raising crops and some cattle, including milk cows, oxen, and horses.²⁸ Many of these animals were bequeathed to Bill Burgess in his mother's will.²⁹ At various points, he also cut ice at Monument Ice Plant for the icehouse in Colorado Springs, worked a mine in the Front Range, and panned gold on Cherry Creek and the South Platte River.³⁰ He also served as a constable with terms beginning on 5 January 1882 and 4 January 1886.³¹ To buy food and supplies, the family would frequently travel to Edgerton by wagon.³²

23. Jaloma, "The Lonely Burgess Cabin' by Dave Hughes corrected by Marion G. (Burgess) Jaloma."

24. Jaloma and Andrews, "Burgess Homestead Cabin."

25. Hemingway, "The People Story Behind the Pioneer Cabin;" Jaloma, "The Lonely Burgess Cabin' by Dave Hughes corrected by Marion G. (Burgess) Jaloma."

26. Bernard Schriever, personal communication with Adam Smith, April 25, 2023.

27. [The story of William Alexander Burgess].

28. Hemingway, "The People Story Behind the Pioneer Cabin;" Jaloma, "The Lonely Burgess Cabin' by Dave Hughes corrected by Marion G. (Burgess) Jaloma."

29. Jaloma, "Burgess Homestead Cabin."

30. Hemingway, "The People Story Behind the Pioneer Cabin;" Jaloma, "The Lonely Burgess Cabin' by Dave Hughes corrected by Marion G. (Burgess) Jaloma."

31. Jaloma, "The Lonely Burgess Cabin' by Dave Hughes corrected by Marion G. (Burgess) Jaloma."

32. Aretz, "Students Discover Pioneer Cabin;" Jaloma, "The Lonely Burgess Cabin' by Dave Hughes corrected by Marion G. (Burgess) Jaloma."

Throughout the Burgess family's time in the cabin, Cheyenne and Arapahoe Indigenous peoples reportedly returned to the Colorado Springs area to reclaim their land in a series of small, unsuccessful raids. Some sources report that Bill Burgess lost his left eye in a raid;³³ however, descendants note that this is untrue, and that Bill was, in fact, friendly with local Indigenous peoples, who would frequently come visit the family's cabin.³⁴

The Capps family were also frequent visitors to the Burgess cabin. The Burgesses sometimes took in the Capps family during times of hardship, though the Capps family never lived in the cabin on a permanent basis.³⁵ Reportedly, two Capps family members were born in the Burgess cabin: Ara Eugene Capps, born 20 May 1883, and Clarence Emerald Capps, born 22 December 1887.³⁶ Clarence later died after eating poisonous wild berries and was buried on a nearby property. He was reinterred near the Burgess cabin in the mid-20th century.³⁷ The close relationship between the Capps and Burgess families was likely due to the fact that they were related by marriage—Timothy K. Capps (Bill Burgess's neighbor who reportedly filed for a homestead with Burgess in Pueblo in 1884) married Adaline Layton's half-sister.³⁸ As such, the Burgess children and the Capps children, including those now buried near the cabin, were first cousins.³⁹

Around 1894, Adaline left Douglass Valley with her and Bill's three daughters—Elizabeth Mary, Emma, and Olive Camilla—and a man she had known in Illinois, James Andrew Davis.⁴⁰ According to Bill Burgess's grandson Bob Burgess, Adaline left Douglass Valley because “she couldn't

33. Hemingway, “The People Story Behind the Pioneer Cabin.”

34. Jaloma, “‘The Lonely Burgess Cabin’ by Dave Hughes corrected by Marion G. (Burgess) Jaloma;” Jaloma, “‘The People Story Behind the Pioneer Cabin’ by Bill Hemingway corrected by Marion G. (Burgess) Jaloma.”

35. Notes of Jack Anthony, Jack Anthony's personal collection.

36. Bill Holland, “Early Settler Returns to Birthplace” United States Air Force News Release, October 23, 1969, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO; Jaloma and Andrews, “Burgess Homestead Cabin;” Jaloma, “Leonard Kenneth Capps Family.”

37. Jaloma, “Burgess Homestead Cabin.”

38. Notes of Jack Anthony, Jack Anthony's personal collection.

39. Jaloma, “‘The Lonely Burgess Cabin’ by Dave Hughes corrected by Marion G. (Burgess) Jaloma.”

40. Jaloma, “‘The Lonely Burgess Cabin’ by Dave Hughes corrected by Marion G. (Burgess) Jaloma;” Hemingway, “The People Story Behind the Pioneer Cabin.”

take the pioneer life any more [sic].”⁴¹ She had reportedly filed for divorce in 1890 on grounds of cruelty, though this was never granted.⁴² The couple and daughters then moved to Fort Morgan, Colorado, where Elizabeth Mary died due to illness on 27 August 1897. In 1906, Adaline, Davis, and the two remaining daughters decided to move to Cottage Grove, Oregon, in response to ongoing harassment from Bill.⁴³ Ultimately, Adaline died in Cottage Grove in 1947.⁴⁴

After Adaline and the daughters left, Bill and the couple’s two sons—Henry Alexander and Oscar Allen—remained in the Douglass Valley cabin.⁴⁵ Bill reportedly spent a lot of time in the 1890s and early 1900s in Colorado Springs and Fort Morgan attempting to get Adaline to return to the cabin, leaving Henry and Oscar to fend for themselves.⁴⁶ Around this time, Burgess borrowed money against the land. In 1889, he borrowed \$150 from Kirke H. Field, trustee, use of David Heron, and George Walker, trustee, use of Kirke H. Field. He paid off this loan in 1891 but later that year borrowed \$250 from Simon J. Dunbar, trustee, use of the Security Loan Company. He defaulted on this second loan in 1892, and the property was sold at auction to Frank H. Pettingell, a member of the Security Loan Company, for \$100.⁴⁷

Oral histories indicate that Bill continued to live in the cabin through 1924; however, he also allegedly borrowed \$80 from the First National Bank of Colorado Springs, mortgaging his property to plant an orchard that failed after several years of drought. This account suggests that Burgess may have acquired and resided on an additional property.⁴⁸ Regardless, in 1924, Bill lost his leg following an injury while working at the

41. Hemingway, “The People Story Behind the Pioneer Cabin;” Jaloma, “‘The Lonely Burgess Cabin’ by Dave Hughes corrected by Marion G. (Burgess) Jaloma.”

42. Jaloma, “Burgess Homestead Cabin.”

43. Jaloma, “Burgess Homestead Cabin.”

44. Hemingway, “The People Story Behind the Pioneer Cabin.”

45. Hemingway, “The People Story Behind the Pioneer Cabin.”

46. Jaloma, “Burgess Homestead Cabin.”

47. The Security Abstract and Title Company, *Abstract of Title No. 84011*.

48. Hemingway, “The People Story Behind the Pioneer Cabin.”

Monument Ice Plant.⁴⁹ He also lost sight in one eye around this time, though the cause is unclear.⁵⁰

Unable to continue living on his own, Bill moved to Colorado Springs to live with his son Henry. He later moved to Englewood, a suburb of Denver, to live with his son Oscar Allen.⁵¹ At this time, his second leg became infected.⁵² Bill Burgess died on May 3, 1930, reportedly as a result of this infection.⁵³ He is buried in Riverside Cemetery in Denver.⁵⁴

2.2 Douglass Valley

Following Frank H. Pettingell's purchase of the Burgess land, he transferred the title to the Security Loan Company, which seemingly maintained ownership until 1900, as the president of the Security Loan Company paid taxes on the property until that date. That year, the land was sold to A. C. Magruder, but the transaction was not legally recognized until 1910. In 1911, Magruder sold the land to Frank L. Dennis. Dennis sold the land to Ethel M. Clark in 1920. In 1924, Clark sold the right-of-way for a driveway to Grace Seymour; she sold the remainder of the land to Gordon Cronkhite in 1925. Cronkhite sold the land in 1933 to Ignacio Montano, who sold the land several months later to Leon Snyder.⁵⁵ Snyder reportedly came to own a 1,520-acre parcel that expanded beyond the former Burgess (and Capps) property.⁵⁶

By the time Snyder acquired the land, improvements included the Burgess-Capps cabin and a large log lodge, located approximately ¼ mile from the Burgess-Capps cabin. The lodge was noted by appraisers at the time of USAFA's acquisition of the property in 1955 as 25–30 years old, indicating that it was constructed by Gordon Cronkhite, Ignacio Montano (though, due to the brevity of his ownership of the property, this is

49. Jaloma, "The Lonely Burgess Cabin" by Dave Hughes corrected by Marion G. (Burgess) Jaloma."

50. Jaloma and Andrews, "Burgess Homestead Cabin;" Hemingway, "The People Story Behind the Pioneer Cabin."

51. Hemingway, "The People Story Behind the Pioneer Cabin."

52. Jaloma, "Burgess Homestead Cabin."

53. Jaloma, "Burgess Homestead Cabin."

54. Hemingway, "The People Story Behind the Pioneer Cabin;" [The story of William Alexander Burgess]; Jaloma, "Burgess Homestead Cabin."

55. The Security Abstract and Title Company, *Abstract of Title No. 84011*.

56. Trout, "Communities of Yesterday," 11–12.

unlikely), or Leon Snyder.⁵⁷ Also at the time of Snyder's acquisition of the land, there was a lean-to constructed on the back of the cabin, though it is unclear who was responsible for its construction (Figure 4).⁵⁸

Figure 4. Burgess-Capps cabin with lean-to visible on north elevation, 4 July 1929. ([Photo of lean-to on back of cabin]. Reprinted with the permission of Jack Anthony.)



At an unknown date, likely in the 1930s, Mr. and Mrs. Earl Douglass purchased the 1,520-acre Snyder property to operate a dude ranch and dairy.⁵⁹ The property was known as Pine Haven Ranch at this time.⁶⁰ By this point, the property featured the Burgess-Capps cabin; a seven-room, single-story house; a three-room frame and log cottage; and various

57. Richard J. Des Jardins, "Appraisal: The Douglass Ranch, Colorado Springs, Colorado," 124.20.80, RG 120, U.S. Air Force Academy Library, Colorado Springs, CO, 15.

58. [Photo of lean-to on back of cabin], personal collection of Jack Anthony.

59. The Douglass' original acquisition date of the property is unknown; Gerald T. Hart, "Appraisal: The Douglass Ranch, El Paso County, Colorado," January 3, 1954, 124.20.78, RG 120, US Air Force Academy Library, Colorado Springs, CO, 1-2; Watson A. Bowes, "Appraisal: Douglass Ranch Property near Colorado Springs, Colorado," November 28, 1954, 124.20.79, RG 120, US Air Force Academy Library, Colorado Springs, CO, 4, 12.

60. Letter from James H. Douglass to Harold E. Talbott, February 3, 1955, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

outbuildings.⁶¹ The Douglasses also built three small cabins, now referred to as the “Boy Scout Cabins,” on the property.⁶²

After purchasing the property, the Burgess-Capps cabin had deteriorated. Earl Douglass, though, was interested in preserving the cabin, so the family “made the few necessary repairs” and started using the building “as a private museum for a few old articles in the possession of [the] family.”⁶³

The necessary repairs involved attempts at restoring the cabin to what the Douglass family believed was its original state by installing new window sashes, caulking some chinks, installing new shingles, and repairing the chimney.⁶⁴ The cabin’s preservation, as well as the ongoing presence of the heirlooms in the cabin, was a condition of the Air Force Academy Construction Agency’s purchase of the land.⁶⁵

At the time of the Douglass’ purchase of the property, the land that would later become USAFA—formerly popular for homesteading and ranching—became a popular location for the summer homes and estates of wealthy residents of Colorado Springs.⁶⁶ By the time that USAFA purchased the land in the 1950s, Douglass Ranch, also known as Douglass Valley, was one of four primary communities and ranches in the area (the others being Pine Valley, Jack Valley, and Cathedral Rock Ranch).⁶⁷

61. Trout, “Communities of Yesterday,” 11–12; Hart, “Appraisal: The Douglass Ranch,” 13.

62. Bernard Schriever, personal communication with Adam Smith, April 25, 2023.

63. Letter from James H. Douglass to Harold E. Talbott.

64. *Gazette Telegraph*, June 26, 1955, C: Environmental & CATCODE Documentation, XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

65. Hemingway, “The People Story Behind the Pioneer Cabin;” *Gazette Telegraph*, June 26, 1955, C: Environmental & CATCODE Documentation, XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

66. Versar, Inc., National Register Eligibility Evaluation of Archaeological Site 5EP1619, 7.

67. Jill R. Trout, “Communities of Yesterday,” July 19, 1988, MSS 0126 SC, Special Collections, Pikes Peak Library District, Penrose Library, Colorado Springs, CO, 2.

2.3 The US Air Force Academy (USAFA) land acquisition⁶⁸

After the US Air Force was established as a separate service in September 1947, planning began for the establishment of an Air Force Academy.⁶⁹ The secretary of the Air Force appointed a commission to select a site for the new academy, and Colorado Springs was 1 of 29 sites being considered.⁷⁰ By 1954, three potential locations remained: Colorado Springs, Colorado; Alton, Illinois; and Lake Geneva, Wisconsin.⁷¹ In a bid to get the Academy to settle on Colorado Springs, the State of Colorado offered a million dollars towards the purchase of land, which would then be given to the Air Force.⁷²

The site north of Colorado Springs, including Douglass Valley, was officially chosen as the future home of USAFA circa 1954. The State of Colorado appointed another commission—the Colorado Land Acquisition Commission—to negotiate with landowners to purchase their land. The commission then appointed three appraisers to appraise each property owner’s holdings, and the highest of the three appraisals was offered to the resident.⁷³

Despite residents’ objections, the Land Acquisition Commission purchased 160 parcels in the designated Academy area, roughly bounded by the Pike National Forest on the west and US Highway 85-87 on the east, with uses including large farming and ranching operations; commercial and industrial properties; small acreage homesteads; and a small, privately-owned airport.⁷⁴ There were 683 extant structures in the acquisition area.⁷⁵ While most of the buildings were demolished prior to facility

68. Parts of this section have been modified and reprinted from Allison R. Young, Carey L. Baxter, Joseph S. Murphey, Karlee E. Feinen, Madison L. Story, and Adam D. Smith, *US Air Force Academy Gallagher and Massey Ranch Houses: Historic American Buildings Surveys CO-237, CO-237-A, and CO-238*, ERDC/CERL SR-23-1 (Champaign, IL: ERDC-CERL, 2023), <http://dx.doi.org/10.21079/11681/47190>. Public domain.

69. United States Air Force Academy, “Air Force Academy History,” Articles, December 2019, <https://www.usafa.af.mil/News/Fact-Sheets/Display/Article/428274/air-force-academy-history/>.

70. Cogswell, *Pine Valley*, 284–286; United States Air Force Academy, “Air Force Academy History.”

71. George V. Fagan, “The Air Force Academy Site and its History,” March 1959, United States Air Force Academy #2, Special Collections, Pikes Peak Library District, Penrose Library, Colorado Springs, CO, 1.

72. Cogswell, *Pine Valley*, 285–287.

73. Cogswell, *Pine Valley*, 286–287.

74. Trout, “Communities of Yesterday,” 1–2.

75. Trout, “Communities of Yesterday,” 17.

construction in 1958, USAFA did retain some buildings for use. These buildings included the three log cabins on Community Center Drive built by Leon H. Snyder sometime between 1929 and 1954 and the Burgess-Capps cabin, built in 1875.⁷⁶

When the Douglass Ranch was appraised for USAFA's purchase in 1954, the graves of George and Bertie Capps were found near the Burgess-Capps cabin.⁷⁷ The cabin also had one outbuilding, an outhouse, at the time of the appraisal (Figure 5 and Figure 6).⁷⁸ The outhouse was a 3 × 4 ft structure constructed of log slabs.⁷⁹ The lean-to had been removed by this time.⁸⁰

Figure 5. The Burgess-Capps cabin with outhouse, n.d. ([Aerial photo of Burgess-Capps cabin]. Public domain.)



76. Trout, "Communities of Yesterday," 13–17.

77. Trout, "Communities of Yesterday," 11–12; Hart, "Appraisal: The Douglass Ranch," 9–10; Bowes, "Appraisal: Douglass Ranch Property," 13.

78. Richard J. Des Jardins, "Appraisal: The Douglass Ranch, Colorado Springs, Colorado," 124.20.80, RG 120, US Air Force Academy Library, Colorado Springs, CO, 15.

79. "Extracts taken from Appraisals (3) conducted in 1954 in preparation for acquisition of Parcel 8," C: Environmental & CATCODE Documentation, XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

80. [Aerial photo of Burgess-Capps cabin], n.d., C: Environmental & CATCODE Documentation, XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

Figure 6. The Burgess-Capps cabin, 1954. (Carson, "Memo for Record, subject: Pioneer Cabin." Public domain.)



The Douglass Ranch underwent at least two appraisals; however, the cabin was only a small part of the 1,520-acre property at this time and, consequently, was minimally discussed. One appraisal described the cabin as follows:

Abe Lincoln Cabin

One and one-half story frame cabin of field stone foundations, hewn log walls chinked with mortar, wood shingle roofing on wood sheathing and frame, pine floors on sleepers or framing, no interior finish, one room first floor, sleeping space in loft with enclosed stairway, stone fireplace and chimney. Building is of primitive but sound construction and appears in fairly good condition for age. Estimated effective age is sixty-five years. Presently used for display purposes only. Has 300 square feet.⁸¹

81. Hart, "Appraisal: The Douglass Ranch," 15-16.

A cost estimate for the cabin itself was not provided by either appraisal.⁸²

2.4 The Burgess-Capps Cabin since USAFA acquisition

After USAFA acquired the Burgess-Capps cabin, USAFA sought to preserve the cabin and open it for public display. Preservation efforts began in late 1955, when USAFA intended to design and install steel mesh grills at each door and window; install a split rail fence around the site; and install no trespassing signs around the fence. Changes recommended to be done at a later date included replacing modern roof shingles and doors, reconstructing the porch, and rethinking the walls.⁸³

Research into the cabin and the nearby Capps graves found that the two graves belonged to George and Bertie Capps, who died as children in 1881 and 1885 (George and Bertie's causes of death are unknown).⁸⁴ These children were buried on what had originally been the Louis Flegell homestead.⁸⁵ Their parentage is unclear, but they were not the children of Timothy K. Capps.⁸⁶ Three more Capps family graves were found during preliminary survey for the siting and construction of Falcon Stadium in 1960.⁸⁷ These graves belonged to spouses Leonard and Mary Capps and their grandchild Clarence Capps, who was the son of Timothy K. Capps (himself the son of Leonard and Mary Capps and brother-in-law of Bill Burgess) and had died after eating poisonous berries.⁸⁸

By 1959, plans for the cabin called for it to be “the central feature of a picnic and recreational area for cadets and other personnel associated with

82. Hart, “Appraisal: The Douglass Ranch;” Des Jardins, “Appraisal: The Douglass Ranch, Colorado Springs, Colorado.”

83. Letter from John P. Humbach to USAFA Superintendent, September 21, 1955, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

84. “Academy Goes Up on Land Rich in Pioneer History,” *Gazette Telegraph*, May 12, 1957, 125.3.21, RG 120, Series 15, Box 5, folder 4, US Air Force Academy Library, Colorado Springs, CO; Trout, “Communities of Yesterday,” 11–12.

85. Jaloma, “‘The Lonely Burgess Cabin’ by Dave Hughes corrected by Marion G. (Burgess) Jaloma;” Jaloma, “Leonard Kenneth Capps Family.”

86. Jaloma, “Leonard Kenneth Capps Family.”

87. Joe Barber, “Academy Works to Fix Grave Markers,” *Gazette*, n.d., personal collection of Jack Anthony.

88. Jaloma, “Burgess Homestead Cabin”; George V. Fagan, “The Air Force Academy Site and the Pikes Peak Region,” 1962, 4489.13, Special Collections, Pikes Peak Library District, Penrose Library, Colorado Springs, CO, 4.

the Academy.”⁸⁹ In accordance with this plan and the discovery of three additional Capps graves, a dedication ceremony was held at the cabin following the reinterment of the graves in August 1961 (Figure 7, Figure 8, Figure 9, and Figure 10). The Palmer Lake Historical Society also placed a marker in memory of pioneers in the region at the cabin and gravesite at this time (Figure 11).⁹⁰

Figure 7. A group of people at the Burgess-Capps cabin dedication, 1961. (Environmental & CATCODE Documentation, XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO. Public domain.)



89. George V. Fagan, "The Air Force Academy Site and its History," March 1959, United States Air Force Academy #2, Special Collections, Pikes Peak Library District, Penrose Library, Colorado Springs, CO, 3-4.

90. George Capps died before he was one year old, while Bertie Capps died at the age of 3. George V. Fagan, "The Air Force Academy Site and the Pikes Peak Region," 1962, 4489.13, Special Collections, Pikes Peak Library District, Penrose Library, Colorado Springs, CO, 4.

Figure 8. Air Force personnel discussing the Capps headstones at the Burgess-Capps cabin dedication, 1961. (Environmental & CATCODE Documentation, XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO. Public domain.)



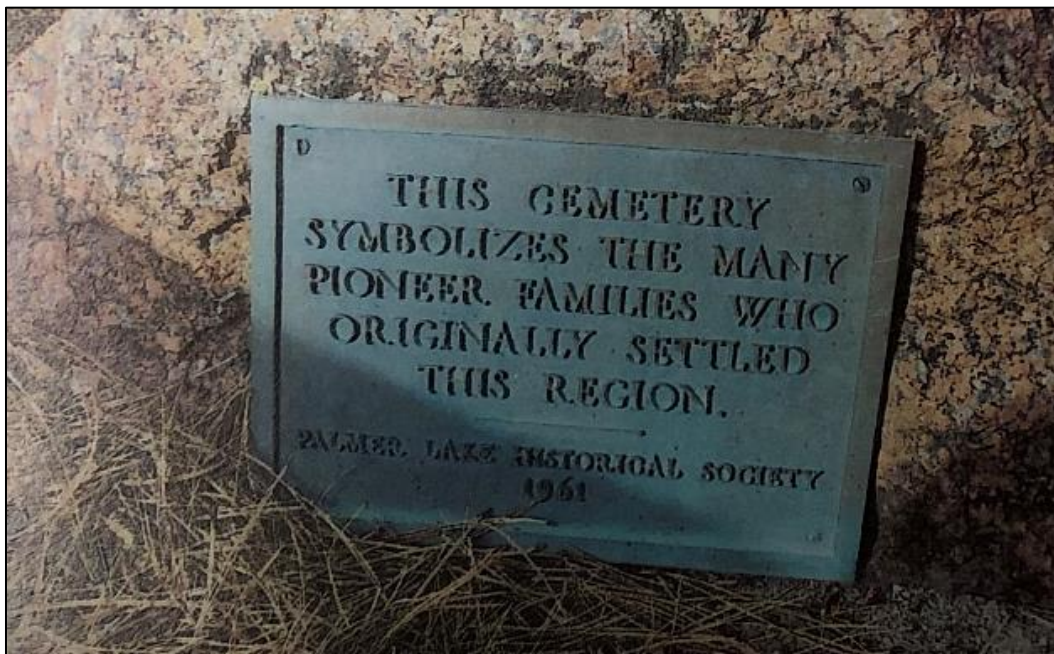
Figure 9. Dedication of the "Pioneer Cabin" sign at the Burgess-Capps cabin dedication, 1961. (Environmental & CATCODE Documentation, XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO. Public domain.)



Figure 10. Surviving members of the Capps family at the Burgess-Capps cabin dedication, 1961. (Environmental & CATCODE Documentation, XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO. Public domain.)



Figure 11. Plaque placed at Burgess-Capps cabin site by Palmer Lake Historical Society, 1961. (Environmental & CATCODE Documentation, XQPZO4550, Real Property Office, US Air Force Academy, Colorado Springs, CO. Public domain.)



Misattribution of the Burgess cabin to the Capps family seemingly began around the 1950s and was compounded by the identification of Capps

family graves.⁹¹ While there is no record indicating the reasons for placing the Capps graves at the Burgess cabin, it is likely that the graves and cabin were assumed to be related and little to no further research was conducted. Regardless, the error in the name of the family who built the cabin was known to be in error by 1969.⁹²

The USAFA has dealt with and addressed a variety of preservation, maintenance, and security issues during its ownership of the Burgess cabin.

In 1969, the cabin was noted as needing “immediate attention,” as

Windows and the front door are boarded up, but the rear door has been broken out and the interior of the building has been vandalized and furnishings broken up.

Though the foundation of the building is bad and one of the original logs in the rear wall is rotten, most of the damage seems to have been willfully done. A lot of the cement chinking has been torn out of the log walls and thrown about the area.⁹³

By the time it was listed on the National Register of Historic Places on 27 January 1975, the cabin was noted as “an outstanding and well preserved . . . original pioneer’s house in the Colorado mountain region.”⁹⁴ At the time of listing, one original window had been replaced with fixed glass, the rear door and frame had been replaced, the gable siding on either end had been replaced, and all window framing had been replaced.⁹⁵

A preservation architect evaluated the building in 1975, noting that all future log replacements “should be marked with a metal stamp reading

91. Hemingway, “The People Story Behind the Pioneer Cabin.”

92. Egon W. G. Wieselmann, “Inspection of the Pioneer Cabin on the United States Air Force Academy Grounds,” September 28, 1969, personal collection of Jack Anthony.

93. Wieselmann, “Inspection of the Pioneer Cabin on the United States Air Force Academy Grounds.”

94. Brewer, “Pioneer Cabin.”

95. Brewer, “Pioneer Cabin.”

‘1975’, characters 1/4 inch to 3/8 inch high.”⁹⁶ He also recommended the following actions to the exterior:

- Treatment of all lower logs with wood preserver
- Installation of a gutter on the north elevation of the cabin
- Installation of a French drain or other mechanism to prevent water from pooling near the cabin
- Treatment of original vertical boards at gable ends with wood preserver
- Repointing the chimney
- Replacement of missing foundation stones⁹⁷

The architect recommended the following actions to the interior:

- Stabilizing the loft, which was sagging
- Refinishing the wood floors
- Painting the interior walls with a water-based paint to resemble the original whitewash
- Replacing the 1/4 in. round baseboard with a 1 to 4 1/2 in. board to mimic a fragment found under the stairs
- Replacing the modern ceiling joists with historically accurate 2 × 6 in. joists⁹⁸

The following year, a local Boy Scout troop was given permission to repair the fence outside the cabin, which had been broken; repair a fallen gravestone; pick up trash outside and inside the compound; and hang a “rustic sign” over the entrance to the compound;⁹⁹ however, a 1981 “Memorandum for Record” noted that the log fence was constructed by Civil Engineering in 1972.¹⁰⁰

Vandalism seems to have started shortly after USAFA acquired the cabin, as the same 1981 “Memorandum for Record” noted that wood planks on

96. Letter from Gerron S. Hite to Hal Brewer, July 31, 1975, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

97. Letter from Gerron S. Hite to Hal Brewer.

98. Letter from Gerron S. Hite to Hal Brewer.

99. Letter from George A. Romero to Tom Ankeny, May 11, 1977, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

100. Mary C. Carson, “Memo for Record, subject: Pioneer Cabin,” June 29, 1981, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

the upper half of the structure had been installed by Civil Engineering to protect the loft from vandalism and the elements.¹⁰¹ In the first known recorded act of vandalism, a child damaged the cabin in 1982 by firing a BB gun without adult supervision within the fenced area around the cabin. Damage included three holes from BB gun pellets in the window on the east corner of the south side of the cabin, as well as two indentations on the window above.¹⁰² Also in 1982, the *Falcon Flyer* noted that “each year people break the windows, tear up the roof tiles, tear down the fence rails, cut into the boards, and dig up the grounds.”¹⁰³

In 1984, a representative of USAFA noted that the wall timbers were “the only original part left” of the cabin.¹⁰⁴ That same year, numerous alterations and repairs were made to the cabin, including

- replacing shingles on the roof of the cabin and porch,
- replacing floorboards on the porch,
- renauling the board on the edge of the roof,
- cementing all the holes in the chimney, and
- replacing the missing chinking on the exterior of the building.¹⁰⁵

In late 1994, fire detectors, smoke detectors, and a security alarm with a motion detector were also added. The final change to the structure made at this time was the installation of a Lexan barrier to the front door to allow a view of the interior without admittance. At the time of these alterations, the facility was not open to the public, and it had not been protected from fire or vandalism.¹⁰⁶ Though installation of a light on the interior of the

101. Carson, “Memo for Record, subject: Pioneer Cabin.”

102. Joseph W. Legere, Jr., “Incident/Complaint Report,” February 26, 1982, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

103. Lt. Jerry P. Haenisch, “Pioneer Cabin Deserves Respect,” *Falcon Flyer*, June 11, 1982, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

104. Letter from Bill Hanchey to Penny Smith, June 4, 1984, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

105. Bill Hanchey, “BCE Real Property Maintenance Request,” May 21, 1984, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

106. J. A. Vinger, “Base Civil Engineer Work Request,” September 19, 1994, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

cabin was also requested at this time, the work was not completed until at least June 1995.¹⁰⁷

Accidents and other preservation issues have also impacted the cabin. For example, there was a fire caused by an unattended campfire behind the cabin from approximately 8:50 p. m. (2050) to 9:10 p. m. (2110) on the evening of 1 July 1985, damaging an approximately 30 × 10 ft patch of ground.¹⁰⁸ Additionally, at an unknown date, USAFA discovered that the cabin was sinking and placed additional rocks under the foundation to support it. The shifting of the chinks resulted in broken windows.¹⁰⁹

Following the stabilization of the cabin and increased security efforts, the cabin has been utilized as a site for field trips and the subject of research projects for local students.¹¹⁰ The most notable event at the Burgess-Capps cabin in recent years was the 2004 replacement of the Capps' gravestones (Figure 12). That year, the wood markers were replaced and corrected—Sarah Capps grave previously stated the name of her and Leonard Capps' daughter, Mary Ann. The new markers were burnished aluminum on concrete and remain extant (Figure 13).¹¹¹

107. Letter from Capt. Vinger to CEP, June 28, 1995, F: Transfer Documentation (DD Form 1354 with key supporting documents), XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

108. "Incident/Complaint Report," L7-03-85, C: Environmental & CATCODE Documentation, XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO.

109. Aretz, "Students Discover Pioneer Cabin."

110. Aretz, "Students Discover Pioneer Cabin."

111. Joe Barber, "Colorado Native Rewrites History," *Gazette*, June 27, 2004, personal collection of Jack Anthony.

Figure 12. Burgess-Capps cabin, 10 September 2004. (R. Steve Andrews, [Burgess-Capps Cabin], September 10, 2004, personal collection of Jack Anthony. Reprinted with the permission of Jack Anthony.)



Figure 13. Replacement headstones, n.d. (C: Environmental & CATCODE Documentation, XQPZ04550, Real Property Office, US Air Force Academy, Colorado Springs, CO. Public domain.)

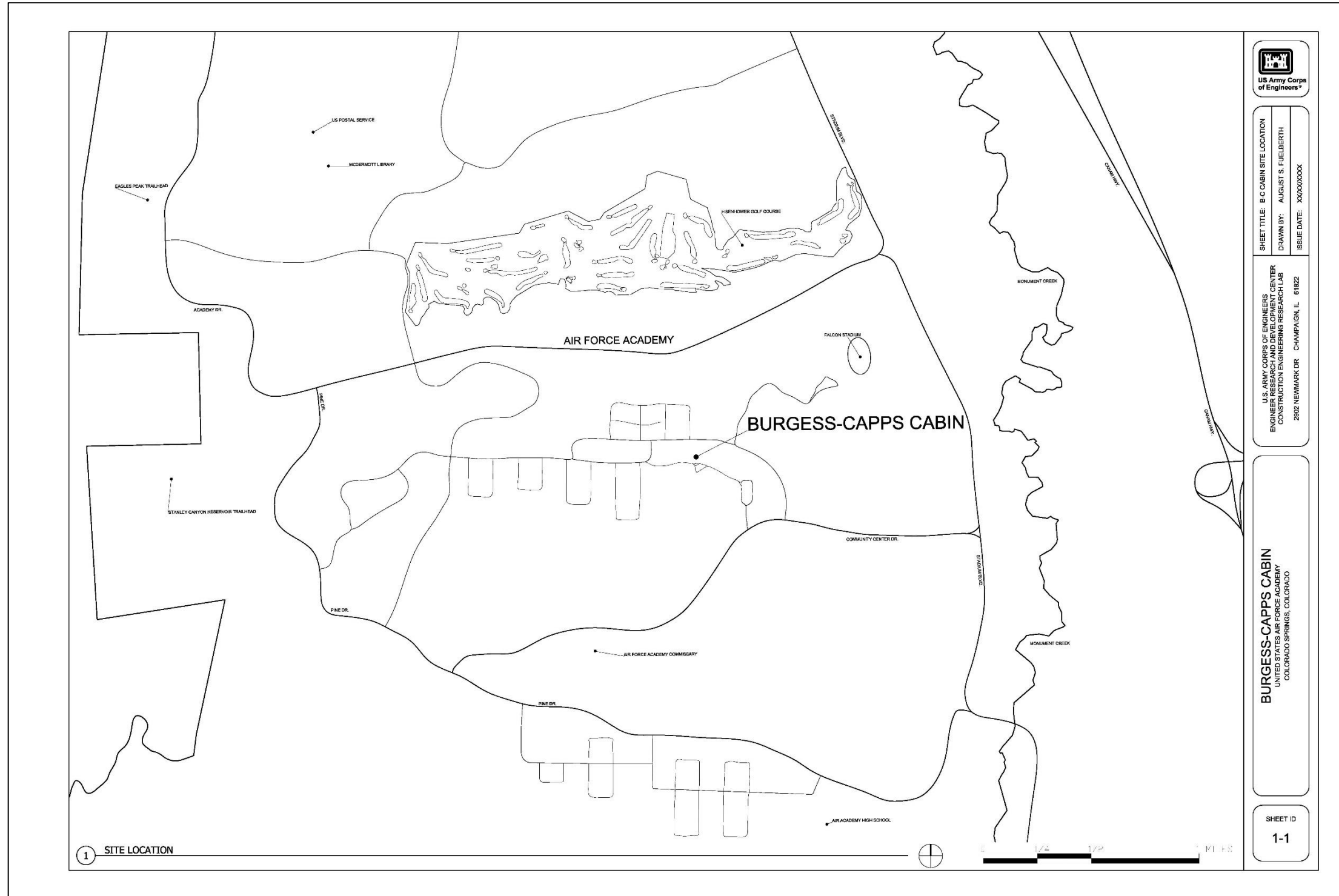


3 Stage II: Site Location, Site Information, and Architectural Description

The Burgess-Capps Cabin is located at USAFA in Colorado Springs, Colorado. To the northeast of the site is Falcon Stadium. To the east is Monument Creek. To the north is the Eisenhower Golf Course. To the south is the Air Academy High School. See site location map in Figure 14.

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Figure 14. Existing site location map of the Burgess-Capps Cabin, 2022. (Drawn by ERDC-CERL.)



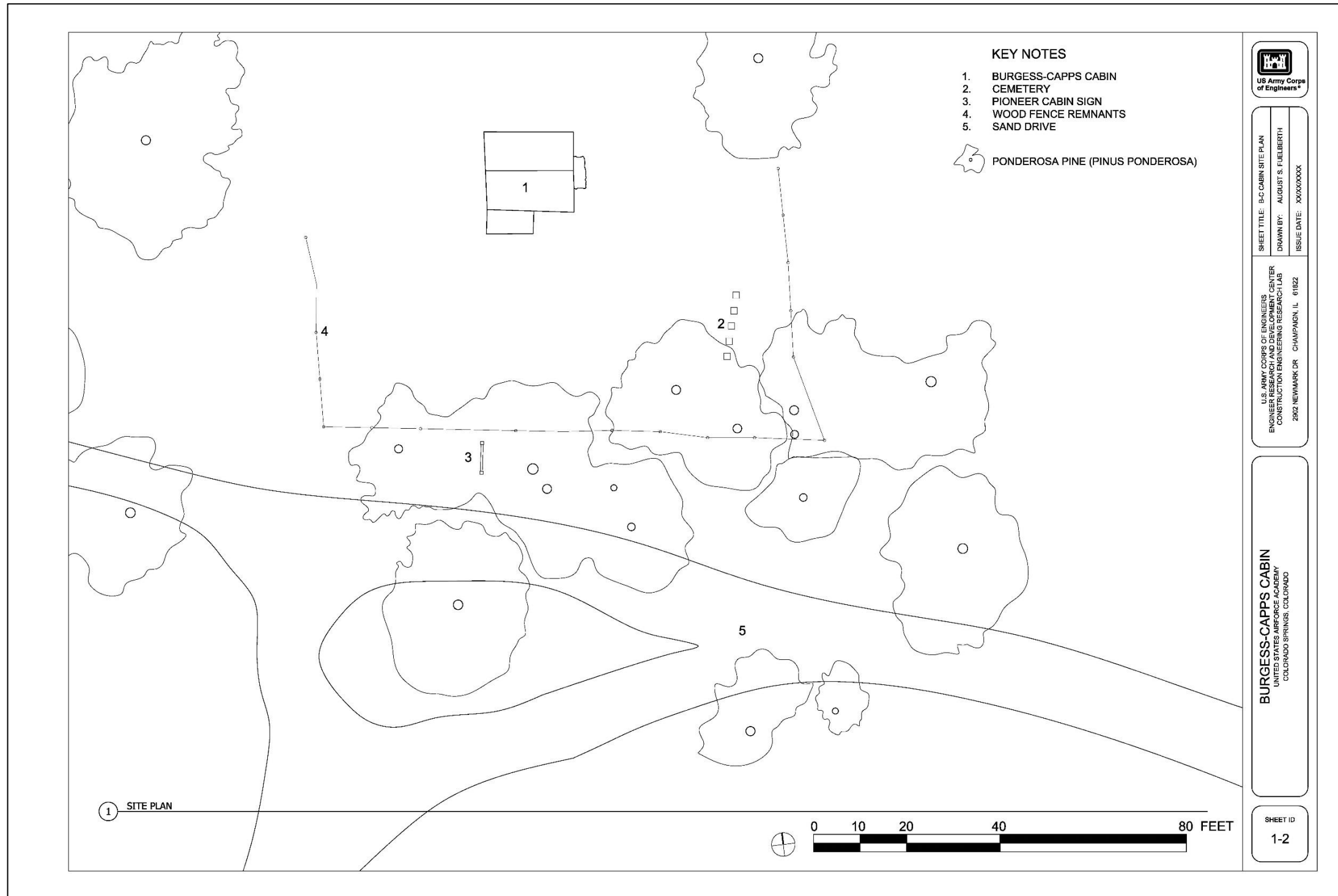
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3.1 Immediate site context

The immediate site context is devoid of buildings. The closest buildings are the Air Force Academy family housing division located west of the site. The Burgess-Capps Cabin is situated amongst a plot of ponderosa pine trees in a cleared area that is accessible by sandy gravel pathways that lead to Capps Road and West Douglass Drive. Nearby are remnants of a wooden fence, a “Pioneer Cabin” dedication sign that was installed in 1961, and five grave markers (Figure 15).

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Figure 15. Site context of the Burgess-Capps Cabin on USAFA, 2022. (Drawn by ERDC-CERL.)



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3.1.1 Vegetation

The land surrounding the Burgess-Capps Cabin consists of ponderosa pine trees (*Pinus ponderosa*) (Figure 16). A unique technique to determine this tree species is the vanilla aroma of the bark.

Figure 16. Ponderosa pine trees surrounding the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



3.1.2 Cemetery

Southeast of the Burgess-Capps Cabin are the five replacement headstones and a cemetery memorial sign (see Figure 17, Figure 18, and Figure 19). This information is described previously in Section 2.

Figure 17. Looking northwest at the Burgess-Capps Cabin and the replacement headstones (photo by ERDC-CERL researchers, 2021).



Figure 18. Looking at the replacement headstones that are southeast of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 19. Cemetery memorial sign (photo by ERDC-CERL researchers, 2021).



3.2 Architectural description

3.2.1 Exterior description

The Burgess-Capps Cabin is a one-room cabin constructed using a single-pen plan and a mixture of full dovetail and half dovetail joinery at its corner wall intersections. The front of the cabin is south facing with the front door, porch, and window located on this elevation. On the east elevation is a stone chimney. The north elevation has another door. The west elevation has a window. The building is constructed using wooden materials, such as logs, posts, planks, and shingles. The wooden elements are secured with possibly original nails and modern connectors that were installed for structural purposes. The log components consist of chinking that is visible on both the interior and the exterior of the building. The massing of the building is very skewed due to the building's age and lack of adequate maintenance. An overall view of the cabin can be seen in perspective and elevation views in Figure 20 and Figure 21. A view of the cabin in its site context can be seen in Figure 22–Figure 25.

Figure 20. Looking northwest at the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 21. Looking north at the south side of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).

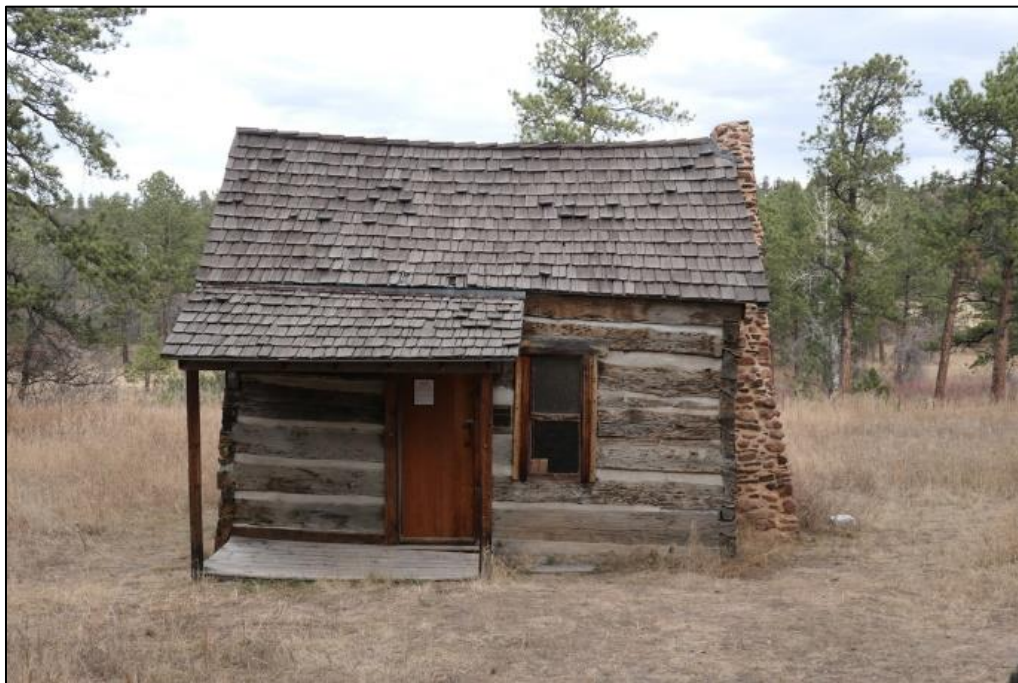


Figure 22. Looking northeast at a wooden fence and the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021.)



Figure 23. Looking southeast at the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 24. Looking south at the north side of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 25. Looking southwest at the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



3.2.2 Interior description

The interior of the Burgess-Capps Cabin contains exposed logs and chinking (see Figure 26), as well as the wooden stair in the northeast corner of the interior, a stone fireplace, two windows, and two doors (see Figure 27). Another notable architectural element is the southern door, which has a chevron pattern (see Figure 28).

Figure 26. Looking at the west interior wall on the first floor of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 27. Looking at the fireplace and stairway on the east interior wall of the first floor of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 28. Looking at the south interior wall on the first floor of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



3.3 Measured drawings

The following drawings were created utilizing measurements from the 3D-scan point cloud data gathered in August 2021 (Figure 29 and Figure 30).

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Figure 29. First- and loft-floor plans of the Burgess-Capps Cabin drawn from a 3D-scanned point cloud, 2022. (Drawn by ERDC-CERL.)

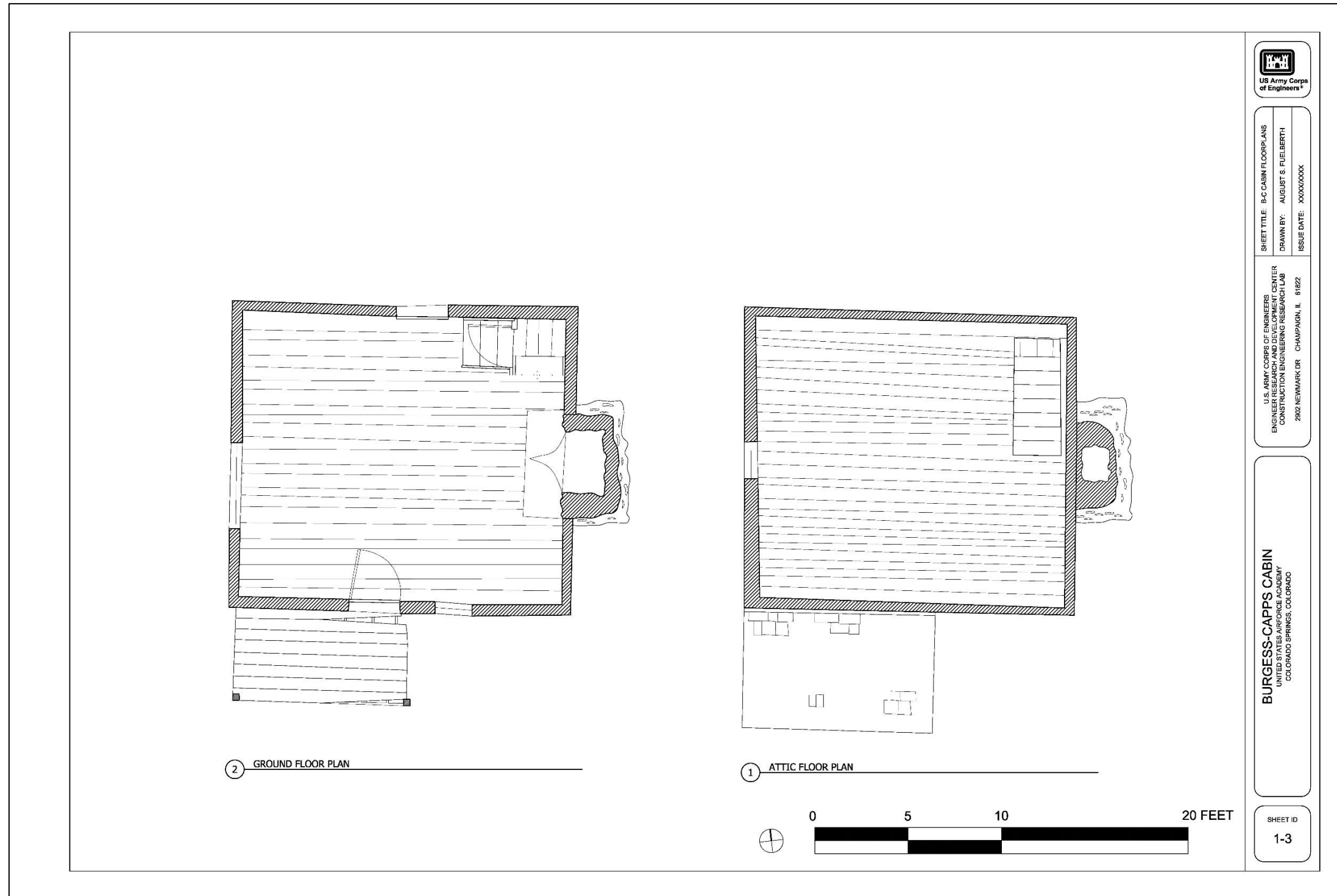
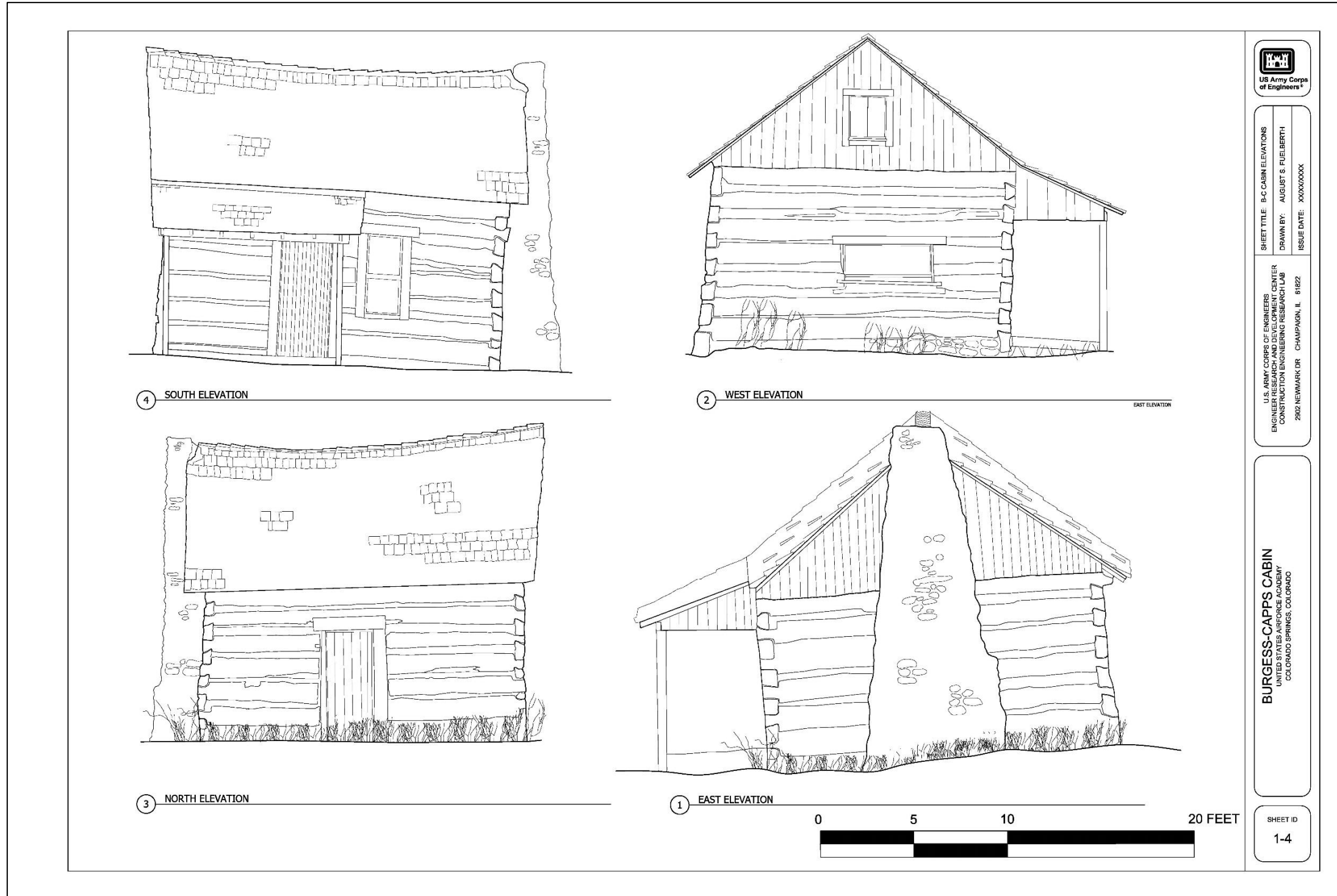


Figure 30. Elevations of the Burgess-Capps Cabin drawn from a 3D-scanned point cloud, 2022. (Drawn by ERDC-CERL.)



4 Stage III: Building Zones

Building zones establish the framework for planning for the operation, maintenance, and rehabilitation of an individual building by dividing the building into logical areas consistent with their use, original design, public access, and integrity. The concept of zoning, while establishing a logical framework, is also consistent with techniques of original architectural programming, design, and construction.

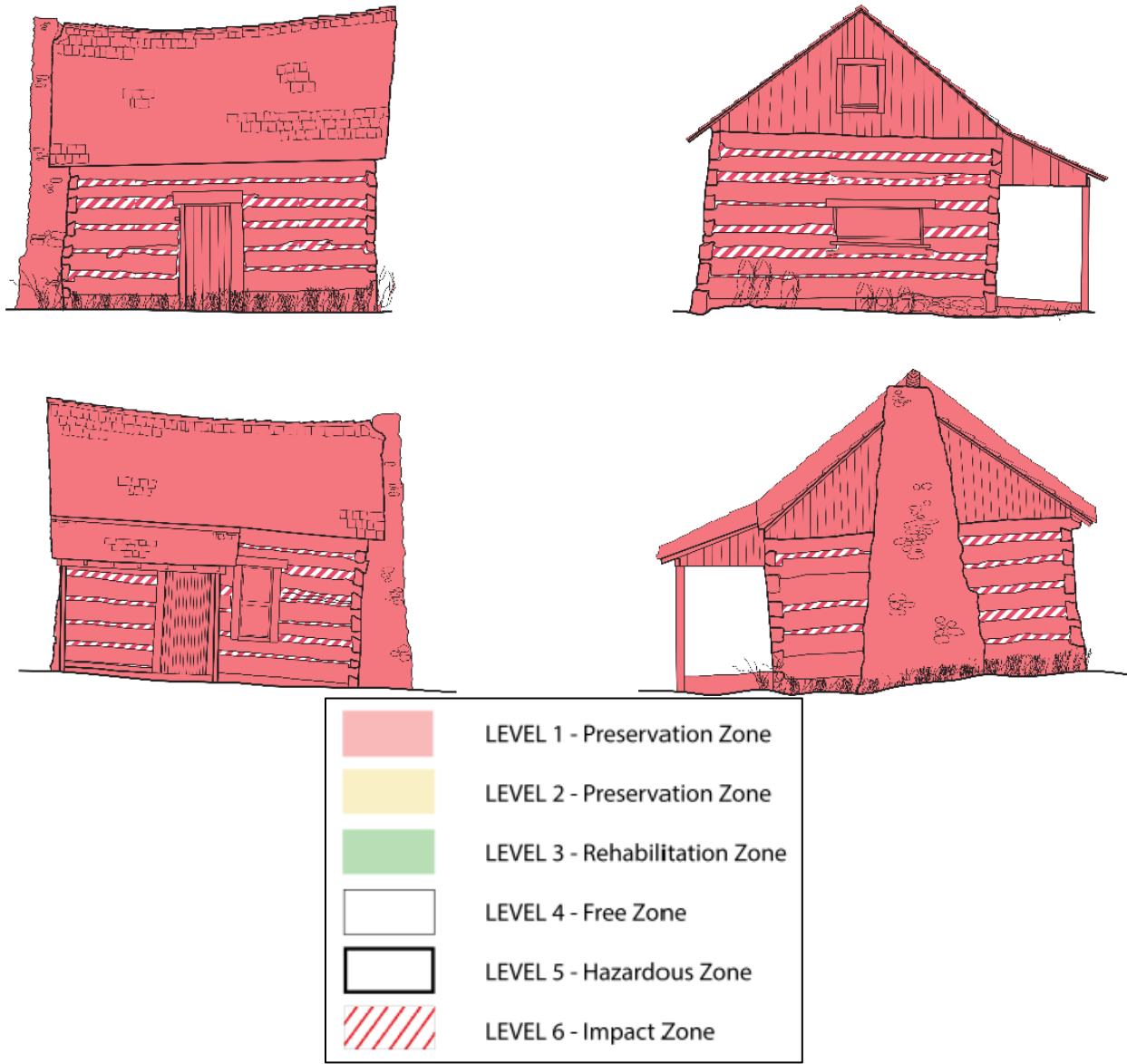
The zoning of the building seeks to identify the differences between more and less architecturally and historically significant interior and exterior building areas and assigns a numerical rating, or level, to each zone. The zone ratings establish management and treatment requirements for each zone (i.e., highly significant public spaces may be in a “preservation zone,” where maintenance is tightly controlled and replacements are restricted). At the other end of the spectrum, larger, more private work areas may be subject to normal maintenance and open to a much broader range of architectural modification. The treatment guidelines for each level convey the general principles of preservation to be applied within the zone.

The six zones are as follows:

- Level 1—Preservation Zone (Red)
- Level 2—Preservation Zone (Yellow)
- Level 3—Rehabilitation Zone (Green)
- Level 4—Free Zone (White)
- Level 5—Rehabilitation Zone (Green)
- Level 6—Impact Zone (Red Stripes)

The Burgess-Capps Cabin has two zones: Level 1—Preservation Zone (Red) and Level 6—Impact Zone (Red Stripes) (Figure 31).

Figure 31. Burgess-Capps Cabin building zones (drawn by ERDC-CERL, 2021)



5 Stage IV: Wood

5.1 Exterior wood features

The primary construction material of the Burgess-Capps Cabin is wood. These materials include logs that are used for the walls, wood shingles, trim, and doors. All wood materials can be seen in Figure 32.

Figure 32. Looking at the wood wall, trim, and roof details of the south elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Wood shingles clad the roof and porch of the Burgess-Capps Cabin. Some shingles are missing, loose, or are curling. Some shingles appear to be many different sizes; however, this is due to splitting. The wood shingles can be seen in Figure 33 and Figure 34.

Figure 33. Looking at wood shingles at the meeting point of the roof and porch roof on the south side of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 34. Looking at splitting and curling wood shingles on the south roof side of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



The Burgess-Capps Cabin has wood plank soffits on both the east and west gable ends of the roof. Some boards appear to be rotten or splitting (see

Figure 35 and Figure 36). Similar to the gables, the wood planks seem to be splitting (see Figure 37).

Figure 35. Looking at a closeup view of wood soffits and vertical siding along the gable of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 36. Looking at wood soffits and vertical siding along the gable of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 37. Looking at wood planks that clad the gable on the east elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



The Burgess-Capps Cabin has wood doors on both the north and south elevations (see Figure 38 and Figure 39). There are also wood windowsills and trim on the exterior elevations. It is important to notice the connection of the wooden logs to the windowsills (see Figure 40). Wooden window and door trim can be seen in Figure 41, Figure 42, and Figure 43.

Figure 38. Wood plank door on the south elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 39. Wood plank door on the north elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 40. Looking at the connection of the exterior logs and wood windowsill on the west side of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 41. Looking at a combination of old and new wood door trim of different sizes on the north elevation of the Burgess-Capps Cabin. There is also a missing plank on the left side of the door (photo by ERDC-CERL researchers, 2021).



Figure 42. Wooden window trim on the south elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 43. Wood window trim on the west elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



The corners of the Burgess-Capps Cabin are constructed using a mixture of full dovetail and half dovetail joinery at its corner wall intersections (see Figure 44).

Figure 44. Looking at exterior logs and connections at the lower northeast corner of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



The Burgess-Capps Cabin's porch is made entirely of wood. The porch is constructed of wood 4×4 s, 2×4 s, and wood planks (see Figure 45, Figure 46, and Figure 47).

Figure 45. Wood 4 × 4 supporting the porch roof of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 46. Wood 2 × 4s supporting the porch roof of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 47. Wood planks that make up the porch roof of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



The porch floor is constructed of wood planks and joists (see Figure 48). The boards are splitting in multiple areas (see Figure 49). The southern door has a visible wooden threshold (see Figure 50).

Figure 48. Wood plank floor on the porch floor of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 49. Split and broken wood planks and wood joists that make up the porch floor of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 50. Wood threshold on the south door of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



5.2 Interior wood features

Within the Burgess-Capps Cabin are the wood log walls and wood plank flooring (see Figure 51). There is a wooden-cased stairwell leading up to the loft (see Figure 52). It is clad in red beaded paneling (see Figure 53). The staircase is constructed of wooden risers and treads (see Figure 54). The wooden stairs lead to a wooden landing (see Figure 55).

Figure 51. Wood log walls and wood plank flooring in the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 52. Looking at wood stairwell door leading to the loft of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).

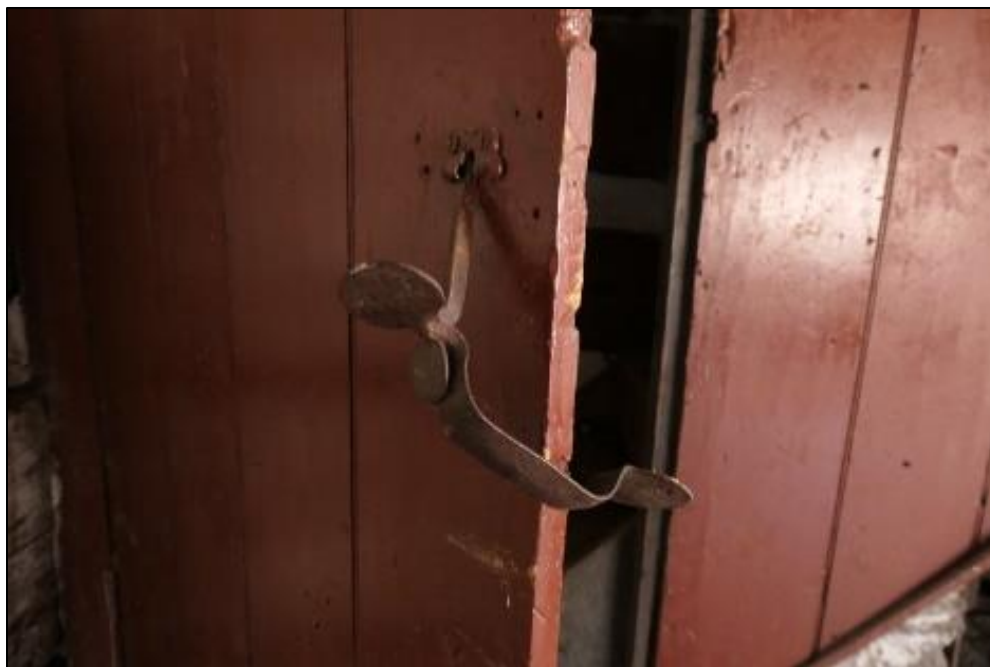


Figure 53. Wide wood plank, beaded paneling encasing the stairwell in the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 54. Interior view of the wooden stairwell leading to the loft of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 55. Wooden landing at the top of the loft stairwell in the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



The Burgess-Capps Cabin has wooden details on its interior, such as the chevron pattern on the main entrance wooden door (see Figure 56). The

west and south elevation windows also have wood trim on their interior (see Figure 57 and Figure 58).

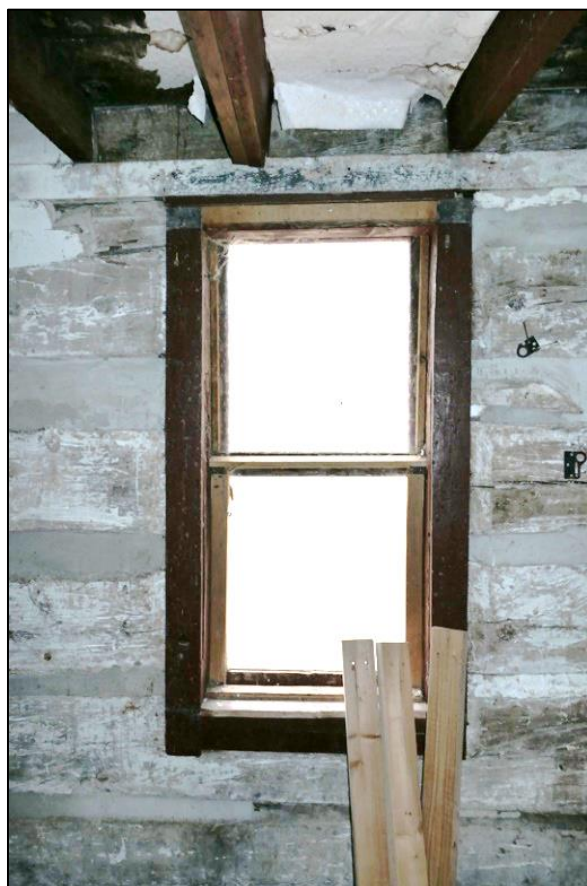
Figure 56. Interior detail of a wooden door with a chevron pattern (photo by ERDC-CERL researchers, 2021).



Figure 57. Interior wood window trim on the west wall of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 58. Interior wood window trim on the south wall of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



The fireplace on the east wall of the Burgess-Capps Cabin has a wood mantle supported by two sticks (see Figure 59).

Figure 59. Wood mantle and wood-stick posts above the fireplace in the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Within the loft of the Burgess-Capps Cabin are ample wood member structural reinforcements that were added at an unknown date (i.e., no documentation found), post original construction according to the USAFA cultural resource manager. Looking at these boards' condition and color, they appear fairly new, similar to the metal hardware's good condition discussed in Section 8. The wood gable structural reinforcements can be seen in Figure 60. The wood roof structural reinforcements can be seen in Figure 61.

Figure 60. Wood structural reinforcements added to the gables of the Burgess-Capps Cabin at an unknown date (i.e., no documentation found) (photo by ERDC-CERL researchers, 2021).



Figure 61. Wood structural reinforcements added to the roof of the Burgess-Capps Cabin at an unknown date (i.e., no documentation found) (photo by ERDC-CERL researchers, 2021).



The loft floor is constructed of wood plank flooring that also acts as the ceiling of the first floor (see wood plank floor and gap to first floor in Figure 62). The wood plank floor is supported by wood floor joists (see Figure 63).

Figure 62. Wood loft floor, which is also the ceiling of the first floor at the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 63. Floor joists below the loft floor (photo by ERDC-CERL researchers, 2021).



5.3 Treatment measures

The following images and documents offer treatment measures for exterior and interior wooden materials that are in poor condition. The sources include information from the National Park Service.

5.3.1 Preservation Brief 26: *The Preservation and Repair of Historic Log Buildings, 1978*¹¹²

26 PRESERVATION BRIEFS



The Preservation and Repair of Historic Log Buildings

Bruce D. Bomberger



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

The intent of this Brief is to present a concise history and description of the diversity of American log buildings and to provide basic guidance regarding their preservation and maintenance. A log building is defined as a building whose structural walls are composed of horizontally laid or vertically positioned logs. While this Brief will focus upon horizontally-laid, corner-notched log construction, and, in particular, houses as a building type, the basic approach to preservation presented here, as well as many of the physical treatments, can be applied to virtually any kind of log structure.

Log buildings, because of their distinct material, physical structure, and sometimes their architectural design, can

develop their own unique deterioration problems. The information presented here is intended to convey the range of appropriate preservation techniques available. It does not, however, detail how to perform these treatments; this work should be left to professionals experienced in the preservation of historic log buildings.

Despite the publication since the 1930s of a number of books and articles on the history of log construction in America, some misconceptions persist about log buildings. Log cabins were not the first type of shelter built by all American colonists. The term "log cabin" today is often loosely applied to any type of log house, regardless of its form and the historic context of its set-



Fig. 1. Log construction was practical in the rough frontier and climate of Alaska, where it was used for a variety of structures such as the Sourdough Lodge (c. 1903) near Cakona. Built to serve the trail leading to the Klondike gold discoveries, this 1-story, L-shaped roadhouse is primarily of horizontal log construction with vertical logs in the front gable. Photo: National Park Service Files.

112. This section reproduces Bruce D. Bomberger, *The Preservation and Repair of Historic Log Buildings*, Preservation Brief 26 (Washington, DC: National Park Service, 1978), <https://www.nps.gov/orgs/1739/upload/preservation-brief-26-log-buildings.pdf>.



Fig. 2. Logs, both round and hewn, continued to be a basic construction material throughout much of the 19th century, here illustrated by (a) these c. 1831 industrial workers' houses for forgemen at the Mt. Etna Iron Furnace in Pennsylvania, and (b) the Larsson-Ostlund House built by Swedish immigrants in New Sweden, Maine, during the 1870s. (c) Corner detail of the Larsson-Ostlund House with the original clapboarding removed during restoration shows close-fitting log joints in the Scandinavian style that did not require chinking. Photos: (a) Jet Lowe, HAER Collection, (b-c) Maine Historic Preservation Commission.

ting. "Log cabin" or "log house" often conjures up associations with colonial American history and rough frontier life (Fig. 1). While unaltered colonial era buildings in general are rare, historic log buildings as a group are neither as old nor as rare as generally believed. One and two-story log houses were built in towns and settlements across the country until about the middle of the 19th century, and in many areas, particularly in the West, as well as the Midwest and southern mountain regions, log continued to be a basic building material despite the introduction of wooden balloon frame construction (Fig. 2). By the early 20th century, the popularity of "rustic" architecture had revived log construction throughout the country, and in many areas where it had not been used for decades.

A distinction should be drawn between the traditional meanings of "log cabin" and "log house." "Log cabin" generally denotes a simple one, or one-and-one-half story structure, somewhat impermanent, and less finished or less architecturally sophisticated. A "log cabin" was usually constructed with *round* rather than *hewn*, or hand-worked, logs, and it was the first generation homestead erected quickly for frontier shelter. "Log house" historically denotes a more permanent, *hewn*-log dwelling, either one or two stories, of more complex design, often built as a second generation replacement. Many of the earliest 18th and early 19th century log houses were traditionally clad, sooner or later, with wood siding or stucco.

Historical Background

No other architectural form has so captured the imagination of the American people than the log cabin. Political supporters of 1840 presidential candidate William Henry Harrison appropriated the log cabin as a campaign symbol. The log cabin was birthplace and home for young Abe Lincoln, as well as other national figures, and assumed by many 19th century historians to be the very first type of house constructed by English colonists. In 1893 Frederick Jackson Turner in his influential paper, *The Significance of the Frontier in American History* suggested that European colonists had adopted this means of shelter from the Indians.

More recent 20th century scholarship has demonstrated that horizontal log buildings were not the first form of shelter erected by all colonists in America. Nor was log

construction technology invented here, but brought by Northern and Central European colonists. Finnish and Swedish settlers are credited with first introducing horizontal log building in the colony of New Sweden (now Pennsylvania) on the upper shores of Delaware Bay in 1638, who later passed on their tradition of log construction to the Welsh settlers in Pennsylvania.

During the 17th and 18th centuries, new waves of Eastern and Central Europeans, including Swiss and Germans, came to America bringing their knowledge of log construction. Even the Scotch-Irish, who did not possess a log building tradition of their own, adapted the form of the stone houses of their native country to log construction, and contributed to spreading it across the frontier. In the Mississippi Valley, Colonial French fur traders and settlers had introduced vertical log construction in the 17th century.

Through the late 18th and early 19th centuries, frontier settlers erected log cabins as they cleared land, winding their way south in and along the Appalachian valleys through the back country areas of Maryland, Virginia, the Carolinas and Georgia. They moved westward across the Appalachian Mountain barrier into the Ohio and Mississippi River valleys transporting their indispensable logcraft with them, into Kentucky and Tennessee, and as far to the southwest as eastern Texas. Log buildings are known to have been con-



Fig. 3. This mid-19th century double-pen cornercrib on the Jamison Farm in Rowan County, North Carolina, is an example of a type of log building that did not require chinking. Photo: Denise Whitley.

structed as temporary shelters by soldiers during the Revolutionary War, and across the country, Americans used logs not only to build houses, but also commercial structures, schools, churches, gristmills, barns, corncribs and a variety of outbuildings (Fig. 3).

Around the mid-19th century, successive generations of fur traders, metal prospectors, and settlers that included farmers and ranchers began to construct log buildings in the Rocky Mountains, the Northwest, California, and Alaska (Fig. 4). In California and Alaska, Americans encountered log buildings that had been erected by Russian traders and colonists in the late 18th and early 19th centuries. Scandinavian and Finnish immigrants who settled in the Upper Midwest later in the 19th century also brought their own log building techniques with them. And, many log structures in the Southwest, particularly in New Mexico, show Hispanic influences of its early settlers.

While many parts of the country never stopped building with logs, wooden balloon frame construction had made it obsolete in some of the more populous parts of the country by about the mid-19th century. However, later in the century, log construction was employed in new ways. In the 1870s, wealthy Americans initiated the Great Camp Movement for rustic vacation retreats in the Adirondack Mountains of upstate New York. Developers such as William Durant, who used natural materials, including wood shingles, stone, and log—often with its bark retained to emphasize the Rustic style—designed comfortable summer houses and lodges that blended with the natural setting (Fig. 5). Durant and other creators of the Rustic style drew upon Swiss chalets, traditional Japanese design, and other sources for simple compositions harmonious with nature.

The Adirondack or Rustic style was balanced in the West with construction of the Old Faithful Inn at Yellowstone National Park in Wyoming, designed by Robert C. Reamer, and begun in 1903 (Fig. 6). This popular resort was tremendously influential in its use of locally-available natural materials, especially log, and gave impetus to Rustic as a true national style. From the turn of the century through the 1920s, Gustav



Fig. 4. Beginning around the mid-19th century, entire western boomtowns were hastily constructed of frame and log, such as the buildings in Bannack, Montana, the site of the State's first gold discovery. Photo: National Park Service Files.



Fig. 5. The main lodge of Echo Camp on Raquette Lake in New York State was built in 1883 by the governor of Connecticut. It typifies the Adirondack style in the use of exposed round logs with crowns, and porches and balconies constructed with bowed logs and round log columns. Photo: Courtesy The Adirondack Museum.



Fig. 6. (a) Old Faithful Inn, Yellowstone National Park, Wyoming, shown here in 1912, brought the Rustic style to the West in 1903 in an original design, and a scale befitting its setting. (b) Although only the first story is of horizontal log construction, the use of logs is striking in the trestle work and cribbed piers around the entrance. Photo: (a) Courtesy National Park Service, (b) Laura Soulliere Harrison.



Fig. 7. The Civilian Conservation Corps built many recreational log structures across the country in the 1930s and 40s, including this rustic log gateway to Camp Morton, Lycoming County, Pennsylvania. Photo: Courtesy Lycoming County Historical Society and Museum.

Stickley and other leaders of the Craftsman Movement promoted exposed log construction. During the 1930s and 40s, the Civilian Conservation Corps (CCC) used log construction extensively in many of the country's Federal and State parks to build cabins, lean-tos, visitor centers, and maintenance and support buildings that are still in service (Fig. 7).

Traditional Log Construction

Plan and Form

When settlers took the craft of log construction with them onto the frontier, they successfully adapted it to regional materials, climates and terrains. One of the most notable characteristics of the earliest 18th and 19th century log houses is the plan and form. The plan can sometimes provide clues to the ethnic origin or route of migration of the original inhabitant or builder. *But in the absence of corroborating documentary evidence, it is important not to infer too much about the ethnic craft traditions of a particular log house.*

Historians have identified a number of traditional house plans and forms as prototypes (Fig. 8). They were often repeated with simple variations. The basic unit of each of these types is the one room enclosure formed by four log walls joined at their corners, called a single "pen" or "crib." The single pen was improved upon by installing interior partitions or by adding another log pen. Some variations of historic log house plans include: the typically mid-Atlantic "continental" plan, consisting of a single-pen of three rooms organized around a central hearth; the "saddlebag" or double-pen plan, composed of two contiguous log pens; and the "dogtrot" plan, formed by two pens separated by an open passage space (sometimes enclosed later), all covered by a continuous roof. The continental plan originated in central and eastern Europe and is attributed to 18th century German immigrants to Pennsylvania. Non-log interior partition walls form the multi-room plan within the exterior log walls. The saddlebag plan consists of two adjoining log pens that share a central chimney. A saddlebag is often the evolution of a single pen with an end chimney, expanded by adding a second pen onto the chimney endwall. The saddlebag was built in a number of different regions across the country. The dogtrot plan may be seen with variation in many parts of the country, although it is sometimes, perhaps erroneously, considered the most typically southern, because its covered passageway provided both air circulation and shelter from the heat. All these plan types were typically built in the form of one or one-and-one-half story settlement cabins.

A somewhat different form evolved in the West around the middle of the 19th century which became especially distinctive of the Rocky Mountain cabin. While the entrance doorway to most earlier log houses was generally placed beneath the eaves, as a means of adapting to the greater snowfall in the Rockies, here the entrance was placed in the gable end, and sometimes protected from roof slides by a porch supported by two corner posts created by an extension of the roof beyond the gable wall (Fig. 9).

From the late 18th through the mid-19th centuries, Americans also built many substantial two-story log

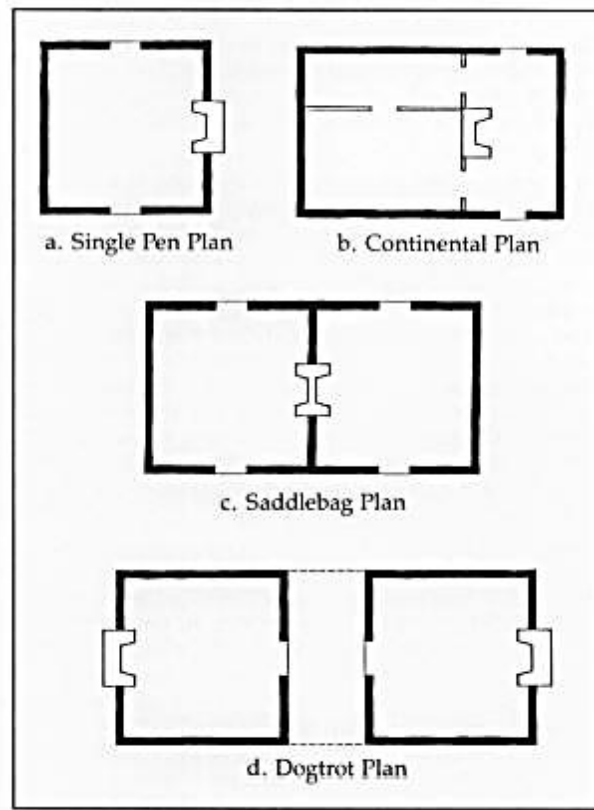


Fig. 8. These log house plans represent some of the basic housing forms constructed during the 18th and 19th centuries, and include: (a) single pen, (b) continental, (c) saddlebag, and (d) dogtrot. Drawing: James Caufield.



Fig. 9. This historic log building on the Walker Ranch in Boulder, Colorado is an example of the Rocky Mountain cabin form which is typified by the entrance door being located in the gable end. Photo: Bernard Weisnerber.

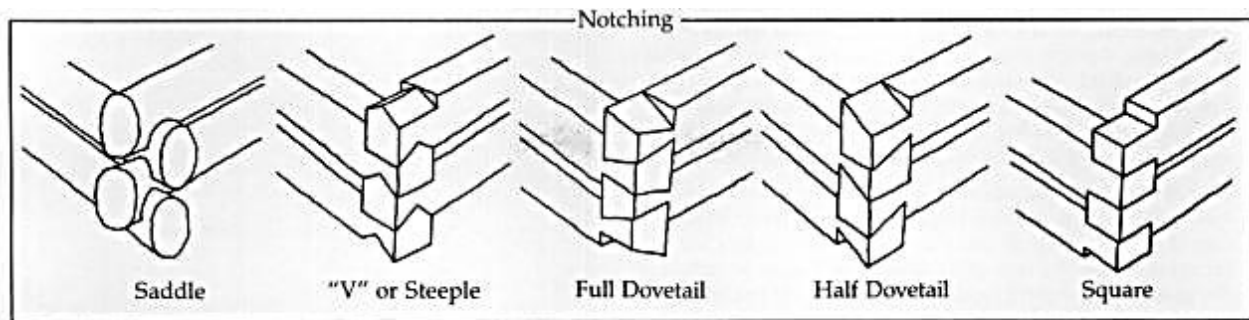


Fig. 10. Five examples of the more common historical methods of corner notching. Drawing: James Caufield.

houses in towns throughout the eastern half of the country. In rural areas two-story log houses were sometimes built to replace earlier, first-generation settlement cabins, but just as often the early hewn-log house was retained and enlarged. A second story was added by removing the roof and gables, constructing a second floor, laying additional courses of logs, and building a new roof, or reassembling the old one. Each generation of owners might expand an early log core building by adding on new log pens, or masonry or wood frame extensions. The addition of a rear ell, or infill construction to link a formerly free-standing outbuilding, such as a kitchen to the log main house was particularly common. Such a layering of alterations is part of the evolution of many log buildings.

Corner Notching and Other Fastening Techniques

Corner notching is another of the characteristic features of log construction. Most notching methods provide structural integrity, by locking the log ends in place, and give the pen rigidity and stability. Like the floor plan, the type of corner notching can sometimes be a clue to the ethnic craft origin of a log building, but it is important not to draw conclusions based only on notching details. Numerous corner notching techniques have been identified throughout the country (Fig. 10). They range from the simple "saddle" notching, which demands minimal time and hewing skill, to the very common "V" notching or "steeple" notching, to "full dovetail" notching, one of the tightest but most time-consuming to accomplish, "half-dovetail" notching which is probably one of the most common, and "square" notching secured with pegs or spikes.

The notching method on some of the earliest eastern cabins and most 19th century western cabins, particularly saddle notching, left an extended log end or "crown." Crowns are especially pronounced or exaggerated in Rustic style structures, and sometimes they are cut shorter as the wall rises, creating a buttress effect at the corners of the building.

Another method of securing log ends consists of fastening logs that are laid without notching ("false notching") with tenons into vertical corner posts, or using spikes or pegs to attach them to vertical corner planks. Vertically positioned logs were secured at their top and bottom ends, usually into roof and sill plate timbers.

Selecting Logs and Assembling the Building

Although wood selection was most likely to be determined by availability, chestnut, white oak, cedar, and fir were preferred because these trees could provide



Fig. 11. Log-hewing tools and techniques: (a) scoring the log with a single-bladed felling axe, or "pole axe" in preparation for removing a uniform thickness of wood; (b) removal to depth of scoring; (c) finish hewing with a broad axe. Photos: Courtesy Bernard Weisgerber.

long, straight, rot-resistant logs. Pine, which also provided long straight logs, was also used in areas where it was plentiful. Woods were often mixed, utilizing harder, heavier rot-resistant wood such as white oak for the foundation "sill log", and lighter, more-easily hewn wood such as yellow poplar for the upper log courses.

One of the principal advantages of log construction was the economy of tools required to complete a structure (Fig. 11). A felling axe was the traditional tool for bringing down the tree and cutting the logs to length. For many frontier and western structures the round logs were debarked or used in their original form with the bark left on, or one or more sides of the logs were hewn flat with a broadaxe, or more finely finished with an adze as smooth thick planks. Notching was done with an axe, hatchet or saw; openings for doors and windows were usually cut after the logs were set into place, and door and window frames, particularly jambs, were put in place during construction to help hold the logs in place. Roof framing members and floor joists were either hewn from logs or of milled lumber. A log cabin could be raised and largely completed with as few as two to four different tools, including a felling axe, a broad axe, and a hand saw or crosscut saw.

The upper gable walls were completed with logs if the roof was constructed with purlins, which is more typical of Scandinavian or Finnish construction, and western and 20th century Rustic styles. However, vertical or horizontal weatherboard sheathing was commonly used throughout the country to cover wood-framed gables.

Chinking and Daubing

The horizontal spaces or joints between logs are usually filled with a combination of materials that together is known as "chinking" and "daubing." Chinking and daubing completed the exterior walls of the log pen by sealing them against driving wind and snow, helping them to shed rain, and blocking the entry of vermin. In addition, chinking and daubing could compensate for a minimal amount of hewing and save time if immediate shelter was needed. Not all types of log buildings were chinked. Corncribs, and sometimes portions of barns where ventilation was needed were not chinked. While more typical of Swedish or Finnish techniques, and not as common in American log construction, tight-fitting plank-hewn or scribed-fit round logs have little or no need for chinking and daubing.

A variety of materials were used for chinking and daubing, including whatever was most conveniently at hand. Generally though, it is a three-part system applied in several steps. The chinking consists of two parts: first, a dry, bulky, rigid blocking, such as wood slabs or stones is inserted into the joint, followed by a soft packing filler such as oakum, moss, clay, or dried animal dung (Fig. 12). Daubing, which completes the system, is the outer wet-troweled finish layer of varying composition, but often consisting of a mixture of clay and lime or other locally available materials. Instead of daubing, carefully fitted quarter poles or narrow wood strips were sometimes nailed lengthwise across the log joints.

Chinking, especially the daubing, is the least durable part of a log building. It is susceptible to cracking as a



Fig. 12. The log joints have been cleaned out in preparation for new daubing exposing carefully laid stone chinking in this building in Virginia. Photo: Bernard Weisgerber.

result of freeze-thaw action, structural settlement, drying of the logs, and a thermal expansion-contraction rate that differs from that of the logs. Seasonal deterioration of chinking necessitates continual inspection and regular patching or replacement.

Exterior Wall Treatments

Although the exterior logs of cabins in the West, and 20th century Rustic buildings are generally not covered, many 18th and 19th century log houses east of the Mississippi, with the exception of some of the simpler cabins and houses in remote or poorer areas, were covered with exterior cladding. The exterior of the log walls was covered for both aesthetic and practical reasons either as soon as the building was completed or sometime later.

In some instances, the exterior (and interior) of the logs was whitewashed. This served to discourage insects, and sealed hairline cracks in the daubing and fissures between the daubing and logs. Although the solubility of whitewash allows it to heal some of its own hairline cracks with the wash of rain, like daubing it has to be periodically reapplied. Usually, a more permanent covering such as wood siding or stucco was applied to the walls, which provided better insulation and protection, and reduced the maintenance of the log walls.

Sometimes log houses were sided or stuccoed later in an attempt to express a newly-achieved financial or social status. Many log houses were immediately sided and trimmed upon completion to disguise their simple construction beneath Georgian, Federal and later architectural styles. Frequently a log house was covered, or recovered, when a new addition was erected in order to harmonize the whole, especially if the original core and its addition were constructed of different materials such as log and wood frame (Fig. 13).

Vertical wood furring strips were generally nailed to the logs prior to applying weatherboarding or stucco (Fig. 14). This ensured that the walls would be plumb, and provided a base on which to attach the clapboards, or on which to nail the wood lath for stucco.



Fig. 13. Historic wood clapboard siding originally applied to conceal the fact that this house was built in two sections of different materials has been inappropriately removed from the 1793 log portion. Photo: National Park Service Files.



Fig. 14. Removal of the historic wood siding from the 1804 Zachariah Price DeWitt House in Butler County, Ohio, reveals that the clapboards were attached to vertical wood furring strips nailed to the logs. Photo: National Park Service Files.

Foundations

Log building foundations varied considerably in quality, material, and configuration. In many cases, the foundation consisted of a continuous course of flat stones (with or without mortar), several piers consisting of rubblestone, single stones, brick, short vertical log pilings, or horizontal log "sleepers" set on grade. The two "sill logs," were laid directly upon one of these types of foundations.

Climate and intended permanence of the structure were the primary factors affecting foundation construction. The earliest log cabins, and temporary log dwellings in general, were the most likely to be constructed on log pilings or log sleepers set directly on grade. Where a more permanent log dwelling was intended, or where a warm, humid climate accelerated wood decay, such as in the South, it was sometimes more common to use stone piers which allowed air to circulate beneath the sill logs. Full cellars were not generally

included in the original construction of most of the earliest log houses, but root cellars were often dug later.

Roofs

Log buildings were roofed with a variety of different framing systems and covering materials. Like log house plans and corner notching styles, the types of roof framing systems used were often variations on particular ethnic and regional carpentry traditions. In most cases wood shingles were the first roof covering used on the earliest 18th and 19th century log houses. As wood shingle roofs deteriorated, many were replaced with standing seam metal roofs, many of which continue to provide good service today. Later pioneer log buildings west of the Mississippi were likely to be roofed with metal or roll roofing, or even with sod. Other log buildings have been re-roofed in the 20th century with asphalt shingles. For some rustic log buildings in the West and Great Camps in the Adirondacks, asphalt shingles are the original historic roofing material.

Chimneys

Ethnic tradition and regional adaptation also influenced chimney construction and placement. Chimneys in log houses were usually built of stone or brick, a combination of the two, or even clay-lined, notched logs or smaller sticks (Fig. 15). Later log buildings were frequently constructed with only metal stacks to accommodate wood stoves. The chimneys of log buildings erected in cold climates tended to be located entirely inside the house to maximize heat retention. In the South, where winters were less severe the chimney stack was more typically constructed outside the log walls. With the advent of more efficient heating systems, interior chimneys were frequently demolished or relocated and rebuilt to maximize interior space.



Fig. 15. The mid-19th century O'Quinn House, Moore County, North Carolina, provides a rare surviving example of a clay-lined log chimney. Although the logs of the house are saddle-notched, the chimney logs are "V" notched. The roof was extended out over the chimney to protect the daubing from the weather, and the chimney stack would have originally projected through a hole in the roof. Photo: Michael Southern.

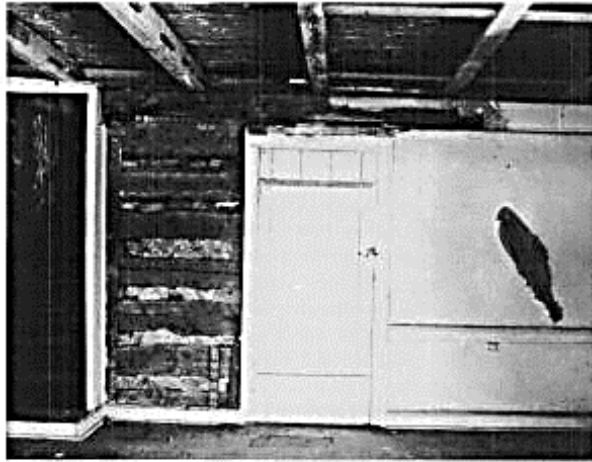


Fig. 16. This photograph of the interior of a 1793 log house in Maryland reveals much about historic log building construction and interior finish treatments. To the left of the plank door plaster has been removed exposing the stone chinking and daubing; remnants of vertical furring strips attached to the logs show evidence of traditional horizontal lath, while the hole broken through the plaster wall on the right shows the use of diagonal lath. The open door reveals a very steep, enclosed stairway typical of many early log houses. Although plaster has been removed from the ceiling, the wall to the right of the door shows the original plaster finish and fine woodwork including beaded chair rail, floor and door molding. Photo: National Park Service Files.

Interior Finishes

Logs on the interiors of many of the simpler cabins and Rustic style structures were often given a flattened surface or left exposed. But, in the more finished log houses of the 18th and 19th century, they were more commonly covered for most of the same reasons that the exterior of the logs was covered—improved insulation, ease of maintenance, aesthetics, and keeping out vermin. Covering the interior log walls with planks, lath and plaster, boards pasted with newspaper, fabric such as muslin, or wallpaper increased their resistance to air infiltration and their insulation value. Finished walls could be cleaned and painted more easily, and plastered walls and ceilings obscured the rough log construction and prepared interior surfaces for decorative wood trim in the current styles (Fig. 16).

Historical Evaluation and Damage Assessment

Before undertaking preservation work on a historic log building, its history and design should be investigated, and physical condition evaluated. It is always advisable to hire a historical architect or qualified professional experienced in preservation work to supervise the project. In addition, State Historic Preservation Offices, regional offices of the National Park Service, and local historical commissions may also provide technical and procedural advice.

The historical investigation should be carried out in conjunction with a visual inspection of the log building. Physical assessment needs to be systematic and thorough. It should include taking notes, photographs

or video recording, and making drawings of existing conditions, including overall and detail views. This will serve as a record of the appearance and condition which can be referred to once work is under way. A physical assessment should also identify causes of deterioration, not just symptoms or manifestations and, in some instances, may need to include a structural investigation.

Foundation Inspection

The foundation of a log building should always be inspected before beginning work because, as in any building, foundation-related problems can transfer structural defects to other components of the building. Settling of the foundation is a typical condition of log buildings. If settlement is not severe and is no longer active, it is not necessarily a problem. If, however, settlement is active or uneven, if it is shifting structural weight to unintended bearing points away from the intended main bearing points of the corner notches and sill log, serious wall deflections may have resulted. Causes of settlement may include foundation or chimney stones or sill logs that have sunk into the ground, decay of log pilings, log sleepers, or of the sill logs themselves.

Log Inspection

Foundation problems usually result in damage to the sill logs and spandrels, which are often the most susceptible to deterioration. Sill logs, along with the corner notching, tend to bear most of the weight of the building, and are closest to vegetation and the ground, which harbors wood-destroying moisture and insects. If the sill log has come into contact with the ground, deterioration is probably underway or likely to begin (Fig. 17). It is also important to check the drainage around the building. The building assessment should note the condition of each log and attempt to identify the sources of problems that appear to exist.

Sill log inspection should not necessitate destruction of historic exterior cladding if it exists. Inspection can usually be made in areas where cladding is missing,



Fig. 17. Contact of this building's sill log with the ground has led to its decay, infestation by wood-destroying insects, and resulting building settlement. Photo: Anne Grimmer.

loose, or deteriorated. Sill log, as well as upper log, deterioration may also be revealed by loose or peeling areas of the cladding. If pieces of cladding must be removed for log inspection, they should be labeled and saved for reinstallation, or as samples for replacement work. Historic cladding generally need not be disturbed unless there are obvious signs of settling or other indications of deterioration.

Other areas of the log walls which are particularly susceptible to deterioration include window and door sills, corner notches, and crowns, and any other areas regularly saturated by rain run-off or backsplash. The characteristic design feature of Adirondack or Rustic style log buildings of leaving log ends or crowns to extend beyond the notched corners of the building positions the crowns beyond the drip-line of the roof edge. This makes them vulnerable to saturation from roof run-off, and a likely spot for deterioration. Saddle notching in which the cut was made out of the top surface of the log and which cups upward, and flat notching, may also be especially susceptible to collecting run-off moisture.

Detection of decay requires thorough inspection. Probing for rot should be done carefully since repair techniques can sometimes save even badly deteriorated logs. Soft areas should be probed with a small knife blade or icepick to determine the depth of decay. Logs should be gently tapped at regular intervals up and down their lengths with the tool handle to detect hollow-sounding areas of possible interior decay. Long cracks which run with the wood grain, called "checks," are not signs of rot, but are characteristic features of the seasoning of the logs. However, a check can admit moisture and fungal decay into a log, especially if it is located on the log's upper surface. Checks should also be probed with a tool blade to determine whether decay is underway inside the log.

Sill log ground contact and relative moisture content also provide ideal conditions for certain types of insect infestation. Wood building members, such as sill logs or weatherboarding, less than eight inches from the ground, should be noted as a potential problem for monitoring or correction. Sighting of insects, or their damage, or telltale signs of their activity, such as mud tunnels, exit holes, or "frass," a sawdust-like powder, should be recorded. Insect infestation is best treated by a professionally licensed exterminator, as the chemicals used to kill wood-destroying insects and deter re-infestation are generally toxic.

Roof Inspection

Along with the foundation, the roof is the other most vital component of any building. The roof system consists of, from top to bottom, the covering, usually some form of shingles or metal sheeting and flashing; board sheathing or roof lath strips; the framing structure, such as rafters or purlins; the top log, sometimes referred to as the "roof plate" or "rafter plate;" and, sometimes, but not always, gutters and downspouts.

The roof and gutters should be inspected and checked for leaks both from the exterior, as well as inside if possible. Inspection may reveal evidence of an earlier roof type, or covering, and sometimes remnants of more than one historic covering material. The roof may be the result of a later alteration, or raised when a second



Fig. 18. Exposed roofing members of Rustic style buildings such as this structure at Yellowstone National Park are highly susceptible to deterioration. Photo: Laura Soulliere Harrison.

story was added, or repaired as the result of storm or fire damage. Often, roof framing may be composed of reused material recycled from earlier buildings. Inspection of the roof framing should note its configuration and condition. Typical problems to look for are framing members that have been dislodged from their sockets in the roof plate, or that are cracked, ridge damage, sagging rafters, broken ties and braces, and decay of exterior exposed rafter or purlin ends, especially common on Rustic style buildings (Fig. 18).

Other Features

The rest of the building should also be inspected as part of the overall assessment, including siding, window sash and frames, door frames and leaves, chimneys, porches, and interior walls, trim, and finishes. Any of these features may exhibit deterioration problems, inherent to the material or to a construction detail, or may show the effects of problems transmitted from elsewhere, such as a deformed or mis-shapen window frame resulting from a failed sill log. The inspection should note alterations and repairs made over time, and identify those modifications which have acquired significance and should be preserved. Nothing should be removed or altered before it has been examined and its historical significance noted.

Preservation Treatments

Since excessive moisture promotes and hastens both fungal and insect attack, it should be dealt with immediately. Not only must the roof and gutters be repaired—if none exist, gutters should probably be added—but the foundation grade should be sloped to ensure drainage away from the building. If the distance from the ground to the sill log or exterior sheathing is less than eight inches, the ground should be graded to achieve this minimum distance. Excess vegetation and debris such as firewood, dead leaves, or rubbish should be cleared from the foundation perimeter, and climbing vines whose leaves retain moisture and tendrils erode daubing, should be killed and removed. Moisture problems due to faulty interior plumbing should also be remedied. Solving or reducing moisture problems may in itself end or halt the progress of rot and wood-destroying insects.

Log Repair

Stabilizing and repairing a log that has been only partially damaged by decay or insects is always preferable to replacing it. Retaining the log, rather than substituting a new one, preserves more of the building's integrity, including historic tool marks and the wood species which may no longer be obtainable in original dimensions. Log repair can generally be done with the log in place at less cost, in less time, and with less damage to building fabric, than by removing, and installing a new hewn and notched replacement log. Log repair is accomplished by two basic methods: traditional methods of splicing-in new or old wood, or through the use of epoxies. These treatments are sometimes combined, and may also be used in conjunction with reinforcing members. *Historic log repair, whether it involves patching techniques or the use of epoxies, should always be performed only by an experienced craftsman or architectural conservator.*

Wood Splicing

Wood splicing can involve several types of techniques. Also referred to as "piecing-in" or "Dutchman" repair, it involves treating a localized area of deterioration by cutting out the decayed area of the log, and carefully carving and installing a matching, seasoned wood replacement plug or splice. The wood species, if available, and the direction and pattern of the grain should match that of adjacent original wood. The location and depth of decay should determine the splicing technique to be used. In a case where decay runs deep within a log, a full-depth segment containing the affected area can be cut out, severing the log completely, and a new segment of log spliced in, using angled "scarf" joints or square-cut "half-lap" joints (Fig. 19). The splice is secured to the severed log by angling lag screws or bolts through the upper and lower surfaces that will be concealed by daubing.

Splicing can also be performed using epoxy as an adhesive. A log with shallow decay on its outer face can be cut back to sound depth, and a half-log face spliced on, adhered with epoxy, screws or bolts. A technique for the repair of badly deteriorated log crowns involves cutting them back to sound wood, and into the notching joint if necessary, and installing new crowns cut to match. Fiberglass or aluminum reinforcement rods are inserted into holes drilled into the new crowns, and into corresponding holes drilled in the ends of the original cut-off logs. Epoxy is used as an adhesive to attach and hold the new crowns in place. Long lag screws can be angled up through the underside of the crown into the log above to provide additional support for the repair.

Epoxy Consolidation and Repair

In some instances, epoxies may be used by themselves to consolidate and fill the voids left by deteriorated wood. Epoxies are versatile in performance, relatively easy to use by experts, and, after curing, may be shaped with wood-working tools. Their use requires that sufficient sound wood survives for the epoxy to adhere. But they can be used to stabilize rotted wood, return full or greater than original strength to decayed structure-bearing members, and to reconstitute the shape of decayed log ends. Epoxies resist decay and

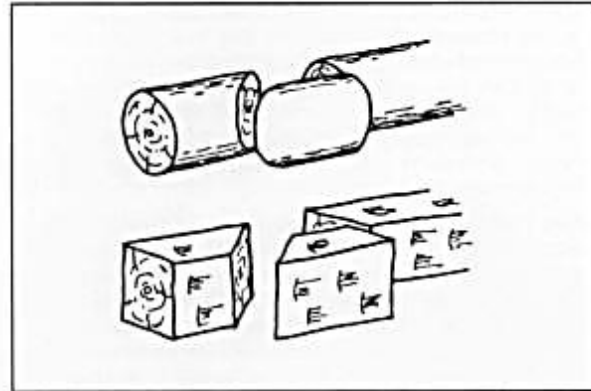


Fig. 19. Log splicing with scarf joints. Drawing: Harrison Goodall.

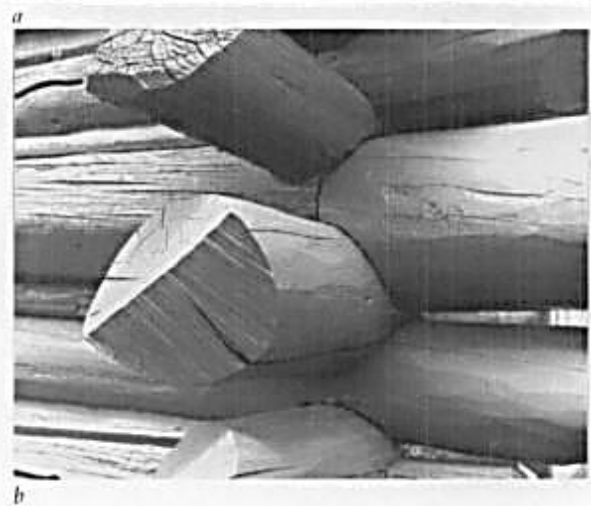
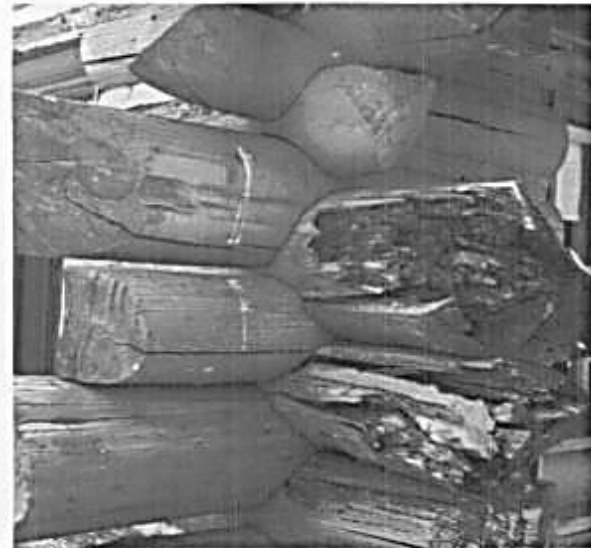


Fig. 20. (a) These deteriorated log crowns were (b) repaired with new crowns which were attached to the historic logs with reinforcing bars and epoxy. Epoxy repair of log crowns is most successful when the repaired crowns are protected from excess moisture by a roof overhang. Photos: Harrison Goodall.

insects, and while epoxy itself is resistant to moisture, epoxy tends to cause adjacent wood to retain moisture rather than dry out, and if not used in the right location, can actually further a continuing cycle of wood decay. Hence, epoxy repairs are most successful in areas where they are protected from moisture. Epoxies, of which there are a variety of commercially-available products on the market, are prepared in essentially two forms: a liquid consolidant and a flexible putty filler. Each consists of a resin and a hardener which must be mixed prior to use.

The technique of treating, for an example, a decayed log crown with epoxies is begun by removing loose decayed wood, and drying the area if necessary (Fig. 20). The rot-affected cavity and surface of the log end is then saturated with liquid epoxy by repeated brushing, or by soaking it in a plastic bag filled with epoxy that is attached to the log. The porous condition of the rot-damaged wood will draw up the epoxy like a lamp wick. Once the liquid epoxy has saturated the log end and cured, the log end has been consolidated, and is ready for the application of an epoxy putty filler. The filler resin and hardener must also be mixed; pigments must be mixed with the filler epoxy to color the patch, and more importantly to protect it from ultraviolet sunlight. The filler can be applied with a putty knife, pressing it into the irregularities of the cavity. The cured patch can be worked like wood and painted with an opaque stain or a dull finish paint to help it blend with surrounding wood, although epoxy repairs can be difficult to disguise on natural, unpainted wood.

Epoxies can be used to consolidate and repair other areas of a log, including rotted internal areas which have not yet progressed to damage the log's outer surface. Saturation of small internal areas can be accomplished by drilling several random holes into the log through an area that will be concealed by daubing, and then pouring in liquid epoxy. If a pure resin is used, it should be a casting resin to minimize shrinkage, and it is best to fill voids with a resin that contains aggregates such as sand, or micro-balloons. Epoxy is frequently used by architectural conservators to strengthen deteriorated structural members. The damaged log can be strengthened by removing the deteriorated wood, and filling the void by imbedding a reinforcing bar in epoxy filler, making sure the void is properly sealed to contain the epoxy before using it (Fig. 21). Sometimes larger decayed internal areas of a log can be more easily accessed and repaired from the interior of a structure. This may be a useful technique if it can be accomplished without causing undue damage to the interior finishes in the log building. However, despite its many advantages, epoxy may not be an appropriate treatment for all log repairs, and it should not be used in an attempt to conceal checking, or extensive log surface patching that is exposed to view, or logs that are substantially decayed or collapsed.

Log Replacement

Repairing or replacing only a segment of a log is not always possible. Replacement of an entire log may be the only solution if it has been substantially lost to decay and collapsed under the weight of logs above it. Log replacement, which should be carried out only by experienced craftsmen, is begun by temporarily

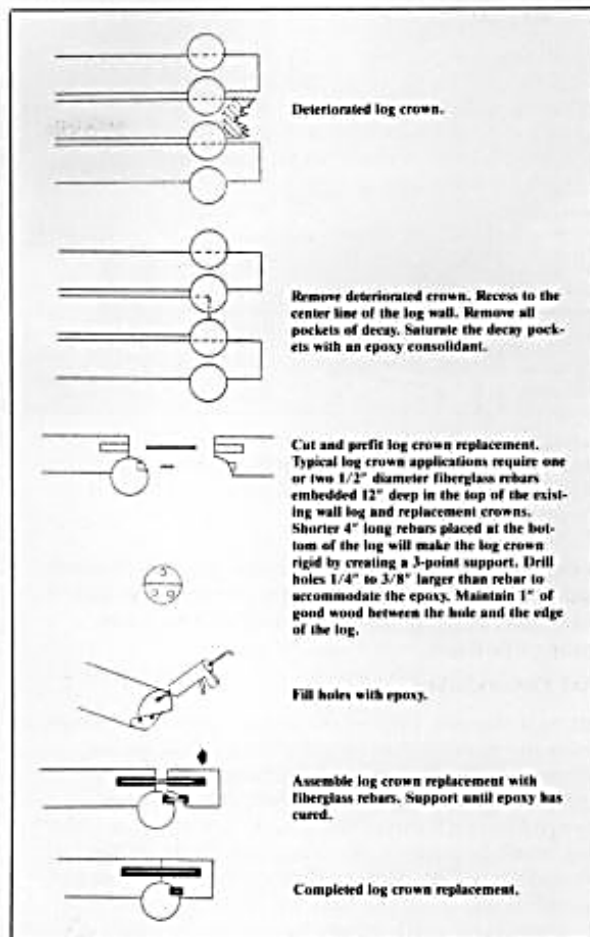


Fig. 21. Epoxy repair. Drawing: Harrison Goodall.

supporting the logs above, and then jacking them up just enough to insert the new log. Potential danger to the structure may include creating inadequate temporary bearing points, and crushing chinking and interior finishes which may have settled slowly into non-original positions that cannot withstand jacking.

To begin the process of log replacement, the entire length of the log must be inspected from the exterior and the interior of the structure to determine whether it supports any structural members or features, and how their load can be taken up by bracing during jacking and removal. On the exterior, sheathing such as weatherboard, and adjacent chinking, must be removed along the length of the log to perform this inspection. Likewise, on the interior, abutting partition walls and plaster may also need to be removed around the log to determine what, if any, features are supported by or tied into the log to be removed.

A replacement log should be obtained to match the wood species of the original being removed. If it is a hewn log, then the replacement must be hewn to replicate the dimensions and tool marks of the original (Fig. 22). If the same wood species cannot be obtained in the original dimensions, a substitute species may have to be used, and may even be preferable in some instances



Fig. 22. The lighter-colored replacement log in this barn matches the dimensions and heaving marks of the original logs, and will darken in time to blend visually with the other logs. Photo: Bernard Weisgerber.

if a more durable wood can be found than the original wood species. It should, however, be chosen to match the visual characteristics of the original species as closely as possible.

Wood Preservatives

In most instances, the use of chemical wood preservatives is not generally recommended on historic log buildings. Preservatives tend to change the color or appearance of the logs. In addition, many are toxic, they tend to leach out of the wood over time, and like paint, must be periodically reapplied. Many of the late 19th and early 20th century Rustic structures were constructed of logs with the bark left on which may provide protection, while others have been painted. However, some log buildings, and especially log houses that have been inappropriately stripped of historic cladding in an earlier restoration, and now show signs of weathering, such as deep checking, may be exceptions to this guidance. A preservative treatment may be worth considering in these cases. Boiled linseed oil may sometimes be appropriate to use on selected exposures of a building that are particularly vulnerable to weathering, although linseed oil does tend to darken over time. Borate solutions, which do not alter the color or appearance of wood, may be another of the few effective, non-hazardous preservatives available. However, borate solutions do not penetrate dry wood well, and thus the wood must be green or wet. Because borate solutions are water-soluble, after treating, the wood must be coated with a water-repellent coating. In some instances, it may be appropriate to reapply varnish where it was used as the original finish treatment. Pressure-treating, while effective for new wood, is not applicable to in-place log treatment, and is generally not effective for large timbers and logs because it does not penetrate deeply enough.

Foundation Repair

The foundation should have good drainage, be stable, adequately support the building as well as any future floorloads, and keep the sill log sufficiently clear of the ground and moisture to deter decay and insect infestation. Log buildings with cellars are less likely to suffer

problems than those built upon the ground or with crawl spaces, as long as the cellar is kept dry and ventilated. Because the foundations of many log buildings were neither dug nor laid below the frostline, they generally tend to be susceptible to freeze-thaw ground heaving and settlement. Also, as previously noted, some foundations consisted of wooden sleepers or pilings in direct contact with the ground. If a foundation problem is minor, such as the need for repointing or resetting a few stones, work should address only those areas. Loose stones should be reset in their original locations if possible. A clearly inadequate foundation that has virtually disappeared into the ground, or where large areas of masonry have buckled or sunk, resulting in excessively uneven or active settlement, will need to be rebuilt using modern construction methods but to match the historic appearance.

Chinking Repair

Repair of chinking, whether it is finished on the exterior with wooden strips or with daubing, should not be done until all log repair or replacement, structural jacking and shoring is completed, and all replacement logs have seasoned. Historically, patching and replacing daubing on a routine basis was a seasonal chore. This was because environmental factors—building settlement, seasonal expansion and contraction of logs, and moisture infiltration followed by freeze-thaw action—cracks and loosens daubing. If the exterior log walls are exposed, and the chinking or daubing requires repair, as much of the remaining inner blocking filler and daubing should be retained as possible. A daubing formula and tooled finish that matches the historic daubing, if known, should be used, or based on one of the mixes listed here. For the most part, modern commercially-available chinking products are not suitable for use on historic log buildings, although an exception might be on the interior of a log building where it will be covered by plaster or wood, and will not be visible. These products tend to have a sandy appearance that may be compatible with some historic daubing, but the color, and other visual and physical characteristics are generally incompatible with historic log surfaces.

Sections of wood chinking which are gone or cannot be made weathertight should be replaced with same-sized species saplings or quarter poles cut to fit. Generally, unless bark was used originally, it should be removed before nailing the new wood chinking replacements tightly into place.

Analysis of daubing can be done in much the same way as mortar analysis. If that is not feasible, by crushing a loose piece of daubing its constituent parts can be exposed, which may typically include lime, sand, clay, and, as binders, straw or animal hair. The color imparted by the sand or pigmented constituents should be noted, and any areas of original daubing should be recorded with color film for later reference. Daubing that is loose or is not adhered to the logs must first be cleaned out by hand. Blocking filler should be left intact, refitting only loose pieces. (Sometimes it may be difficult to obtain a good bond in which case it may be necessary to clean out the joint entirely.) If needed, soft filler should be added, such as jute or bits of fiberglass batt, pressed firmly into voids with a stick or blunt

tool. Concealed reinforcement may sometimes be used, depending upon the authenticity of the restoration. This can include galvanized nails partially inserted only on the upper side of the log to allow for the daubing to move with the upper log and keep the top joint sealed, or galvanized wire mesh secured with galvanized nails (Fig. 23). Like repointing masonry, daubing should not be done in full sun, excessive heat or when freezing temperatures are expected. The daubing materials should be dry-mixed, the chinking rechecked as being tight and secure, and the mix wetted and stirred to a stiff, paste-like consistency. The mix dries quickly, so no more daubing should be prepared at a time than can be applied in about 30 minutes. A test patch of new daubing, either on the building, or in a mock-up elsewhere, will help test the suitability of the formula's color and texture match.

Before applying the daubing, the chinking area, including filler and log surfaces to be covered, should be sprayed with water to prevent the dry filler from too rapidly drawing off the daubing moisture which will result in hairline cracking. A trowel, ground to the width of the daubing, is used to press the daubing into the chinking space, and to smooth the filled areas. Wide or deep chinking spaces or joints may have to be daubed in layers, to prevent sagging and separation from the logs, by applying one or two scratch coats before finishing the surface.

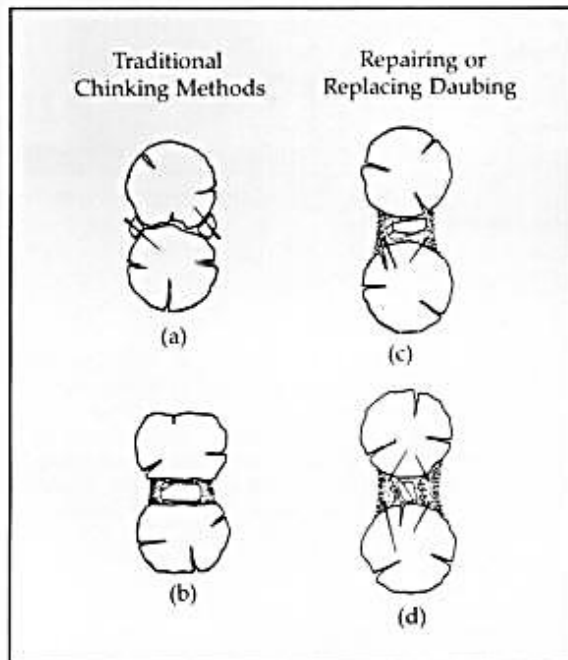


Fig. 23. Illustrated are various methods of chinking and daubing: (a) wood strips, or thin saplings nailed in place; and (b) 3-part system consisting of an inner blocking filler of stones or wood slabs, together with soft filler, such as clay, stuffed around the blocking, composes the chinking, and wet-applied daubing. Concealed aids that may improve the adherence of new daubing include (c) galvanized nails, or (d) galvanized mesh lath. Drawing: James Caufield.

Daubing Mixes

	parts (volume)	material
Mix A.	1/4	cement
	1	lime
	4	sand
	1/8	dry color hog bristles or excelsior

(Donald A. Hutslar, "Log Cabin Restoration: Guidelines for the Historical Society," American Association for State and Local History, Technical Leaflet No. 74, "History News," Vol. 29, No. 5 (May 1974).)

Mix B.	6	sand
	4	lime
	1	cement
Mix C.	1	portland cement
	4-8	lime
	7-10	sand

Mix B and C are reprinted from "Log Structures: Preservation and Problem-Solving," by Harrison Goodall and Renee Friedman, Nashville, TN: American Association for State and Local History, 1980.

Portland cement was a part of the original daubing used in many late 19th and early 20th century log buildings, and is therefore appropriate to include in repairing buildings of this period. Although a small amount of portland cement may be added to a lime, clay and sand mix for workability, there should not be more than 1 part portland cement to 2 parts of lime in daubing mixes intended for most historic log buildings. Portland cement tends to shrink and develop hairline cracks, and retain moisture, all of which can be potentially damaging to the logs.

Interior Treatments

There is no single appropriate way to finish or restore the interior of a historic log house. Each building and its history is unique. The temptation should be resisted to impart an unfinished frontier character by removing plaster to expose interior log walls or joists in the ceiling. Instead, interior treatments should be based on existing evidence, and guided by old photographs, written documentation, and interviews with previous owners. Interior features and finishes that might exist in some 18th and 19th century log houses include wood paneled walls, wood moldings, stairs, and fire-place mantels; where they have survived, these features should be retained. Many of the more rustic log buildings built later in the 19th or early 20th century intentionally featured exposed interior log walls, sometimes with the logs peeled and varnished. If interior plaster is severely damaged or has previously been removed, and evidence such as lath ghosting on the logs exists, walls should be replastered or recovered with gypsum board or dry wall to match the historic appearance.



Preserving Log Buildings in Their Historic Settings

Log buildings are too often viewed as portable resources. Like other historic buildings, moved or relocated log structures can suffer a loss of integrity of materials and of setting (Fig. 24). Historic buildings listed in the National Register of Historic Places may be subject to loss of that status if moved. Despite the popularity of dismantling and relocating log buildings, they should be moved only as a last resort, if that is the only way to save them from demolition. If they must be moved, it is preferable that they be moved intact—that is, in one piece rather than disassembled. Disassembling and moving a log building can result in considerable loss of the historic building materials. While the logs and roof framing members can be numbered for reassembly, dismantling a log building can result in loss of such features as foundation and chimney, chinking and daubing, exterior cladding, and interior finishes. Furthermore, log buildings can rarely be put back together as easily as they were taken apart.

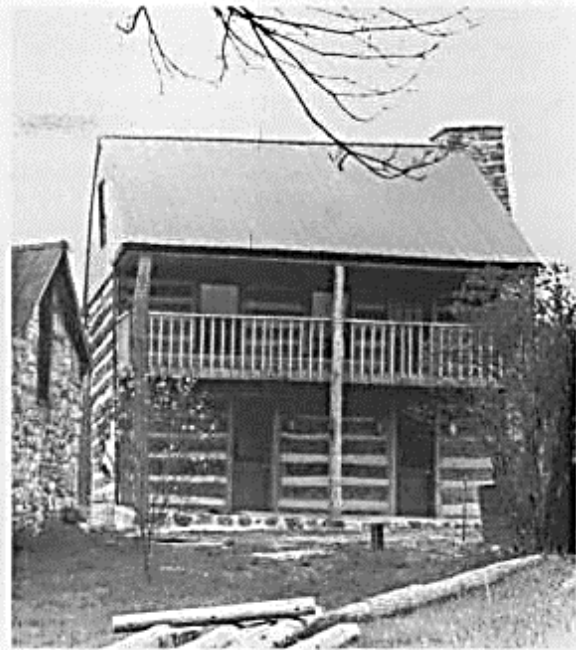


b

Fig. 24. Some towns still retain a high number of early log houses. (a) Middleway, West Virginia, is a small village dominated by 18th and 19th century log houses, and, with the exception of outbuildings, all are clad in original wood siding or stucco. Removal of one of the houses from this streetscape would not only result in a loss of integrity to the building, but also to the historic district. (b) The original wood clapboard of two of these c. 1830 log houses in Stouchsburg, Pennsylvania, has been covered with asphalt siding, and later porches added. Rehabilitation plans might appropriately include retention of the porches as having acquired significance over time, and removal of the asphalt siding. Uneven spacing between the two upper left windows of the house on the left, and the center chimney are indications that the house was built in two stages. Photos: (a) Anne Grimmer, (b) Pennsylvania Historical and Museum Commission.

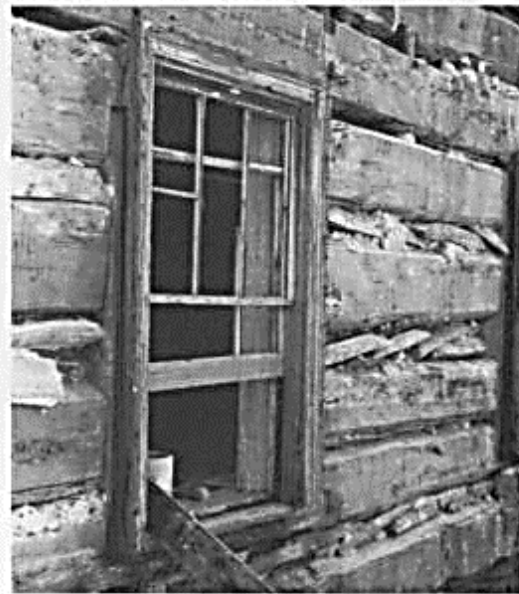


a



b

Fig. 25. (a) Prior to rehabilitation, the exterior of this late 18th century log house was sided with wood clapboard, which had been covered over by a later artificial siding, while the upper gallery of the second floor porch was stuccoed. (b) During the rehabilitation both the historic wood siding and stucco were removed to expose the logs, the gables were sided with wood shingles, and what would have originally been milled wood columns supporting the porch were replaced with rough, unmilled log posts. Collectively, these treatments diminished the building's architectural integrity, and gave it an appearance it never had. (c) The depth that the window frames extend out beyond the log surface allowing space for siding is an indication that cladding was part of the building's original construction. Photos: National Park Service Files.



c

Summary

Historic log buildings regardless of whether they are of horizontal or vertical construction, or whether they are 18th century log houses or early 20th century Rustic style cabins, are unique. Their conservation essentially centers on the preservation and repair of the logs, and appropriate repairs to chinking and daubing, which like repointing of masonry, is necessary to ensure that most log buildings are weathertight. Log building preservation may be accomplished with a variety of techniques including splicing and piecing-in, the use of epoxy, or a combination of patching and epoxy, and often, selected replacement. But, like any historic

building, a log structure is a system that functions through the maintenance of the totality of its parts.

The exterior of many of the earliest late 18th and 19th century log buildings, and particularly those east of the Mississippi, were commonly covered at the time of construction or later with some type of cladding, either horizontal or vertical wood siding, stucco, or sometimes a combination. If extant, this historic cladding, which may be hidden under a later, non-historic artificial siding such as aluminum, vinyl, or asbestos, should be preserved and repaired, or replaced if evidence indicates that it existed, as a significant character-defining feature of the building (Fig. 25).

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Cover Photograph (logo): The log cabin was used on this 1840 campaign medal to symbolize frontier life and democratic egalitarianism, a platform that successfully elected William Henry Harrison to the presidency. Photo: The State Museum of Pennsylvania, Pennsylvania Historical and Museum Commission.

5.3.2 Preservation Brief 19: *The Repair and Replacement of Historic Wooden Shingle Roofs, 1978*¹¹³

19 PRESERVATION BRIEFS

The Repair and Replacement of Historic Wooden Shingle Roofs

Sharon C. Park, AIA

U.S. Department of the Interior, National Park Service
Preservation Assistance Division, Technical Preservation Services



The Secretary of the Interior's "Standards for Rehabilitation" call for the repair or replacement of missing architectural features "based on accurate duplication of features, substantiated by historic, physical, or pictorial evidence rather than on conjectural designs." On a wooden shingle roof, it is important not only to match the size, shape, texture, and configuration of historic shingles, but also to match the craftsmanship and details that characterize the historic roof. Proper installation and maintenance will extend the life of the new roof.

Introduction

Wooden shingle roofs are important elements of many historic buildings. The special visual qualities imparted by both the *historic shingles* and the *installation patterns* should be preserved when a wooden shingle roof is replaced. This requires an understanding of the size, shape, and detailing of the historic shingle and the method of fabrication and installation. These combined to create roofs expressive of particular architectural styles, which were often influenced by regional craft practices. The use of wooden shingles from the early settlement days to the present illustrates an extraordinary range of styles (see illus. 1, 2, 3, 4).

Wooden shingle roofs need periodic replacement. They can last from 15 to over 60 years, but the shingles should be replaced before there is deterioration of other wooden components of the building. Appropriate replacement shingles are available, but careful research, design, specifications, and the selection of a skilled roofer are necessary to assure a job that will both preserve the appearance of the historic building and extend the useful life of the replacement roof.

Unfortunately, the wrong shingles are often selected or are installed in a manner incompatible with the appearance of the historic roof. There are a number of reasons why the wrong shingles are selected for replacement roofs. They include the failure to identify the appearance of the original shingles; unfamiliarity with available products; an inadequate budget; or a *confusion in terminology*. In any discussion about historic roofing materials and practices, it is important to understand the historic definitions of terms like "shingles," as well as the modern definitions or use of those terms by craftsmen and the industry. Historically, from the first buildings in America, these wooden roofing

products were called *shingles*, regardless of whether they were the earliest handsplit or the later machine-sawn type. The term *shake* is a relatively recent one, and today is used by the industry to distinguish the sawn products from the split products, but through most of our building history there has been no such distinction.

Considering the confusion among architects and others regarding these terms as they relate to the appearance of early roofs, it should be stated that there is a considerable body of documentary information about historic roofing practices and materials in this country, and that many actual specimens of historic shingles from various periods and places have been collected and preserved so that their historic appearances are well established. Essentially, the rustic looking shake that we see used so much today has little in common with the shingles that were used on most of our early buildings in America.

Throughout this **Brief**, the term *shingle* will be used to refer to historic wooden roofs in general, whether split or sawn, and the term *shake* will be used only when it refers to a commercially available product. The variety and complexity of terminology used for currently available products will be seen in the accompanying chart entitled "Shingles and Shakes."

This **Brief** discusses what to look for in historic wooden shingle roofs and when to replace them. It discusses ways to select or modify modern products to duplicate the appearance of a historic roof, offers guidance on proper installation, and provides information on coatings and maintenance procedures to help preserve the new roof.*

(***Preservation Brief 4: Roofing for Historic Buildings** discusses research methods, analysis of deterioration, and the general significance of historic roofs.)

113. This section reproduces Sharon C. Park, *The Repair and Replacement of Historic Wooden Shingle Roofs*, Preservation Brief 19 (Washington, DC: National Park Service, 1978), <https://www.nps.gov/orgs/1739/upload/preservation-brief-19-wood-shingle-roofs.pdf>. Public domain.

Wooden Shingle Roofs in America

Because trees were plentiful from the earliest settlement days, the use of wood for all aspects of construction is not surprising. Wooden shingles were lightweight, made with simple tools, and easily installed. Wooden shingle roofs were prevalent in the Colonies, while in Europe at the same time, thatch, slate and tile were the prevalent roofing materials. Distinctive roofing patterns exist in various regions of the country that were settled by the English, Dutch, Germans, and Scandinavians. These patterns and features include the size, shape and exposure length of shingles, special treatments such as swept valleys, combed ridges, and decorative butt end or long side-lapped beveled handsplit shingles. Such features impart a special character to each building, and prior to any restoration or rehabilitation project the physical and photographic evidence should be carefully researched in order to document the historic building as much as



1. The Rolfe-Warren House, a tidewater Virginia property, was restored to its 18th-century appearance in 1933. The handsplit and dressed wooden shingles are typical of the tidewater area with special features such as curved butts, projecting ridge comb and closed swept valleys at the dormer roof connections. Circa 1970 Photo: Association for the Preservation of Virginia Antiquities.



3. Readily available and inexpensive sawn shingles were used not only for roofs, but also for gables and wall surfaces. The circa 1891 Chambers House, Eugene, Oregon used straight sawn butts for the majority of the roof and hexagonal butts for the lower portion of the corner tower. Decorative shingles in the gable ends and an attractive wooden roof cresting feature were also used. Photo: Lane County Historical Society.

possible. Care should be taken not to assume that aged or deteriorated shingles in photographs represent the historic appearance.

Shingle Fabrication. Historically wooden shingles were usually thin ($3/8''-3/4''$), relatively narrow ($3''-8''$), of varying length ($14''-36''$), and almost always smooth. The traditional method for making wooden shingles in the 17th and 18th centuries was to handsplit them from log sections known as bolts (see illus. 5A). These bolts were quartered or split into wedges. A mallet and froe (or ax) were used to split or rive out thin planks of wood along the grain. If a tapered shingle was desired, the bolt was flipped after each successive strike with the froe and mallet. The wood species varied according to available local woods, but only the heartwood, or inner section, of the log was usually used. The softer sapwood generally was not used because it deteriorated quickly. Because handsplit shingles were somewhat irregular along the split surface, it was necessary



2. Handsplit and dressed shingles were also used on less elaborate buildings as seen in the restoration of the circa 1840 kitchen at the Winedale Inn, Texas. The uneven surfaces of the handsplit shingles were generally dressed or smoothed with a draw-knife to keep the rainwater from collecting in the wood grain and to ensure that the shingles lay flat on the sub-roof. Photo: Thomas Taylor.



4. With the popularity of the revival of historic styles in the late 19th and early 20th centuries, a new technique was developed to imitate English thatch roofs. For the Tudor Revival thatch cottages, steaming and curving of sawn shingles provided an undulating pattern to this picturesque roof shape. Photo: Courtesy of C.H. Roofing.

to dress or plane the shingles on a shavinghorse with a draw-knife or draw-shave (see illus. 5B) to make them fit evenly on the roof. This reworking was necessary to provide a tight-fitting roof over typically open shingle lath or sheathing boards. Dressing, or smoothing of shingles, was almost universal, no matter what wood was used or in what part of the country the building was located, except in those cases where a temporary or very utilitarian roof was needed.

Shingle fabrication was revolutionized in the early 19th century by steam-powered saw mills (see illus. 6). Shingle mills made possible the production of uniform

shingles in mass quantities. The sawn shingle of uniform taper and smooth surface eliminated the need to hand dress. The supply of wooden shingles was therefore no longer limited by local factors. These changes coincided with (and in turn increased) the popularity of architectural styles such as Carpenter Gothic and Queen Anne that used shingles to great effect.

Handsplitted shingles continued to be used in many places well after the introduction of machine sawn shingles. There were, of course, other popular roofing materials, and some regions rich in slate had fewer examples of wooden shingle roofs. Some western



5. Custom Handsplitted shingles are still made the traditional way with a mallet and froe or ax. For these cypress shingles, a "bolt" section of log (photo A) the length of the shingle has been sawn and is ready to be split into wedge-shaped segments. Handsplitted shingles are fabricated with the ax or froe cutting the wood along the grain and separating, or riving, the shingle away from the remaining wedge. The rough surfaces are dressed on a shavinghorse using a draw-knife as shown above (photo B). Note the long wooden shingles covering the work shed in photo A. Photos: Al Honeycutt, North Carolina Division of Archives and History.



6. Modern machine-made shingles are sawn. Shown are: (photo A) Eastern White Pine quarter split shingle block on equalizer saw being trimmed to parallel the ends; and (photo B) the restored 19th-century shingle mill saw cutting tapered flitches or shingles. The thickness and taper can be precisely controlled. Photo: Steve Ruscio, The Shingle Mill.

“boom” towns used sheet metal because it was light and easily shipped. Slate, terneplate, and clay tile were used on ornate buildings and in cities that limited the use of flammable wooden shingles. Wooden shingles, however, were never abandoned. Even in the 20th century, architectural styles such as the Colonial Revival and Tudor Revival, used wooden shingles.

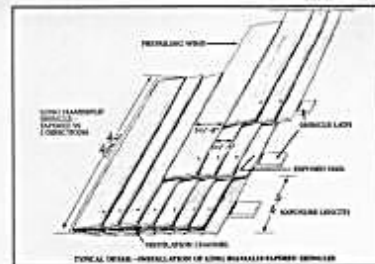
Modern wooden shingles, both sawn and split, continue to be made, but it is important to understand how these new products differ from the historic ones and to know how they can be modified for use on historic buildings. Modern commercially available shakes are generally thicker than the historic handsplit counterpart and are usually left “undressed” with a rough, corrugated surface. The rough surface shake, furthermore, is often promoted as suitable for historic preservation projects because of its rustic appearance. It is an erroneous assumption that the more irregular the shingle, the more authentic or “historic” it will appear.

Historic Detailing and Installation Techniques. While the size, shape and finish of the shingle determine the roof’s texture and scale, the installation patterns and details give the roof its unique character. Many details reflect the craft practices of the builders and the architectural style prevalent at the time of construction. Other details had specific purposes for reducing moisture penetration to the structure. In addition to the most visible aspects of a shingle roof, the details at the rake boards, eaves, ridges, hips, dormers, cupolas, gables, and chimneys should not be overlooked.

The way the shingles were laid was often based on functional and practical needs. Because a roof is the most vulnerable element of a building, many of the roofing details that have become distinctive features were first developed simply to keep water out. Roof combs on the windward side of a roof protect the ridge line. Wedges, or cant strips, at dormer cheeks roll the water away from the vertical wall. Swept valleys and fanned hips keep the grain of the wood in the shingle parallel to the angle of the building joint to aid water



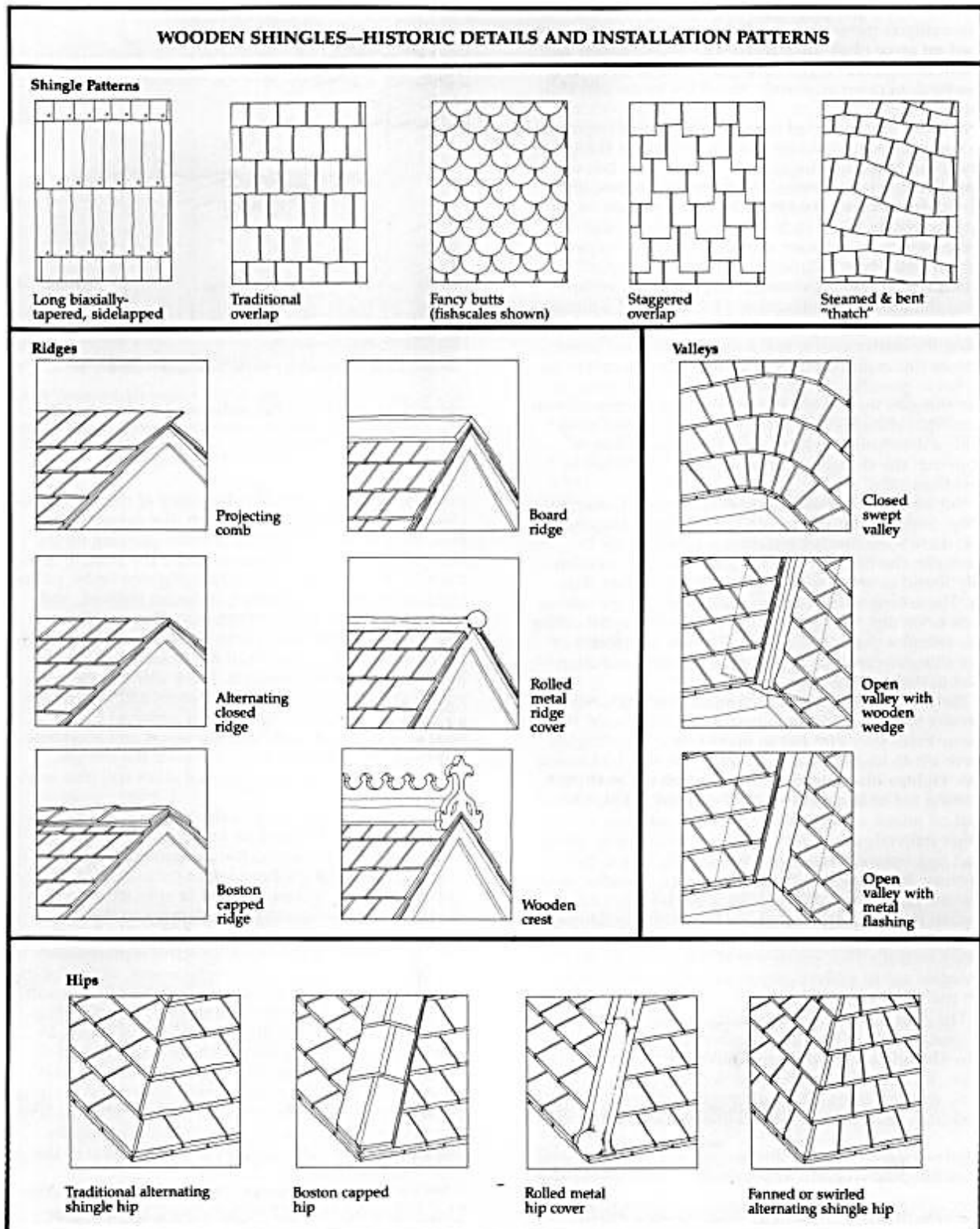
7. The reshingling of the circa 1856 Stovewood House in Decorah, Iowa, revealed the original open sheathing boards and pole rafters. Sawn cedar shingles were used as a replacement for the historic cedar shingles seen still in place at the ridge. A new starter course is being laid at the eaves. Photo: Norwegian-American Museum, Decorah, Iowa.



8. The long biaxially tapered handsplit shingles on the Ephrata Cloisters in Pennsylvania were overlapped both vertically and horizontally. The insert sketch shows channels under the shingles that provided ventilation and drainage of any trapped moisture. The aged appearance of these handsplit and dressed shingles belies their original smoothness. Replacement shingles should match the original, not the aged appearance. Photo: National Park Service; Sketch: Reed Engle.



9. This 1927 view of the reshingling of the French Castle at Old Fort Niagara, N.Y., shows the wooden sleepers being laid (see arrow) over solid sheathing in order to raise the shingles up slightly to allow under-shingle ventilation. Note that the horizontal strips are not continuous to allow airflow and trapped moisture to drain away. This cedar roof has lasted for over 60 years in a harsh moist environment. Photo: Old Fort Niagara, Assoc. Inc.



10. The Historic Details and Installation Patterns Chart illustrates a number of special features found on wooden roofs. Documented examples of these features, different for every building and often reflecting regional variations, should be accurately reproduced when a replacement roof is installed. Chart: Sharon C. Park; delineation by Kaye Ellen Simonson.

run-off. The slight projection of the shingles at the eaves directs the water run-off either into a gutter or off the roof away from the exterior wall. These details varied from region to region and from style to style. They can be duplicated even with the added protection of modern flashing.

In order to have a weathertight roof, it was important to have adequate coverage, proper spacing of shingles, and straight grain shingles. Many roofs were laid on open shingle lath or open sheathing boards (see illus. 7). Roofers typically laid three layers of shingles with approximately 1/3 of each shingle exposed to the weather. Spaces between shingles (1/8"-1/2" depending on wood type) allowed the shingles to expand when wet. It was important to stagger each overlapping shingle by a minimum of 1-1/2" to avoid a direct path for moisture to penetrate a joint. Doubling or tripling the starter course at the eave gave added protection to this exposed surface. In order for the roof to lay as flat as possible, the thickness, taper and surface of the shingles was relatively uniform; any unevenness on handsplit shingles had already been smoothed away with a drawknife. To keep shingles from curling or cupping, the shingle width was generally limited to less than 10".

Not all shingles were laid in evenly spaced, overlapping, horizontal rows. In various regions of the country, there were distinct installation patterns; for example, the biaxially-tapered long shingles occasionally found in areas settled by the Germans (see illus. 8). These long shingles were overlapped on the side as well as on top. This formed a ventilation channel under the shingles that aided drying. Because ventilation of the shingles can prolong their life, roofers paid attention to these details (see illus. 9).

Early roofers believed that applied coatings would protect the wood and prolong the life of the roof. In many cases they did; but in many cases, the shingles were left to weather naturally and they, too, had a long life. Eighteenth-century coatings included a pine pitch coating not unlike turpentine, and boiled linseed oil or fish oil mixed with oxides, red lead, brick dust, or other minerals to produce colors such as yellow, Venetian red, Spanish brown, and slate grey. In the 19th century, in addition to the earlier colors, shingles were stained or painted to complement the building colors: Indian red, chocolate brown, or brown-green. During the Greek Revival and later in the 20th century with other revival styles, green was also used. Untreated shingles age to a silver-grey or soft brown depending on the wood species.

The craft traditions of the builders often played an important role in the final appearance of the building. The Historic Details and Installation Patterns Chart (see illus. 10) identifies many of the features found on historic wooden roofs. These elements, different on each building, should be preserved in a re-roofing project.

Replacing Deteriorated Roofs: Matching the Historic Appearance

Historic wooden roofs using straight edgegrain heartwood shingles have been known to last over sixty years. Fifteen to thirty years, however, is a more realistic lifespan for most premium modern wooden shingle roofs. Contributing factors to deterioration include the



11. The replacement sawn red cedar shingles matched the deteriorated shingles exactly for this barn re-roofing. The old shingles, seen to the far left, were removed as the new shingles were installed. Even the horizontal coursing matched because the exposure length for both old and new shingles was the same. Photo: Williamsport Preservation Training Center.

thinness of the shingle, the durability of the wood species used, the exposure to the sun, the slope of the roof, the presence of lichens or moss growing on the shingle or in the roof, the presence of overhanging tree limbs, pollutants in the air, the original installation method, and the history of the roof maintenance. Erosion of the softer wood within the growth rings is caused by rainwater, wind, grit, fungus and the breakdown of cells by ultraviolet rays in sunlight. If the shingles cannot adequately dry between rains, if moss and lichens are allowed to grow, or if debris is not removed from the roof, moisture will be held in the wood and accelerate deterioration. Moisture trapped under the shingle, condensation, or poorly ventilated attics will also accelerate deterioration.

In addition to the eventual deterioration of wooden shingles, impact from falling branches and workmen walking on the roof can cause localized damage. If, however, over 20% of the shingles on any one surface appear eroded, cracked, cupped or split, or if there is evidence of pervasive moisture damage in the attic, replacement should be considered. If only a few shingles are missing or damaged, selective replacement may be possible. For limited replacement, the old shingle is removed and a new shingle can be inserted and held in place with a thin metal tab, or "babbie." This reduces disturbance to the sound shingles above. In instances where a few shingles have been cracked or the joint of overlapping shingles is aligned and thus forms a passage for water penetration, a metal flashing piece slipped under the shingle can stop moisture temporarily. If moisture is getting into the attic, repairs must be made quickly to prevent deterioration of the roof structural framing members.

When damage is extensive, replacement of the shingles will be necessary, but the historic sheathing or shingle lath under the shingles may be in satisfactory condition. Often, the historic sheathing or shingle laths, by their size, placement, location of early nail holes, and water stain marks, can give important infor-



12. Inappropriately selected and installed wooden shingles can drastically alter the historic character of a building. This tavern historically was roofed with handsplit and dressed shingles of a relatively smooth appearance. In this case, a commercially available shake was used to effect a "rustic" appearance. Photo: National Park Service.

mation regarding the early shingles used. Before specifying a replacement roof, it is important to *establish the original shingle material, configuration, detailing and installation* (see illus. 11). If the historic shingles are still in place, it is best to remove several to determine the size, shape, exposure length, and special features from the unweathered portions. If there are already replacement shingles on the roof, it may be necessary to verify through photographic or other research whether the shingles currently on the roof were an accurate replacement of the historic shingles.

The following information is needed in order to develop accurate specifications for a replacement shingle:

- Original wood type** (White Oak, Cypress, Eastern White Pine, Western, Red Cedar, etc.)
- Size of shingle** (length, width, butt thickness, taper)
- Exposure length and nailing pattern** (amount of exposure, placement and type of nails)
- Type of fabrication** (sawn, handsplit, dressed, beveled, etc.)
- Distinctive details** (hips, ridges, valleys, dormers, etc.)
- Decorative elements** (trimmed butts, variety of pattern, applied color coatings, exposed nails)
- Type of substrate** (open shingle lath or sheathing, closed sheathing, insulated attics, sleepers, etc.)

Replacement roofs must comply with local codes which may require, for example, the use of shingles treated with chemicals or pressure-impregnated salts to retard fire. These requirements can usually be met without long-term visual effects on the appearance of the replacement roof.

The accurate duplication of a wooden shingle roof will help ensure the preservation of the building's architectural integrity. Unfortunately, the choice of an inappropriate shingle or poor installation can severely detract from the building's historic appearance (see illus. 12). There are a number of commercially available wooden roofing products as well as custom roofers who can supply specially-made shingles for historic preservation projects (see Shingle and Shake Chart, illus. 13). Unless restoration or reconstruction is being

undertaken, shingles that match the visual appearance of the historic roof without replicating every aspect of the original shingles will normally suffice. For example, if the historic wood species is no longer readily available, Western Red Cedar or Eastern White Pine may be acceptable. Or, if the shingles are located high on a roof, sawn shingles or commercially available shakes with the rustic faces factory-sawn off may adequately reproduce the appearance of an historic handsplit and dressed shingle.

There will always be certain features, however, that are so critical to the building's character that they should be accurately reproduced. Following is guidance on matching the most important visual elements.

Highest Priority in Replacement Shingles:

- best quality wood with a similar surface texture
- matching size and shape: thickness, width, length
- matching installation pattern: exposure length, overlap, hips, ridges, valleys, etc.
- matching decorative features: fancy butts, color, exposed nails

Areas of Acceptable Differences:

- species of wood
- method of fabrication of shingle, if visual appearance matches
- use of fire-retardants, or preservative treatments, if visual impact is minimal
- use of modern flashing, if sensitively installed
- use of small sleepers for ventilation, if the visual impact is minimal and rake boards are sensitively treated
- method of nailing, if the visual pattern matches

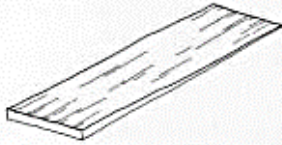
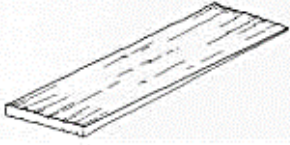
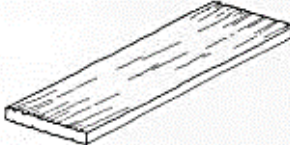
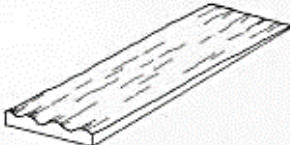
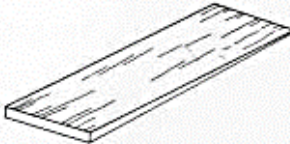
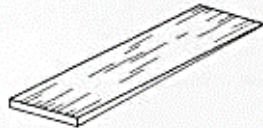
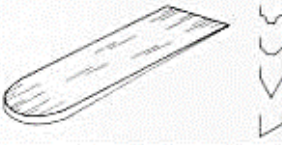

Treatments and Materials to Avoid:

- highly textured wood surfaces and irregular butt ends, unless documented
- standardized details (prefab hips, ridges, panels, etc.) unless documented
- too wide shingles or those with flat grain (which may curl), unless documented

What is Currently Available

Types of Wood: Western Red Cedar, Eastern White Pine, and White Oak are most readily available today. For custom orders, cypress, red oak, and a number of other historically used woods may still be available. Some experiments using non-traditional woods (such as yellow pine and hemlock) treated with preservative chemicals are being tested for the new construction market, but are generally too thick, curl too easily, or have too pronounced a grain for use on historic buildings.

Method of manufacture: Commercially available modern shingles and shakes are for the most part machine-made. While commercially available shakes are promoted by the industry as handsplit, most are split by machine (this reduces the high cost of hand labor). True handsplit shingles, made the traditional way with a froe and mallet, are substantially more expensive, but are more authentic in appearance than the rough, highly textured machine-split shakes. An experienced shingler can control the thickness of the handsplit shingle and keep the shingle surface grain relatively

AVAILABLE WOODEN SHINGLES AND SHAKES FOR RE-ROOFING			
TYPE	SIZE	DESCRIPTION	NOTES
Custom split & dressed 	Made to match historic shingles	Handsplit the traditional way with froe & mallet. Tapered. Surfaces dressed for smoothness	Appropriate if: <ul style="list-style-type: none"> • Worked to match uniformly dressed original shingles
Tapersplit* 	Typically: L = 15", 18", 24" W = 4" - 14" Butts vary 1/2" - 3/4"	Commercially available. Handsplit the traditional way with froe & mallet. Tapered. Bundles contain varying widths & butt thicknesses. Surfaces may be irregular along grain.	Appropriate if: <ul style="list-style-type: none"> • irregular surfaces are dressed • butt thicknesses ordered uniform • wide shingles are split
Straightsplit 	Typically: L = 15", 18", 24" W = 4" - 14" Butts vary mediums = 3/8 - 3/4" heavies = 3/4 - 1 1/4"	Commercially available. Hand or machine split without taper. Bundles contain varying butt thicknesses; often very wide shingles. Surface may be irregular along the grain. Thick shingles not historic.	Not appropriate for most preservation projects <ul style="list-style-type: none"> • Limited use of thin, even straightsplits on some cabins, barns, etc.
Handsplit* resawn 	Typically: L = 15", 18", 24" W = 4" - 14" Butts vary mediums = 3/8 - 3/4" heavies = 3/4 - 1 1/4"	Commercially available. Machine split and sawn on the backs to taper. Split faces often irregular, even corrugated in appearance. Butt thickness vary and may be too wide.	Not appropriate for preservation projects
Tapersawn* 	Typically: L = 15", 18", 24" W = 4" - 14" Butts vary 1/2" - 3/4"	Commercially available. Made from split products with sawn surfaces. Tapered. Butt thicknesses vary and shingles may be too wide. Saw marks may be pronounced.	Appropriate if: <ul style="list-style-type: none"> • butt thicknesses ordered uniform • wide shingles are split • pronounced saw marks sanded
Sawn-straight butt 	Typically: L = 16" - .40 (< 3/8") 18" - .45 24" - .50 (1/2") W = Varies by order	Custom or commercially available. Tapered. Sawn by circular saw.	Appropriate to reproduce historic sawn shingles
Sawn-fancy butt 	Typically: L = 16" - .40 (< 3/8") 18" - .45 24" - .50 (1/2") W = Varies by order	Custom or commercially available. Tapered. Sawn by circular saw. A variety of fancy butts available	Appropriate to reproduce historic fancy butts
Steam-bent 	Varies by order to match "Thatch" roofs	Custom or commercially available. Tapered. Thin sawn shingles are steamed and bent into rounded forms.	Appropriate to reproduce "thatch" shingles

13. This chart identifies a variety of shingles and shakes used for reroofing buildings. The * identifies product names used by the Red Cedar Shingle and Handsplit Shake Bureau, although shingles and shakes of the types described are available in other woods. Manufacturers define "Shakes" as split products while "shingles" refer to sawn products. Shingle, however, is the historic term used to describe wooden roofing products, regardless of how they were made. Whether shingles or shakes are specified for re-roofing, they should match the size and appearance of the historic shingles. Chart: Sharon C. Park; delineation by Kaye Ellen Simonson.

even. To have an even roof installation, it is important to have handsplit shingles of uniform taper and to have less than 1/8th variation across the surface of the shingle. For that reason, it is important to dress the shingles or to specify uniform butt thickness, taper, and surfaces. Commercially available shakes are shipped with a range of butt sizes within a bundle (e.g., 1/2", 5/8", 3/4" as a mix) unless otherwise specified. Commercially available shakes with the irregular surfaces sawn off are also available. In many cases, except for the residual circular saw marks, these products appear not unlike a dressed handsplit shingle.

Sawn shingles are still made much the same way as they were historically—using a circular saw. The circular saw marks are usually evident on the surface of most sawn shingles. There are a number of grooved, striated, or steamed shingles of the type used in the 20th century to effect a rustic or thatched appearance. Custom sawn shingles with fancy butts or of a specified thickness are still available through mill shops. In fact, shingles can be fabricated to the weathered thickness in order to be integrated into an existing historic roof. If sawn shingles are being used as a substitute for dressed handsplit shingles, it may be desirable to belt sand the surface of the sawn shingles to reduce the prominence of the circular saw marks.

As seen from the Shingle and Shake chart, few of the commercially available shakes can be used without some modification or careful specification. Some, such as heavy shakes with a corrugated face, should be avoided altogether. While length, width, and butt configuration can be specified, it is more difficult to ensure that the thickness and the texture will be correct. For that reason, whatever shingle or shake is desired, it is important to view samples, preferably an entire bundle, before specifying or ordering. If shingles are to be trimmed at the site for special conditions, such as fanned hips or swept valleys, additional shingles should be ordered.

Coatings and Treatments: Shingles are treated to obtain a fire-retardant rating; to add a fungicide preservative (generally toxic); to revitalize the wood with a penetrating stain (oil as well as water-based); and to give color.

While shingles can be left untreated, local codes may require that only fire-retardant shingles be used. In those circumstances, there are several methods of obtaining rated shingles (generally class "B" or "C"). The most effective and longest-lasting treatment is to have treated salts pressure-impregnated into the wood cells after the shingles have been cut. Another method (which must be periodically renewed) is to apply chemicals to the surface of the shingles. If treated shingles need trimming at the site, it is important to check with the manufacturer to ensure that the fire-retardant qualities will not be lost. Pressure-impregnated shingles, however, may usually be trimmed without loss of fire-retardant properties.

The life of a shingle roof can be drastically shortened if moss, lichens, fungi or bacterial spores grow on the wood. Fungicides (such as chromated copper arsenate, CCA) have been found to be effective in inhibiting such fungal growth, but most are toxic. Red cedar has a natural fungicide in the wood cells and unless the shingles are used in unusually warm, moist environments, or where certain strains of spores are found, an

applied fungicide is usually not needed. For most woods, the Forest Products Laboratory of the U.S. Department of Agriculture has found that fungicides do extend the life of the shingles by inhibiting growth on or in the wood. There are a variety available. Care should be taken in applying these chemicals and meeting local code requirements for proper handling.

Penetrating stains and water repellent sealers are sometimes recommended to revitalize wood shingles subject to damage by ultraviolet rays. Some treatments are oil-borne, some are water-borne, and some are combined with a fungicide or a water repellent. If any of these treatments is to be used, they should be identified as part of the specifications. Manufacturers should be consulted regarding the toxicity or other potential complications arising from the use of a product or of several in combination. It is also important not to coat the shingles with vapor-impermeable solutions that will trap moisture within the shingle and cause rotting from beneath.

Specifications for the Replacement Roof

Specifications and roofing details should be developed for each project. Standard specifications may be used as a basic format, but they should be modified to reflect the conditions of each job. Custom shingles can still be ordered that accurately replicate a historic roof, and if the roof is simple, an experienced shingler could install it without complicated instructions. Most rehabilitation projects will involve competitive bidding, and each contractor should be given very specific information as to what type of shingles are required and what the installation details should be. For that reason, both written specifications and detailed drawings should be part of the construction documents.

For particularly complex jobs, it may be appropriate to indicate that only roofing contractors with experience in historic preservation projects be considered (see illus. 14). By pre-qualifying the bidders, there is greater assurance that a proper job will be done. For smaller jobs, it is always recommended that the owner or architect find a roofing contractor who has recently completed a similar project and that the roofers are similarly experienced.

Specifications identify exactly what is to be received from the supplier, including the wooden shingles, nails, flashing, and applied coatings. The specifications also include instructions on removing the old roofing (sometimes two or more earlier roofs), and on preparing the surface for the new shingles, such as repairing damage to the lath or sheathing boards. If there are to be modifications to a standard product, such as cutting beveled butts, planing off residual surface circular saw marks, or controlling the mixture of acceptable widths (3"-8"), these too should be specified. Every instruction for modifying the shingles themselves should be written into the specifications or they may be overlooked.

The specifications and drawn details should describe special features important to the roof. Swept valleys, combed ridges, or wedged dormer cheek run-offs should each be detailed not only with the patterning of the shingles, but also with the placement of flashing or other unseen reinforcements. There are some modern products that appear to be useful. For example, paper-

Replacement Roofing for Appomattox Manor: City Point Unit of Petersburg National Battlefield, Hopewell, Virginia



A. The later non-historic shingles were removed from Appomattox Manor (circa 1840 with later additions) and roofing paper was installed for temporary protection during the re-shingling.



B. These weathered historic 19th-century handsplit and dressed shingles were found in place under a later altered roof. Note the straight butt eave shingles under the curved butts of the historic dormer shingles.



D. The fanned hips (seen here), swept valleys, and projecting ridge combs were installed as part of the re-roofing project. Special features, when documented, should be reproduced when re-shingling historic roofs.

14. Original 19th-century handsplit and dressed wooden shingles 18" long, 3"-4" wide, and 5/8" thick were found in place on the Appomattox Manor at Hopewell, Virginia. The butts were curved and evidence of a red stain remained. The specifications and details were researched so that the appearance of the historic shingles and installation patterns could be matched in the re-shingling project. Photos: John Ingle.

Excerpts from Specifications:

Type of wood to be used: Western Red Cedar.

Grade of wood and manufacturing process: Number One, Tapersplit Shakes, 100% clear, 100% edgegrain, 100% heartwood, no excessive grain sweeps, curvatures not to exceed 1/2" from level plain in length of shake; off grade (7% tolerance) material must *not* be used.

Size of the shingle: 18" long, 5/8" butt tapered to 1/4" head, 3"-4" wide, sawn curved butts, 5-1/2" exposure
Surface finish and any applied coatings: relatively smooth natural grain, no more than 1/8" variation in surface texture, butt thickness to be uniform throughout bundles. Site dipped with fire-rated chemicals tinted with red iron oxide for opaque color.

Type of nails and flashing: double hot dipped galvanized nails sized to penetrate sheathing totally; metal flashing to be 20 oz. lead-coated copper, or terne-coated stainless steel; additional flashing reinforcement to be aluminum foil type with fiber backing to use at hips, ridges, eaves, and valleys.

Type of sheathing: uninsulated attic, any deteriorated 3/4" sheathing boards, spaced 1/2"-3/4", to be replaced in kind.



C. The replacement shingles (see specifications above), matched the historic shingles and were of such high quality that little hand dressing was needed at the site. The building paper, a temporary protection, was removed as the shingles were installed on the sheathing boards.



E. In order to achieve a "Class B" fire-rating, the shingles were dipped in fire-retardant chemicals and allowed to dry prior to installation. Iron oxide was added to this chemical dip to stain the shingles to match the historic red color. These coatings will need periodic reapplication.

coated and reinforced metal-laminated flashing is easy to use and, in combination with other flashing, gives added protection over eaves and other vulnerable areas; adhesives give a stronger attachment at projecting roofing combs that could blow away in heavy wind storms. Clear or light-colored sealants may be less obvious than dark mastic often used in conjunction with flashing or repairs. These modern treatments should not be overlooked if they can prolong the life of the roof without changing its appearance.

Roofing Practices to Avoid

Certain common roofing practices for modern installations should be avoided in re-roofing a historic building unless specifically approved in advance by the architect. These practices interfere with the proper drying of the shingles or result in a sloppy installation that will accelerate deterioration (see illus. 15). They include improper coverage and spacing of shingles, use of staples to hold shingles, inadequate ventilation, particularly for heavily insulated attics, use of heavy building felts as an underlayment, improper application of surface coatings causing stress in the wood surfaces, and use of inferior flashing that will fail while the shingles are still in good condition.

Avoid skimpy shingle coverage and heavy building papers. It has become a common modern practice to lay impregnated roofing felts under new wooden shingle roofs. The practice is especially prevalent in roofs that do not achieve a full triple layering of shingles. Historically, approximately one third of each shingle was exposed, thus making a three-ply or three-layered roof. This assured adequate coverage. Due to the expense of wooden shingles today, some roofers expose more of the shingle if the pitch of the roof allows, and compensate for less than three layers of shingles by using building felts interwoven at the top of each row of shingles. This absorptive material can hold moisture on the underside of the shingles and accelerate deterioration. If a shingle roof has proper coverage and proper flashing, such felts are unnecessary as a general rule.



15. These commercially available roofing products with rustic split faces are not appropriate for historic preservation projects. In addition to the inaccurate appearance, the irregular surfaces and often wide spaces between shingles will allow wind-driven moisture to penetrate up and under them. The excessively wide boards will tend to cup, curl and crack. Moss, lichens and debris will have a tendency to collect on these irregular surfaces, further deteriorating the roofing. Photo: Sharon C. Park.

However, the selective use of such felts or other reinforcements at ridges, hips and valleys does appear to be beneficial.

Beware of heavily insulated attic rafters. Historically, the longest lasting shingle roofs were generally the ones with the best roof ventilation. Roofs with shingling set directly on solid sheathing and where there is insulation packed tightly between the wooden rafters without adequate ventilation run the risk of condensation-related moisture damage to wooden roofing components. This is particularly true for air-conditioned structures. For that reason, if insulation must be used, it is best to provide ventilation channels between the rafters and the roof decking, to avoid heavy felt building papers, to consider the use of vapor barriers, and perhaps to raise the shingles slightly by using "sleepers" over the roof deck. This practice was popular in the 1920s in what the industry called a "Hollywood" installation, and examples of roofs lasting 60 years are partly due to this under-shingle ventilation (refer to illus. 9).

Avoid staples and inferior flashing. The common practice of using pneumatic staple guns to affix shingles can result in shooting staples through the shingles, in crushing the wood fibers, or in cracking the shingle. Instead, corrosion-resistant nails, generally with barked or deformed shanks long enough to extend about 3/4" into the roof decking, should be specified. Many good roofers have found that the pneumatic nail guns, fitted with the proper nails and set at the correct pressure with the nails just at the shingle surface, have worked well and reduced the stress on shingles from missed hammer blows. If red cedar is used, copper nails should not be specified because a chemical reaction between the wood and the copper will reduce the life of the roof. Hot-dipped, zinc-coated, aluminum, or stainless steel nails should be used. In addition, copper flashing and gutters generally should not be used with red cedar shingles as staining will occur, although there are some historic examples where very heavy gauge copper was used which outlasted the roof shingles. Heavier weight flashing (20 oz.) holds up better than lighter flashing, which may deteriorate faster than the shingles. Some metals may react with salts or chemicals used to treat the shingles. This should be kept in mind when writing specifications. Terne-coated stainless steel and lead-coated copper are generally the top of the line if copper is not appropriate.

Avoid patching deteriorated roof lath or sheathing with plywood or composite materials. Full size lumber may have to be custom-ordered to match the size and configuration of the original sheathing in order to provide an even surface for the new shingles. It is best to avoid plywood or other modern composition boards that may deteriorate or delaminate in the future if there is undetected moisture or leakage. If large quantities of shingle lath or sheathing must be removed and replaced, the work should be done in sections to avoid possible shifting or collapse of the roof structure.

Avoid spray painting raw shingles on a roof after installation. Rapidly drying solvent in the paint will tend to warp the exposed surface of the shingles. Instead, it is best to dip new shingles prior to installation to keep all of the wood fibers in the same tension. Once the entire shingle has been treated, however, later coats can be limited to the exposed surface.

Maintenance

The purpose of regular or routine maintenance is to extend the life of the roof. The roof must be kept clean and inspected for damage both to the shingles and to the flashing, sheathing, and gutters. If the roof is to be walked on, rubber soled shoes should be worn. If there is a simple ridge, a ladder can be hooked over the roof ridge to support and distribute the weight of the inspector.

Keeping the roof free of debris is important. This may involve only sweeping off pine needles, leaves and branches as needed. It may involve trimming overhanging branches. Other aspects of maintenance, such as removal of moss and lichen build-up, are more difficult. While they may impart a certain charm to roofs, these moisture-trapping organisms will rot the shingles and shorten the life of the roof. Buildups may need scraping and the residue removed with diluted bleaching solutions (chlorine), although caution should be used for surrounding materials and plants. Some roofers recommend power washing the roofs periodically to remove the dead wood cells and accumulated debris. While this makes the roof look relatively new, it can put a lot of water under shingles, and the high pressure may crack or otherwise damage them. The added water may also leach out applied coatings.

If the roof has been treated with a fungicide, stain, or revitalizing oil, it will need to be re-coated every few years (usually every 4-5). The manufacturer should be consulted as to the effective life of the coating. With the expense associated with installation of wood shingles, it is best to extend the life of the roof as long as possible. One practical method is to order enough shingles in the beginning to use for periodic repairs.

Periodic maintenance inspections of the roof may reveal loose or damaged shingles that can be selectively replaced before serious moisture damage occurs (see illus. 16). Keeping the wooden shingles in good condition and repairing the roof, flashing and guttering, as needed, can add years of life to the roof.



16. Routine maintenance is necessary to extend the life of the roof. On this roof, the shingles have not seriously eroded, but the presence of lichens and moss is becoming evident and there are a few cracked and missing shingles. The moss spores should be removed, missing shingles replaced, and small pieces of metal flashing slipped under cracked shingles to keep moisture from penetrating. Photo: Williamsport Preservation Training Center.

Cover Photo: 1907 view of a young couple's first home in a cedar stump with a shingled roof. Photo: Historical Society of Seattle and King County, Washington.

Conclusion

A combination of careful research to determine the historic appearance of the roof, good specifications, and installation details designed to match the historic roof, and long-term maintenance, will make it possible to have not only a historically authentic roof, but a cost-effective one. It is important that professionals be part of the team from the beginning. A preservation architect should specify materials and construction techniques that will best preserve the roof's historic appearance. The shingle supplier must ensure that the best product is delivered and must stand behind the guarantee if the shipment is not correct. The roofer must be knowledgeable about traditional craft practices. Once the new shingle roof is in place, it must be properly maintained to give years of service.

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6 Stage IV: Mortar

6.1 Exterior mortar features

To preserve the original appearance of the Burgess-Capps Cabin, mortar joints were added between the logs. The shape of the logs resulted in various sizes and profiles of the mortar widths. The mortar widths fluctuate across the building's elevations (see Figure 64). Closeup images of the mortar joints can be seen in Figure 65 and Figure 66.

Refer to Chapter 10 for information gathered from the material testing part of this project.

Figure 64. Overall look at exterior mortar composition on the south elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 65. Closeup look at two rows of mortar on the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 66. Closeup look at a singular row of mortar on the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



There are mortar joints in the stone wall foundation of the Burgess-Capps Cabin (see Figure 67). The stone chimney on the east side of the building is also secured with mortar (see Figure 68 and Figure 69).

Figure 67. Mortar along with the stone foundation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 68. Mortar in the stone chimney on the east elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).

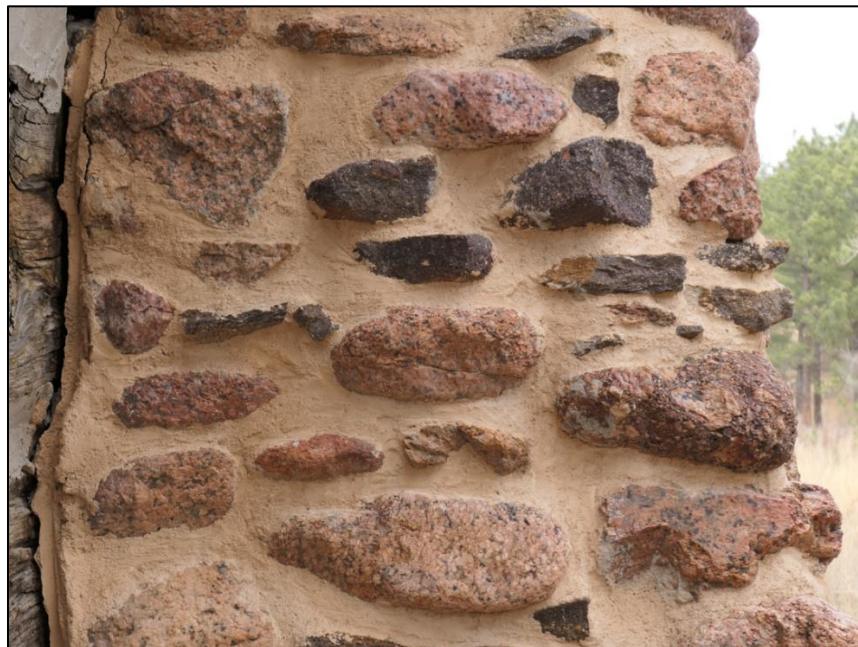


Figure 69. Mortar color difference between log and stone mortar (photo by ERDC-CERL researchers, 2021).



6.2 Interior mortar features

The mortar joints are visible on the interior of the Burgess-Capps Cabin (see Figure 70). The mortar joints appear staggered due to the size of the logs at the wall intersections (see Figure 71).

Figure 70. Overall look at the interior mortar composition on the west interior wall of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 71. Looking at multiple mortar widths at a corner wall of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



6.3 Treatment measures: “Chinking Repair” section of Preservation Brief 26: The Preservation and Repair of Historic Log Buildings, 1978¹¹⁴

The following images and documents offer treatment measures for exterior and interior mortar materials that are in poor condition. The sources include information from the National Park Service.

114. This section reproduces Bruce D. Bomberger, *The Preservation and Repair of Historic Log Buildings*, Preservation Brief 26 (Washington, DC: National Park Service, 1978), 12–13, <https://www.nps.gov/orgs/1739/upload/preservation-brief-26-log-buildings.pdf>.

Chinking Repair

Repair of chinking, whether it is finished on the exterior with wooden strips or with daubing, should not be done until all log repair or replacement, structural jacking and shoring is completed, and all replacement logs have seasoned. Historically, patching and replacing daubing on a routine basis was a seasonal chore. This was because environmental factors—building settlement, seasonal expansion and contraction of logs, and moisture infiltration followed by freeze-thaw action—cracks and loosens daubing. If the exterior log walls are exposed, and the chinking or daubing requires repair, as much of the remaining inner blocking filler and daubing should be retained as possible. A daubing formula and tooled finish that matches the historic daubing, if known, should be used, or based on one of the mixes listed here. For the most part, modern commercially-available chinking products are not suitable for use on historic log buildings, although an exception might be on the interior of a log building where it will be covered by plaster or wood, and will not be visible. These products tend to have a sandy appearance that may be compatible with some historic daubing, but the color, and other visual and physical characteristics are generally incompatible with historic log surfaces.

Sections of wood chinking which are gone or cannot be made weathertight should be replaced with same-sized species saplings or quarter poles cut to fit. Generally, unless bark was used originally, it should be removed before nailing the new wood chinking replacements tightly into place.

Analysis of daubing can be done in much the same way as mortar analysis. If that is not feasible, by crushing a loose piece of daubing its constituent parts can be exposed, which may typically include lime, sand, clay, and, as binders, straw or animal hair. The color imparted by the sand or pigmented constituents should be noted, and any areas of original daubing should be recorded with color film for later reference. Daubing that is loose or is not adhered to the logs must first be cleaned out by hand. Blocking filler should be left intact, refitting only loose pieces. (Sometimes it may be difficult to obtain a good bond in which case it may be necessary to clean out the joint entirely.) If needed, soft filler should be added, such as jute or bits of fiberglass batt, pressed firmly into voids with a stick or blunt

tool. Concealed reinforcement may sometimes be used, depending upon the authenticity of the restoration. This can include galvanized nails partially inserted only on the upper side of the log to allow for the daubing to move with the upper log and keep the top joint sealed, or galvanized wire mesh secured with galvanized nails (Fig. 23). Like repointing masonry, daubing should not be done in full sun, excessive heat or when freezing temperatures are expected. The daubing materials should be dry-mixed, the chinking rechecked as being tight and secure, and the mix wetted and stirred to a stiff, paste-like consistency. The mix dries quickly, so no more daubing should be prepared at a time than can be applied in about 30 minutes. A test patch of new daubing, either on the building, or in a mock-up elsewhere, will help test the suitability of the formula's color and texture match.

Before applying the daubing, the chinking area, including filler and log surfaces to be covered, should be sprayed with water to prevent the dry filler from too rapidly drawing off the daubing moisture which will result in hairline cracking. A trowel, ground to the width of the daubing, is used to press the daubing into the chinking space, and to smooth the filled areas. Wide or deep chinking spaces or joints may have to be daubed in layers, to prevent sagging and separation from the logs, by applying one or two scratch coats before finishing the surface.

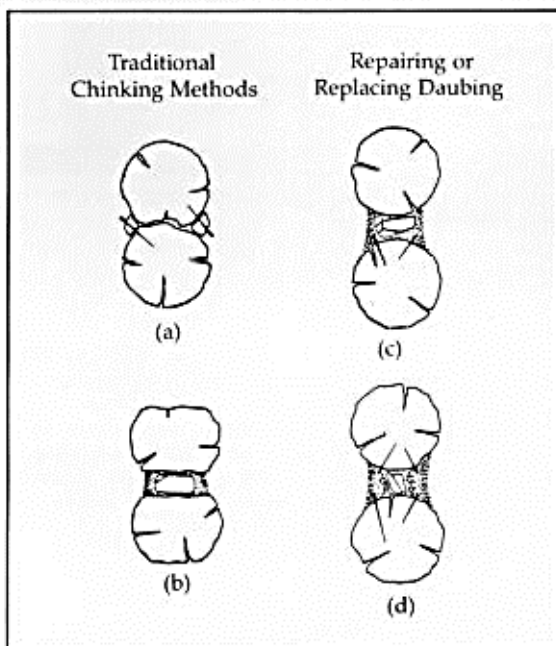


Fig. 23. Illustrated are various methods of chinking and daubing: (a) wood strips, or thin saplings nailed in place; and (b) 3-part system consisting of an inner blocking filler of stones or wood slabs, together with soft filler, such as clay, stuffed around the blocking, and wet-applied daubing. Concealed aids that may improve the adherence of new daubing include (c) galvanized nails, or (d) galvanized mesh lath. Drawing: James Caufield.

Daubing Mixes

	parts (volume)	material
Mix A.	1/4	cement
	1	lime
	4	sand
	1/8	dry color hog bristles or excelsior

(Donald A. Hutsler, "Log Cabin Restoration: Guidelines for the Historical Society," American Association for State and Local History, Technical Leaflet No. 74, "History News," Vol. 29, No. 5 (May 1974).)

Mix B.	6	sand
	4	lime
	1	cement

Mix C.	1	portland cement
	4-8	lime
	7-10	sand

Mix B and C are reprinted from "Log Structures: Preservation and Problem-Solving," by Harrison Goodall and Renee Friedman, Nashville, TN: American Association for State and Local History, 1980.

Portland cement was a part of the original daubing used in many late 19th and early 20th century log buildings, and is therefore appropriate to include in repairing buildings of this period. Although a small amount of portland cement may be added to a lime, clay and sand mix for workability, there should not be more than 1 part portland cement to 2 parts of lime in daubing mixes intended for most historic log buildings. Portland cement tends to shrink and develop hairline cracks, and retain moisture, all of which can be potentially damaging to the logs.

Interior Treatments

There is no single appropriate way to finish or restore the interior of a historic log house. Each building and its history is unique. The temptation should be resisted to impart an unfinished frontier character by removing plaster to expose interior log walls or joists in the ceiling. Instead, interior treatments should be based on existing evidence, and guided by old photographs, written documentation, and interviews with previous owners. Interior features and finishes that might exist in some 18th and 19th century log houses include wood paneled walls, wood moldings, stairs, and fireplace mantels; where they have survived, these features should be retained. Many of the more rustic log buildings built later in the 19th or early 20th century intentionally featured exposed interior log walls, sometimes with the logs peeled and varnished. If interior plaster is severely damaged or has previously been removed, and evidence such as lath ghosting on the logs exists, walls should be replastered or recovered with gypsum board or dry wall to match the historic appearance.

7 Stage IV: Stone

The Burgess-Capps Cabin uses stone for structural and aesthetic purposes. The chimney is the predominate location of the stonework, with some stones used as a foundation for the log walls.

7.1 Exterior stone features

On the east elevation of the Burgess-Capps Cabin is a stone chimney (see Figure 72 and Figure 73). The chimney is wide at the bottom and decreases in width toward the top. It is constructed of a mixture of dark and light stones of various sizes, some circular and some flat (see Figure 74 and Figure 75).

Figure 72. Front view of the stone chimney on the east elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 73. Side view of the stone chimney on the east elevation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 74. Multiple stone sizes on the chimney of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 75. Thin stones heavily secured in the mortar of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



The structural stone of the Burgess-Capps Cabin is the stone foundation (see Figure 76). The foundation is visible on only one side of the cabin due to the unevenness of the cabin floor and the grade levels. There are also tall grasses that surround the building. The stone foundation is wall-like and is secured with mortar joints and galvanized metal flashing atop the stone that provides a surface for the logs to rest on. Similar to the stone chimney, the stone foundation is made up of multiple stone sizes (see Figure 77).

Figure 76. Stone foundation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 77. Close-up of multiple stone sizes secured in mortar on the foundation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



7.2 Interior stone features

The Burgess-Capps Cabin has a stone fireplace on the east wall of the interior, which connects to the exterior stone chimney. Stones from the chimney can be seen in the rear of the fireplace (see Figure 78). In front of the fireplace is a stone hearth with a design in the center. It appears to be cracked in the central-right portion of the hearth (see Figure 79).

Figure 78. Stone fireplace on the interior east wall of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 79. Stone hearth inside the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



7.3 Treatment measures¹¹⁵

Generally, the best treatment measure for the actual stones used in stonework is to leave them alone. If stones must be cleaned, then the cleaning methods used should be effective but gentle and should leave no damage behind that would further deteriorate them. The patina of age on stones used in stonework is one of the hallmarks of historic buildings and “like new” appearance should not be the goal.

The first step is to identify why it needs be cleaned. Some staining issues are caused by water or moisture issues, while others are from biological growth. There are different methods for these types of staining, but it needs to be reiterated that stones should only be cleaned if absolutely necessary.

Testing should be performed first on an inconspicuous portion of the stonework. Water tends to be the gentlest, and cleaning work is always done from the bottom up and not the top down.

Work should be contracted out to those that have experience in historic stonework. Each project is unique due to different types of stones and mortars. The types of stone should be part of any contract when attempting to assess the appropriate contractor.

The following images and documents offer treatment measures for exterior and interior mortar materials that are in poor condition. The sources include information from the National Park Service.

115. The section reproduces Section 8.3 of August S. Fuelberth, Karlee E. Feinen, Peter B. Stynoski, Joseph A. Gamez, Allison R. Young, Carey L. Baxter, Madelyn G. McCoy, Joseph S. Murphey, Madison L. Story, and Adam D. Smith, *José María Gil Adobe: Historic Context, Maintenance Issues, Measured Drawings, and Adaptive Reuse*, ERDC/CERL TR-23-23 (Champaign, IL: ERDC-CERL, 2023). Public domain.

7.3.1 Preservation Brief 1: Accessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings, 1978¹¹⁶

1 PRESERVATION BRIEFS

Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings

Robert C. Mack, AIA
Anne Grimmer



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

Inappropriate cleaning and coating treatments are a major cause of damage to historic masonry buildings. While either or both treatments may be appropriate in some cases, they can be very destructive to historic masonry if they are not selected carefully. Historic masonry, as considered here, includes stone, brick, architectural terra cotta, cast stone, concrete and concrete block. It is frequently cleaned because cleaning is equated with improvement. Cleaning may sometimes be followed by the application of a water-repellent coating. However, unless these procedures are carried out under the guidance and supervision of an architectural conservator, they may result in irrevocable damage to the historic resource.

The purpose of this Brief is to provide information on the variety of cleaning methods and materials that are available for use on the exterior of historic masonry buildings, and to provide guidance in selecting the most appropriate method or combination of methods. The difference between

water-repellent coatings and waterproof coatings is explained, and the purpose of each, the suitability of their application to historic masonry buildings, and the possible consequences of their inappropriate use are discussed.

The Brief is intended to help develop sensitivity to the qualities of historic masonry that makes it so special, and to assist historic building owners and property managers in working cooperatively with architects, architectural conservators and contractors (Fig. 1). Although specifically intended for historic buildings, the information is applicable to all masonry buildings. This publication updates and expands *Preservation Brief 1: The Cleaning and Waterproof Coating of Masonry Buildings*. The Brief is not meant to be a cleaning manual or a guide for preparing specifications. Rather, it provides general information to raise awareness of the many factors involved in selecting cleaning and water-repellent treatments for historic masonry buildings.



Figure 1. Low-to medium-pressure steam (hot-pressurized water washing), is being used to clean the exterior of the U.S. Tariff Commission Building, the first marble building constructed in Washington, D.C., in 1839. This method was selected by an architectural conservator as the "gentlest means possible" to clean the marble. Steam can soften heavy soiling deposits such as those on the cornice and column capitals, and facilitate easy removal. Note how these deposits have been removed from the right side of the cornice which has already been cleaned.

116. This section reproduces Robert C. Mack and Anne Grimmer, *Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings*, Preservation Brief 1 (Washington, DC: National Park Service, 1978), [Preservation Brief 1: Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings \(nps.gov\)](https://www.nps.gov/preservation/briefs/1). Public domain.

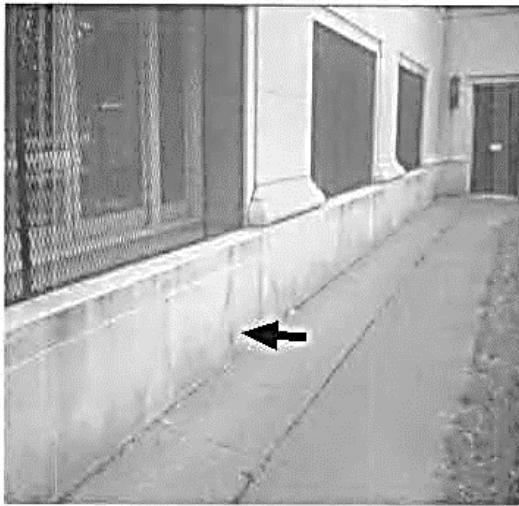


Figure 2. Biological growth as shown on this marble foundation can usually be removed using a low-pressure water wash, possibly with a non-ionic detergent added to it, and scrubbing with a natural or synthetic bristle brush.



Figure 3. This small test area has revealed a red brick patch that does not match the original beige brick. This may explain why the building was painted, and may suggest to the owner that it may be preferable to keep it painted.

Preparing for a Cleaning Project

Reasons for cleaning. First, it is important to determine whether it is appropriate to clean the masonry. The objective of cleaning a historic masonry building must be considered carefully before arriving at a decision to clean. There are several major reasons for cleaning a historic masonry building: **improve the appearance of the building** by removing unattractive dirt or soiling materials, or non-historic paint from the masonry; **retard deterioration** by removing soiling materials that may be damaging the masonry; or **provide a clean surface** to accurately match repointing mortars or patching compounds, or to conduct a condition survey of the masonry.

Identify what is to be removed. The general nature and source of dirt or soiling material on a building must be identified to remove it in the *gentlest means possible*—that is, in the most effective, yet least harmful, manner. Soot and smoke, for example, require a different cleaning agent to remove than oil stains or metallic stains. Other common cleaning problems include biological growth such as mold or mildew, and organic matter such as the tendrils left on masonry after removal of ivy (Fig. 2).

Consider the historic appearance of the building. If the proposed cleaning is to remove paint, it is important in each case to learn whether or not unpainted masonry is historically appropriate. And, it is necessary to consider why the building was painted (Fig. 3). Was it to cover bad repointing or unmatched repairs? Was the building painted to protect soft brick or to conceal deteriorating stone? Or, was painted masonry simply a fashionable

treatment in a particular historic period? Many buildings were painted at the time of construction or shortly thereafter; retention of the paint, therefore, may be more appropriate historically than removing it. And, if the building appears to have been painted for a long time, it is also important to think about whether the paint is part of the character of the historic building and if it has acquired significance over time.

Consider the practicalities of cleaning or paint removal. Some gypsum or sulfate crusts may have become integral with the stone and, if cleaning could result in removing some of the stone surface, it may be preferable not to clean. Even where unpainted masonry is appropriate, the retention of the paint may be more practical than removal in terms of long range preservation of the masonry. In some cases, however, removal of the paint may be desirable. For example, the old paint layers may have built up to such an extent that removal is necessary to ensure a sound surface to which the new paint will adhere.

Study the masonry. Although not always necessary, in some instances it can be beneficial to have the coating or paint type, color, and layering on the masonry researched before attempting its removal. Analysis of the nature of the soiling or of the paint to be removed from the masonry, as well as guidance on the appropriate cleaning method, may be provided by professional consultants, including architectural conservators, conservation scientists and preservation architects. The State Historic Preservation Office (SHPO), local historic district commissions, architectural review boards and preservation-oriented websites may also be able to supply useful information on masonry cleaning techniques.

Understanding the Building Materials

The construction of the building must be considered when developing a cleaning program because inappropriate cleaning can have a deleterious effect on the masonry as well as on other building materials. The masonry material or materials must be correctly identified. It is sometimes difficult to distinguish one type of stone from another; for example, certain sandstones can be easily confused with limestones. Or, what appears to be natural stone may not be stone at all, but cast stone or concrete. Historically, cast stone and architectural terra cotta were frequently used in combination with natural stone, especially for trim elements or on upper stories of a building where, from a distance, these substitute materials looked like real stone (Fig. 4). Other features on historic buildings that appear to be stone, such as decorative cornices, entablatures and window hoods, may not even be masonry, but metal.

Identify prior treatments. Previous treatments of the building and its surroundings should be researched and building maintenance records should be obtained, if available. Sometimes if streaked or spotty areas do not seem to get cleaner following an initial cleaning, closer inspection and analysis may be warranted. The discoloration may turn out not to be dirt but the remnant of a water-repellent coating applied long ago which has darkened the surface of the masonry over time (Fig. 5). Successful removal may require testing several cleaning agents to find something that will dissolve and remove the coating. Complete removal may not always be possible. Repairs may have been stained to match a dirty building, and cleaning may make these differences apparent. De-icing salts used near the building that have dissolved can



Figure 4. The foundation of this brick building is limestone, but the decorative trim above is architectural terra cotta intended to simulate stone.



Figure 5. Repeated water washing did not remove the staining inside this limestone porte cochere. Upon closer examination, it was determined to be a water-repellent coating that had been applied many years earlier. An alkaline cleaner may be effective in removing it.

migrate into the masonry. Cleaning may draw the salts to the surface, where they will appear as efflorescence (a powdery, white substance), which may require a second treatment to be removed. Allowances for dealing with such unknown factors, any of which can be a potential problem, should be included when investigating cleaning methods and materials. Just as more than one kind of masonry on a historic building may necessitate multiple cleaning approaches, unknown conditions that are encountered may also require additional cleaning treatments.

Choose the appropriate cleaner. The importance of testing cleaning methods and materials cannot be over emphasized. Applying the wrong cleaning agents to historic masonry can have disastrous results. Acidic cleaners can be extremely damaging to acid-sensitive stones, such as marble and limestone, resulting in etching and dissolution of these stones. Other kinds of masonry can also be damaged by incompatible cleaning agents, or even by cleaning agents that are usually compatible. There are also numerous kinds of sandstone, each with a considerably different geological composition. While an acid-based cleaner may be safely used on some sandstones, others are acid-sensitive and can be severely etched or dissolved by an acid cleaner. Some sandstones contain water-soluble minerals and can be eroded by water cleaning. And, even if the stone type is correctly identified, stones, as well as some bricks, may contain unexpected impurities, such as iron particles, that may react negatively with a particular cleaning agent and result in staining. Thorough understanding of the physical and chemical properties of the masonry will help avoid the inadvertent selection of damaging cleaning agents.



Figure 6. Timed water soaking can be very effective for cleaning limestone and marble as shown here at the Marble Collegiate Church in New York City. In this case, a twelve-hour water soak using a multi-nozzle manifold was followed by a final water rinse. Photo: Diane S. Kaese, Wiss, Janney, Elstner Associates, Inc., N.Y., N.Y.

Other building materials also may be affected by the cleaning process. Some chemicals, for example, may have a corrosive effect on paint or glass. The portions of building elements most vulnerable to deterioration may not be visible, such as embedded ends of iron window bars. Other totally unseen items, such as iron cramps or ties which hold the masonry to the structural frame, also may be subject to corrosion from the use of chemicals or even from plain water. The only way to prevent problems in these cases is to study the building construction in detail and evaluate proposed cleaning methods with this information in mind. However, due to the very likely possibility of encountering unknown factors, any cleaning project involving historic masonry should be viewed as unique to that particular building.

Cleaning Methods and Materials

Masonry cleaning methods generally are divided into three major groups: water, chemical, and abrasive. *Water methods* soften the dirt or soiling material and rinse the deposits from the masonry surface. *Chemical cleaners* react with dirt, soiling material or paint to effect their removal, after which the cleaning effluent is rinsed off the masonry surface with water. *Abrasive methods* include blasting with grit, and the use of grinders and sanding discs, all of which mechanically remove the dirt, soiling material or paint (and, usually, some of the masonry surface). Abrasive cleaning is also often followed with a water rinse. *Laser cleaning*, although not discussed here in detail, is another technique that is used sometimes by conservators to clean small areas of historic masonry. It can be quite effective for cleaning limited areas, but it is expensive and generally not practical for most historic masonry cleaning projects.

Although it may seem contrary to common sense, masonry cleaning projects should be carried out starting at the

bottom and proceeding to the top of the building always keeping all surfaces wet below the area being cleaned. The rationale for this approach is based on the principle that dirty water or cleaning effluent dripping from cleaning in progress above will leave streaks on a dirty surface but will not streak a clean surface as long as it is kept wet and rinsed frequently.

Water Cleaning

Water cleaning methods are generally the *gentlest means possible*, and they can be used safely to remove dirt from all types of historic masonry.* There are essentially four kinds of water-based methods: soaking; pressure water washing; water washing supplemented with non-ionic detergent; and steam, or hot-pressurized water cleaning. Once water cleaning has been completed, it is often necessary to follow up with a water rinse to wash off the loosened soiling material from the masonry.

Soaking. Prolonged spraying or misting with water is particularly effective for cleaning limestone and marble. It is also a good method for removing heavy accumulations of soot, sulfate crusts or gypsum crusts that tend to form in protected areas of a building not regularly washed by rain. Water is distributed to lengths of punctured hose or pipe with non-ferrous fittings hung from moveable scaffolding or a swing stage that continuously mists the surface of the masonry with a very fine spray (Fig. 6). A timed on-off spray is another approach to using this cleaning technique. After one area has been cleaned, the apparatus is moved on to another. Soaking is often used in combination with water washing and is also followed by a final water rinse. Soaking is a very slow method—it may take several days or a week—but it is a very gentle method to use on historic masonry.

Water Washing. Washing with low-pressure or medium-pressure water is probably one of the most commonly used methods for removing dirt or other pollutant soiling from historic masonry buildings (Fig. 7). Starting with a very low pressure (100 psi or below), even using a garden hose, and progressing as needed to slightly higher pressure—generally no higher than 300-400 psi—is always the recommended way to begin. Scrubbing with natural bristle or synthetic bristle brushes—never metal which can abrade the surface and leave metal particles that can stain the masonry—can help in cleaning areas of the masonry that are especially dirty.

Water Washing with Detergents. Non-ionic detergents—which are not the same as soaps—are synthetic organic compounds that are especially effective in removing oily soil. (Examples of some of the numerous proprietary non-ionic detergents include Igepal by GAF, Tergitol by Union Carbide and Triton by Rohm & Haas.) Thus, the addition of a non-ionic detergent, or surfactant, to a low- or medium-pressure water wash can be a useful aid in the cleaning

*Water cleaning methods may not be appropriate to use on some badly deteriorated masonry because water may exacerbate the deterioration, or on gypsum or alabaster which are very soluble in water.

process. (A non-ionic detergent, unlike most household detergents, does not leave a solid, visible residue on the masonry.) Adding a non-ionic detergent and scrubbing with a natural bristle or synthetic bristle brush can facilitate cleaning textured or intricately carved masonry. This should be followed with a final water rinse.

Steam/Hot-Pressurized Water Cleaning. Steam cleaning is actually low-pressure hot water washing because the steam condenses almost immediately upon leaving the hose. This is a gentle and effective method for cleaning stone and particularly for acid-sensitive stones. Steam can be especially useful in removing built-up soiling deposits and dried-up plant materials, such as ivy disks and tendrils. It can also be an efficient means of cleaning carved stone details and, because it does not generate a lot of liquid water, it can sometimes be appropriate to use for cleaning interior masonry (Figs. 8-9).

Potential hazards of water cleaning. Despite the fact that water-based methods are generally the most gentle, even they can be damaging to historic masonry. Before beginning a water cleaning project, it is important to make sure that all mortar joints are sound and that the building is watertight. Otherwise water can seep through the walls to the interior, resulting in rusting metal anchors and stained and ruined plaster.

Some water supplies may contain traces of iron and copper which may cause masonry to discolor. Adding a chelating or complexing agent to the water, such as EDTA (ethylene diamine tetra-acetic acid), which inactivates other metallic ions, as well as softens minerals and water hardness, will help prevent staining on light-colored masonry.

Any cleaning method involving water should never be done in cold weather or if there is any likelihood of frost or freezing because water within the masonry can freeze, causing spalling and cracking. Since a masonry wall may take over a week to dry after cleaning, no water cleaning should be permitted for several days prior to the first average frost date, or even earlier if local forecasts predict cold weather.

Most essential of all, it is important to be aware that using water at too high a pressure, a practice common to "power washing" and "water blasting", is very abrasive and can easily etch marble and other soft stones, as well as some types of brick (Figs. 10-11). In addition, the distance of the nozzle from the masonry surface and the type of nozzle, as well as gallons per minute (gpm), are also important variables in a water cleaning process that can have a significant impact on the outcome of the project. This is why it is imperative that the cleaning be closely monitored to ensure that the cleaning operators do not raise the pressure or bring the nozzle too close to the masonry in an effort to "speed up" the process. The appearance of grains of stone or sand in the cleaning effluent on the ground is an indication that the water pressure may be too high.



Figure 7. Glazed architectural terra cotta often may be cleaned successfully with a low-pressure water wash and hand scrubbing supplemented, if necessary, with a non-ionic detergent. Photo: National Park Service Files.

Chemical Cleaning

Chemical cleaners, generally in the form of proprietary products, are another material frequently used to clean historic masonry. They can remove dirt, as well as paint and other coatings, metallic and plant stains, and graffiti. Chemical cleaners used to remove dirt and soiling include acids, alkalis and organic compounds. Acidic cleaners, of course, should not be used on masonry that is acid sensitive. Paint removers are alkaline, based on organic solvents or other chemicals.

Chemical Cleaners to Remove Dirt

Both alkaline and acidic cleaning treatments include the use of water. Both cleaners are also likely to contain surfactants (wetting agents), that facilitate the chemical reaction that removes the dirt. Generally, the masonry is wet first for both types of cleaners, then the chemical cleaner is sprayed on at very low pressure or brushed onto the surface. The cleaner is left to dwell on the masonry for an amount of time recommended by the product manufacturer or, preferably, determined by testing, and rinsed off with a low- or moderate-pressure cold, or sometimes hot, water wash. More than one application of the cleaner may be necessary, and it is always a good practice to test the product manufacturer's recommendations concerning dilution rates and dwell times. Because each cleaning situation is unique, dilution rates and dwell times can vary considerably. The masonry surface may be scrubbed lightly with natural or synthetic bristle brushes prior to rinsing. After rinsing, pH strips should be applied to the surface to ensure that the masonry has been neutralized completely.



Figure 8. (Left) Low-pressure (under 100 psi) steam cleaning (hot-pressurized water washing), is part of the regular maintenance program at the Jefferson Memorial, Washington, D.C. The white marble interior of this open structure is subject to constant soiling by birds, insects and visitors. (Right) This portable steam cleaner enables prompt cleanup when necessary. Photos: National Park Service Files.

Acidic Cleaners. Acid-based cleaning products may be used on **non-acid sensitive** masonry, which generally includes: granite, most sandstones, slate, unglazed brick and unglazed architectural terra cotta, cast stone and concrete (Fig. 12). Most commercial acidic cleaners are composed primarily of hydrofluoric acid, and often include some phosphoric acid to prevent rust-like stains from developing on the masonry after the cleaning. Acid cleaners are applied to the pre-wet masonry which should be kept wet while the acid is allowed to "work", and then removed with a water wash.

Alkaline Cleaners. Alkaline cleaners should be used on acid-sensitive masonry, including: limestone, polished and unpolished marble, calcareous sandstone, glazed brick and glazed architectural terra cotta, and polished granite. (Alkaline cleaners may also be used sometimes on masonry materials that are not acid sensitive—after testing, of course

—but they may not be as effective as they are on acid-sensitive masonry.) Alkaline cleaning products consist primarily of two ingredients: a non-ionic detergent or surfactant; and an alkali, such as potassium hydroxide or ammonium hydroxide. Like acidic cleaners, alkaline products are usually applied to pre-wet masonry, allowed to dwell, and then rinsed off with water. (Longer dwell times may be necessary with alkaline cleaners than with acidic cleaners.) Two additional steps are required to remove alkaline cleaners after the initial rinse. First the masonry is given a slightly acidic wash—often with acetic acid—to neutralize it, and then it is rinsed again with water.

Chemical Cleaners to Remove Paint and Other Coatings, Stains and Graffiti

Removing paint and some other coatings, stains and graffiti can best be accomplished with alkaline paint removers, organic solvent paint removers, or other cleaning compounds. The removal of layers of paint from a masonry surface usually involves applying the remover either by brush, roller or spraying, followed by a thorough water wash. As with any chemical cleaning, the manufacturer's recommendations regarding application procedures should always be tested before beginning work.

Alkaline Paint Removers. These are usually of much the same composition as other alkaline cleaners, containing potassium or ammonium hydroxide, or trisodium phosphate. They are used to remove oil, latex and acrylic paints, and are effective for removing multiple layers of paint. Alkaline cleaners may also remove some acrylic, water-repellent coatings. As with other alkaline cleaners, both an acidic neutralizing wash and a final water rinse are generally required following the use of alkaline paint removers.

Organic Solvent Paint Removers. The formulation of organic solvent paint removers varies and may include a combination of solvents, including methylene chloride, methanol, acetone, xylene and toluene.



Figure 9. (Left) This small steam cleaner—the size of a vacuum cleaner—offers a very controlled and gentle means of cleaning limited, or hard-to-reach areas or carved stone details. (Right) It is particularly useful for interiors where it is important to keep moisture to a minimum, such as inside the Washington Monument, Washington, D.C., where it was used to clean the commemorative stones. Photos: Audrey T. Tepper.



Figure 10. High-pressure water washing too close to the surface has abraded and, consequently, marred the limestone on this early-20th century building.

Other Paint Removers and Cleaners. Other cleaning compounds that can be used to remove paint and some painted graffiti from historic masonry include paint removers based on N-methyl-2-pyrrolidone (NMP), or on petroleum-based compounds. Removing stains, whether they are industrial (smoke, soot, grease or tar), metallic (iron or copper), or biological (plant and fungal) in origin, depends on carefully matching the type of remover to the type of stain (Fig. 13). Successful removal of stains from historic masonry often requires the application of a number of different removers before the right one is found. The removal of layers of paint from a masonry surface is usually accomplished by applying the remover either by brush, roller or spraying, followed by a thorough water wash (Fig. 14).

Potential hazards of chemical cleaning. Since most chemical cleaning methods involve water, they have many of the potential problems of plain water cleaning. Like water methods, they should not be used in cold weather because of the possibility of freezing. Chemical cleaning should never be undertaken in temperatures below 40 degrees F (4 degrees C), and generally not below 50 degrees F. In addition, many chemical cleaners simply do not work in cold temperatures. Both acidic and alkaline cleaners can be dangerous to cleaning operators and, clearly, there are environmental concerns associated with the use of chemical cleaners.

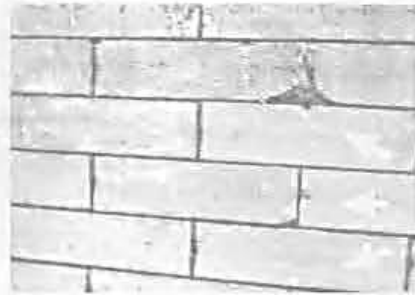


Figure 11. Rinsing with high-pressure water following chemical cleaning has left a horizontal line of abrasion across the bricks on this late-19th century row house.

If not carefully chosen, chemical cleaners can react adversely with many types of masonry. Obviously, acidic cleaners should not be used on acid-sensitive materials; however, it is not always clear exactly what the composition is of any stone or other masonry material. For this reason, testing the cleaner on an inconspicuous spot on the building is always necessary. While certain acid-based cleaners may be appropriate if used as directed on a particular type of masonry, if left too long or if not adequately rinsed from the masonry they can have a negative effect. For example, hydrofluoric acid can etch masonry leaving a hazy residue (whitish deposits of silica or calcium fluoride salts) on the surface. While this efflorescence may usually be removed by a second cleaning—although it is likely to be expensive and time-consuming—hydrofluoric acid can also leave calcium fluoride salts or a colloidal silica deposit on masonry which may be impossible to remove (Fig. 15). Other acids, particularly hydrochloric (muriatic) acid, which is very powerful, should not be used on historic masonry, because it can dissolve lime-based mortar, damage brick and some stones, and leave chloride deposits on the masonry.



Figure 12. A mild acidic cleaning agent is being used to clean this heavily soiled brick and granite building. Additional applications of the cleaner and hand-scrubbing, and even poulticing, may be necessary to remove the dark stains on the granite arches below. Photo: Sharon C. Park, FAIA.

Alkaline cleaners can stain sandstones that contain a ferrous compound. Before using an alkaline cleaner on sandstone it is always important to test it, since it may be difficult to know whether a particular sandstone may contain a ferrous compound. Some alkaline cleaners, such as sodium hydroxide (caustic soda or lye) and ammonium bifluoride, can also damage or leave disfiguring brownish-yellow stains and, in most cases, should not be used on historic masonry. Although alkaline cleaners will not etch a masonry surface as acids can, they are caustic and can burn the surface. In addition, alkaline cleaners can deposit potentially damaging salts in the masonry which can be difficult to rinse thoroughly.

Abrasive and Mechanical Cleaning

Generally, abrasive cleaning methods are not appropriate for use on historic masonry buildings. Abrasive cleaning methods are just that—abrasive. Grit blasters, grinders, and sanding discs all operate by *abrading* the dirt or paint off the surface of the masonry, rather than *reacting* with the dirt and the masonry which is how water and chemical methods work. Since the abrasives do not differentiate between the dirt and the masonry, they can also remove the outer surface of the masonry at the same time, and result in permanently damaging the masonry. Brick, architectural terra cotta, soft stone, detailed carvings, and polished surfaces are especially susceptible to physical and aesthetic damage by abrasive methods. Brick and architectural terra cotta are fired products which have a smooth, glazed surface which can be removed by abrasive blasting or grinding (Figs. 18-19). Abrasively-cleaned masonry is damaged aesthetically as well as physically, and it has a rough surface which tends to hold dirt and the roughness will make future cleaning more difficult. Abrasive cleaning processes can also increase the likelihood of subsurface cracking of the masonry. Abrasion of carved details causes a rounding of sharp corners and other loss of delicate features, while abrasion of polished surfaces removes the polished finish of stone.



Figure 13. Sometimes it may be preferable to paint over a thick asphaltic coating rather than try to remove it, because it can be difficult to remove completely. However, in this case, many layers of asphaltic coating were removed through multiple applications of a heavy duty chemical cleaner. Each application of the cleaner was left to dwell following the manufacturer's recommendations, and then rinsed thoroughly. (As much as possible of the asphalt was first removed with wooden scrapers.) Although not all the asphalt was removed, this was determined to be an acceptable level of cleanliness for the project.



Figure 14. Chemical removal of paint from this brick building has revealed that the cornice and window hoods are metal rather than masonry.

Mortar joints, especially those with lime mortar, also can be eroded by abrasive or mechanical cleaning. In some cases, the damage may be visual, such as loss of joint detail or increased joint shadows. As mortar joints constitute a significant portion of the masonry surface (up to 20 percent in a brick wall), this can result in the loss of a considerable amount of the historic fabric. Erosion of the mortar joints may also permit increased water penetration, which will likely necessitate repointing.



Figure 15. The whitish deposits left on the brick by a chemical paint remover may have resulted from inadequate rinsing or from the chemical being left on the surface too long and may be impossible to remove.

Poulticing to Remove Stains and Graffiti



a



b



c



d

Figure 16. (a) The limestone base was heavily stained by runoff from the bronze statue above. (b) A poultice consisting of copper stain remover and ammonia mixed with fuller's earth was applied to the stone base and covered with plastic sheeting to keep it from drying out too quickly. (c) As the poultice dried, it pulled the stain out of the stone. (d) The poultice residue was removed carefully from the stone surface with wooden scrapers and the stone was rinsed with water. Photos: John Dwyer.

Graffiti and stains, which have penetrated into the masonry, often are best removed by using a poultice. A poultice consists of an absorbent material or clay powder (such as kaolin or fuller's earth, or even shredded paper or paper towels), mixed with a liquid (solvent or other remover) to form a paste which is applied to the stain (Figs. 16-17). As it dries, the paste absorbs the staining material so that it is not redeposited on the masonry surface. Some commercial cleaning products and paint removers are specially formulated as a paste or gel that will cling to a vertical surface and remain moist for a longer period of time in order to prolong the action of the chemical on the stain. Pre-mixed poultices are also available as a paste or in powder form needing only the addition of the appropriate liquid. The masonry must be pre-wet before applying an alkaline cleaning agent, but not when using a solvent. Once the stain has been removed, the masonry must be rinsed thoroughly.



Figure 17. A poultice is being used to remove salts from the brownstone statuary on the facade of this late-19th century stone church. Photo: National Park Service Files.



Figure 18. The glazed bricks in the center of the pier were covered by a signboard that protected them being damaged by the sandblasting which removed the glaze from the surrounding bricks.



Figure 19. A comparison of undamaged bricks surrounding the electrical conduit with the rest of the brick facade emphasizes the severity of the erosion caused by sandblasting.

Abrasive Blasting. Blasting with abrasive grit or another abrasive material is the most frequently used abrasive method. Sandblasting is most commonly associated with abrasive cleaning. Finely ground silica or glass powder, glass beads, ground garnet, powdered walnut and other ground nut shells, grain hulls, aluminum oxide, plastic particles and even tiny pieces of sponge, are just a few of the other materials that have also been used for abrasive cleaning. Although abrasive blasting is not an appropriate method of cleaning historic masonry, it can be safely used to clean some materials. Finely-powdered walnut shells are commonly used for cleaning monumental bronze sculpture, and skilled conservators clean delicate museum objects and finely detailed, carved stone features with very small, micro-abrasive units using aluminum oxide.

A number of current approaches to abrasive blasting rely on materials that are not usually thought of as abrasive, and not as commonly associated with traditional abrasive grit cleaning. Some patented abrasive cleaning processes—one dry, one wet—use finely-ground glass powder intended to "erase" or remove dirt and surface soiling only, but not paint or stains (Fig. 20). Cleaning with baking soda (sodium bicarbonate) is another patented process. Baking soda blasting is being used in some communities as a means of quick graffiti removal. However, it should not be used on historic masonry which it can easily abrade and can permanently "etch" the graffiti into the stone; it can also leave potentially damaging salts in the stone which cannot be removed. Most of these abrasive grits may be used either dry or wet, although dry grit tends to be used more frequently.

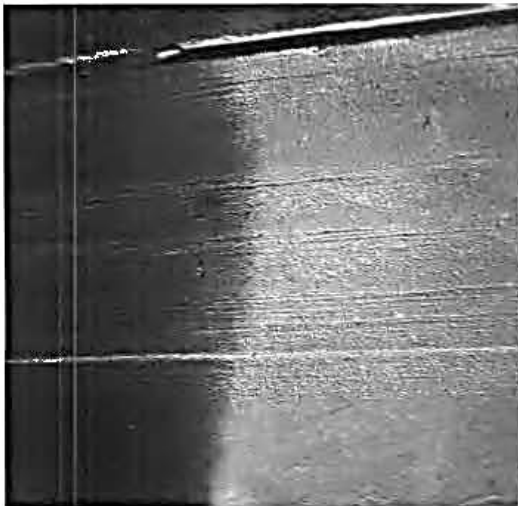


Figure 20. (Left) A comparison of the limestone surface of a 1920s office building before and after "cleaning" with a proprietary abrasive process using fine glass powder clearly shows the effectiveness of this method. But this is an abrasive technique and it has "cleaned" by removing part of the masonry surface with the dirt. Because it is abrasive, it is generally not recommended for large-scale cleaning of historic masonry, although it may be suitable to use in certain, very limited cases under controlled circumstances. (Right) A vacuum chamber where the used glass powder is collected for environmentally safe disposal is a unique feature of this particular process. The specially-trained operators in the chamber wear protective clothing, masks and breathing equipment. Photos: Tom Keohan.

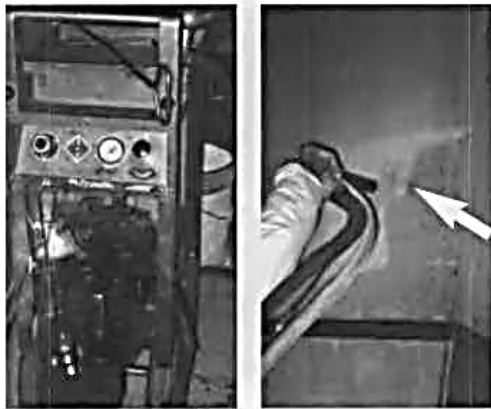


Figure 21. Low-pressure blasting with ice pellets or ice crystals (left) is an abrasive cleaning method that is sometimes recommended for use on interior masonry because it does not involve large amounts of water. However, like other abrasive materials, ice crystals "clean" by removing a portion of the masonry surface with the dirt, and may not remove some stains that have penetrated into the masonry without causing further abrasion (right). Photos: Audrey T. Tepper.

Ice particles, or pelletized dry ice (carbon dioxide or CO₂), are another medium used as an abrasive cleaner (Fig. 21). This is also too abrasive to be used on most historic masonry, but it may have practical application for removing mastics or asphaltic coatings from some substrates.

Some of these processes are promoted as being more environmentally safe and not damaging to historic masonry buildings. However, it must be remembered that they are abrasive and that they "clean" by removing a small portion of the masonry surface, even though it may be only a minuscule portion. The fact that they are essentially abrasive treatments must always be taken into consideration when planning a masonry cleaning project. *In general, abrasive methods should not be used to clean historic masonry buildings.* In some, very limited instances, highly-controlled, gentle abrasive cleaning may be appropriate on selected, hard-to-clean areas of a historic masonry building if carried out under the watchful supervision of a professional conservator. But, abrasive cleaning should never be used on an entire building.

Grinders and Sanding Disks. Grinding the masonry surface with mechanical grinders and sanding disks is another means of abrasive cleaning that should not be used on historic masonry. Like abrasive blasting, grinders and disks do not really clean masonry but instead grind away and abrasively remove and, thus, damage the masonry surface itself rather than remove just the soiling material.

Planning A Cleaning Project

Once the masonry and soiling material or paint have been identified, and the condition of the masonry has been evaluated, planning for the cleaning project can begin.

Testing cleaning methods. In order to determine the *gentlest means possible*, several cleaning methods or materials may have to be tested prior to selecting the best one to use on the building. Testing should always begin with the gentlest and least invasive method proceeding gradually, if necessary, to more complicated methods, or a combination of methods. All too often simple methods, such as low-pressure water wash, are not even considered, yet they frequently are effective, safe, and not expensive. Water of slightly higher pressure or with a non-ionic detergent additive also may be effective. It is worth repeating that these methods should always be tested prior to considering harsher methods; they are safer for the building and the environment, often safer for the applicator, and relatively inexpensive.

The level of cleanliness desired also should be determined prior to selection of a cleaning method. Obviously, the intent of cleaning is to remove most of the dirt, soiling material, stains, paint or other coating. A "brand new" appearance, however, may be inappropriate for an older building, and may require an overly harsh cleaning method to be achieved. When undertaking a cleaning project, it is important to be aware that some stains simply may not be removable. It may be wise, therefore, to agree upon a slightly lower level of cleanliness that will serve as the standard for the cleaning project. The precise amount of residual dirt considered acceptable may depend on the type of masonry, the type of soiling and difficulty of total removal, and local environmental conditions.

Cleaning tests should be carried out in an area of sufficient size to give a true indication of their effectiveness. It is preferable to conduct the test in an inconspicuous location on the building so that it will not be obvious if the test is not successful. A test area may be quite small to begin, sometimes as small as six square inches, and gradually may be increased in size as the most appropriate methods and cleaning agents are determined. Eventually the test area may be expanded to a square yard or more, and it should include several masonry units and mortar joints (Fig. 22). It should be remembered that a single building may have several types of masonry and that even similar materials may have different surface finishes. Each material and different finish should be tested separately. Cleaning tests should be evaluated only after the masonry has dried completely. *The results of the tests may indicate that several methods of cleaning should be used on a single building.*

When feasible, test areas should be allowed to weather for an extended period of time prior to final evaluation. A waiting period of a full year would be ideal in order to expose the test patch to a full range of seasons. If this is not possible, the test patch should weather for at least a month or two. For any building which is considered historically important, the delay is insignificant compared to the potential damage and disfigurement which may result from using an incompletely tested method. *The successfully cleaned test patch should be protected as it will serve as a standard against which the entire cleaning project will be measured.*

Environmental considerations. The potential effect of any method proposed for cleaning historic masonry should be evaluated carefully. Chemical cleaners and paint removers may damage trees, shrubs, grass, and plants. A plan must be provided for environmentally safe removal and disposal of the cleaning materials and the rinsing effluent before beginning the cleaning project. Authorities from the local regulatory agency—usually under the jurisdiction of the federal or state Environmental Protection Agency (EPA) should be consulted prior to beginning a cleaning project, especially if it involves anything more than plain water washing. This advance planning will ensure that the cleaning effluent or run-off, which is the combination of the cleaning agent and the substance removed from the masonry, is handled and disposed of in an environmentally sound and legal manner. Some alkaline and acidic cleaners can be neutralized so that they can be safely discharged into storm sewers. However, most solvent-based cleaners cannot be neutralized and are categorized as pollutants, and must be disposed of by a licensed transport, storage and disposal facility. Thus, it is always advisable to consult with the appropriate agencies before starting to clean to ensure that the project progresses smoothly and is not interrupted by a stop-work order because a required permit was not obtained in advance.

Vinyl guttering or polyethylene-lined troughs placed around the perimeter of the base of the building can serve to catch chemical cleaning waste as it is rinsed off the building. This will reduce the amount of chemicals entering and polluting the soil, and also will keep the cleaning waste contained until it can be removed safely. Some patented cleaning systems have developed special equipment to facilitate the containment and later disposal of cleaning waste.

Concern over the release of volatile organic compounds (VOCs) into the air has resulted in the manufacture of new, more environmentally responsible cleaners and paint removers, while some materials traditionally used in cleaning may no longer be available for these same reasons. Other health and safety concerns have created additional cleaning challenges, such as lead paint removal, which is likely to require special removal and disposal techniques.

Cleaning can also cause damage to non-masonry materials on a building, including glass, metal and wood. Thus, it is usually necessary to cover windows and doors, and other features that may be vulnerable to chemical cleaners. They should be covered with plastic or polyethylene, or a masking agent that is applied as a liquid which dries to form a thin protective film on glass, and is easily peeled off after the cleaning is finished. Wind drift, for example, can also damage other property by carrying cleaning chemicals onto nearby automobiles, resulting in etching of the glass or spotting of the paint finish. Similarly, airborne dust can enter surrounding buildings, and excess water can collect in nearby yards and basements.

Safety considerations. Possible health dangers of each method selected for the cleaning project must be considered before selecting a cleaning method to avoid harm to the



Figure 22. Cleaning test areas may be quite small at first and gradually increase in size as testing determines the "gentlest means possible".
Photo: Frances Gale.

cleaning applicators, and the necessary precautions must be taken. The precautions listed in Material Safety Data Sheets (MSDS) that are provided with chemical products should always be followed. Protective clothing, respirators, hearing and face shields, and gloves must be provided to workers to be worn at all times. Acidic and alkaline chemical cleaners in both liquid and vapor forms can also cause serious injury to passers-by (Fig. 23). It may be necessary to schedule cleaning at night or weekends if the building is located in a busy urban area to reduce the potential danger of chemical overspray to pedestrians. Cleaning during non-business hours will allow HVAC systems to be turned off and vents to be covered to prevent dangerous chemical fumes from entering the building which will also ensure the safety of the building's occupants. Abrasive and mechanical methods produce dust which can pose a serious health hazard, particularly if the abrasive or the masonry contains silica.

Water-Repellent Coatings and Waterproof Coatings

To begin with, it is important to understand that waterproof coatings and water-repellent coatings are not the same. Although these terms are frequently interchanged and commonly confused with one another, they are completely different materials. **Water-repellent coatings**—often referred to incorrectly as "sealers", but which do not or should not seal—are intended to keep liquid water from penetrating the surface but to allow water vapor to enter and leave, or pass through, the surface of the masonry (Fig. 24). Water-repellent coatings are generally *transparent*, or clear, although once applied some may darken or discolor certain types of masonry while others may give it a glossy or shiny appearance. **Waterproof coatings** seal the surface from liquid water and from water vapor. They are usually *opaque*, or pigmented, and include bituminous coatings and some elastomeric paints and coatings.

Water-Repellent Coatings

Water-repellent coatings are formulated to be vapor permeable, or "breathable". They do not seal the surface completely to water vapor so it can enter the masonry wall as well as leave the wall. While the first water-repellent coatings to be developed were primarily acrylic or silicone resins in organic solvents, now most water-repellent coatings are water-based and formulated from modified siloxanes, silanes and other alkoxysilanes, or metallic stearates. While some of these products are shipped from the factory ready to use, other waterborne water repellents must be diluted at the job site. Unlike earlier water-repellent coatings which tended to form a "film" on the masonry surface, modern water-repellent coatings actually penetrate into the masonry substrate slightly and, generally, are almost invisible if properly applied to the masonry. They are also more vapor permeable than the old coatings, yet they still reduce the vapor permeability of the masonry. Once inside the wall, water vapor can condense at cold spots producing liquid water which, unlike water vapor, cannot escape through a water-repellent coating. The liquid water within the wall, whether from condensation, leaking gutters, or other sources, can cause considerable damage.

Water-repellent coatings are not consolidants. Although modern water repellents may penetrate slightly beneath the masonry surface, instead of just "sitting" on top of it, they do not perform the same function as a consolidant which is to "consolidate" and replace lost binder to strengthen deteriorating masonry. Even after many years of laboratory study and testing few consolidants have proven very effective. The composition of fired products such as brick and architectural terra cotta, as well as many types of building stone, does not lend itself to consolidation.

Some modern water-repellent coatings which contain a binder intended to replace the natural binders in stone that have been lost through weathering and natural erosion are described in product literature as both a water repellent and a consolidant. The fact that newer water-repellent coatings penetrate beneath the masonry surface instead of just forming a layer on top of the surface may indeed convey at least some consolidating properties to certain stones. However, a water-repellent coating cannot be considered a consolidant. In some instances, a water-repellent or "preservative" coating, if applied to already damaged or spalling stone, may form a surface crust which, if it fails, may exacerbate the deterioration by pulling off even more of the stone (Fig. 25).

Is a Water-Repellent Treatment Necessary?

Water-repellent coatings are frequently applied to historic masonry buildings for the wrong reason. They also are often applied without an understanding of what they are and what they are intended to do. And these coatings can be very difficult, if not impossible, to remove from the masonry if they fail or become discolored. Most importantly, the application of water-repellent coatings to historic masonry is usually unnecessary.



Figure 23. A tarpaulin protects and shields pedestrians from potentially harmful spray while chemical cleaning is underway on the granite exterior of the U.S. Treasury Building, Washington, D.C.

Most historic masonry buildings, unless they are painted, have survived for decades without a water-repellent coating and, thus, probably do not need one now. Water penetration to the interior of a masonry building is seldom due to porous masonry, but results from poor or deferred maintenance. Leaking roofs, clogged or deteriorated gutters and downspouts, missing mortar, or cracks and open joints around door and window openings are almost always the cause of moisture-related problems in a historic masonry building. If historic masonry buildings are kept watertight and in good repair, water-repellent coatings should not be necessary.

Rising damp (capillary moisture pulled up from the ground), or condensation can also be a source of excess moisture in masonry buildings. A water-repellent coating will not solve this problem either and, in fact, may be likely to exacerbate it. Furthermore, a water-repellent coating should never be applied to a damp wall. Moisture in the wall would reduce the ability of a coating to adhere to the masonry and to penetrate below the surface. But, if it did adhere, it would hold the moisture inside the masonry because, although a water-repellent coating is permeable to water vapor, liquid water cannot pass through it. In the case of rising damp, a coating may force the moisture to go even higher in the wall because it can slow down evaporation, and thereby retain the moisture in the wall.

Excessive moisture in masonry walls may carry waterborne soluble salts from the masonry units themselves or from the mortar through the walls. If the water is permitted to come to the surface, the salts may appear on the masonry surface as efflorescence (a whitish powder) upon evaporation. However, the salts can be potentially dangerous if they remain in the masonry and crystallize



Figure 24. Although the application of a water-repellent coating was probably not needed on either of these buildings, the coating on the brick building (above), is not visible and has not changed the character of the brick. But the coating on the brick column (below), has a high gloss that is incompatible with the historic character of the masonry.



beneath the surface as subflorescence. Subflorescence eventually may cause the surface of the masonry to spall, particularly if a water-repellent coating has been applied which tends to reduce the flow of moisture out from the subsurface of the masonry. Although many of the newer water-repellent products are more breathable than their predecessors, they can be especially damaging if applied to masonry that contains salts, because they limit the flow of moisture through masonry.

When a Water-Repellent Coating May be Appropriate

There are some instances when a water-repellent coating may be considered appropriate to use on a historic masonry building. Soft, incompletely fired brick from the 18th- and early-19th centuries may have become so porous that paint or some type of coating is needed to protect it from further deterioration or dissolution. When a masonry building has been neglected for a long period of time, necessary repairs may be required in order to make it watertight. If, following a reasonable period of time after the building has been made watertight and has dried out completely, moisture appears actually to be penetrating through the repointed and repaired masonry walls, then the application of a water-repellent coating may be considered in *selected areas only*. This decision should be made in consultation with an architectural conservator. And, if such a treatment is undertaken, it should not be applied to the entire exterior of the building.

Anti-graffiti or barrier coatings are another type of clear coating—although barrier coatings can also be pigmented—that may be applied to exterior masonry, but they are not formulated primarily as water repellents. The purpose of these coatings is to make it harder for graffiti to stick to a masonry surface and, thus, easier to clean. But, like water-repellent coatings, in most cases the application of anti-graffiti coatings is generally not recommended for historic masonry buildings. These coatings are often quite shiny which can greatly alter the appearance of a historic masonry surface, and they are not always effective (Fig. 26). Generally, other ways of discouraging graffiti, such as improved lighting, can be more effective than a coating. However, the application of anti-graffiti coatings may be appropriate in some instances on vulnerable areas of historic masonry buildings which are frequent targets of graffiti that are located in out-of-the-way places where constant surveillance is not possible.

Some water-repellent coatings are recommended by product manufacturers as a means of keeping dirt and pollutants or biological growth from collecting on the surface of masonry buildings and, thus, reducing the need for frequent cleaning. While this at times may be true, in some cases a coating may actually retain dirt more than uncoated masonry. Generally, the application of a water-repellent coating is not recommended on a historic masonry building as a means of preventing biological growth. Some water-repellent coatings may actually encourage biological growth on a masonry wall. Biological growth on masonry buildings has traditionally been kept at bay through regularly-scheduled cleaning as part of a maintenance plan. Simple clearing of the masonry with low-pressure water using a natural- or synthetic-bristled scrub brush can be very effective if done on a regular basis. Commercial products are also available which can be sprayed on masonry to remove biological growth.

In most instances, a water-repellent coating is not necessary if a building is watertight. The application of a water-repellent coating is not a recommended treatment for historic masonry buildings unless there is a specific



Figure 25. The clear coating applied to this limestone molding has failed and is taking off some of the stone surface as it peels. Photo: Frances Gale.

problem which it may help solve. If the problem occurs on only part of the building, it is best to treat only that area rather than an entire building. Extreme exposures such as parapets, for example, or portions of the building subject to driving rain can be treated more effectively and less expensively than the entire building. Water-repellent coatings are not permanent and must be reapplied



Figure 26. The anti-graffiti or barrier coating on this column is very shiny and would not be appropriate to use on a historic masonry building. The coating has discolored as it has aged and whitish streaks reveal areas of bare concrete where the coating was incompletely applied.

periodically although, if they are truly invisible, it can be difficult to know when they are no longer providing the intended protection.

Testing a water-repellent coating by applying it in one small area may not be helpful in determining its suitability for the building because a limited test area does not allow an adequate evaluation of such a treatment. Since water may enter and leave through the surrounding untreated areas, there is no way to tell if the coated test area is "breathable." But trying a coating in a small area may help to determine whether the coating is visible on the surface or if it will otherwise change the appearance of the masonry.

Waterproof Coatings

In theory, waterproof coatings usually do not cause problems as long as they exclude all water from the masonry. If water does enter the wall from the ground or from the inside of a building, the coating can intensify the damage because the water will not be able to escape. During cold weather this water in the wall can freeze causing serious mechanical disruption, such as spalling.

In addition, the water eventually will get out by the path of least resistance. If this path is toward the interior, damage to interior finishes can result; if it is toward the exterior, it can lead to damage to the masonry caused by built-up water pressure (Fig. 27).

In most instances, waterproof coatings should not be applied to historic masonry. The possible exception to this might be the application of a waterproof coating to below-grade exterior foundation walls as a last resort to stop water infiltration on interior basement walls. Generally, however, waterproof coatings, which include *elastomeric paints*, should almost never be applied above grade to historic masonry buildings.



Figure 27. Instead of correcting the roof drainage problems, an elastomeric coating was applied to the already saturated limestone cornice. An elastomeric coating holds moisture in the masonry because it does not "breathe" and does not allow liquid moisture to escape. If the water pressure builds up sufficiently it can cause the coating to break and pop off as shown in this example, often pulling pieces of the masonry with it. Photo: National Park Service Files.

Summary

A well-planned cleaning project is an essential step in preserving, rehabilitating or restoring a historic masonry building. Proper cleaning methods and coating treatments, when determined necessary for the preservation of the masonry, can enhance the aesthetic character as well as the structural stability of a historic building. Removing years of accumulated dirt, pollutant crusts, stains, graffiti or paint, if done with appropriate caution, can extend the life and longevity of the historic resource. Cleaning that is carelessly or insensitively prescribed or carried out by inexperienced workers can have the opposite of the intended effect. It may scar the masonry permanently, and may actually result in hastening deterioration by introducing harmful residual chemicals and salts into the masonry or causing surface loss. Using the wrong cleaning method or using the right method incorrectly, applying the wrong kind of coating or applying a coating that is not needed can result in serious damage, both physically and aesthetically, to a historic masonry building. Cleaning a historic masonry building should always be done using the *gentlest means possible* that will clean, but not damage the building. It should always be taken into consideration before applying a water-repellent coating or a waterproof coating to a historic masonry building whether it is really necessary and whether it is in the best interest of preserving the building.

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Front Cover: Chemical cleaning of the brick and architectural terra cotta frieze on the 1880s Pension Building, Washington, D.C. (now the National Building Museum), is shown here in progress. Photo: Christina Henry.

Photographs used to illustrate this Brief were taken by Anne Grimmer unless otherwise credited.

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7.3.2 Preservation Brief 6: *Dangers of Abrasive Cleaning to Historic Buildings, 1978*¹¹⁷

6 PRESERVATION BRIEFS

Dangers of Abrasive Cleaning to Historic Buildings

Anne E. Grimmer



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

"The surface cleaning of structures shall be undertaken with the gentlest means possible. Sandblasting and other cleaning methods that will damage the historic building materials shall not be undertaken."—The Secretary of the Interior's "Standards for Historic Preservation Projects."

Abrasive cleaning methods are responsible for causing a great deal of damage to historic building materials. To prevent indiscriminate use of these potentially harmful techniques, this brief has been prepared to explain abrasive cleaning methods, how they can be physically and aesthetically destructive to historic building materials, and why they generally are not acceptable preservation treatments for historic structures. There are alternative, less harsh means of cleaning and removing paint and stains from historic buildings. However, careful testing should precede general cleaning to assure that the method selected will not have an adverse effect on the building materials. A historic building is irreplaceable, and should be cleaned using only the "gentlest means possible" to best preserve it.

What is Abrasive Cleaning?

Abrasive cleaning methods include all techniques that physically abrade the building surface to remove soils, discolorations or coatings. Such techniques involve the use of certain *materials* which impact or abrade the surface under pressure, or abrasive *tools and equipment*. Sand, because it is readily available, is probably the most commonly used type of grit material. However, any of the following materials may be substituted for sand, and all can be classified as abrasive substances: ground slag or volcanic ash, crushed (pulverized) walnut or almond shells, rice husks, ground corncobs, ground coconut shells, crushed eggshells, silica flour, synthetic particles, glass beads and micro-balloons. Even *water* under pressure can be an abrasive substance. Tools and equipment that are abrasive to historic building materials include wire

brushes, rotary wheels, power sanding disks and belt sanders.

The use of water in combination with grit may also be classified as an abrasive cleaning method. Depending on the manner in which it is applied, water *may* soften the impact of the grit, but water that is too highly pressurized can be very abrasive. There are basically two different methods which can be referred to as "wet grit," and it is important to differentiate between the two. One technique involves the addition of a stream of water to a regular sandblasting nozzle. This is done primarily to cut down dust, and has very little, if any, effect on reducing the aggressiveness, or cutting action of the grit particles. With the second technique, a very small amount of grit is added to a pressurized water stream. This method may be controlled by regulating the amount of grit fed into the water stream, as well as the pressure of the water.

Why Are Abrasive Cleaning Methods Used?

Usually, an abrasive cleaning method is selected as an expeditious means of quickly removing years of dirt accumulation, unsightly stains, or deteriorating building fabric or finishes, such as stucco or paint. The fact that sandblasting is one of the best known and most readily available building cleaning treatments is probably the major reason for its frequent use.

Many mid-19th century brick buildings were painted immediately or soon after completion to protect poor quality brick or to imitate another material, such as stone. Sometimes brick buildings were painted in an effort to produce what was considered a more harmonious relationship between a building and its natural surroundings. By the 1870s, brick buildings

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Abractively Cleaned vs. Untouched Brick. Two brick rowhouses with a common façade provide an excellent point of comparison when one of the houses has been sandblasted. It is clear that abrasive blasting, by removing the outer surface, has left the brickwork on the left rough and pitted, while that on the right still exhibits an undamaged and relatively smooth surface. Note that the abrasive cleaning has also removed a considerable portion of the mortar from the joints of the brick on the left side, which will require repointing.

were often left unpainted as mechanization in the brick industry brought a cheaper pressed brick and fashion decreed a sudden preference for dark colors. However, it was still customary to paint brick of poorer quality for the additional protection the paint afforded.

It is a common 20th-century misconception that all historic masonry buildings were initially unpainted. If the intent of a modern restoration is to return a building to its original appearance, removal of the paint not only may be historically inaccurate, but also harmful. Many older buildings were painted or stuccoed at some point to correct recurring maintenance problems caused by faulty construction techniques, to hide alterations, or in an attempt to solve moisture problems. If this is the case, removal of paint or stucco may cause these problems to reoccur.

Another reason for paint removal, particularly in rehabilitation projects, is to give the building a "new image" in response to contemporary design trends and to attract investors or tenants. Thus, it is necessary to consider the purpose of the intended cleaning. While it is clearly important to remove unsightly stains, heavy encrustations of dirt, peeling paint or other surface coatings, it may not be equally desirable to remove paint from a building which originally was painted. Many historic buildings which show only a slight amount of soil or discoloration are much better left as they are. A thin layer of soil is more often protective of the building fabric than it is harmful, and seldom detracts from the building's



Abrading the Surface without Removing the Paint. Even though the entire outer surface layer of the brick has been sandblasted off, spots of paint still cling to the masonry. Sandblasting or other similarly abrasive methods are not always a successful means of removing paint.

architectural and/or historic character. Too thorough cleaning of a historic building may not only sacrifice some of the building's character, but also, misguided cleaning efforts can cause a great deal of damage to historic building fabric. Unless there are stains, graffiti or dirt and pollution deposits which are destroying the building fabric, it is generally preferable to do as little cleaning as possible, or to repaint where necessary. It is important to remember that a historic building does not have to look as if it were newly constructed to be an attractive or successful restoration or rehabilitation project. For a more thorough explanation of the philosophy of cleaning historic buildings see Preservation Briefs: No. 1 "The Cleaning and Waterproof Coating of Masonry Buildings," by Robert C. Mack, AIA.

Problems of Abrasive Cleaning

The crux of the problem is that abrasive cleaning is just that—abrasive. An abrasively cleaned historic structure may be physically as well as aesthetically damaged. Abrasive methods "clean" by eroding dirt or paint, but at the same time they also tend to erode the surface of the building material. In this way, abrasive cleaning is destructive and causes irreversible harm to the historic building fabric. If the fabric is brick, abrasive methods remove the hard, outer protective surface, and therefore make the brick more susceptible to rapid weathering and deterioration. Grit blasting may also increase the water permeability of a brick wall. The impact of the grit particles tends to erode the bond between the mortar and the brick, leaving cracks or enlarging existing cracks where water can enter. Some types of stone develop a protective patina or "quarry crust" parallel to the worked surface (created by the movement of moisture towards the outer edge), which also may be damaged by abrasive cleaning. The rate at which the material subsequently weathers depends on the quality of the inner surface that is exposed.

Abrasive cleaning can destroy, or substantially diminish, decorative detailing on buildings such as a molded brickwork or architectural terra-cotta, ornamental carving on wood or stone, and evidence of historic craft techniques, such as tool marks and other surface textures. In addition, perfectly sound and/or "tooled" mortar joints can be worn away by abrasive techniques. This not only results in the loss of historic craft detailing but also requires repointing, a step involving con-

siderable time, skill and expense, and which might not have been necessary had a gentler method been chosen. Erosion and pitting of the building material by abrasive cleaning creates a greater surface area on which dirt and pollutants collect. In this sense, the building fabric "attracts" more dirt, and will require more frequent cleaning in the future.

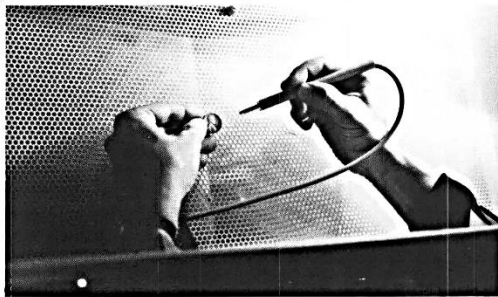
In addition to causing physical and aesthetic harm to the historic fabric, there are several adverse environmental effects of dry abrasive cleaning methods. Because of the friction caused by the abrasive medium hitting the building fabric, these techniques usually create a considerable amount of dust, which is unhealthy, particularly to the operators of the abrasive equipment. It further pollutes the environment around the job site, and deposits dust on neighboring buildings, parked vehicles and nearby trees and shrubbery. Some adjacent materials not intended for abrasive treatment such as wood or glass, may also be damaged because the equipment may be difficult to regulate.

Wet grit methods, while eliminating dust, deposit a messy slurry on the ground or other objects surrounding the base of the building. In colder climates where there is the threat of frost, any wet cleaning process applied to historic masonry structures must be done in warm weather, allowing ample time for the wall to dry out thoroughly before cold weather sets in. Water which remains and freezes in cracks and openings of the masonry surface eventually may lead to spalling. High-pressure wet cleaning may force an inordinate amount of water into the walls, affecting interior materials such as plaster or joist ends, as well as metal building components within the walls.

Variable Factors

The greatest problem in developing practical guidelines for cleaning any historic building is the large number of variable and unpredictable factors involved. Because these variables make each cleaning project unique, it is difficult to establish specific standards at this time. This is particularly true of abrasive cleaning methods because their inherent potential for causing damage is multiplied by the following factors:

- the type and condition of the material being cleaned;
- the size and sharpness of the grit particles or the mechanical equipment;
- the pressure with which the abrasive grit or equipment is applied to the building surface;
- the skill and care of the operator; and
- the constancy of the pressure on all surfaces during the cleaning process.



Micro-Abrasive Cleaning. This small, pencil-sized micro-abrasive unit is used by some museum conservators to clean small objects. This particular micro-abrasive unit is operated within the confines of a box (approximately 2 cubic feet of space), but a similar and slightly larger unit may be used for cleaning larger pieces of sculpture, or areas of architectural detailing on a building. Even a pressure cleaning unit this small is capable of eroding a surface, and must be carefully controlled.



"Line Drop." Even though the operator of the sandblasting equipment is standing on a ladder to reach the higher sections of the wall, it is still almost impossible to have total control over the pressure. The pressure of the sand hitting the lower portion of the wall will still be greater than that above, because of the "line drop" in the distance from the pressure source to the nozzle. (Hugh Miller)

Pressure: The damaging effects of most of the variable factors involved in abrasive cleaning are self evident. However, the matter of pressure requires further explanation. In cleaning specifications, pressure is generally abbreviated as "psi" (pounds per square inch), which technically refers to the "tip" pressure, or the amount of pressure at the nozzle of the blasting apparatus. Sometimes "psig," or pressure at the gauge (which may be many feet away, at the other end of the hose), is used in place of "psi." These terms are often incorrectly used interchangeably.

Despite the apparent care taken by most architects and building cleaning contractors to prepare specifications for pressure cleaning which will not cause harm to the delicate fabric of a historic building, it is very difficult to ensure that the same amount of pressure is applied to all parts of the building. For example, if the operator of the pressure equipment stands on the ground while cleaning a two-story structure, the amount of force reaching the first story will be greater than that hitting the second story, even if the operator stands on scaffolding or in a cherry picker, because of the "line drop" in the distance from the pressure source to the nozzle. Although technically it may be possible to prepare cleaning specifications with tight controls that would eliminate all but a small margin of error, it may not be easy to find professional cleaning firms willing to work under such restrictive conditions. The fact is that many professional building cleaning firms do not really understand the extreme delicacy of historic building fabric, and how it differs from modern construction materials. Consequently, they may ac-

cept building cleaning projects for which they have no experience.

The amount of pressure used in any kind of cleaning treatment which involves pressure, whether it is dry or wet grit, chemicals or just plain water, is crucial to the outcome of the cleaning project. Unfortunately, no standards have been established for determining the correct pressure for cleaning each of the many historic building materials which would not cause harm. The considerable discrepancy between the way the building cleaning industry and architectural conservators define "high" and "low" pressure cleaning plays a significant role in the difficulty of creating standards.

Nonhistoric/Industrial: A representative of the building cleaning industry might consider "high" pressure water cleaning to be anything over 5,000 psi, or even as high as 10,000 to 15,000 psi! Water under this much pressure may be necessary to clean industrial structures or machinery, but would destroy most historic building materials. Industrial chemical cleaning commonly utilizes pressures between 1,000 and 2,500 psi.



Spalling Brick. This soft, early 19th-century brick was sandblasted in the 1960s; consequently, severe spalling has resulted. Some bricks have almost totally disintegrated, and will eventually have to be replaced. (Robert S. Gamble)

Historic: By contrast, conscientious dry or wet abrasive cleaning of a historic structure would be conducted within the range of 20 to 100 psi at a range of 3 to 12 inches. Cleaning at this low pressure requires the use of a very fine 00 or 0 mesh grit forced through a nozzle with a ¼ inch opening. A similar, even more delicate method being adopted by architectural conservators uses a micro-abrasive grit on small, hard-to-clean areas of carved, cut or molded ornament on a building façade. Originally developed by museum conservators for cleaning sculpture, this technique may employ glass beads, micro-balloons, or another type of micro-abrasive gently powered at approximately 40 psi by a very small, almost pencil-like pressure instrument. Although a slightly larger pressure instrument may be used on historic buildings, this technique still has limited practical applicability on a large scale building cleaning project because of the cost and the relatively few technicians competent to handle the task. In general, architectural conservators have determined that only through very controlled conditions can most historic building material be abrasively cleaned of soil or paint without measurable damage to the surface or profile of the substrate.

Yet some professional cleaning companies which specialize in cleaning historic masonry buildings use chemicals and water at a pressure of approximately 1,500 psi, while other cleaning firms recommend lower pressures ranging from 200 to 800 psi for a similar project. An architectural conservator might decide, *after testing*, that some historic structures could be cleaned properly using a moderate pressure (200–600 psi), or even a high pressure (600–1800 psi) water rinse. However,

cleaning historic buildings under such high pressure should be considered an exception rather than the rule, and would require *very careful* testing and supervision to assure that the historic surface materials could withstand the pressure without gouging, pitting or loosening.

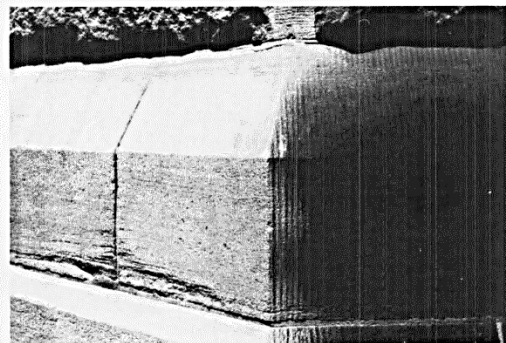
These differences in the amount of pressure used by commercial or industrial building cleaners and architectural conservators point to one of the main problems in using abrasive means to clean historic buildings: misunderstanding of the potentially fragile nature of historic building materials. There is no one cleaning formula or pressure suitable for all situations. Decisions regarding the proper cleaning process for historic structures can be made only after careful analysis of the building fabric, and testing.

How Building Materials React to Abrasive Cleaning Methods

Brick and Architectural Terra-Cotta: Abrasive blasting does not affect all building materials to the same degree. Such techniques quite logically cause greater damage to softer and more porous materials, such as brick or architectural terra-cotta. When these materials are cleaned abrasively, the hard, outer layer (closest to the heat of the kiln) is eroded, leaving the soft, inner core exposed and susceptible to accelerated weathering. Glazed architectural terra-cotta and ceramic veneer have a baked-on glaze which is also easily damaged by abrasive cleaning. Glazed architectural terra-cotta was designed for easy maintenance, and generally can be cleaned using detergent and water; but chemicals or steam may be needed to remove more persistent stains. Large areas of brick or architectural terra-cotta which have been painted are best left painted, or repainted if necessary.

Plaster and Stucco: Plaster and stucco are types of masonry finish materials that are softer than brick or terra-cotta; if treated abrasively these materials will simply disintegrate. Indeed, when plaster or stucco is treated abrasively it is usually with the intention of removing the plaster or stucco from whatever base material or substrate it is covering. Obviously, such abrasive techniques should not be applied to clean sound plaster or stuccoed walls, or decorative plaster wall surfaces.

Building Stones: Building stones are cut from the three main categories of natural rock: dense, igneous rock such as granite; sandy, sedimentary rock such as limestone or sandstone; and crystalline, metamorphic rock such as marble. As op-

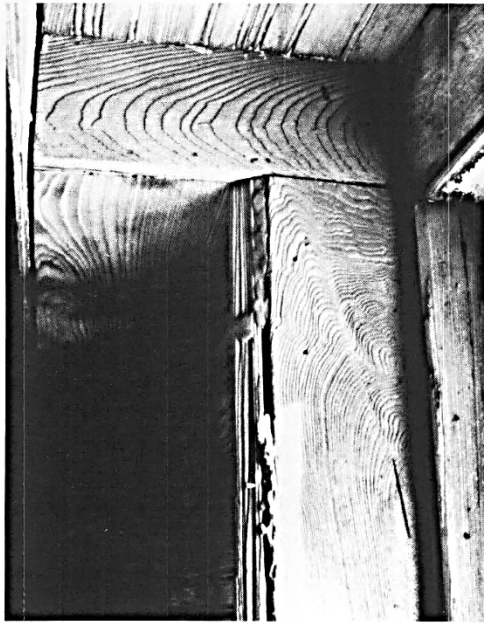


Abrasive Cleaning of Tooled Granite. Even this carefully controlled "wet grit" blasting has erased vertical tooling marks in the cut granite blocks on the left. Not only has the tooling been destroyed, but the damaged stone surface is now more susceptible to accelerated weathering.

posed to kiln-dried masonry materials such as brick and architectural terra-cotta, building stones are generally homogeneous in character at the time of a building's construction. However, as the stone is exposed to weathering and environmental pollutants, the surface may become friable, or may develop a protective skin or patina. These outer surfaces are very susceptible to damage by abrasive or improper chemical cleaning.

Building stones are frequently cut into ashlar blocks or "dressed" with tool marks that give the building surface a specific texture and contribute to its historic character as much as ornately carved decorative stonework. Such detailing is easily damaged by abrasive cleaning techniques; the pattern of tooling or cutting is erased, and the crisp lines of moldings or carving are worn or pitted.

Occasionally, it may be possible to clean small areas of rough-cut granite, limestone or sandstone having a heavy dirt encrustation by using the "wet grit" method, whereby a small amount of abrasive material is injected into a controlled, pressurized water stream. However, this technique requires very careful supervision in order to prevent damage to the stone. Polished or honed marble or granite should *never* be treated abrasively, as the abrasion would remove the finish in much the way glass would be etched or "frosted" by such a process. It is generally preferable to underclean, as too strong a cleaning procedure will erode the stone, exposing a new and increased surface area to collect atmospheric moisture and dirt. Removing paint, stains or graffiti from most types of stone may be accomplished by a chemical treatment carefully selected to best handle the removal of the particular type of paint or stain without damaging the stone. (See section on the "Gentlest Means Possible")



Abrasive Cleaning of Wood. This wooden windowsill, molding and paneling have been sandblasted to remove layers of paint in the rehabilitation of this commercial building. Not only is some paint still embedded in cracks and crevices of the woodwork, but more importantly, grit blasting has actually eroded the summer wood, in effect raising the grain, and resulting in a rough surface.

Wood: Most types of wood used for buildings are soft, fibrous and porous, and are particularly susceptible to damage by abrasive cleaning. Because the summer wood between the lines of the grain is softer than the grain itself, it will be worn away by abrasive blasting or power tools, leaving an uneven surface with the grain raised and often frayed or "fuzzy." Once this has occurred, it is almost impossible to achieve a smooth surface again except by extensive hand sanding, which is expensive and will quickly negate any costs saved earlier by sandblasting. Such harsh cleaning treatment also obliterates historic tool marks, fine carving and detailing, which precludes its use on any interior or exterior woodwork which has been hand planed, milled or carved.

Metals: Like stone, metals are another group of building materials which vary considerably in hardness and durability. Softer metals which are used architecturally, such as tin, zinc, lead, copper or aluminum, generally should not be cleaned abrasively as the process deforms and destroys the original surface texture and appearance, as well as the acquired patina. Much applied architectural metal work used on historic buildings—tin, zinc, lead and copper—is often quite thin and soft, and therefore susceptible to denting and pitting. Galvanized sheet metal is especially vulnerable, as abrasive treatment would wear away the protective galvanized layer.

In the late 19th and early 20th centuries, these metals were often cut, pressed or otherwise shaped from sheets of metal into a wide variety of practical uses such as roofs, gutters and flashing, and façade ornamentation such as cornices, friezes, dormers, panels, cupolas, oriel windows, etc. The architecture of the 1920s and 1930s made use of metals such as chrome, nickel alloys, aluminum and stainless steel in decorative exterior panels, window frames, and doorways. Harsh abrasive blasting would destroy the original surface finish of most of these metals, and would increase the possibility of corrosion.

However, conservation specialists are now employing a sensitive technique of glass bead peening to clean some of the harder metals, in particular large bronze outdoor sculpture. Very fine (75–125 micron) glass beads are used at a low pressure of 60 to 80 psi. Because these glass beads are completely spherical, there are no sharp edges to cut the surface of the metal. After cleaning, these statues undergo a lengthy process of polishing. Coatings are applied which protect the surface from corrosion, but they must be renewed every 3 to 5 years. A similarly delicate cleaning technique employing glass beads has been used in Europe to clean historic masonry structures without causing damage. But at this time the process has not been tested sufficiently in the United States to recommend it as a building conservation measure.

Sometimes a very fine *smooth* sand is used at a low pressure to clean or remove paint and corrosion from copper flashing and other metal building components. Restoration architects recently found that a mixture of crushed walnut shells and copper slag at a pressure of approximately 200 psi was the only way to remove corrosion successfully from a mid-19th century terne-coated iron roof. Metal cleaned in this manner must be painted immediately to prevent rapid recurrence of corrosion. It is thought that these methods "work harden" the surface by compressing the outer layer, and actually may be good for the surface of the metal. But the extremely complex nature and the time required by such processes make it very expensive and impractical for large-scale use at this time.

Cast and wrought iron architectural elements may be gently sandblasted or abrasively cleaned using a wire brush to remove layers of paint, rust and corrosion. Sandblasting was, in fact, developed originally as an efficient maintenance procedure for engineering and industrial structures and heavy machinery—iron and steel bridges, machine tool frames, engine frames, and railroad rolling stock—in order to clean and prepare them for repainting. Because iron is hard, its surface,

which is naturally somewhat uneven, will not be noticeably damaged by controlled abrasion. Such treatment will, however, result in a small amount of pitting. But this slight abrasion creates a good surface for paint, since the iron must be repainted immediately to prevent corrosion. Any abrasive cleaning of metal building components will also remove the caulking from joints and around other openings. Such areas must be recaulked quickly to prevent moisture from entering and rusting the metal, or causing deterioration of other building fabric inside the structure.

When is Abrasive Cleaning Permissible?

For the most part, abrasive cleaning is destructive to historic building materials. A limited number of special cases have been explained when it may be appropriate, if supervised by a skilled conservator, to use a delicate abrasive technique on some historic building materials. The type of "wet grit" cleaning which involves a small amount of grit injected into a stream of low pressure water may be used on small areas of stone masonry (i.e., rough cut limestone, sandstone or unpolished granite), where milder cleaning methods have not been totally successful in removing harmful deposits of dirt and pollutants. Such areas may include stone window sills, the tops of cornices or column capitals, or other detailed areas of the façade.

This is still an abrasive technique, and without proper caution in handling, it can be *just as harmful to the building surface as any other abrasive cleaning method*. Thus, the decision to use this type of "wet grit" process should be made only after consultation with an experienced building conservator. Remember that *it is very time consuming and expensive to use any abrasive technique on a historic building in such a manner that it does not cause harm to the often fragile and friable building materials*.

At this time, and only under certain circumstances, abrasive cleaning methods may be used in the rehabilitation of interior spaces of warehouse or industrial buildings for contemporary uses.

Interior spaces of factories or warehouse structures in which the masonry or plaster surfaces do not have significant design, detailing, tooling or finish, and in which wooden architectural features are not finished, molded, beaded or worked by hand, may be cleaned abrasively in order to remove layers of paint and industrial discolorations such as smoke, soot, etc. It is expected after such treatment that brick surfaces will be rough and pitted, and wood will be somewhat frayed or "fuzzy"



Permissible Abrasive Cleaning. In accordance with the Secretary of the Interior's Guidelines for Rehabilitation Projects, it may be acceptable to use abrasive techniques to clean an industrial interior space such as that illustrated here, because the masonry surfaces do not have significant design, detailing, tooling or finish, and the wooden architectural features are not finished, molded, beaded or worked by hand.

with raised wood grain. These nonsignificant surfaces will be damaged and have a roughened texture, but because they are interior elements, they will not be subject to further deterioration caused by weathering.

Historic Interiors that Should Not Be Cleaned Abrasively

Those instances (generally industrial and some commercial properties), when it may be acceptable to use an abrasive treatment on the interior of historic structures have been described. But for the majority of historic buildings, the Secretary of the Interior's *Guidelines for Rehabilitation* do not recommend "changing the texture of exposed wooden architectural features (including structural members) and masonry surfaces through sandblasting or use of other abrasive techniques to remove paint, discolorations and plaster. . . ."

Thus, it is not acceptable to clean abrasively interiors of historic residential and commercial properties which have *finished* interior spaces featuring milled woodwork such as doors, window and door moldings, wainscoting, stair balustrades and mantelpieces. Even the most modest historic *house* interior, although it may not feature elaborate detailing, contains plaster and woodwork that is architecturally significant to the original design and function of the house. Abrasive cleaning of such an interior would be destructive to the historic integrity of the building.

Abrasive cleaning is also impractical. Rough surfaces of abrasively cleaned wooden elements are hard to keep clean. It is also difficult to seal, paint or maintain these surfaces which can be splintery and a problem to the building's occupants. The force of abrasive blasting may cause grit particles to lodge in cracks of wooden elements, which will be a nuisance as the grit is loosened by vibrations and gradually sifts out. Removal of plaster will reduce the thermal and insulating value of the walls. Interior brick is usually softer than exterior brick, and generally of a poorer quality. Removing surface plaster from such brick by abrasive means often exposes gaping mortar joints and mismatched or repaired brickwork which was never intended to show. The resulting bare brick wall may require repointing, often difficult to match. It also may be necessary to apply a transparent surface coating (or sealer) in order to prevent the mortar and brick from "dusting." However, a sealer may not only change the color of the brick, but may also compound any existing moisture problems by restricting the normal evaporation of water vapor from the masonry surface.

"Gentlest Means Possible"

There are alternative means of removing dirt, stains and paint from historic building surfaces that can be recommended as more efficient and less destructive than abrasive techniques. The "gentlest means possible" of removing dirt from a building surface can be achieved by using a low-pressure water wash, scrubbing areas of more persistent grime with a natural bristle (never metal) brush. Steam cleaning can also be used effectively to clean some historic building fabric. Low-pressure water or steam will soften the dirt and cause the deposits to rise to the surface, where they can be washed away.

A third cleaning technique which may be recommended to remove dirt, as well as stains, graffiti or paint, involves the use of commercially available chemical cleaners or paint removers, which, when applied to masonry, loosen or dissolve the dirt or stains. These cleaning agents may be used in combination with water or steam, followed by a clear water wash to remove the residue of dirt and the chemical cleaners from the masonry. A natural bristle brush may also facilitate this type of chemically assisted cleaning, particularly in areas of heavy dirt deposits or stains, and a wooden scraper can be



Do not Abrasively Clean these Interiors. Most historic residential and some commercial interior spaces contain finished plaster and wooden elements such as this stair balustrade and paneling which contribute to the historic and architectural character of the structure. Such interiors should not be subjected to abrasive techniques for the purpose of removing paint, dirt, discoloration or plaster.

useful in removing thick encrustations of soot. A limewash or absorbent talc, whitening or clay poultice with a solvent can be used effectively to draw out salts or stains from the surface of the selected areas of a building façade. It is almost impossible to remove paint from masonry surfaces without causing some damage to the masonry, and it is best to leave the surfaces as they are or repaint them if necessary.

Some physicists are experimenting with the use of pulsed laser beams and xenon flash lamps for cleaning historic masonry surfaces. At this time it is a slow, expensive cleaning method, but its initial success indicates that it may have an increasingly important role in the future.

There are many chemical paint removers which, when applied to painted wood, soften and dissolve the paint so that it can be scraped off by hand. Peeling paint can be removed from wood by hand scraping and sanding. Particularly thick layers of paint may be softened with a heat gun or heat plate, providing appropriate precautions are taken, and the paint film scraped off by hand. Too much heat applied to the same spot can burn the wood, and the fumes caused by burning paint are dangerous to inhale, and can be explosive. Furthermore, the hot air from heat guns can start fires in the building cavity. Thus, adequate ventilation is important when using a heat gun or heat plate, as well as when using a chemical stripper. A torch or open flame should never be used.

Preparations for Cleaning: It cannot be overemphasized that all of these cleaning methods must be approached with cau-

tion. When using any of these procedures which involve water or other liquid cleaning agents on masonry, it is imperative that *all* openings be tightly covered, and all cracks or joints be well pointed in order to avoid the danger of water penetrating the building's façade, a circumstance which might result in serious moisture related problems such as efflorescence and/or subflorescence. Any time water is used on masonry as a cleaning agent, either in its pure state or in combination with chemical cleaners, it is very important that the work be done in warm weather when there is no danger of frost for several months. Otherwise water which has penetrated the masonry may freeze, eventually causing the surface of the building to crack and spall, which may create another conservation problem more serious to the health of the building than dirt.

Each kind of masonry has a unique composition and reacts differently with various chemical cleaning substances. Water and/or chemicals may interact with minerals in stone and cause new types of stains to leach out to the surface immediately, or more gradually in a delayed reaction. What may be a safe and effective cleaner for certain stain on one type of stone, may leave unattractive discolorations on another stone, or totally dissolve a third type.

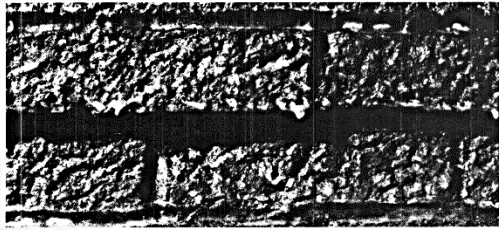
Testing: Cleaning historic building materials, particularly masonry, is a technically complex subject, and thus, should never be done without expert consultation and testing. No cleaning project should be undertaken without first applying the intended cleaning agent to a representative test patch area in an inconspicuous location on the building surface. The test patch or patches should be allowed to weather for a period of time, preferably through a complete seasonal cycle, in order to determine that the cleaned area will not be adversely affected by wet or freezing weather or any by-products of the cleaning process.

Mitigating the Effects of Abrasive Cleaning

There are certain restoration measures which can be adopted to help preserve a historic building exterior which has been damaged by abrasive methods. Wood that has been sandblasted will exhibit a frayed or "fuzzed" surface, or a harder wood will have an exaggerated raised grain. The only way to remove this rough surface or to smooth the grain is by laborious sanding. Sandblasted wood, unless it has been extensively sanded, serves as a dustcatcher, will weather faster, and will present a continuing and ever worsening maintenance problem. Such wood, after sanding, should be painted or given a clear surface coating to protect the wood, and allow for somewhat easier maintenance.

There are few successful preservative treatments that may be applied to grit-blasted exterior masonry. Harder, denser stone may have suffered only a loss of crisp edges or tool marks, or other indications of craft technique. If the stone has a compact and uniform composition, it should continue to weather with little additional deterioration. But some types of sandstone, marble and limestone will weather at an accelerated rate once their protective "quarry crust" or patina has been removed.

Softer types of masonry, particularly brick and architectural terra-cotta, are the most likely to require some remedial treatment if they have been abrasively cleaned. Old brick, being essentially a soft, baked clay product, is greatly susceptible to increased deterioration when its hard, outer skin is removed through abrasive techniques. This problem can be minimized by painting the brick. An alternative is to treat it with a clear sealer or surface coating but this will give the masonry a glossy or shiny look. It is usually preferable to paint the brick rather than to apply a transparent sealer since



Hazards of Sandblasting and Surface Coating. In order to "protect" this heavily sandblasted brick, a clear surface coating or sealer was applied. Because the air temperature was too cold at the time of application, the sealer failed to dry properly, dripping in places, and giving the brick surface a cloudy appearance.

sealers reduce the transpiration of moisture, allowing salts to crystallize as subflorescence that eventually spalls the brick. If a brick surface has been so extensively damaged by abrasive cleaning and weathering that spalling has already begun, it may be necessary to cover the walls with stucco, if it will adhere.

Of course, the application of paint, a clear surface coating (sealer), or stucco to deteriorating masonry means that the historical appearance will be sacrificed in an attempt to conserve the historic building materials. However, the original color and texture will have been changed already by the abrasive treatment. At this point it is more important to try to preserve the brick, and there is little choice but to protect it from "dusting" or spalling too rapidly. As a last resort, in the case of severely spalling brick, there may be no option but to replace the brick—a difficult, expensive (particularly if custom-made reproduction brick is used), and lengthy process. As described earlier, sandblasted interior brick work, while not subject to change of weather, may require the application of a transparent surface coating or painting as a maintenance procedure to contain loose mortar and brick dust. (See Preservation Briefs: No. 1 for a more thorough discussion of coatings.)

Metals, other than cast or wrought iron, that have been pitted and dented by harsh abrasive blasting usually cannot be smoothed out. Although fillers may be satisfactory for smoothing a painted surface, exposed metal that has been damaged usually will have to be replaced.

Summary

Sandblasting or other abrasive methods of cleaning or paint removal are by their nature destructive to historic building materials and should not be used on historic buildings except in a few well-monitored instances. There are exceptions when certain types of abrasive cleaning may be permissible, but only if conducted by a trained conservator, and if cleaning is necessary for the preservation of the historic structure.

There is no one formula that will be suitable for cleaning all historic building surfaces. Although there are many commercial cleaning products and methods available, it is impossible to state definitively which of these will be the most effective without causing harm to the building fabric. It is often difficult to identify ingredients or their proportions contained in cleaning products; consequently it is hard to predict how a product will react to the building materials to be cleaned. Similar uncertainties affect the outcome of other cleaning methods as they are applied to historic building materials. Further advances in understanding the complex nature of the many variables of the cleaning techniques may someday provide a better and simpler solution to the problems. But until that time, the process of cleaning historic buildings must be approached with caution through trial and error.

It is important to remember that historic building materials are neither indestructible, nor are they renewable. They must be treated in a responsible manner, which may mean little or no cleaning at all if they are to be preserved for future generations to enjoy. If it is in the best interest of the building to clean it, then it should be done "using the gentlest means possible."



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This Preservation Brief was written by Anne E. Grimmer, Architectural Historian, Technical Preservation Services Division. Valuable suggestions and comments were made by Hugh C. Miller, AIA, Washington, D.C.; Martin E. Weaver, Ottawa, Ontario, Canada; Terry Bryant, Downers Grove, Illinois; Daniel C. Cammer, McLean, Virginia; and the professional staff of Technical Preservation Services Division. Deborah Cooney edited the final manuscript.

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8 Stage IV: Metal

There are minimal metal materials on the exterior of the Burgess-Capps Cabin. Due to the main construction material of the building being wood, the visible metal materials on the exterior are not meant to have any significance. They are solely for structural or weather purposes, and were most likely added at a later date post original construction. The interior metal features are also minimal; however, these materials are mainly hardware (for structural purposes in the loft) or door hardware for aesthetics and durability on the main floor. Almost all metal in the building is not original.

8.1 Exterior metal features

The Burgess-Capps Cabin has galvanized metal flashing located in the roof joint areas, such as the meeting point of the roof to the actual structure (see Figure 80). Along the sides of the roof planks are galvanized metal edges (see Figure 81 and Figure 82).

Figure 80. Galvanized metal flashing at the meeting point of the main roof and porch roof of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 81. Galvanized metal edging along the porch roof planks on the east side of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 82. Galvanized metal edging along the board edges of the porch roof on the west side of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Atop the stone foundation is also galvanized metal flashing (see Figure 83). Throughout the exterior of the Burgess-Capps Cabin are visible hardware that are both potentially original and newer, such as nails and other structural reinforcements (see, for instance, the bolt in Figure 84).

Figure 83. Looking at galvanized metal flashing on the top of the stone foundation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 84. Bolt and double-headed nail near the foundation of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



8.2 Interior metal features

There are minimal metal interior features in the Burgess-Capps Cabin. These materials are mainly hardware (for structural purposes in the loft) or door hardware for aesthetics and durability on the main floor. A door hardware handle and hinge example can be seen in Figure 85 and Figure 86. There are also multiple bolts that could be from previous locks (see Figure 87). Metal brackets for security purposes were installed on the interior side of the front door (see Figure 88 and Figure 89).

Figure 85. Possible original door handle to the loft staircase of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 86. Metal hinge on a door in the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 87. Various types of metal hardware on the interior side of the door of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 88. Metal brackets for security purposes on the interior side of the door of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 89. Close-up of metal brackets for security purposes on the interior side of the door of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



In the loft of the Burgess-Capps Cabin are multiple fasteners that were installed at an unknown date (i.e., no documentation found), according to the USAFA cultural resource manager. There are also turn-buckles (seen in Figure 90 and Figure 91), strong ties (seen in Figure 92), and L-beams (seen in Figure 93).

Figure 90. Turn-buckle and cable that is fastened to a double 2 × 8 below the loft floor, which connects to a turnbuckle, which is bolted to two steel angle brackets, which are lag bolted to the top wall timber in the loft of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 91. Multiple turnbuckle and cables that are fastened to a double 2 × 8 board below the loft floor, which connects to a turnbuckle, which is bolted to two steel angle brackets, which are lag bolted to the top wall timber in the loft of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).

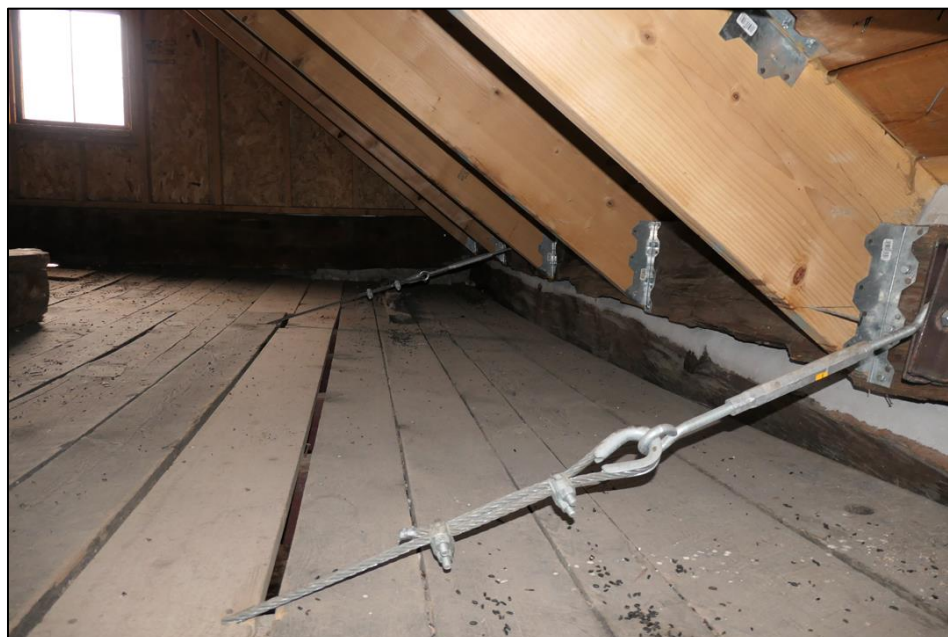


Figure 92. Simpson Strong-Tie NER-413 metal brackets fasten some of the deck board to the new 2 × 10 joists. Two of these brackets are installed on both sides of the joists in the loft of the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



Figure 93. Bottom of 2 × 10 roof joists showing anchorage to top wall timbers using L2 × 2 × 1/8 in. angles in the Burgess-Capps Cabin (photo by ERDC-CERL researchers, 2021).



8.3 Treatment measures: “Cleaning Door Hardware,” 2017¹¹⁸

The following images and documents offer treatment measures for exterior and interior metal materials that are in poor condition. The sources include information from the General Services Administration.

118. This section reproduces US General Services Administration, “Cleaning Door Hardware,” Historic Preservation Technical Procedures, 2017, <https://www.gsa.gov/real-estate/historic-preservation/historic-preservation-policy-tools/preservation-tools-resources/technical-documents>. Public domain.

 An official website of the United States government



Cleaning Door Hardware

Procedure code:

870002S

Source:

National Capitol Region Specifications

Division:

Concrete

Section:

Hardware

Last Modified:

06/08/2017

Technical Procedures Disclaimer

Prior to inclusion in GSA's library of procedures, documents are reviewed by one or more qualified preservation specialists for general consistency with the Secretary of Interior Standards for rehabilitating historic buildings as understood at the time the procedure is added to the library. All specifications require project-specific editing and professional judgement regarding the applicability of a procedure to a particular building, project or location. References to products and suppliers are to serve as a general guideline and do not constitute a federal endorsement or determination that a product or method is the best or most current alternative, remains available, or is compliant with current environmental regulations and safety standards. The library of procedures is intended to serve as a resource, not a substitute, for specification development by a qualified preservation professional.

Rewrite

We've reviewed these procedures for general consistency with federal standards for rehabilitating historic buildings and provide them only as a reference. Specifications should only be applied under the guidance of a qualified preservation professional who can assess the applicability of a procedure to a particular building, project or location. References to products and suppliers serve as general guidelines and do not constitute a federal endorsement nor a

determination that a product or method is the best alternative or compliant with current environmental regulations and safety standards.

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on cleaning door hardware associated with the restoration of the finish on wooden doors.

B. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals
4. Quality Assurance
5. Delivery, Storage and Handling
6. Project/Site Conditions
7. Sequencing and Scheduling
8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product literature and instructions to the Contracting Officer's Representative for all cleaning materials.

1.03 PROJECT/SITE CONDITIONS

A. Environmental Requirements: Daily dispose of all used solutions, finishing products, solvent residue and soiled rags in sealed noncombustible containers to prevent a fire hazard.

PART 2---PRODUCTS

2.01 MATERIALS

A. Solvent: Mineral spirits, turpentine, or denatured alcohol.

Mineral Spirits:

1. A petroleum distillate that is used especially as a paint or varnish thinner. It was developed as an inexpensive replacement for the vegetable-based turpentine, and is a light version of kerosene. It comes in three grades, and cost rises as refining quality increases.

2. Other chemical or common names include Benzine (not Benzene); Naphtha; Petroleum spirits; White spirit; Varisol; Solvent naphtha; Stoddard solvent.

3. Potential Hazards: TOXIC AND FLAMMABLE.

4. Safety Precautions:

a. Work in a well ventilated area.

b. ALWAYS wear proper PPE such as rubber gloves, safety glasses/goggles and a properly rated respirator when handling any solvent such as mineral spirits.

c. AVOID REPEATED OR PROLONGED SKIN CONTACT. If any chemical is splashed onto the skin, wash immediately with soap and water.

5. Available from construction specialties distributors, hardware store, paint store, or printer's supply distributor.

Turpentine:

3. Potential Hazards: TOXIC AND FLAMMABLE. Due to the fact that turpentine can cause spasms of the airways particularly in people with asthma and whooping cough, it can contribute to a worsening of breathing issues in persons with these diseases if inhaled.

4. Safety Precautions:

- a. Work in a well ventilated area.
- b. ALWAYS wear proper PPE such as rubber gloves, safety glasses/goggles and a properly rated respirator when handling any solvent such as mineral spirits.
- c. AVOID REPEATED OR PROLONGED SKIN CONTACT. If any turpentine is splashed onto the skin, wash immediately with soap and water.
- d. Observe safety rules as turpentine is flammable, and the fumes can trip an ionization smoke detection system.
- e. Store soiled cloths in a metal safety container to guard against spontaneous combustion.
- f. Available from hardware store or paint store.

Denatured Alcohol:

1. Denatured Alcohol is ethanol or ethyl alcohol that has additives added to it which intentionally make it poisonous and not consumable. Some of these additives can include acetone and MEK (methyl ethyl ketone).
 2. Other chemical or common names include Methylated spirit.
 3. Potential hazards: TOXIC AND FLAMMABLE.
 4. Available from hardware store, paint store or printer's supply distributor.
 5. Denatured alcohol should be a satisfactory substitute for ethyl alcohol for stain removing purposes.
- B. Cloths: Clean, soft, lint-free cotton.
- C. Mild Soap: "Ivory Liquid", "Joy", or equal.
- D. Silicon carbide abrasive pads such as "Scotch-Brite" (3M Company) or standard commercially available pumice stone; or stainless steel wool. Do not use steel wool, which may

promote discoloration of the bronze.

E. Oxidizing Agent: If prescribed by a qualified conservator, oxidizing agents such as Aluminum Chloride or liquid sulphur may be used under controlled conditions by trained and experienced personnel.

1. Danger: Oxidizing agents such as Aluminum Chloride are corrosive, can cause burns to any area of contact, and inhalation of its vapors can be fatal in some cases. Oxidizing agents are water reactive and under the right conditions they can be explosive. These agents require special training and handling precautions. Proper PPE MUST be worn when dealing with any Oxidizing agent.

Further information on Aluminum Chloride in particular may be found at

<http://hazard.com/msds/mf/baker/baker/files/a2790.htm>

<http://hazard.com/msds/f2/bkz/bkzqx.html>

<http://www.sciencestuff.com/prod/Chem-Rgnts/C1176>

1. A distilled wood-product, typically used as a solvent and thinner.
2. Other chemical or common names include spirits of turpentine, turps, and wood turpentine.

2.02 EQUIPMENT

A. Brushes: Soft, natural animal hair bristle.

PART 3---EXECUTION

3.01 PREPARATION

A. Surface Preparation: Carefully remove hardware. Store in a secure location for reinstallation after refinishing is complete. All refinishing actions on hardware should take place after it has been completely removed from the wooden door.

3.02 ERECTION, INSTALLATION, APPLICATION

A. Carefully remove adhesive residue, and paint and varnish drips using paint stripper applied with soft cloths. If necessary, apply light pressure using natural bristle brush.

- B. Retain statuary finish on door bronze knobs. Do not apply solvents which may remove patina.
- C. Clean bronze and stainless steel door knobs, escutcheon plates, and kickplates using mild soap and water.
- D. For stubborn dirt and hard to clean areas, apply detergent with "Scotch-Brite" pad. Under the direction of a qualified conservator, areas of bright metal work may be refinished with a suitable oxidizing agent to match existing patinas. Rinse thoroughly and buff dry with soft cotton cloths.
- E. Re-install hardware after it has been refinished. If the wooden door itself is also being refinished do not replace the hardware until that process has been completed.

Last Reviewed: 2017-09-28

9 Structural Assessment

9.1 Introduction

9.1.1 Background

A “high-level” assessment of the Burgess-Capps Cabin (Figure 94) was performed by ERDC-CERL to determine if it is structurally sound and can remain as a historic object in the landscape. Visitors are currently not allowed inside the building on a normal basis.

Figure 94. Exterior view of the log cabin and chimney from the southeast corner (photo by ERDC-CERL researchers, 2021).



The “Capp’s/Burgess Cabin Preservation, Stabilization and Archaeological Report” indicates the cabin rests at its original location (Figure 95).¹¹⁹ This report indicates the front porch structure and flooring, exterior gable end framing, shingles, and interior flooring are not original and date from a series of different periods of restoration and reconstruction. Dimensional

119. Roberts Thorne Architects, “Capp’s/Burgess Cabin Preservation Stabilization and Archaeological Report,” November 9, 1992, Cultural Resources Program Office, US Air Force Academy, CO.

lumber at the exterior end gables was placed on the building after settlement and is true to level of existing grades, which visually manifests itself as being out of true with the logs themselves.

Figure 95. Front-exterior (south side) view of the log cabin (photo by ERDC-CERL researchers, 2021).



9.1.2 Objective

The objective of this high-level assessment was to ascertain the structural stability of this log cabin, primarily by visual inspection, and consider its ability to resist snow and wind loads.

9.2 Approach

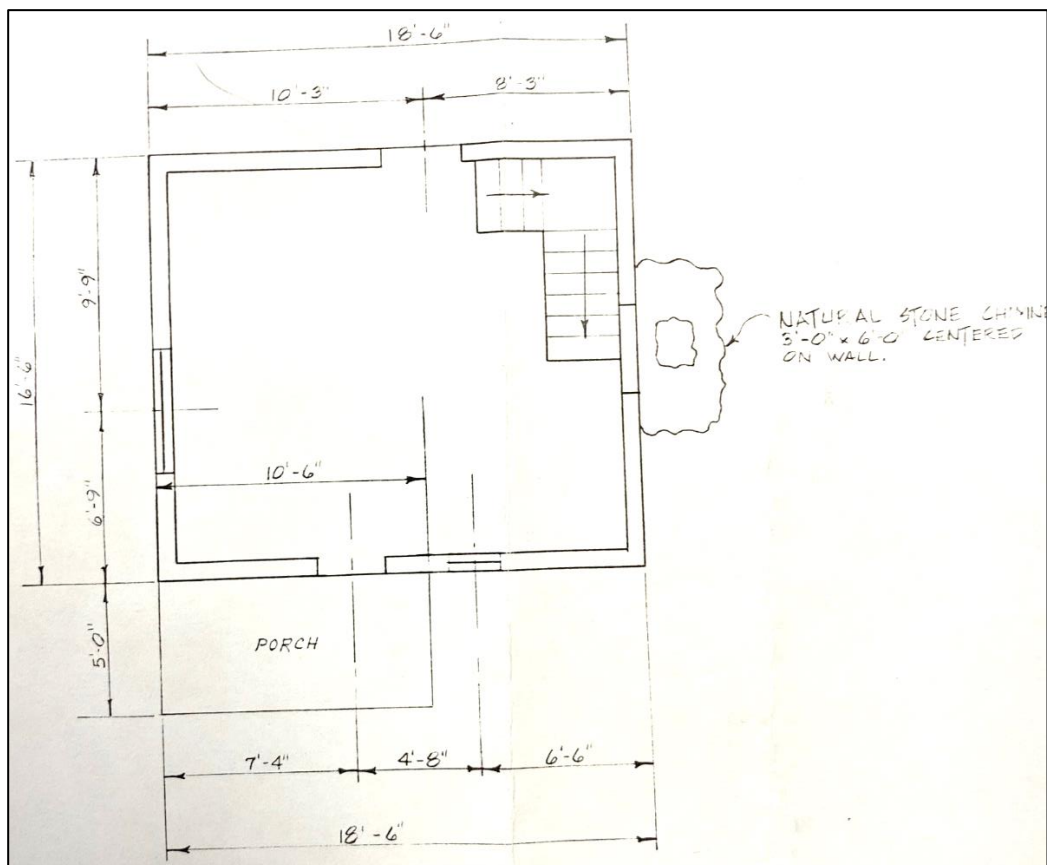
The log cabin was visually inspected on 27 October 2021, and photographs were taken to document observations reported in the following chapters of this report. Simple hand calculations evaluated the capacity of the building to resist gravity, snow, wind, and seismic loads. Recommendations will be made based on the visual inspection and hand calculations.

9.3 Site inspection observations

The Burgess-Capps Cabin was inspected on 27 October 2021. Visual inspection revealed that numerous upgrades to several components of the building were performed over the years. These upgrades include the foundation; wall timbers (or logs); mortar joints; addition of saw-cut boards to the gable walls, doors and windows, and their framing and roof sheathing; steel brackets that tie the top timbers together; the entire roof system; and turnbuckles and cables used to anchor the top timbers to loft floor joists.

Figure 96 provides a floor plan, showing the building's dimensions. This drawing also shows stairs up to the loft. The following sections summarize the visual observations.

Figure 96. Diagrammatic floor plan showing dimensions and stairs to the attic.



9.3.1 Foundation condition and observations

In their investigation, the firm Roberts Thorne Architects discovered a preexisting foundation at the north side of the building, which is the

backside as seen from Figure 97. Their report speculated that the earlier room or shed either collapsed or sustained rot.¹²⁰

The foundation is primarily a stone wall with mortar joints. This wall is most visible at the west side, and west ends of the north and south walls. Figure 98 through Figure 100 show these walls. The lowest timbers of portions of the north and south walls appear to bear directly on the soil, but closer inspection and a little hand digging reveal that the lowest timbers bear on stone walls. Figure 101 shows where mortar is found below the lowest timber on the east wall near the intersection with the south wall.

Figure 97. Stone and mortar foundation at the west wall (photo by ERDC-CERL researchers, 2021).



¹²⁰ Roberts Thorne Architects, “Capp’s/Burgess Cabin Preservation Stabilization and Archaeological Report.”

Figure 98. Stone and mortar foundation at the west end of the south wall (photo by ERDC-CERL researchers, 2021).



Figure 99. Closeup view of the foundation wall at the west end of the south wall showing galvanized metal flashing (photo by ERDC-CERL researchers, 2021).



Figure 100. Foundation at the west end of the north wall (photo by ERDC-CERL researchers, 2021).



Figure 101. Foundation below the east wall, near the south wall, where mortar and possibly stone is below the lowest timber (photo by ERDC-CERL researchers, 2021).



Figure 99 shows galvanized metal flashing installed between the stone foundation and the bottom of the first timber at the west end of the south wall. Similar flashing can be felt along the east end of the south wall. The interior surface of the timbers near the bottom of the west portion of the north wall look relatively new with little weathering. The presence of the metal flashing and lack of weathered timber near the bottom of the

building give the impression that this cabin was completely disassembled, most components saved, and reassembled. This speculation that the cabin was disassembled and reassembled at the same site concurs with the “Capp’s/Burgess Cabin Preservation Stabilization and Archaeological Report (1992). Chapter “Findings, Architectural Building Elements” states that the “archaeological investigation has revealed a pre-existing foundation on the northern side of the structure.”¹²¹ This “preexisting foundation” could be the original foundation that was not rebuilt when the building was disassembled and reassembled. Later sections of this report describe and show pictures of several components of this cabin that are not original construction.

No differential settlement or cracks in the foundation wall can be seen. If this cabin was disassembled and reassembled, the foundation may also have been rebuilt using original or new stones and new mortar. The foundation needs to carry the gravity load from the building’s self-weight and snow. The almost direct bearing on the soil and minimal bearing pressure on the foundation, lack of foundation cracking and good condition of the mortar, and engineering judgement provide confidence that this foundation has adequate capacity.

9.3.2 Walls’ condition and observations

The cabin walls were constructed with log timbers and mortar joints which was a typical construction method for log cabins during the mid-to-late 1800s. The interior faces of a few timbers on the west side of the north wall appear to have relatively little weathering. The wall timbers seen on the east side of the south wall in Figure 102 appear well weathered, with chink marks. These timbers also have significant holes from woodpeckers, which is evidence of insect infestation. The sawn-lumber window framing and windows are not original due to the age of the wood and the clear changes made to the log walls. The timbers and mortar shown in Figure 102 are like the other walls and should have adequate capacity to resist the gravity and snow load.

¹²¹ Roberts Thorne Architects, “Capp’s/Burgess Cabin Preservation Stabilization and Archaeological Report.”

Figure 102. East side of the south wall showing the timber and mortar condition (photo by ERDC-CERL researchers, 2021).



A level was held up against all four walls of the cabin to visually determine which walls may be pitched or rotated in the plane of the wall or leaning out-of-plane, either toward the building interior or outward. The east and west wall lean out-of-plane toward the building interior, such that the rest of the building supports these walls. In the out-of-plane direction, the south wall was originally of greater concern because this wall leans outward away from the building, as seen in Figure 103. The single-story construction, thickness of the wall, and minor leaning of this wall indicate the out-of-plane wall leaning is not a concern for any cabin wall. A later section of this report shows turnbuckles and cables tie back the top north and south timber to the lean-to floor, providing further support for the south wall. There was no indication of cracking of mortar joints, indicating that the east, west, and south walls likely leaned during the original construction and the walls are stable.

Figure 103. Southeast corner of the cabin showing the south wall leaning outward away from the building (photo by ERDC-CERL researchers, 2021).



The stone chimney appears to lean slightly toward the building, where the cabin would support it, but there is no evidence of cracking. The stone chimney is well supported by the cabin, including near the top where the upgraded roof system supports it. The top of the chimney extends approximately only 1 ft above the roof peak, providing further confidence that it is well supported.

The cabin wall timbers (logs) of several walls slope in the plane of the walls. The greatest wall slope of this type appears to be at the east side of the south wall, as shown in Figure 104. There does not appear to be cracking or recent settlement, indicating this and most other walls are stable and likely constructed with this degree of slope.

Figure 104. The south wall at the southeast corner of the cabin showing wall timbers sloped to the east (photo by ERDC-CERL researchers, 2021).



The east portion of the north wall shown in Figure 105, however, has considerable rot and settlement. Figure 106 shows a closeup view from the cabin interior of this wall just above and east of the door frame shown in Figure 105. The wide mortar joint near the top of the door in Figure 105 is covered by the tape measure in Figure 106. Figure 106 shows where a $\frac{3}{4}$ -inch-wide crack was measured near the door frame. It appears that recent rot of the wall timbers may have caused wall settlement directly east of the door. The door frame and lintel prevented settlement of the timber above, leading to the crack seen in Figure 106. The rotted timbers east of this door frame should be replaced soon. During the cabin inspection on 27 October 2021, the wall timbers below the wide mortar joint and east of the door were easily moved outward when pushed by hand, further revealing the poor condition of this portion of the north wall.

Figure 105. East portion of the north wall where considerable timber rot and settlement was seen (photo by ERDC-CERL researchers, 2021).



Figure 106. Wall crack (3/4 inch thick) measured just east of the door lintel on the north wall (photo by ERDC-CERL researchers, 2021).



Figure 105 further shows the north door framing is rotted, including the door threshold shown in Figure 107.

Figure 107. Rotted north door framing, including the threshold (photo by ERDC-CERL researchers, 2021).



9.3.3 Cabin floor's condition and observations

The interior floor planks bear on small floor joists, and those floor joists appear to rest directly on the ground below. Figure 108 shows the floor planks just inside the south door entrance to the cabin. Figure 109 is a closeup view taken at the center of Figure 108, showing a floor joist supporting the planks and this joist bearing on the soil below.

Figure 108. Floor planks inside the cabin's south door (photo by ERDC-CERL researchers, 2021).



Figure 109. Closeup view showing a floor joist bearing on the soil below (photo by ERDC-CERL researchers, 2021).



The floor joists are likely continuously supported by the soil below, as shown in Figure 109, because the floor planks do not sag, and the floor joists are shallow. The sawn lumber used in the floor planks indicates these and most joists below are not original construction. The lack of floor joist sagging and good condition of the planks and joists below indicate this floor should have sufficient capacity for normal residential

foot traffic, which is a uniform distributed live load of 40 pounds per square foot (psf).¹²² The roof has had many reinforcements, which support the shingle-clad wooden planks on the exterior (Figure 110).

Figure 110. Wood joists added to one side of the roof without roof sheathing (photo by ERDC-CERL researchers, 2021).



9.3.4 Cabin loft floor's condition and observations

The cabin has a stairway leading up to a small, second-story loft (Figure 96), likely used for sleeping quarters. The bottom of Figure 111 shows the north portion of the loft floor. The floor planks (1×6 and 1×8 boards) span in the east–west direction of the cabin, and floor joists below span in the north–south direction. Figure 112 shows the floor joists at the underside of the loft floor.

122. See ASCE (American Society of Civil Engineers). *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, ASCE Standard 7-16 (Reston, Virginia: American Society of Civil Engineers, 2017), Table 4.3-1, p. 15.

Figure 111. Loft floor joist with the turnbuckles and threaded rods running to the top of the wall timbers (photo by ERDC-CERL researchers, 2021).



Figure 112 shows the north portion of this loft floor. It is expected that this loft is not original because the floor planks and joists are both saw cut. Some of these joists have true 2×6 in. dimensions. These joists are spaced approximately 3 ft on center and are believed to have been installed when the loft was originally constructed. At some later date, newer 2×8 s were installed that have the present-day dimensions of $1\frac{1}{2} \times 7\frac{1}{4}$ in. Some of these 2×8 s are single, while others are double. Two double 2×8 s were installed approximately 5 ft from the east and west walls. Cables were installed between these 2×8 s and connected to the turnbuckles that were anchored to the top wall timbers of the walls, as shown in Figure 111. The double 2×8 s are expected to have been installed at the same time as the cables and turnbuckles as a means to strengthen both the loft floor and prevent the top wall timbers from moving outward during strong winds. These cables and turnbuckles were installed in the opposite direction on the south side of the loft floor to the south wall top timber. The turnbuckles were connected to the same double 2×8 s, balancing the load under strong winds, where the double 2×8 could effectively resist the tension load along the short distance between the opposing cables. Single 2×8 s were installed between original 2×6 s where the double 2×8 did not exist so that either the original 2×6 s or new 2×8 s were placed at approximately 18 in. on center.

Figure 112. Floor joists below the loft floor (photo by ERDC-CERL researchers, 2021).



Neither the old 2×6 s or new 2×8 joists rest on the wall timbers. They are rather supported by relatively small, old 2×4 s that are fastened to a wall timber. This 2×4 along the north wall can be seen at the bottom of the joists in Figure 112. Figure 113 zooms in on the same 2×4 , showing that it has rotated and has pulled partly away from the supporting timber. The loft area has limited ceiling height and should never have large occupancy, but modern building codes still require significant load bearing capacity if it is to be open to the public. Habitable attics and sleeping areas should have a uniform load capacity of 30 psf.¹²³ The 2×4 support for the loft joists has far less capacity than would be needed to support this live load plus the self-weight of the loft floor. The cables and turnbuckles are clearly helping support these joists, plus they help to hold the joists up against the top wall timber. Adequate support for these joists should be designed and installed.

123. Pikes Peak region, Colorado, Pikes Peak Regional Building Code § 1608.1.

Figure 113. Closeup view of the joist-supporting 2 × 4 along the north wall (photo by ERDC-CERL researchers, 2021).



9.3.5 Roof system's condition and observations

The roof system was the greatest concern prior to the site inspection because the design wind speed for Colorado Springs is high and the roof is relatively light weight. The roof system could be lifted off the cabin if it is not securely anchored to the top wall timber. The site inspection revealed there have been numerous upgrades to the roof system over the years, many likely related to increasing the wind load resistance. No design assumptions, calculations, and upgrade details were available to review. The visual inspection observations below follow the wind-load-resistance load path from the roof shingles down to the top timbers of the cabin walls.

- Wood shingles fasten to the roof sheathing planks, as seen in Figure 95 and Figure 96.
- Horizontal wood planks span in the east–west direction of the cabin. Figure 114 shows the underside of these planks at the exterior north-west corner of the roof.
- Galvanized metal edging for the roof planks is shown in Figure 114.

- Figure 114 shows an old roof joist at the cabin's northwest corner. These roof joists are irregularly cut, approximately 4 in. deep by 4 in. wide, and are spaced approximately 3 ft apart on center. Figure 115 provides an interior view showing the old roof joists. The method of fastening the roof boards to the old joists could not be seen, but they are likely nailed.
- New 2 × 10 (1 ½ × 9 ¼ in. actual dimension) roof joists were added approximately halfway between the old joists so that they were also spaced 31 inches apart from one another.
- Simpson Strong-Tie NER-413 metal brackets fasten some of the deck board to the new 2 × 10 joists. Two of these brackets are installed on both sides of the joists (see Figure 116). This is similar to the A34 or A35 bracket found in a current Simpson Strong-Tie catalog.
- Plywood gusset plates connect the new 2 × 10s at the peak of the roof, as shown in Figure 117.
- The bottom of the new 2 × 10 roof joist is anchored to the top of the top wall timbers using 2 × 2 × 1/8 in. thick steel angles and Simpson Strong-Tie brackets, as seen in Figure 118. The angles are well anchored to the joists using wood screws, so it is reasonably assumed the bottom ends of these angles are also well anchored to the wall timbers, but these details cannot be seen. Figure 119 shows the Simpson Strong-Tie brackets are fastened to the top wall timber using wood screws, shown in Figure 115.
- Figure 115 and Figure 117 show 1 × 4 diagonal braces for the new 2 × 10 roof joists. These appear to have been installed to prevent rotation of the new joists before the roof boards were installed.
- Figure 119 shows a closeup view of a cable that is fastened to a double 2 × 8 below the loft floor, which connects to a turnbuckle, which is bolted to two steel angle brackets, which is lag bolted to the top wall timber.
- The wall timber at the top of the north and south walls are connected to the wall timbers at the top of the east and west walls using the steel brackets shown in Figure 120. This picture shows the northeast corner, where the north timber on the left side bears on the east timber. The brackets consist of a steel angle with a stiffener plate welded to it. The sides of the angle are lag bolted to the wall timbers, as shown in Figure 121.
- Prior to the installation of the interior brackets shown in Figure 120, two railroad-type steel spikes are used to fasten the exterior corners of

- the wall top timbers to one another. Figure 121 shows the spikes installed at the southeast corner of the cabin.
- Figure 115 and Figure 117 show small portions of the west and east gable walls, respectively. The walls are framed with modern 2×4 studs, spaced at the standard 16 in. on center. These walls are sheathed with modern oriented strand board (OSB) plywood. The exterior of these walls is covered with the older vertical saw-cut board siding. The vertical exterior boards may have been removed from the earlier gable walls when the new roof system was installed and then reinstalled over the OSB sheathing.

Figure 114. Exterior view of the northwest corner of the roof showing the roof boards, galvanized metal edge, old roof joist, and gable end wall planks (photo by ERDC-CERL researchers, 2021).



Figure 115. Interior view of the north side of the roof showing the roof boards, old and new roof joists, turnbuckle, and Simpson Strong-tie metal brackets (photo by ERDC-CERL researchers, 2021).



Figure 116. Simpson Strong-tie NER-413 metal brackets used to anchor the roof boards to the new joists (photo by ERDC-CERL researchers, 2021).



Figure 117. Northeast side of roof showing the roof-peak plywood gussets and steel angle anchorage at the bottom (photo by ERDC-CERL researchers, 2021).

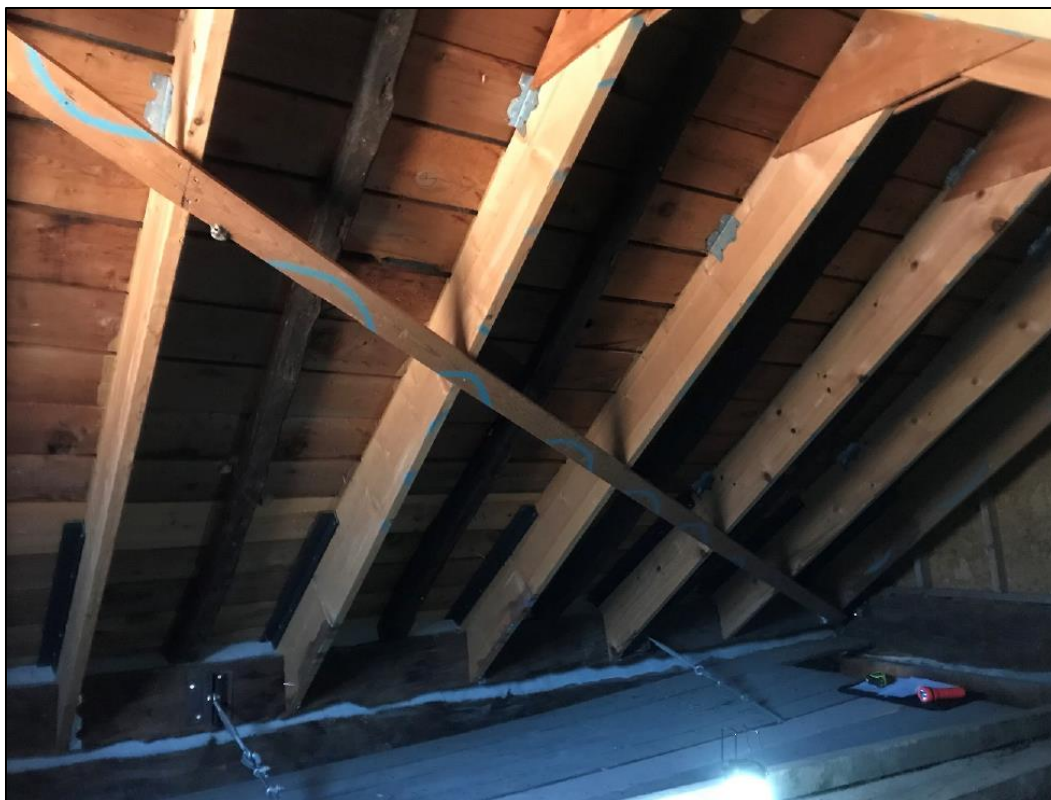


Figure 118. Bottom of the 2 × 10 roof joists showing the anchorage to top wall timbers using L2 × 2 × 1/8 in. angles and Simpson Strong-Tie brackets (photo by ERDC-CERL researchers, 2021).



Figure 119. Close-up of a cable, turnbuckle, and bracket used to tie the loft floor joists to a wall top timber (photo by ERDC-CERL researchers, 2021).



Figure 120. Steel angle bracket used to bolt the top timbers to one another at each corner (photo by ERDC-CERL researchers, 2021).



Figure 121. Two rail spikes used to fasten the south wall timber to the east wall top timber below (photo by ERDC-CERL researchers, 2021).



Figure 120 and Figure 121 show that considerable effort was made to mechanically fasten the top wall timbers to one another at all four corners. This would have stabilized the building, increased wind uplift resistance, and even prevented spreading of the roof when loaded with heavy snow. The entire roof system is clearly not original construction, as seen by the

new roof joists, roof boards, and many hardware upgrades. The entire roof system must have been disassembled in order to install the new 2 × 10 roof joists. The 1 × 4 roof joist brace shown in Figure 115 and Figure 117 would have been installed to stabilize the joist prior to reinstalling the roof boards. The steel angles like the one shown in Figure 118 would have been anchored to the top wall timbers prior to reinstalling the roof boards.

Significant upgrades have been made to the cabin roof system as described above, including the brackets installed at the exterior and interior of the wall timbers, the cable and buckles, the angle and Simpson Strong-tie brackets anchoring the bottom of the roof joists, the 2 × 10 roof joists, the plywood gusset plates at the top of the roof joists, and the brackets fastening the roof boards to the trusses. This roof system is well tied together and to the reinforced top of the cabin walls. Therefore, the roof system should effectively resist the 130 mph design wind and the 30 psf design snow load.

9.4 Current design loads and capacity to resist these loads

Building code requirements have changed dramatically since the Burgess-Capps Cabin was constructed. Residential construction in the 1870s would not have been governed by any building code. ERDC-CERL has been asked to assess the structural safety of the Burgess-Capps Cabin. This can be estimated in terms of its capacity to resist the loads defined by modern building codes.

Design loads include gravity dead and live loads, wind, snow, and seismic loads. Engineering judgement can be used to rule out consideration of many loads applied to several building components. For example, no consideration need be given to the dead or self-load and live loads applied to the ground floor of the cabin, because the floorboards are supported by floor joists that appear to be directly on the ground below. A brief evaluation of the selected cabin components' ability to resist modern building code loads is presented in this chapter. This evaluation will include the loft floor's ability to resist dead and live loads. The walls and roof system's ability to resist dead, snow, wind, and seismic loads will be evaluated.

The balance loading snow load below 7,000 ft is 30 psf,¹²⁴ and in a 15 October 2021 email, Adam Smith indicated the Burgess-Capps Cabin's

124. Pikes Peak region, Colorado, Pikes Peak Regional Building Code § 1608.1.

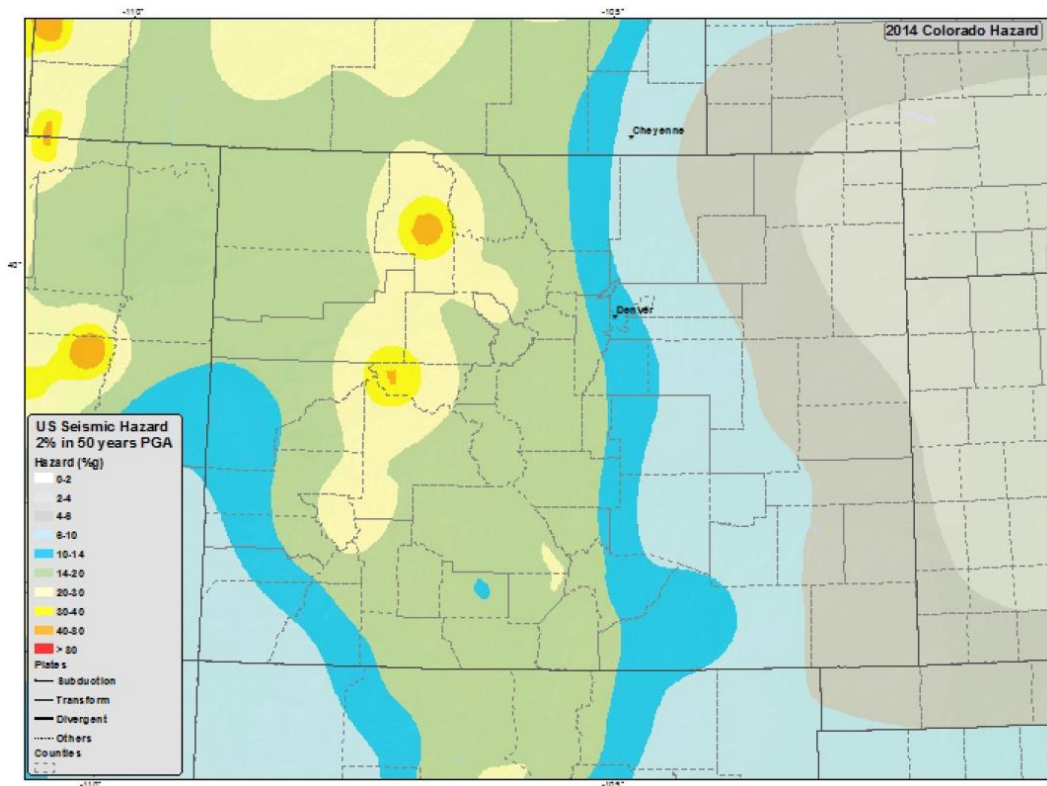
elevation is 6,673 ft. ASCE 7-16 defines the application of snow loads to sloped roofs.¹²⁵ The Pikes Peak Regional Building Code defines the ultimate design wind speed to be 130 mph for Category I/II buildings.¹²⁶

Figure 122 is a 2014 seismic hazard map for Colorado showing the estimated peak ground acceleration (PGA) based on a 2% probability of exceedance in 50 years. Colorado Springs and the Air Force Academy are almost at the *center* of this map, *slightly offset to the right of center*, where the *blue vertical band* intersects the *green central area*. At this location, the PGA is 0.14 g. This is a very low seismic hazard so that wind load governs the applied lateral load for every component of the cabin. Vertical seismic loads would also have far less impact than the vertical loading effects of snow or wind. For these reasons, no further consideration of seismic loads is given.

125. ASCE (American Society of Civil Engineers), *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, ASCE Standard 7-16 (Reston, Virginia: American Society of Civil Engineers, 2017), Section 7.4.

126. Pikes Peak region, Colorado, Pikes Peak Regional Building Code § 1609.3.

Figure 122. Seismic hazard for Colorado defined by the peak ground acceleration with a 2% probability of exceedance in 50 years. (Image from USGS. Public domain.)¹²⁷



The adequacy of the roof to resist the snow loads will be confirmed. Figure 119 shows that the bottoms of the new roof joists are anchored to what appears to be the top timber of the wall. However, it may be possible for the top wall timbers to be lifted off the building under the very strong 130 mph design wind speed. Under strong wind loads, the entire roof could uplift, pulling the roof off. This would remove the out-of-plane bracing of the walls, potentially causing complete collapse of the building. The recent upgrade to the roof would have strengthened it. However, this may have made the roof more vulnerable to tear-off because the entire roof could uplift as a single intact unit, and this value will be used to assess the uplift forces on the roof and perhaps the adequacy of the anchorage of the wall timbers to one another.

127. Earthquake Hazards Program, "2014 Seismic Hazard Map-Colorado," US Geological Survey (USGS), <https://www.usgs.gov/media/images/2014-seismic-hazard-map-colorado>.

10 Material Sampling and Analysis

Researchers collected 18 material samples on a site visit to the Burgess-Capps Cabin during October 2021 from locations identified in Table 1. Of these samples, 13 were collected from the exterior, and 5 were collected from the interior. The sample locations are diagrammed in Figure 123–Figure 127.

Figure 123. South elevation diagram of Burgess-Capps Cabin showing the location for material sample 2. (Drawn by ERDC-CERL.)

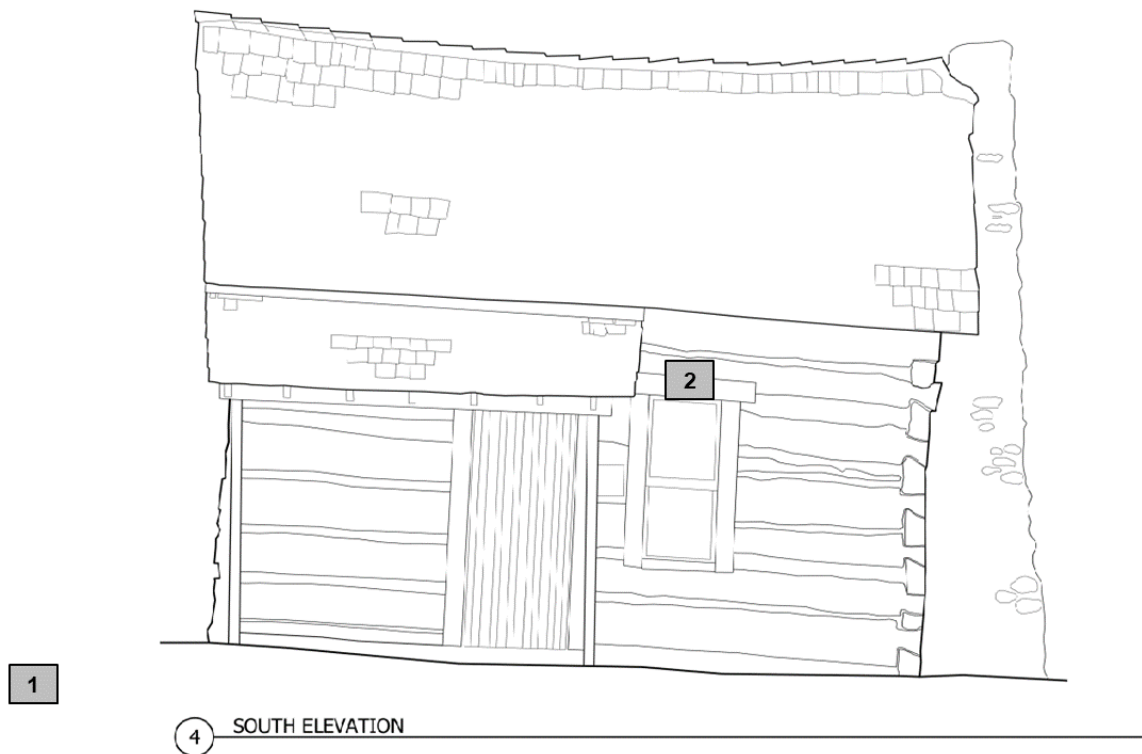
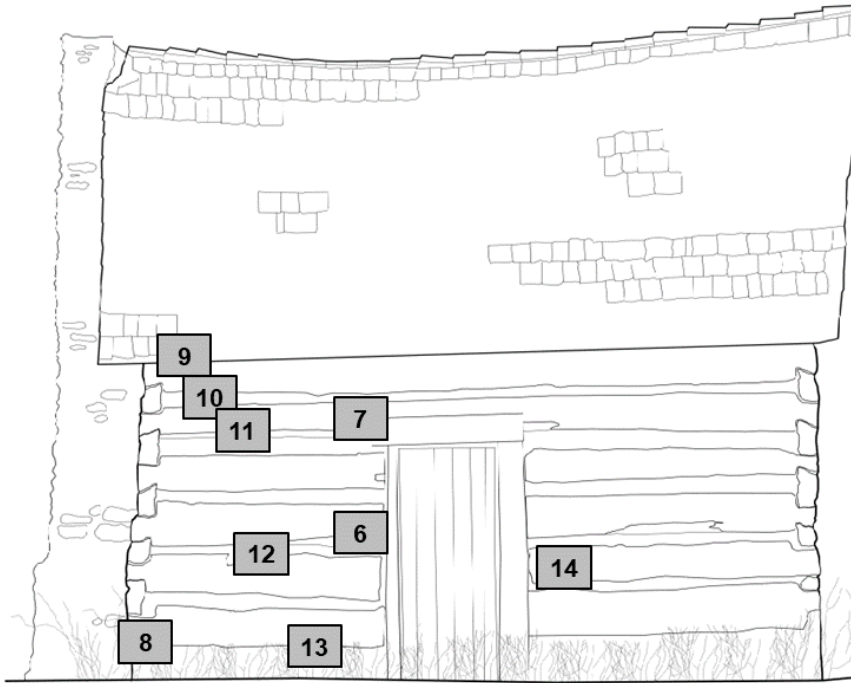


Figure 124. North elevation diagram of Burgess-Capps Cabin showing the locations for material samples 6-14. (Drawn by ERDC-CERL.)



3 NORTH ELEVATION

Figure 125. East elevation diagram of Burgess-Capps Cabin showing the locations for material samples 15-18. (Drawn by ERDC-CERL.)

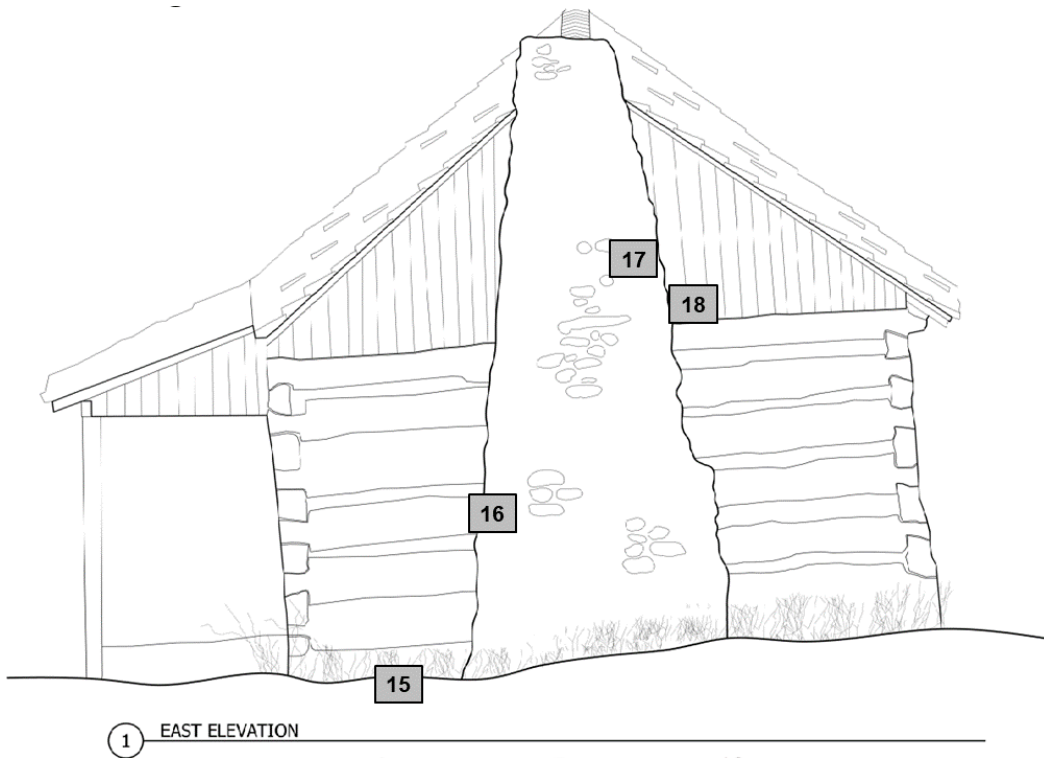


Figure 126. West elevation diagram of Burgess-Capps Cabin showing the locations for material samples 3-5. (Drawn by ERDC-CERL.)

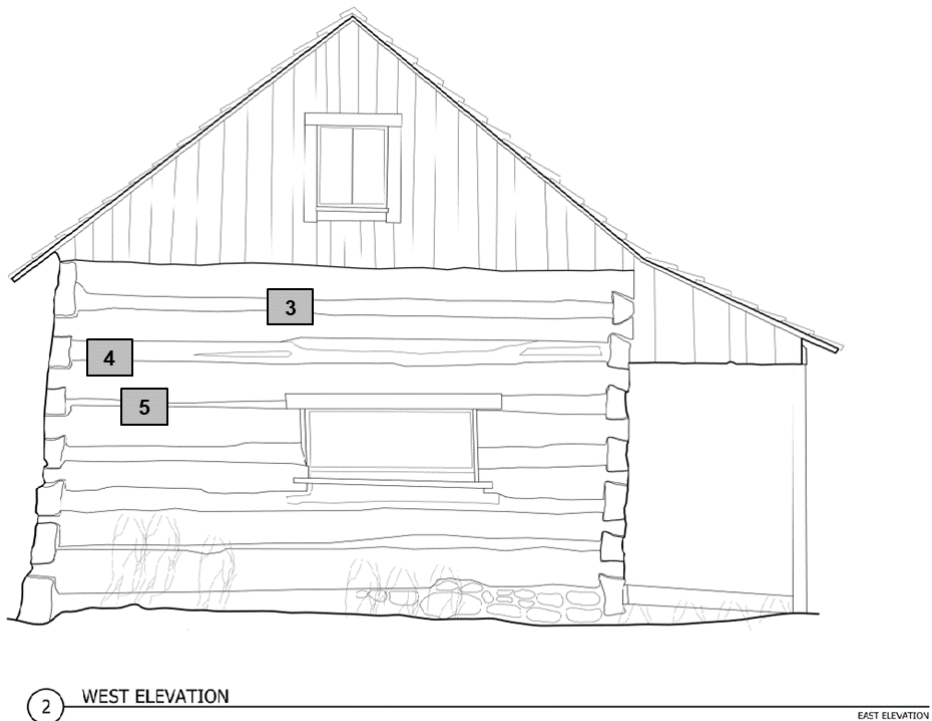


Figure 127. Interior diagram of Burgess-Capps Cabin showing the locations for material samples 2, 4, 5, and 14–18. (Drawn by ERDC-CERL.)

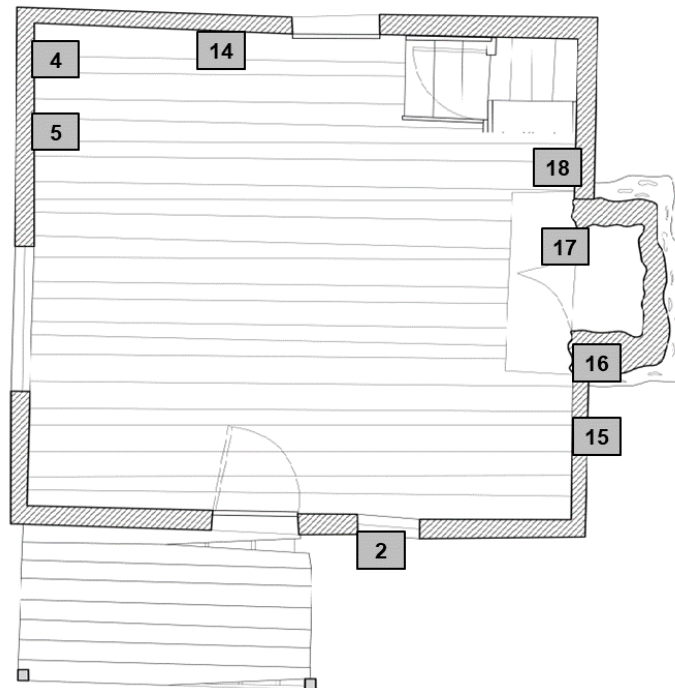


Table 1. Material sample locations and descriptions.

ID	Location	Material Description
1	S exterior	native soil; coarse-grained, nonplastic
2	S exterior	header mortar; appears similar to 12
3	W exterior	top-row mortar; appears unique
4	W interior	mortar with white coating
5	W interior	soil-based filler (possibly original)
6	N exterior	weathered timber; appears significantly older than 14
7	N exterior	2nd from top timber (weathered)
8	N exterior	bottom timber (weathered)
9	N exterior	top-level mortar; appears similar to 16
10	N exterior	1st from top mortar; smooth, modern, good repair technique
11	N exterior	2nd from top mortar; good technique, but different mix from 10
12	N exterior	4th from top mortar; coarse mix, unique from others
13	N exterior	6th from top mortar; modern fiber reinforcement
14	N interior	timber that appears new or recently sawn
15	E exterior	foundation material; appears as lime plaster

Table 1 (cont.). Material sample locations and descriptions.

ID	Location	Material Description
16	E exterior	chimney mortar; appears to contain pigment
17	E interior	white mortar from back of chimney; possibly lime based
18	E interior	fiber-reinforced mortar; appears similar to 13

The samples taken can be seen in Figure 128 to Figure 149.

Figure 128. Photograph of sample 1 (photo by ERDC-CERL researchers, 2021).



Figure 129. Native soil southwest of the cabin (sample 1) (photo by ERDC-CERL researchers, 2021).



Figure 130. Photograph of sample 2 (photo by ERDC-CERL researchers, 2021).



Figure 131. Photograph of sample 3 (photo by ERDC-CERL researchers, 2021).



Figure 132. Unique mortar near the top of the west exterior wall (sample 3) (photo by ERDC-CERL researchers, 2021).



Figure 133. Photograph of sample 4 (photo by ERDC-CERL researchers, 2021).



Figure 134. Photograph of sample 5 (photo by ERDC-CERL researchers, 2021).



Figure 135. Photograph of sample 6 (photo by ERDC-CERL researchers, 2021.)



Figure 136. Photograph of sample 7 (photo by ERDC-CERL researchers, 2021.)



Figure 137. Photograph of sample 8 (photo by ERDC-CERL researchers, 2021.)



Figure 138. Photograph of sample 9 (photo by ERDC-CERL researchers, 2021.)



Figure 139. Photograph of sample 10 (photo by ERDC-CERL researchers, 2021).



Figure 140. Photograph of sample 11, a larger, irregular, light-colored aggregate fragment, next to a ruler for scale.



Figure 141. Photograph of sample 12 (photo by ERDC-CERL researchers, 2021).



Figure 142. Photograph of sample 13 (photo by ERDC-CERL researchers, 2021).



Figure 143. Fiber-reinforced mortar (samples 13 and 18) with white coloration evident of carbonation (photo by ERDC-CERL researchers, 2021).



Figure 144. Photograph of sample 14 (photo by ERDC-CERL researchers, 2021).



Figure 145. Photograph of sample 15 (photo by ERDC-CERL researchers, 2021).

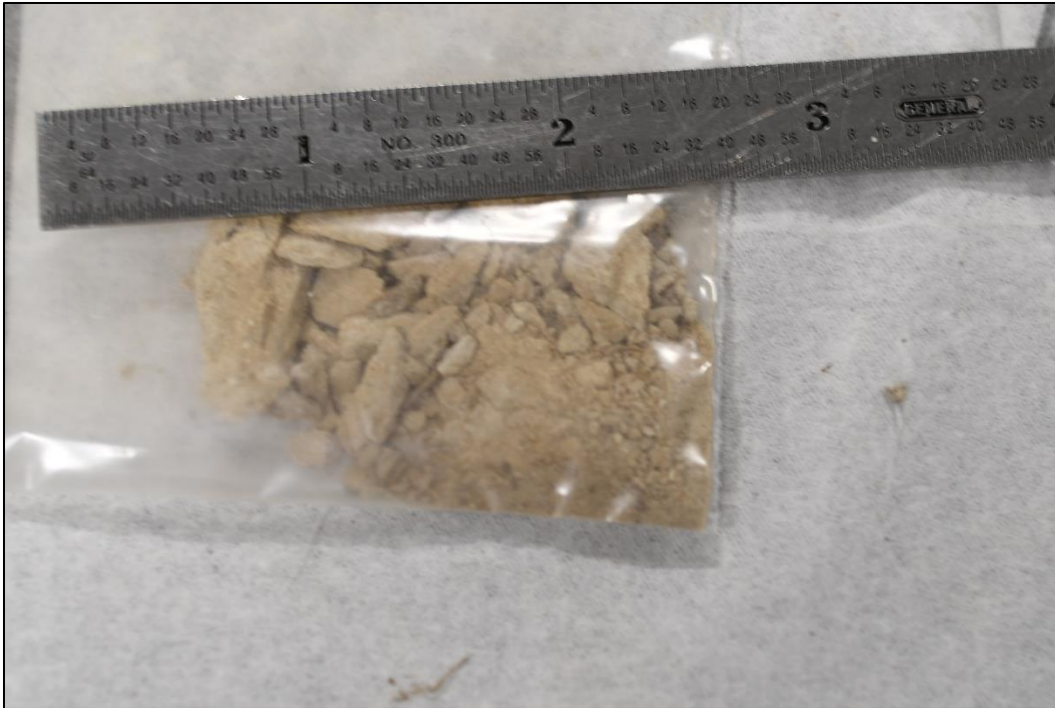


Figure 146. Photograph of sample 16 (photo by ERDC-CERL researchers, 2021).



Figure 147. Photograph of sample 17 (photo by ERDC-CERL researchers, 2021).



Figure 148. White mortar spread on the interior surface of the chimney (sample 17) (photo by ERDC-CERL researchers, 2021).



Figure 149. Photograph of sample 18 (photo by ERDC-CERL researchers, 2021).



A material analysis approach was developed in consideration of Preservation Brief 43, Section “Materials Investigation and Testing,” and Preservation Brief 2, “Repointing Mortar Joints in Historic Masonry Buildings.” The depth and fidelity of the overall analysis was adjusted to match the scope of the project. It was not possible to perform all possible analytical techniques on all 18 samples due to limited time and personnel resources.

10.1 General observations

We concur with the 1992 report in that the structure overall does not appear to accurately approximate what might have historically occurred at the site. Several of the wall timbers, especially on the north wall, have minimal weathering and are rough sawn, not hand hewn, indicating recent refurbishment or replacement. A freshly milled timber that might fit over the north door as a header was found in the attic (Figure 152). Some of the ceiling joists appear true dimensional and hand hewn, while others are rough sawn, and still others made from notched and sistered (joined side by side) modern dimensional lumber (Figure 150). A metal flashing, likely aluminum due to lack of corrosion, was found under the south wall. Considering these observations, we surmise that the structure was either moved to this location after the onset of aluminum flashing in general construction (approximately 1920s) or the whole structure was lifted in order

to place the flashing during foundation repair and or reconstruction of the wall timbers.¹²⁸ It is possible that structural issues, such as the poor connection in between the north wall plate and the ceiling joists shown in Figure 151, was caused by the moving or lifting of the structure.

Figure 150. A combination of a rough-sawn or hewn, true-dimensional joist and a notched, sistered dimensional lumber joist (photo by ERDC-CERL researchers, 2021).



128. Jeffrey L. Erdly and Gregg M. Bekelja, "The History of Flashing and Its Importance in Both Modern and Historic Masonry Construction," in *Building Envelope Technology Symposium* (Raleigh, NC: International Institute of Building Enclosure Consultants [IIBEC], 2008), 97–104, <https://iibec.org/wp-content/uploads/2016/04/2008-BES-erdly-bekelja.pdf>.

Figure 151. Example of a poor connection between the north wall plate and the ceiling joists (photo by ERDC-CERL researchers, 2021).



Figure 152. Timber found in the attic that appears cut to fit as a header over the north doorway (photo by ERDC-CERL researchers, 2021).



We further concur with the 1992 report that waterproofing should be monitored and addressed immediately, as we observed significant gaps between the chimney and the east timber wall (Figure 153 and Figure 154). Due to settlement of the foundation and natural “breathing” of the timbers in the structure, it would be difficult to permanently close this gap using historically relevant materials, such as coal tar. Replacing timbers due to inadequate treatment can result in a harsh color difference (see Figure 155). Fire-rated elastomer or silicone sealants designed for outdoor use may provide the longest-lasting repair between the chimney and the timbers.

Figure 153. Close-up of the pigmented chimney mortar (sample 16) interfacing with the gaps between at least two different mortars (photo by ERDC-CERL researchers, 2021).

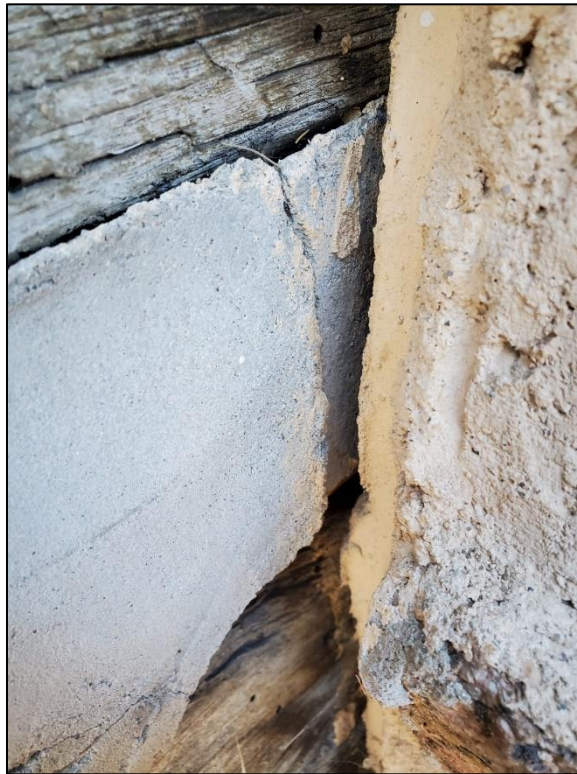
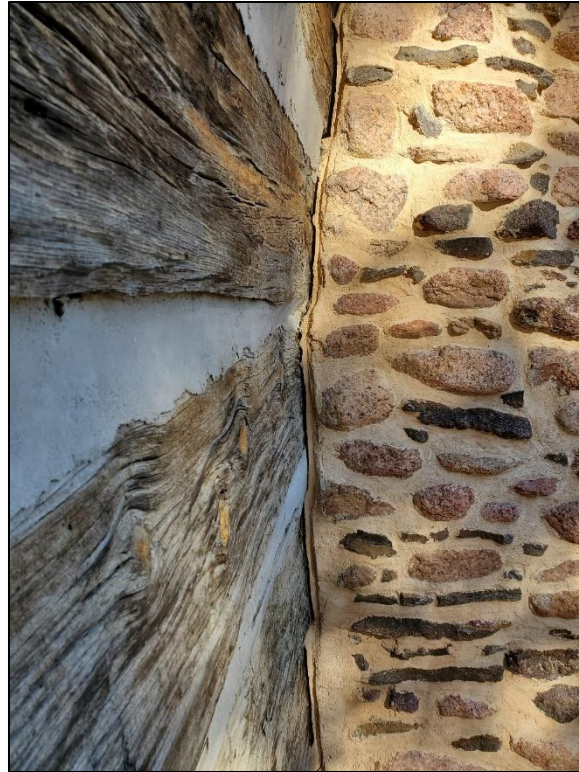


Figure 154. Poor connection between east exterior wall and chimney (photo by ERDC-CERL researchers, 2021).



The beetle and woodpecker damage referenced in the 1992 report continues to the present day, especially on the south wall. Material samples of a few timbers were taken for typing analysis. A full investigation of the wood species and age of each timber composing this cabin would require between \$40,000 to \$80,000 of focused financial support, sample analysis, and reporting efforts. If desired, we recommend engaging the USDA Forest Products Laboratory regarding a comprehensive effort of typing and dating.

Figure 155. Freshly sawn timber in the north interior wall (sample 14) (photo by ERDC-CERL researchers, 2021).



We found at least five different mortars in the exterior chinking, as well as expanded metal lath (commonplace in North American construction from approximately the 1900s onward) providing reinforcement in numerous, but not all, timber joints. The north wall provides the best example of this complicated assortment of chinking formulas and reinforcements (Figure 156 and Figure 157). We located a small quantity of soil-based chinking in the northwest corner of the interior that might represent the original chinking, which would have been installed prior to commonplace use of Portland cement for this application (Figure 158).

Figure 156. North exterior wall (samples 6 through 13) (photo by ERDC-CERL researchers, 2021).

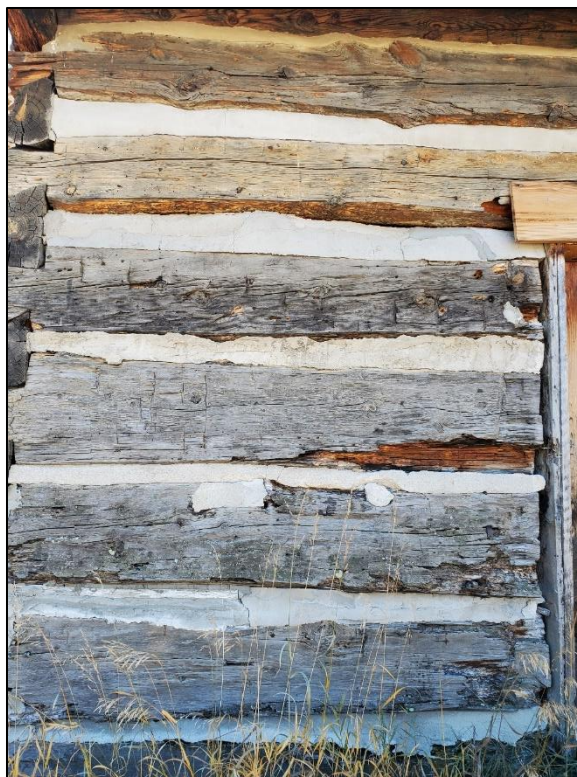


Figure 157. Example of nails and wire lath used as reinforcement for various layers of chinking (photo by ERDC-CERL researchers, 2021).



Figure 158. Mortar with white coating and soil-based filler on the west interior wall (samples 4 and 5 (photo by ERDC-CERL researchers, 2021)).



The visible foundation under the east wall, south of the chimney, has a small section of friable material that could be lime or gypsum plaster (Figure 159). The west wall foundation is composed of granite stones and mortar that carry the same color, composition, and construction style as the chimney (Figure 160). The chinking at the top plate appears to have the same pigment as the pointing on the external faces of the chimney, so it is likely that the roof was repaired and anchored at the same time as the chimney was pointed.

Figure 159. Foundation material under the east exterior wall (sample 15) (photo by ERDC-CERL researchers, 2021).



Figure 160. Example interface between the stone foundation and the west wall timbers (photo by ERDC-CERL researchers, 2021).



10.2 Wood-typing analysis (limited)

Macroscopic and microscopic wood-typing analysis was performed by an external laboratory on samples 6, 7, 8, and 14. Sample 6 presented with decay that precluded complete species typing, but it was narrowed down to the hard pine group, which includes lodgepole pine (*Pinus contorta*), ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), and jack pine (*Pinus banksiana*). The remaining samples were identified as most likely lodgepole pine (*Pinus contorta*), which is prevalent in natural stands in the Colorado region, or possibly Jack pine (*Pinus banksiana*), but this alternative species does not grow in natural stands in Colorado. Since lodgepole pine (*Pinus contorta*) is not considered endangered, historically accurate restorations of the wall timbers should consider specifying this species, subject to risk-benefit analysis when considering the potential for insect intrusion and woodpecker damage.

10.3 Wood Identification

The following reproduces the wood-typing analysis that was performed on the samples from the Burgess-Capp cabin.

LIGNO LOGIC LLC

1919 Woodlawn Ave.
Eugene, OR 97403
Phone /Fax: 541 485-7991
E-mail: suzana@lignologic.com

WOOD SPECIES IDENTIFICATION REPORT

DATE:	February 9, 2023
WOOD ID NUMBER:	W23-0209
CLIENT:	US Army ERDC-CERL
SUBMITTER:	Pete Stynoski, PhD
ANALYZED BY:	Suzana Radivojevic, PhD

WOOD SPECIES IDENTIFICATION SUMMARY:**Sample #6:**

Submitted Sample ID: 6
Source: Burgess-Capps Pioneer Cabin
Component: Unknown
Geographic Location: Colorado Springs, CO
Construction Date: 1870s
Wood Species: Hard pine group: lodgepole pine (*Pinus contorta*), ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), and Jack pine (*Pinus banksiana*)

Sample #7:

Submitted Sample ID: 7
Source: Burgess-Capps Pioneer Cabin
Component: Unknown
Geographic Location: Colorado Springs, CO
Construction Date: 1870s
Wood Species: Lodgepole pine (*Pinus contorta*)
Alternative Wood Species: Jack pine (*Pinus banksiana*)

Sample #8:

Submitted Sample ID: 8
Source: Burgess-Capps Pioneer Cabin
Component: Unknown
Geographic Location: Colorado Springs, CO
Construction Date: 1870s
Wood Species: Lodgepole pine (*Pinus contorta*)
Alternative Wood Species: Jack pine (*Pinus banksiana*)

Sample #14:

Submitted Sample ID: 14
Source: Burgess-Capps Pioneer Cabin
Component: Unknown
Geographic Location: Colorado Springs, CO
Construction Date: 1870s
Wood Species: Lodgepole pine (*Pinus contorta*)
Alternative Wood Species: Jack pine (*Pinus banksiana*)

NOTES:

Thank you for submitting your samples for wood identification. Four samples were examined for macroscopic anatomical features and microscopically using standard wood identification methodology:

Sample #6

Sample description: Sample size approximately 1/8" x 1/4" x 1". Fungal decay present throughout the sample. Sufficiently sound for sectioning. Tree rings narrow.

Macroscopic features: No characteristic odor. Color brown, non-characteristic due to decay. Straight and even grained. Hardness unavailable due to decay. Growth rings distinct, narrow to wide, delineated by a band of darker latewood. Earlywood/latewood transition abrupt. Latewood zones narrow. Resin canals present, longitudinal, solitary.

Microscopic features: Tracheids with bordered pits in one row. Latewood up to 12 cells wide. Cross-field pitting destroyed by fungal decay. Rays uniseriate and fusiform. Ray tracheids present, marginal and interspersed, prominently dentate. Resin canal diameters unavailable due to decay.

Conclusions: The sample could not be identified to the level of species due to advanced fungal decay of cellular diagnostic features. Based on the available features, the sample is identified as belonging to a hard pine group, specifically: lodgepole pine (*Pinus contorta*), ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), and Jack pine (*Pinus banksiana*).

Sample #7

Sample description: Sample size approximately 1/4" x 1/4" x 1 1/2". Sample weathered on exterior surfaces, free of fungal decay. Sufficiently sound for sectioning. Tree rings narrow to medium wide.

Macroscopic features: Color brown. Non-characteristic odor. Grain straight. Moderately soft. Growth rings distinct, narrow to wide, delineated by a band of darker latewood. Earlywood/latewood transition abrupt. Latewood zones narrow. Resin canals present, longitudinal, mostly solitary, and numerous.

Microscopic features: Tracheids with bordered pits in one row. Cross-field pitting pinoid with 2-6 pits (generally 4) per cross-field. Rays uniseriate and fusiform. Ray tracheids present, marginal and interspersed, prominently dentate. Marginal tracheids often in several rows. Ray parenchyma thin-walled. Diameter of longitudinal resin canals diameter 80-100µm.

Conclusions: Based on the macroscopic and microscopic cellular features, the sample is identified as lodgepole pine (*Pinus contorta*) and, alternatively, jack pine (*Pinus banksiana*). Lodgepole pine and jack pine have similar anatomical features and cannot be separated reliably based on their anatomy. However, lodgepole pine is native to the geographic location of the building site in Colorado. In contrast, the native range of jack pine extends northwest of Indiana and Pennsylvania and northeast of Minnesota and does not grow in natural stands in Colorado. If locally available timber was used for building construction of the Burgess-Capps Pioneer Cabin, it could be assumed that the sample is lodgepole pine.

Sample #8

Sample description: Sample size approximately 1/4" x 3/16" x 1 1/2". Sample appears free of fungal decay. Sufficiently sound for sectioning. Tree rings narrow to medium wide.

Macroscopic features: See notes for Sample #7.

Microscopic features: See notes for Sample #7.

Conclusions: Based on the macroscopic and microscopic cellular features, the sample is identified as lodgepole pine (*Pinus contorta*) and, alternatively, jack pine (*Pinus banksiana*). See notes for Sample #7.

Sample #14

Sample description: Sample size approximately 3/16" x 3/16" x 1 1/2". Fungal staining present in the sample, free of fungal decay. Sufficiently sound for sectioning. Tree rings narrow to medium wide.

Macroscopic features: See notes for Sample #7.

Microscopic features: See notes for Sample #7.

Conclusions: Based on the macroscopic and microscopic cellular features, the sample is identified as lodgepole pine (*Pinus contorta*) and, alternatively, jack pine (*Pinus banksiana*). See notes for Sample #7.

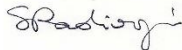
RECOMMENDATIONS:

Sample #6 is identified as a 'hard pine' group of pines, which, except jack pine, comprise species native to Colorado, including lodgepole pine, ponderosa pine, and Jeffrey pine.

Samples #7, #8, and #14 are microscopically identified as lodgepole pine or jack pine (*Pinus banksiana*). If the use of locally available pines for construction of the Burgess-Capps Pioneer Cabin can be supported by documentation and archival research, these samples should be separated as lodgepole pine since jack pine does not grow naturally in Colorado.

None of the pine species identified in the samples is endangered. The lumber (or timber) of identified species is expected to be commercially available. Lodgepole pine, ponderosa pine, and Jeffrey pine have comparable strength characteristics and appearance and are often used interchangeably for repair and replacement if the wood species cannot be identified or is commercially unavailable.

Sincerely,



Suzana Radivojevic, PhD
Wood scientist

Disclaimer

Ligno Logic LLC disclaims any liability of any kind arising out of use or misuse of the information contained and referenced in this report. All information in this report is provided to the best of our knowledge and believed by Ligno Logic LLC to be accurate at the time of analysis and based on sources believed to be reliable; it may however not be regarded as legally binding.

10.4 Material conclusions and recommendations

Recommendations for rehabilitation materials are considered in relation to the historical context about this structure as well as in National Park Service Preservation Briefs 2 and 43.

10.4.1 Chinking mortar

It is not possible to determine which of the numerous chinking materials is original to the structure. The architect should communicate their desired color and surface finish of chinking, considering the historical context and existing appearance. There are three main categories of chinking materials to consider for repairs: soil-based, Portland-based, and synthetic. Due to the brittle nature of Portland-based materials, and the limited durability of soil-based materials, we recommend making the jump to modern synthetic chinking materials. Considering the questionable historical accuracy in other areas of the structure, combined with the limited continuing resources for rehabilitation of this structure, it may be in the owner's best interest to utilize modern synthetic chinking for a long-lasting repair. Synthetic materials are ductile enough to move along with the timber structure, which should enable the most durable repair. However, we recognize that the owner or architect might prefer to retain the historical relevance of soil-based or Portland-based chinking materials. Regardless of the material selection, any loose, existing materials should be cleared prior to following the best practice or manufacturer recommendations for applying chinking repairs. New or replacement expanded metal lath may be required.

Should a Portland and lime mixture be desired, care should be taken to avoid overzealous additions of lime that could lead to carbonation distress, as we observed on the lowest timber of the north wall. Portland-based mortar mixture designs for chinking repairs should follow the guidance of Type N nonstructural mortars in American Society for Testing and Materials (ASTM) C270, *Standard Specification for Mortar for Unit Masonry*. The sand gradation should be specified and monitored to ensure the desired surface finish and uniformity across mixtures. The contractor should also heed the guidance of American Concrete Institute (ACI) PRC-546, *Guide to Concrete Repair*, and ACI PRC-303, *Guide to Cast-in-Place Architectural Concrete Practice*. The addition of fiber reinforcement to the chinking mortar mixture, as seen in samples 4, 9, 13, and 18, will enhance

the durability of the mortar against cracking due to structural heaving but could result in a rough surface finish with visible fibers (Figure 161).

Figure 161. Typical rough surface finish resulting from fibers in fiber-reinforced mortar.



10.4.2 Chimney pointing

The chimney pointing mortar is best made from a Portland cement mortar. This mortar may follow a similar nonstructural ASTM C270 Type N recipe as would a chinking mortar having a Portland cement binder. The architect should select a pigment in keeping with both the historical context of the structure and the existing materials on the structure.

10.4.3 Timber refinishing and replacement

In order to specify the most historically accurate repair or replacement of wall timbers, it is recommended that the owner perform a comprehensive analysis of the species and age of each individual timber. It is not possible to conclude which timbers are original to the structure without this complete picture of information. In the absence of such analysis, if timbers require replacement, we recommend that the architect select a species of timber that is resistant to beetle and other insect intrusion and, therefore, resistant to woodpecker damage. The USDA Forest Products Laboratory

may provide assistance in this material selection. Furthermore, in order to maintain a minimum level of historical accuracy, we recommend that the owner specifies that all timbers shall be hand hewn for appearance. Timbers may be rough sawn or otherwise shaped by modern methods, so long as the finishing techniques are historically relevant.

11 Summary and Recommendations

The Burgess-Capps Cabin's construction began in 1875. The design consists of a one-and-one-half story frame cabin constructed of hewn log walls chinked with mortar. There is a loft with an enclosed stairway, a stone fireplace, and a chimney. The building retains many original elements from the time of its construction, but notable exceptions include the chinking, many wooden elements on the interior (mainly for structural purposes) as well as updated and exposed hardware, and heavy modifications to the exterior chimney.

11.1 Character-defining features

In Preservation Brief #17, Lee H. Nelson reminds readers that

the Secretary of the Interior's "Standards for the Treatment of Historic Properties" embodies 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; and various aspects of its site and environment.

[. . .]

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.¹²⁹

129. Lee H. Nelson, *Architectural Character-Identifying the Visual Aspect of Historic Buildings as an Aid to Preserving their Character*, Preservation Brief 17 (Washington, DC: National Park Service, 1998), <https://www.nps.gov/orgs/1739/upload/preservation-brief-17-architectural-character.pdf>;

A list of character-defining features for the Burgess-Capps Cabin follows:

- Massing
- Square footprint
- Log structure
- Porch
- Wood-shake shingles
- Stone foundation
- Wood-framed windows
- Wood trim size and profile around window and door openings
- Stone chimney
- Open first floor
- Open loft floor
- Fireplace mantel
- Wood-paneled stair enclosure
- Wood stairs
- Wood floors
- Wood beams on first-floor ceiling

11.2 Treatment

“The Secretary of the Interior is responsible for establishing professional standards and providing advice on the stewardship of cultural resources listed on or listed as eligible for the National Register of Historic Places.”¹³⁰ The *Standards* describe four basic approaches to the treatment of historic landscapes.

11.2.1 Restoration approach

“Restoration is defined as the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and

130. National Park Service, *The Secretary of the Interior’s Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*, edited by Charles A. Birnbaum with Christine Capella Peters (Washington, DC: National Park Service, 1996), 3.

plumbing systems and other code-required work to make properties functional is appropriate within a restoration project.”¹³¹

The restoration approach is appropriate for the Burgess-Capps Cabin as its primary future use is for educational and museum purposes. It is recommended that, for this use, the cabin be restored back to its frontier period. It is recommended that the foundation be restructured to adequately support the building while following 1870s foundation practices, that the damaged logs be replaced with lodgepole pine logs as suggested in Section 10.2, and that the roof be restructured to withstand wind and snow loads but represent 1870s roof structure practices.

11.2.2 Reconstruction approach

“Reconstruction is defined as the act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location.”¹³² The reconstruction “Standards” establish a limited framework for recreating a vanished or non-surviving building with new materials, primarily for interpretive purposes.

This approach is not recommended since most of the cabin’s original character-defining features are extant.

11.2.3 Preservation approach

“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. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project. However,

131. National Park Service, “The Secretary of the Interior’s Standards for the Treatment of Historic Properties: Restoration as a Treatment and Standards for Restoration,” last updated October 26, 2022, <https://www.nps.gov/articles/000/treatment-standards-restoration.htm>.

132. National Park Service, “The Secretary of the Interior’s Standards for the Treatment of Historic Properties: Reconstruction as a Treatment and Standards for Reconstruction,” last updated October 26, 2022, <https://www.nps.gov/articles/000/treatment-standards-reconstruction.htm>.

new exterior additions are not within the scope of this treatment.”¹³³ The “Standards” for preservation require retention of the greatest amount of historic fabric along with the building’s historic form.

Preservation is not appropriate for the Burgess-Capps Cabin due to the need for the cabin to be deconstructed and reconstructed to fix the foundation issues, roof structure issues, and the replacement of the heavily damaged logs.

11.2.4 Rehabilitation approach

“Rehabilitation is defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.”¹³⁴ The rehabilitation “Standards” acknowledge the need to alter or add to a historic building to meet continuing or new uses while retaining the building’s historic character.

Rehabilitation is not appropriate for the Burgess-Capps Cabin as the most likely use of the building is for educational and museum purposes.

11.3 Management issues and recommendations

The Burgess-Capps Cabin is federally owned by USAFA, and the building was listed on the NRHP in 1975. As such, USAFA consults for all undertakings that affect the building with the State of Colorado, History Colorado, which serves as the State Historic Preservation Officer (SHPO) for consultation purposes.

Current issues include the following:

- Deteriorated lodgepole pine logs
- Nonperiod chinking that is causing damage to the lodgepole pine logs
- Crumbling and almost nonexistent stone foundation
- Structure sinking towards the southeast corner

133. National Park Service, “The Secretary of the Interior's Standards for the Treatment of Historic Properties: Preservation as a Treatment and Standards for Preservation,” last updated October 26, 2022, <https://www.nps.gov/articles/000/treatment-standards-preservation.htm>.

134. National Park Service, “The Secretary of the Interior's Standards for the Treatment of Historic Properties: Rehabilitation as a Treatment and Standards for Rehabilitation,” last updated October 26, 2022, <https://www.nps.gov/articles/000/treatment-standards-rehabilitation.htm>.

- Nonperiod-appropriate wood and metal structural elements on the underside of the roof
- Missing window sashes
- Missing door and window trim
- Splitting or curled wood shingles
- Chimney mortar that may not be nonperiod and has been tinted pink-red

11.4 Historic building recommendations

The following actions are recommended to address the issues outlined above in Section 11.3 and should be written into any renovation contract for the Burgess-Capps Cabin:

- The renovation contractor should meet the secretary of interior's "Standards for Rehabilitation."
- Materials sourced and used in the reconstruction approach should be period appropriate.
- The contractor should use period-appropriate techniques in modifying materials being used in the cabin, including period-appropriate joinery practices, mortar tooling, and cleaning methods.

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Appendix: 1975 National Register of Historic Places Nomination¹³⁵

DATA SHEET PH0066702

Form 10-306 (Oct. 1972): UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY - NOMINATION FORM FOR FEDERAL PROPERTIES
(Type all entries - complete applicable sections)

STATE: Colorado	
COUNTY: El Paso	
FOR NPS USE ONLY	
ENTRY DATE: JAN 27 1975	

1. NAME

COMMON: Pioneer Cabin
AND/OR HISTORIC: Burgess, William A., House

2. LOCATION

STREET AND NUMBER: 11 Miles North of I-25 from Colorado Springs, Colorado
CITY OR TOWN: Colorado Springs CONGRESSIONAL DISTRICT: 5th Congressional District
STATE: (S₂, NE₄, N₂, SE₄, Sec 23) COLORADO T12S, R67W, 6PM CODE 08 COUNTY: El Paso CODE 041

3. CLASSIFICATION

CATEGORY (Check One)	OWNERSHIP	STATUS	ACCESSIBLE TO THE PUBLIC
<input type="checkbox"/> District <input type="checkbox"/> Site <input type="checkbox"/> Object <input checked="" type="checkbox"/> Building <input type="checkbox"/> Structure	<input checked="" type="checkbox"/> Public <input type="checkbox"/> Private <input type="checkbox"/> Both	Public Acquisition: <input type="checkbox"/> In Process <input type="checkbox"/> Being Considered <input type="checkbox"/> Occupied <input checked="" type="checkbox"/> Unoccupied <input type="checkbox"/> Preservation work in progress	Yes: <input type="checkbox"/> Restricted <input checked="" type="checkbox"/> Unrestricted <input type="checkbox"/> No
PRESENT USE (Check One or More as Appropriate)			
<input type="checkbox"/> Agricultural <input type="checkbox"/> Commercial <input type="checkbox"/> Educational <input type="checkbox"/> Entertainment	<input type="checkbox"/> Government <input type="checkbox"/> Industrial <input type="checkbox"/> Military <input checked="" type="checkbox"/> Museum	<input type="checkbox"/> Park <input type="checkbox"/> Private Residence <input type="checkbox"/> Religious <input type="checkbox"/> Scientific	<input type="checkbox"/> Transportation <input type="checkbox"/> Other (Specify) <input type="checkbox"/> Comments

4. AGENCY

United States Air Force
REGIONAL HEADQUARTERS: (If applicable) United States Air Force Academy
CITY OR TOWN: Colorado Springs STATE: Colorado CODE 08

5. LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC.: USAF Academy CO 80840 (DEVPR/Bldg. 8116)
STREET AND NUMBER:
CITY OR TOWN: Colorado Springs STATE: Colorado CODE 08

6. REPRESENTATION IN EXISTING SURVEYS

TITLE OF SURVEY: Colorado State Inventory of Historical Sites
DATE OF SURVEY: 1971 Federal State County Local
DEPOSITORY FOR SURVEY RECORDS: State Historical Society
STREET AND NUMBER: 200 14th Avenue
CITY OR TOWN: Denver STATE: Colorado CODE 08


SEE INSTRUCTIONS

STATE: Colorado COUNTY: El Paso

FOR NPS USE ONLY
ENTRY NUMBER: DATE:

RECEIVED
DEC 31 1974
NATIONAL REGISTER

135. This appendix reproduces Pioneer Cabin, Site Number 5EP182, data sheet PH00066702, nomination received December 31, 1974, entered into National Register on January 27, 1975, National Register of Historic Places Inventory, National Park Service, <https://npgallery.nps.gov/AssetDetail/b395560b-09f1-4c28-92af-f8c2baf576f6>. Public domain.

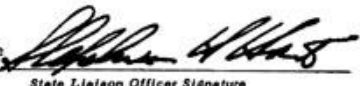
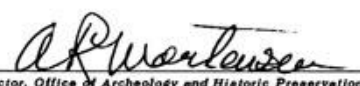
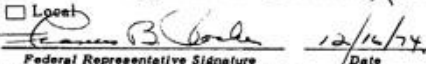

7. DESCRIPTION	
CONDITION	(Check One)
	<input type="checkbox"/> Excellent <input type="checkbox"/> Good <input checked="" type="checkbox"/> Fair <input type="checkbox"/> Deteriorated <input type="checkbox"/> Ruins <input type="checkbox"/> Unexposed
	(Check One)
	<input checked="" type="checkbox"/> Altered <input type="checkbox"/> Unaltered <input type="checkbox"/> Moved <input checked="" type="checkbox"/> Original Site
DESCRIBE THE PRESENT AND ORIGINAL (if known) PHYSICAL APPEARANCE	
<p>Single Room Cabin with floored attic space, usually a sleeping space. Construction consists of hand hewn 12" log exterior walls laid on mortered stone foundation. Attic floor is planked, main floor is planked.</p> <p>Roof is framed from 4" round logs and is wood shingled. Original fireplace built from round river stones.</p> <p>Alterations & repairs: One original window has been replaced with fixed glass. Rear door and frame has been replaced. Gable siding at each end has been replaced. Window framing has been replaced. Foundation needs checking and correction. Regrading is necessary for proper drainage.</p>	
	

SEE INSTRUCTIONS

B. SIGNIFICANCE			
PERIOD (Check One or More as Appropriate)			
<input type="checkbox"/> Pre-Columbian	<input type="checkbox"/> 16th Century	<input type="checkbox"/> 18th Century	<input type="checkbox"/> 20th Century
<input type="checkbox"/> 15th Century	<input type="checkbox"/> 17th Century	<input checked="" type="checkbox"/> 19th Century	
SPECIFIC DATE(S) (If Applicable and Known)			
AREAS OF SIGNIFICANCE (Check One or More as Appropriate)			
<input type="checkbox"/> Aboriginal	<input type="checkbox"/> Education	<input type="checkbox"/> Political	<input type="checkbox"/> Urban Planning
<input type="checkbox"/> Prehistoric	<input type="checkbox"/> Engineering	<input type="checkbox"/> Religion/Philosophy	<input type="checkbox"/> Other (Specify)
<input checked="" type="checkbox"/> Historic	<input type="checkbox"/> Industry	<input type="checkbox"/> Science	_____
<input type="checkbox"/> Agriculture	<input type="checkbox"/> Invention	<input type="checkbox"/> Sculpture	_____
<input type="checkbox"/> Architecture	<input type="checkbox"/> Landscape Architecture	<input type="checkbox"/> Social/Humanitarian	_____
<input type="checkbox"/> Art	<input type="checkbox"/> Literature	<input type="checkbox"/> Theater	_____
<input type="checkbox"/> Commerce	<input type="checkbox"/> Military	<input type="checkbox"/> Transportation	_____
<input type="checkbox"/> Communications	<input type="checkbox"/> Music		
<input type="checkbox"/> Conservation			
STATEMENT OF SIGNIFICANCE			
<p>An outstanding and well preserved example of the original pioneer's house in the Colorado mountain region. Most of the examples of this type of building have either been lost through natural deterioration or vandalism. This structure should be perserved as an important example of our heritage.</p> <p>This is the only cabin left to remind the present generation of the pioneers that came and settled in Douglass Valley. The cabin was built by William Alexander Burgess between 1871 and 1877. It was built with hand-hewn logs and the fireplace and chimney of jagged rocks. It is one of the oldest standing structures in this Pikes Peak region.</p>			

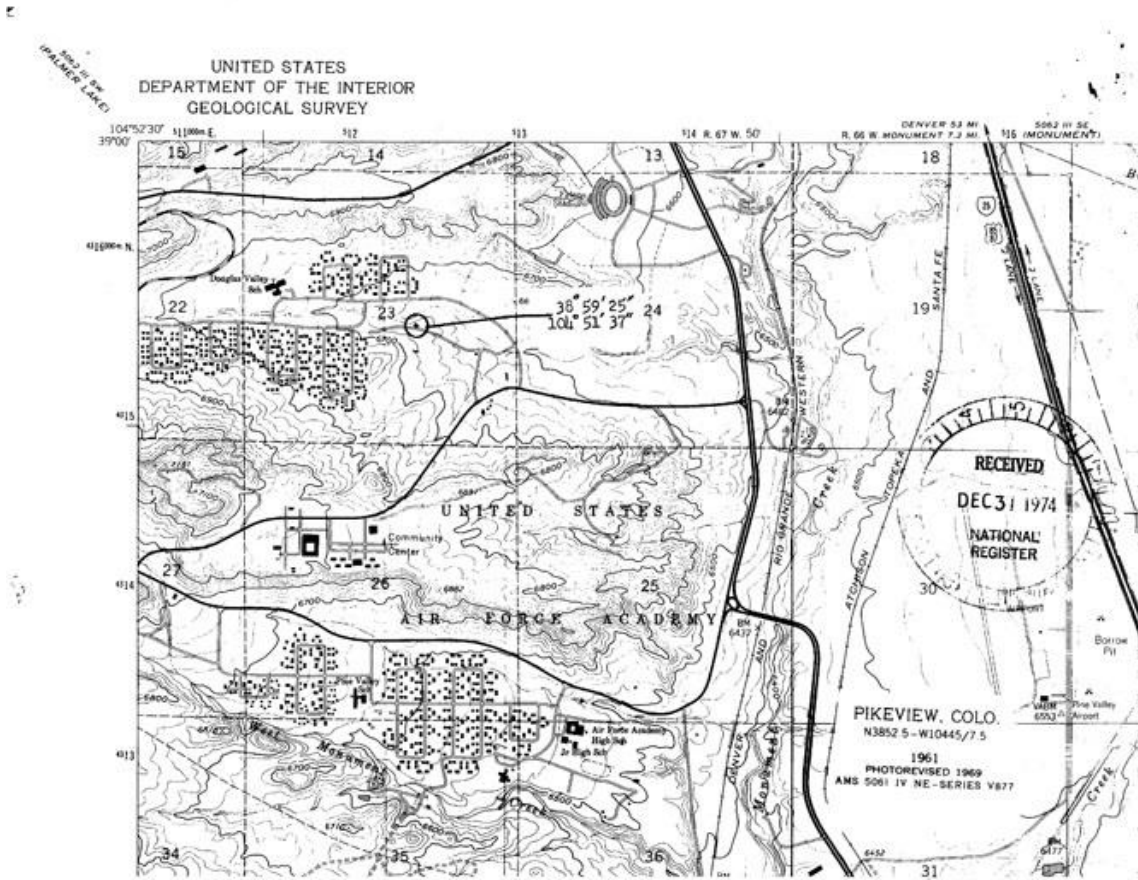
SEE INSTRUCTIONS

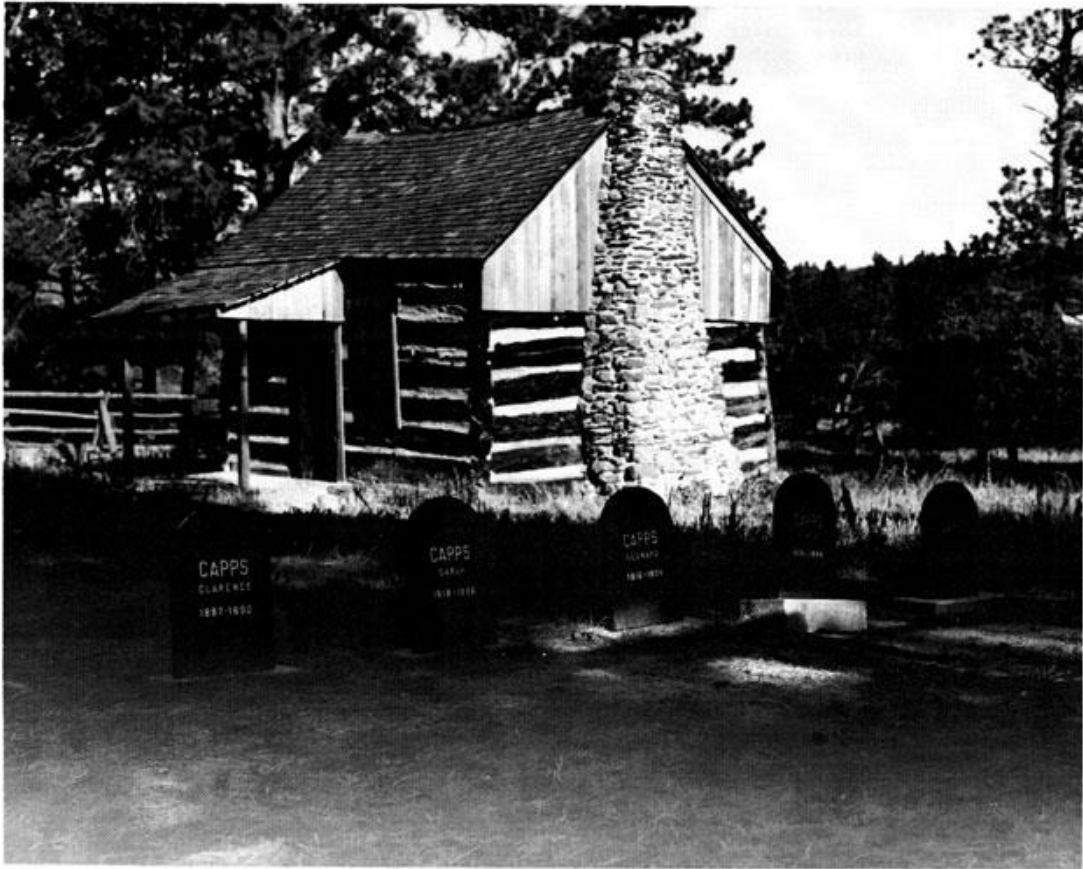


9. MAJOR BIBLIOGRAPHICAL REFERENCES				
USAF Academy CO 80840				
10. GEOGRAPHICAL DATA				
LATITUDE AND LONGITUDE COORDINATES DEFINING A RECTANGLE LOCATING THE PROPERTY		LATITUDE AND LONGITUDE COORDINATES DEFINING THE CENTER POINT OF A PROPERTY OF LESS THAN TEN ACRES		
CORNER	LATITUDE	LONGITUDE	R	
	Degrees Minutes Seconds	Degrees Minutes Seconds		Degrees Minutes Seconds
NW	0 0 0	0 0 0		38 59 25
NE	0 0 0	0 0 0		104 51 22
SE	0 0 0	0 0 0		
SW	0 0 0	0 0 0		
APPROXIMATE ACREAGE OF NOMINATED PROPERTY: Less than one				
LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES				
STATE:	CODE	COUNTY:	CODE	
Colorado	08	El Paso	004	
STATE:	CODE	COUNTY:	CODE	
STATE:	CODE	COUNTY:	CODE	
STATE:	CODE	COUNTY:	CODE	
11. FORM PREPARED BY				
NAME AND TITLE:		DATE:		
HAL M. BREWER, Chief, Real Estate Management Branch		9 Sep 1974		
BUSINESS ADDRESS:				
DEVPR/Bldg 8116				
STREET AND NUMBER:		PHONE:		
USAF Academy		472-2072		
CITY OR TOWN:		STATE	CODE	
Colorado Springs		Colorado	08	
12. CERTIFICATION OF NOMINATION		NATIONAL REGISTER VERIFICATION		
State Liaison Officer recommendation: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> None  State Liaison Officer Signature		I hereby certify that this property is included in the National Register.  Director, Office of Archeology and Historic Preservation		
In compliance with Executive Order 11593, I hereby nominate this property to the National Register, certifying that the State Liaison Officer has been allowed 90 days in which to present the nomination to the State Review Board and to evaluate its significance. The recommended level of significance is <input type="checkbox"/> National <input checked="" type="checkbox"/> State <input type="checkbox"/> Local  Federal Representative Signature Date: 12/16/74		Date: 1/27/75 ATTEST:  Keeper of The National Register Date: 1.22.75		
Dir, Real Property & Natural Resources, OASD(I&L)IR Title				

NC
 U M
 SEE INSTRUCTIONS







Form No. 10-301a
(7/72)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

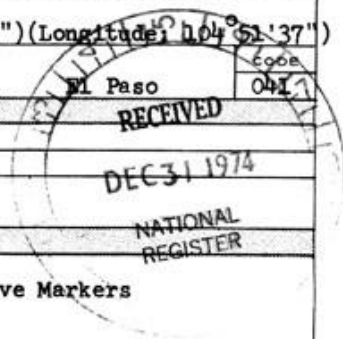
**NATIONAL REGISTER OF HISTORIC PLACES
PROPERTY PHOTOGRAPH FORM**

(Type all entries - attach to or enclose with photograph)

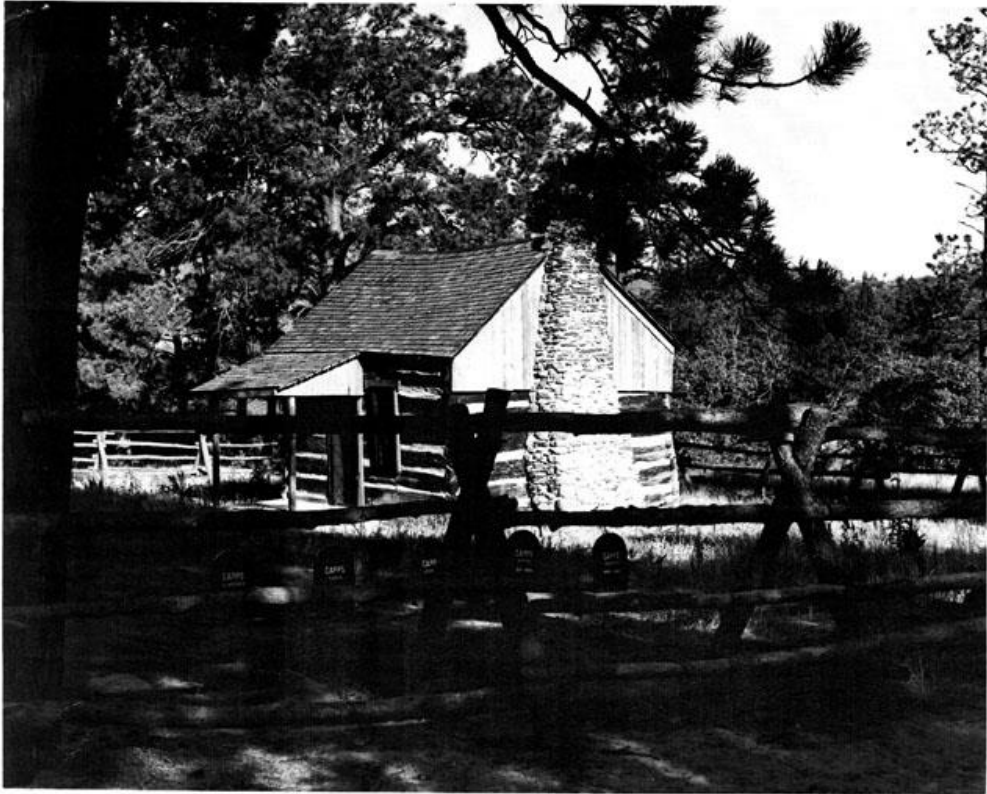
STATE Colorado	
COUNTY El Paso	
FOR NPS USE ONLY	
ENTRY NUMBER JAN 27 1975	DATE

SEE INSTRUCTIONS

1. NAME			
COMMON:		Pioneer Cabin	
AND/OR HISTORIC:		Burgess, William A., House	
2. LOCATION			
STREET AND NUMBER: 11 Miles North on I-25 from Colorado Springs, Colorado			
CITY OR TOWN: Colorado Springs (Latitude: 38°59'25" (Longitude: 104°51'37"))			
STATE:	CODE	COUNTY:	CODE
Colorado	08	El Paso	041
3. PHOTO REFERENCE			
PHOTO CREDIT:		United States Air Force Academy	
DATE OF PHOTO:		6 Sept 1974	
NEGATIVE FILED AT:		United States Air Force Academy	
4. IDENTIFICATION			
DESCRIBE VIEW, DIRECTION, ETC. #2923 - Looking Northwest toward Grave Markers			



#1073



Form No. 10-301a
(7/72)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

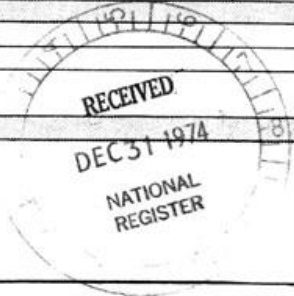
**NATIONAL REGISTER OF HISTORIC PLACES
PROPERTY PHOTOGRAPH FORM**

(Type all entries - attach to or enclose with photograph)

STATE Colorado	
COUNTY El Paso	
FOR NPS USE ONLY	
ENTRY NUMBER	DATE
JAN 27 1975	

SEE INSTRUCTIONS

1. NAME			
COMMON: Pioneer Cabin			
AND/OR HISTORIC: Burgess, William A., House			
2. LOCATION			
STREET AND NUMBER: 11 Miles North on I-25 from Colorado Springs, Colorado			
CITY OR TOWN: Colorado Springs (Latitude: 38°59'25")(Longitude: 104°51'37")			
STATE: Colorado	CODE 08	COUNTY: El Paso	CODE 041
3. PHOTO REFERENCE			
PHOTO CREDIT: United States Air Force Academy			
DATE OF PHOTO: 6 Sept 1974			
NEGATIVE FILED AT: United States Air Force Academy			
4. IDENTIFICATION			
DESCRIBE VIEW, DIRECTION, ETC. #2922 - Looking Northwest toward Grave Markers			



#2922



Form No. 10-301a
(7/72)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES
PROPERTY PHOTOGRAPH FORM

(Type all entries - attach to or enclose with photograph)

SEE INSTRUCTIONS

STATE	
Colorado	
COUNTY	
El Paso	
FOR NPS USE ONLY	
ENTRY NUMBER	DATE
	JAN 27 1975

1. NAME			
COMMON: Pioneer Cabin			
AND/OR HISTORIC: Burgess, William A., House			
2. LOCATION			
STREET AND NUMBER: 11 Miles North on I-25 from Colorado Springs, Colorado			
CITY OR TOWN: Colorado Springs (Latitude: 38°59'25" (Longitude: 104°51'37"))			
STATE:	CODE	COUNTY:	CODE
Colorado	08	El Paso	041
3. PHOTO REFERENCE			
PHOTO CREDIT: United States Air Force Academy			
DATE OF PHOTO: 6 Sept 1974			
NEGATIVE FILED AT: United States Air Force Academy			
4. IDENTIFICATION			
DESCRIBE VIEW, DIRECTION, ETC. #2921 - Looking Northeast at Cabin			



#303

INT: 154-72

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#303

2921-74

Abbreviations

ACI	American Concrete Institute
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
CERL	Construction Engineering Research Laboratory
CRM	Cultural Resources Management
ERDC	Engineer Research and Development Center
IIBEC	International Institute of Building Enclosure Consultants
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
OSB	Oriented strand board
PGA	Peak ground acceleration
SHPO	State Historic Preservation Officer
USAFA	US Air Force Academy

REPORT DOCUMENTATION PAGE

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				START DATE FY 22	END DATE FY 23
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5a. CONTRACT NUMBER		5b. GRANT NUMBER		5c. PROGRAM ELEMENT	
5d. PROJECT NUMBER		5e. TASK NUMBER		5f. WORK UNIT NUMBER	
6. AUTHOR(S) August S. Fuelberth, James Wilcoski, Peter B. Stynoski, Carey L. Baxter, Madison L. Story, Adam D. Smith, and Joseph S. Murphey					
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14. ABSTRACT The Burgess-Capps Cabin is located on the US Air Force Academy (USA-FA), Colorado, and was placed on the National Register of Historic Places (NRHP) in 1975 under the name of "Pioneer Cabin." The building is currently not occupied but used as a history interpretive site. It is one of the few log cabins that remain in this part of Colorado from the time of Euro-pean settlement. All buildings, especially historic ones, require regular planned maintenance and repair. The most notable cause of historic building element failure or decay is not the fact that the historic building is old, but rather, it is caused by incorrect or inappropriate repair or basic neglect of the historic building fabric. This document is a maintenance manual compiled with as-is conditions of construction materials of the cabin. The secretary of interior's guidelines on rehabilitation and repair per material are discussed to provide the cultural resources manager at USAFA a guide to maintain this historic building. Additional chapters include information regarding the historic materials and a structural analysis. This report satisfies Section 110 of the National Historic Preservation Act (NHPA) of 1966 as amended and will help USAFA Cultural Resources Management Office to manage this historic building.					
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