National Park Service
U.S. Department of the Interior

Fort Pulaski National Monument
Georgia

West End Bunkers

Historic Structures Report

Cultural Resources, Partnerships and Science Division

Interior Region 2: South Atlantic-Gulf

West End Bunkers

Fort Pulaski National Monument

Historic Structures Report

Prepared by:
Liz Sargent HLA
1855 Winston Road
Charlottesville, Virginia 22903

Wiss, Janney, Elstner Associates, Inc.
330 Pfingsten Road
Northbrook, Illinois 60062

Prepared for:

National Park Service
Interior Region 2: South Atlantic-Gulf
100 Alabama Street SW
Atlanta, Georgia 30303

Cultural Resources, Partnerships and Science Division
Interior Region 2: South Atlantic-Gulf
National Park Service
100 Alabama Street, SW
Atlanta, Georgia 30303
(404) 562-3117

About the front cover: South bunker, West End bunkers, view from north, undated photograph. (Source: Fort Pulaski National Monument, BX70_2154_FOPU.jpg)

This manuscript has been authored by Liz Sargent HLA., and Wiss, Janney, Elstner Associates, Inc., under Contract Number 140P2019D0006 with the National Park Service. The United States Government retains and the publisher, by accepting the article for publication, acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this manuscript, or allow others to do so, for United States Government purposes.

West End Bunkers

Fort Pulaski National Monument

Historic Structures Report

MELISSA MEMORY Digitally signed by MELISSA MEMORY Date: 2024.07.02 11:08:54 -04'00'

Approved by:

Superintendent, Fort Pulaski National Monument Date

JULIE ERNSTEIN Digitally signed by JULIE ERNSTEIN Date: 2024.07.05 19:08:31 -04'00'

Recommended by:

Chief, Cultural Resources, Partnerships and Science Division, Interior Region 2: South Atlantic-Gulf Date

MYRNA PALFREY Digitally signed by MYRNA PALFREY Date: 2024.07.18 10:43:15 -04'00'

Recommended by:

Deputy Regional Director, Interior Region 2: South Atlantic-Gulf Date

MARK FOUST Digitally signed by MARK FOUST Date: 2024.07.18 13:47:53 -04'00'

Approved by:

Regional Director, Interior Region 2: South Atlantic-Gulf Date

Contents

List of Figures vii
Project Team xi
Foreword xii

Management Summary

Management Summary 1
Historical Data 1
Treatment and Use 4
Administrative Data 4
Locational Data 4
Related Studies 4
Cultural Resource Data 5
Project Scope and Methodology 5

Developmental History

Early History of Cockspur Island 9
Planning and Construction of Fort Pulaski 10
Fort Pulaski during the Civil War, 1861–1865 12
Fort Pulaski after the Civil War, 1865–1898 13
Establishment and Early Years of the New Quarantine Station 14
Establishment and Early Stewardship of Fort Pulaski National Monument, 1924–1933 17
New Deal Programs at Fort Pulaski, 1933–1941 17
The Quarantine Station during the New Deal Era 19
Fort Pulaski during World War II, 1939–1945 20
Savannah during World War II 21
The War along Georgia's Coast 22
The U.S. Navy on Cockspur Island 23
Fort Pulaski after World War II, 1946–1956 32
Mission 66 at Fort Pulaski, 1956–1966 38
Maintenance of the World War II Bunkers, 1966 to the present 40
West End Bunkers Chronology 44

Physical Description and Condition Assessment

Site 47
North Bunker 50
Exterior 50
Interior 56
South Bunker 57
Exterior 57
Interior 69
Structural Analysis 73
Methodology 73
Findings 73
Conclusions 74
Laboratory Materials Studies 75
Methodology 75
Findings 76
Conclusions 76
Condition Assessment 77
North Bunker 77
South Bunker 81

Significance and Integrity

National Register of Historic Places 89
Significance Criteria 89
National Register Significance Evaluation 90
Period of Significance 91
Character-Defining Features 92
Assessment of Integrity 92

Treatment and Use

Requirements for Treatment and Use 95
Laws, Regulations, and Functional Requirements 95
Alternatives for Treatment and Use 96
Ultimate Treatment and Use: Standards and Guidelines for Treatment 97
Recommendations 99
Site 99
Concrete 99
Restoration of Glass Block at Windows 102
Drainage for Bunker Interiors 102
Terra Cotta 103
Steel Doors 103
Other Steel Elements 105
Current and Forthcoming Work 105
Recommendations for Further Research 105
Resilience to Natural Hazards 105

Bibliography 111

Appendices

Appendix A: Measured Drawings
Appendix B: Structural Analysis
Appendix C: Laboratory Materials Studies

List of Figures

Management Summary

Figure 1. Map of Georgia showing location of Fort Pulaski National Monument on the coast near Savannah..... 7
Figure 2. Map of Fort Pulaski National Monument and surrounding areas showing the location of the West End bunkers. 8
Figure 3. Aerial View of the West End bunkers and surrounding area. 8

Developmental History

Figure 4. 1831 plan of Fort Pulaski, showing the fort as it was constructed. 11
Figure 5. Drawing of Fort Pulaski after bombardment,1861. 12
Figure 6. The southeast corner of Fort Pulaski following the attack, 1862. 13
Figure 7. Fort Pulaski, 1862, showing damaged casemate masonry at the southeast corner. 13
Figure 8. Aerial view of Fort Pulaski, before 1925. Note the overgrowth of trees and shrubs at the parade ground and demilune, low plants in the former moats, caretaker's house atop the terreplein, and small outbuilding on the parade ground. 16
Figure 9. The 67-foot diesel motorboat, known as "NPS-1," used for regular ferry service, 1934–1938 18
Figure 10. The moat and west elevation of the fort following restoration, 1936. Note the dredging steam shovel in the background at left. 19
Figure 11. SS James Oglethorpe at launching on November 20, 1942. 22
Figure 12. Aerial view of the U.S. Navy Section Base at Savannah located at the old quarantine station at the west end of Cockspur Island, April 21, 1943. The location of the West End bunkers is out of view. 26
Figure 13. Aerial view of the U.S. Navy Section Base at Savannah, April 21, 1943, showing the development on the west end of Cockspur Island. The location of the West End bunkers is noted by the red circle. 27
Figure 14. Aerial view of the U.S. Navy Section Base at Savannah, April 22, 1943, showing the development on the west end of Cockspur Island. The general location of the West End bunkers is noted by the red circle. 27
Figure 15. Developed areas plan, prepared as part of the Master Plan for Fort Pulaski National Monument, National Park Service Branch of Plans and Design, 1939, annotated as of January 1, 1943, to reflect use of Fort Pulaski as a U.S. Navy Section Base. 28
Figure 16. List of buildings present on site in 1948 indicates structures added by the U.S. Navy during the war, as well as earlier structures that remained at the time the U.S. Navy left the property 29
Figure 17. Undated image of the south bunker at the west end of Cockspur Island. 30
Figure 18. The Naval Base on Cockspur Island, view from south, June 1946. The Crews Quarters and Recreational facilities on right, with paint locker on left. 32
Figure 19. The Bachelor Officers Quarters, a building considered by the University of Georgia for reuse, June 1946. 33
Figure 20. Fort Pulaski in the late 1940s, photographed by Frances Benjamin Johnston. 34
Figure 21. Developed Area Plan, Fort Pulaski National Monument, 1949. The West End bunkers are highlighted in red. 36
Figure 22. Existing Conditions Plan, Fort Pulaski National Monument, 1952. The West End bunkers are highlighted in red. 36
Figure 23. A NPS maintenance form describing the south bunker (referred to as a warehouse), 1950. 37
Figure 24. View of Quarantine Attendants' Quarters and Quarantine Officer's Quarters, circa 1949. 37
Figure 25. Superintendent's Residence, 1950s. 37
Figure 26. Road and Trail System Plan, Fort Pulaski National Monument, 1953. The south bunker is outlined in red. 38
Figure 27. Masonry repairs on the south exterior wall, 1961. The wood portcullis at the sallyport was reconstructed in 1960. 39
Figure 28. The south face of the demilune covered with vegetation, circa 1959. 40
Figure 29. The south face of the demilune after clearing of woody vegetation and establishment of grass cover, 1960. 40
Figure 30. An undated photograph of the north elevation of the south bunker. Note the glass block windows in place and the whitewash finish. 41

Figure 31. An undated photograph of the north elevation of the south bunker. Note the glass block windows in place and the whitewash finish. 42
Figure 32. An undated photograph of the south bunker showing the broken glass block units. 42
Figure 33. An undated photograph of the south bunker showing the broken glass block units. 43
Figure 34. South bunker, 2005. 43

Physical Description and Condition Assessment

Figure 35. Aerial view showing the two bunkers as well as Cockspur Island Road. 47
Figure 36. Gravel drive leading toward bunkers, view from east. 48
Figure 37. North bunker in background beyond shed, view from south. 48
Figure 38. South bunker as seen from gravel drive, view from northwest. 48
Figure 39. Area around the bunkers. Note the trees and shrubbery. 48
Figure 40. Metal fence support that remains south of the south bunker. 49
Figure 41. Steel tower located to the south of the south bunker. 49
Figure 42. A storage structure at the base of the steel tower. 49
Figure 43. Entrance to one of the bunkers on Georgia Department of Transportation property, which is similar to the north bunker. 49
Figure 44. Entrance to another bunker on Georgia Department of Transportation property, with concrete walls similar to those at the north bunker. 49
Figure 45. Large bunker on Georgia Department of Transportation property. This bunker is similar to the south bunker. Note the glass block remaining in the window openings. 49
Figure 46. Reproduced 1946 map showing the location of other structures historically present at the west end of Cockspur Island. Red line is approximate location of Fort Pulaski National Monument boundary 50
Figure 47. South elevation, north bunker. 51
Figure 48. East elevation, north bunker. 51
Figure 49. North elevation, north bunker. 52
Figure 50. Exterior wall at north bunker. Note the visible lines from the plywood formwork. 52
Figure 51. West elevation of north bunker showing the concrete walkway leading to the interior. 53
Figure 52. Detailed view of concrete walkway. 53
Figure 53. The north retaining wall is angled. 54
Figure 54. Partial view of the south retaining wall. Note the door at the far left. 54
Figure 55. Steel door at south retaining wall 54
Figure 56. Steel drip edge at door head. 54
Figure 57. Steel hinge at base of door. Note the steel cable above. 55
Figure 58. Steel bolt latch at the west jamb of the door. 55
Figure 59. Door handle and latch at west jamb of the door. 55
Figure 60. Eye holes at door frame. 55
Figure 61. Interior face of steel door. 55
Figure 62. Vented opening east of the door. 56
Figure 63. Embedded metal plate west of the door. 56
Figure 64. Vent stack at southwest corner of the bunker. 56
Figure 65. Interior of the north bunker, view from north. 56
Figure 66. Whitewash at the interior walls of the bunker, view from northwest. 57
Figure 67. Door and vent at north wall of bunker, view from southwest. 57
Figure 68. Vent at north wall of bunker, view from south. 57
Figure 69. East elevation of south bunker, with edge of sloping wing wall visible at right. 58
Figure 70. South elevation of south bunker 58
Figure 71. West elevation of south bunker, with edge of sloping wing wall visible at left. 59
Figure 72. Lines are visible from the wood-board formwork used during construction of the bunker. Note the chamfer at the top of the wall. 59
Figure 73. Remnants of whitewash at the exterior of the south bunker. 60
Figure 74. North elevation of the south bunker. 60
Figure 75. East wing wall at north elevation of the south bunker. 61
Figure 76. The entrance to the interior of the bunker and raised concrete platform. 61
Figure 77. Raised platform at the north side of the south bunker. 62

Figure 78. Embedded steel angle at the north edge of raised platform. 62
Figure 79. Stair at west edge of raised platform. 62
Figure 80. Earthen ramp leading to the raised platform. 62
Figure 81. Set of doors at entrance to south bunker. 62
Figure 82. Embedded steel sill at doors. 63
Figure 83. Gap between steel doors. 63
Figure 84. Steel drip edge at door head 63
Figure 85. Typical hinge at steel doors at south bunker. 63
Figure 86. Remnants of steel door latch 64
Figure 87. Operable ventilation panel at base of door. 64
Figure 88. U-shaped handle at operable ventilation panel 64
Figure 89. Hinge and ventilation panel. 64
Figure 90. Interior face of the west door. 64
Figure 91. Interior face of east door. 65
Figure 92. Screen at interior side of ventilation panel. 65
Figure 93. Sliding steel latch at the top and bottom of the west door. 65
Figure 94. Sill at door. Note hole to engage sliding latch. 65
Figure 95. Embedded metal plate west of the door 66
Figure 96. Infilled former clerestory windows at the east end of the north elevation. 66
Figure 97. Exposed brick infill at former window openings at the west end of the north elevation, viewed from the interior 66
Figure 98. Edge of the east wing wall, view from east. 67
Figure 99. Edge of the west wing wall, view from west. 67
Figure 100. The wing walls are wider than the parapet wall at the north elevation 68
Figure 101. A reglet is present at the backside of the parapet wall 68
Figure 102. Remnant membrane below the reglet. 68
Figure 103. Exposed portions of the bunker walls and roof. 68
Figure 104. Remnant waterproofing at the exposed bunker roof. 68
Figure 105. Vent stack near southwest corner of the bunker. 69
Figure 106. Interior of the south bunker, view from northwest. 69
Figure 107. Interior of the south bunker, view from southwest. 70
Figure 108. Two columns near the center of the bunker interior, view from northeast 70
Figure 109. Typical column at bunker interior, view from southeast. 71
Figure 110. Capital and shear cap at engaged column. 71
Figure 111. Infilled window openings at the north wall, view from south 71
Figure 112. Electrical panel. 72
Figure 113. Opening at the ceiling near the southwest corner of the bunker. 72
Figure 114. Plastic drainpipe located near the southwest corner of the bunker. 72
Figure 115. Crack at concrete walkway with vegetation growing up through the crack. 77
Figure 116. Biological growth at the north retaining wall. 77
Figure 117. Isolated cracking at the top of the concrete retaining walls. 78
Figure 118. Honeycombing at the exterior face of the concrete retaining walls. 78
Figure 119. Efflorescence at the base of the north retaining wall. 78
Figure 120. A formed notch at the top of the south retaining wall 78
Figure 121. Corrosion at the base of the steel door frame and door. 79
Figure 122. Corrosion at the base of the steel door frame. 79
Figure 123. Biological growth at the base of the exterior face of the door. 79
Figure 124. Broken steel cable near the base of the steel door 79
Figure 125. Standing water at the southeast corner of the bunker. 80
Figure 126. Deteriorated whitewash adjacent to standing water at the southeast corner of the bunker. 80
Figure 127. Staining at the interior floor of the bunker. 80
Figure 128. Corrosion along the base of the south wall of the bunker interior. 80
Figure 129. Corrosion at the base of the wall at the bunker interior. 80
Figure 130. Isolated honeycombing at the interior concrete walls. 81
Figure 131. Insect nests at the top of the interior walls. 81

Figure 132. Staining and biological growth at the north elevation. 81
Figure 133. Staining at the top of the east wing wall. 81
Figure 134. Deterioration of whitewash at the north elevation. 81
Figure 135. The whitewash is largely intact at the east wing wall. 82
Figure 136. Vines at the north elevation of the bunker. 82
Figure 137. Portions of the vines have been cut at the base of the wall. 82
Figure 138. Two core holes at the north elevation, east of the door. 82
Figure 139. Craze cracking at the north elevation. Note the efflorescence at the cracks. 82
Figure 140. Corrosion at the embedded steel angle at the north edge of the raised platform. 83
Figure 141. Cracking at the top of the raised platform. 83
Figure 142. Abandoned anchors at the north elevation, east of the door. 83
Figure 143. Spalled concrete and exposed rebar. Note the corrosion at the rebar. 83
Figure 144. Minor spalling along the top edge of the reglet at the south face of the parapet wall. 84
Figure 145. Vertical cracks at the parapet wall 84
Figure 146. The doors to the bunker do not fully close. Note the gap between the doors. 84
Figure 147. The steel drip edge at the head of the door is bent and detached. 84
Figure 148. Staining and biological growth at the base of the door. 85
Figure 149. Corroded handle at the ventilation panel. 85
Figure 150. Section loss at the steel panels on the exterior face of the door. 85
Figure 151. Section loss at the steel panels on the interior face of the door. 85
Figure 152. Section loss at the steel panels on the interior face of the door. 85
Figure 153. Steel latch at east door. Note that the latch does not extend over the west door to engage the eye hole. 85
Figure 154. Displaced and detached stops at the door head. 86
Figure 155. Tears in the mesh screen at the interior of the ventilation panel. 86
Figure 156. Exposed portion of the roof showing the deteriorated membrane. 86
Figure 157. Cracked and missing pieces of terra cotta at the vent stack. 86
Figure 158. Staining at the northwest corner of the bunker. 87
Figure 159. Spalled parge coating over the brick infill at the former window. 87
Figure 160. A crack at the interior floor slab. 87
Figure 161. Spalled concrete at the interior floor slab. 87

Treatment and Use

Figure 146. Aerial view of Fort Pulaski after Hurricane Irma, showing the dike system holding in floodwater. 106
Figure 147. View of the dike south of the fort retaining floodwater after Hurricane Irma. 106
Figure 148. Container ship traveling along the North Channel near Fort Pulaski. 109

Project Team

National Park Service

Cultural Resources, Partnerships and Science Division, Interior Region 2: South Atlantic-Gulf

Celinda Hicks, Contracting Officer
Megan Jenkins, Historical Architect, Park Historic Architecture and Cultural Landscape Stewardship

Fort Pulaski National Monument

Melissa Memory, Superintendent
Katherine D. Purcell, Exhibit Specialist and Contracting Officer's Representative
Laura Seifert, Chief of Resource Management and Science
Emily Forlenza, Supervisory Facility Operations Specialist

Liz Sargent HLA

Liz Sargent, Project Manager
Nell Boeschenstein, Researcher/Historian
Leonard Kliwinski, Copy Editor

Wiss, Janney, Elstner Associates, Inc.

Deborah Slaton, Historian/Conservator
Tim Penich, Historical Architect
Heba Elsayed, Project Engineer
Tyler Young, Project Engineer
Mike Horst, Structural Engineer

Foreword

We are pleased to make available this Historic Structures Report for the West End Bunkers at Fort Pulaski National Monument, part of the ongoing effort to provide comprehensive documentation for the landscapes and historic structures of the National Park Service. The success of this project is due in large part to the staff of Fort Pulaski National Monument; the Park has long sought to protect and interpret this important resource. Katherine D. Purcell, Exhibit Specialist and Contracting Officer's Representative, has been instrumental in providing support for this project. We would also like to thank Emily Forlenza, Supervisory Facility Operations Specialist, and Laura Seifert, Acting Chief of Resources, for their assistance with this project.

We would like to thank the following for their thorough research, rigorous existing conditions documentation, and carefully considered recommendations: from Liz Sargent HLA, Liz Sargent, Project Manager; Nell Boeschenstein, Researcher and Historian; and Leonard Kliwinski, Copy Editor; and from Wiss, Janney, Elstner Associates, Inc., Deborah Slaton, Conservator; Tim Penich, Historical Architect; Heba Elsayed, Project Engineer; Tyler Young, Project Engineer; and Mike Horst, Structural Engineer. The Park would also like to thank Interior Region 2 Historical Architect Megan Jenkins for her work as the NPS regional Subject Matter Expert on this project.

Melissa Memory
Superintendent
Fort Pulaski National Monument

Management Summary

Management Summary

At the request of the National Park Service (NPS), Liz Sargent Historical Landscape Architect (LSHLA), and its subconsultant, Wiss, Janney, Elstner Associates, Inc. (WJE), have developed this Historic Structures Report (HSR) for the West End bunkers at Fort Pulaski National Monument in Savannah, Georgia. Figure 1 is a map of Georgia showing the location of Fort Pulaski National Monument. Figure 2 is a map showing the boundaries of Fort Pulaski National Monument and the surrounding area. Figure 3 is an annotated aerial view showing the location of the West End bunkers.

The West End bunkers are located at the west end of Cockspur Island, which is located near the mouth of the Savannah River. Fort Pulaski National Monument encompasses 5,623 acres on Cockspur and McQueen's Islands between Savannah and Tybee Island.[1] The West End bunkers are two concrete structures commissioned as part of a United States Navy base that was present on Cockspur Island during World War II. The bunkers were part of a larger complex of structures built by the Navy at the west end of the island during the war, which included residences, utilities, munitions storage, and other facilities. The two bunkers addressed in this study are the only remaining structures constructed by the Navy that are on park property; other nearby bunkers are on property owned by the Georgia Department of Transportation.

The bunkers, constructed by the Navy of cast-in-place concrete, consist of the larger south bunker, currently used for storage, and the small north bunker, currently used for black powder storage, which was also its historic use.

Although not listed in the National Register of Historic Places, the West End bunkers have been determined eligible by the National Park Service for listing in the National Register of Historic Places. They are listed as contributing resources in the National Park Service Cultural Landscape Inventory for Fort Pulaski National Monument and are managed as a cultural resource by the National Park Service. (The National Register nomination for Fort Pulaski National Monument is being updated concurrently with work on this Historic Structures Report. The nomination update will take into consideration the West End bunkers and associated period of significance.)

Historical Data

Coastal defenses at Cockspur Island were first developed during the French and Indian War of the eighteenth century. During the Revolutionary War, several high-ranking British officials took refuge on Cockspur Island and for a short time, the island was the Loyalist capital of the Georgia colony, until the British reoccupied Savannah in 1778, at which time, the island was once again abandoned.

Following the British invasion of Washington, D.C., during the War of 1812, the U.S. government planned fifty new forts as part of a third system of

1. National Park Service, *Fort Pulaski National Monument: Foundation Document*, August 2016.

national coastal defenses, which included Fort Pulaski to defend the approaches to Savannah. Plans were completed in 1831 for a single-level brick masonry fort topped by an open terreplein. Construction began in 1833 but progressed slowly due to frequent storms and limited funding. The overall structure was not completed until 1839, and the demilune and interior were not fully completed until early in 1847.

After the election of Abraham Lincoln, southern states began to consider secession from the United States. South Carolina seceded on December 20, 1860, and less than a week later, a small U.S. Army garrison occupied Fort Sumter in Charleston Harbor. Fearful that Federal forces would soon occupy Fort Pulaski, Georgia Governor Joseph E. Brown ordered the Georgia militia to seize the fort on January 2, 1861.

War officially began with the Confederate assault on Fort Sumter in April 1861. In the fall of 1861, Federal forces moved south by sea to begin a planned naval blockade of the South. By early 1862, Federal forces had established gun positions along the Savannah River and blockaded Fort Pulaski. Fort Pulaski had a six-month supply of food in January 1862, making surrender of the fort inevitable if the blockade could not be broken.

The main Federal position was on Tybee Island, which was too far for conventional smoothbore guns and mortars to be effective against a heavy masonry wall. However, Federal officers were confident that the new rifled gun could breach the walls of Fort Pulaski from Tybee Island. On the morning of April 10, the Federal assault began. By the end of the day, the Confederate defenders realized that Fort Pulaski was in significantly damaged condition, as the 7-1/2-foot-thick wall at the southeast corner now had an intact thickness of only 3 feet. The bombardment of Fort Pulaski continued at dawn the next morning. Shortly after noon, the southeast angle of the fort was in ruins, with two sizeable holes present, making the inside of the fort visible from Tybee Island. At approximately 2:30 p.m. on April 11, the Confederate flag was lowered, a gun was fired from the casemate, and a white sheet was raised. Fort Pulaski was surrendered to Federal control.

The 48th New York Infantry arrived at Fort Pulaski in June 1862 and was charged with making repairs to the damaged fort, which included rebuilding the fort's southeast corner. In addition, the batteries on Tybee Island were dismantled, with some of the guns relocated to Fort Pulaski. By June 1863, the fort's garrison was largely reduced to a holding force as fighting continued elsewhere.

Following the war, the U.S. Army sought to modernize the fort in response to its failure to withstand the Federal fire directed at it in 1862. Beginning in 1869, the U.S. Army Corps of Engineers made a series of improvements to the fort. Construction on Fort Pulaski stopped in 1872 after the Corps of Engineers made plans to construct a new fort on nearby Tybee Island. In 1873, the remaining Army units stationed at the fort were withdrawn and Fort Pulaski was officially closed, although it remained under army administration as a military reservation.

The National Board of Fortifications, headed by Secretary of War William C. Endicott and convened in 1885, determined that a new coastal defense system was needed to address innovations in rifled artillery, iron-clad naval vessels, and submarine use. The Endicott Board submitted a report of its findings that suggested sweeping changes in the nation's coastal defense system. Its recommendations included the need to establish a new system of artillery fortifications at twenty-seven ports or harbors in the continental United States that became known as the Endicott Battery System.

By 1893, the U.S. Board of Engineers had prepared plans for implementing Endicott System features to be used in the defense of the Tybee Roads area. As approved by the Secretary of War, the plans for Fort Screven called for the construction of seven batteries—later named Batteries Hambright, Brumby, Garland, Fenwick, Backus, Gantt, and Habersham—to house various sizes of gun and support submarine mine placement operations. Mines were placed in the north channel of the Savannah River in 1898 in response to the threat posed by the Spanish-American War.

By World War I the technology for which the Endicott fortifications were created had become obsolete, due once again to innovations in armaments, the use of airplanes, fast torpedo boats, and destroyers.

In 1915, Fort Pulaski was identified as eligible for preservation as a national monument under the Antiquities Act. In 1924, Fort Pulaski was designated Fort Pulaski National Monument, to be administered by the War Department. In 1933, administration of Fort Pulaski National Monument, as well as many of the historic military sites that had been the responsibility of the War Department, was transferred to the National Park Service.

During the 1930s, Fort Pulaski National Monument benefitted from several New Deal-era programs, including the Public Works Administration (PWA) and Civilian Conservation Corps (CCC), which performed repairs to the fort and its site. During World War II, however, these programs were terminated, and work at Fort Pulaski halted.

As early as June 1941, Cockspur Island was reported to be the possible future site of a naval control base. Following the United States' entry into World War II, the U.S. Navy established a section base on Cockspur Island in late 1941 on the site of the old quarantine station and CCC camp. The base, commissioned on July 8, 1942, served as the supply and training base for the patrol, providing fuel, provisions, and barracks. It included shops for the repair and maintenance of gas, diesel, and electrical machinery required for the patrol vessels and minesweepers based there. The Savannah Section Base Inshore Patrol was responsible for patrolling the coastal waters of Georgia and South Carolina, while the intracoastal waterways were patrolled by the United States Coast Guard.

The Navy determined that the west end of the island best met its needs and cordoned off Fort Pulaski itself. A maintenance worker remained as caretaker at Fort Pulaski throughout the Navy's occupation of Cockspur Island.

The Navy carried out a number of changes to the west end of the island during its occupancy of the site, most notably improvements to accommodate use as a military base. During the course of the war, the Navy spent about $2,000,000 to renovate existing buildings and construct additional structures to house and support its men and equipment. New structures included barracks, an administrative office, an air-cooled movie auditorium, club rooms, cooking facilities, an officer's club, a gymnasium, and an athletic field and tennis court. At the southwest corner of the island, the Navy constructed ten magazines to store munitions, two of which are located on what is now park property.

Of the two magazine structures that are part of Fort Pulaski National Monument, the larger, south bunker was used to store small arms and the smaller, north bunker to store black powder. Both bunkers were constructed of cast-in-place concrete and covered, except for the entrance facade of the south bunker and the entrance to the north bunker, with an earthen berm with turf.

In mid-1945, following the conclusion of the war, the U.S. Navy turned over the base to the U.S. Coast Guard for use as one of several Coast Guard separation centers set up across the country to facilitate the demobilization process. Following completion of its use as a separation center, the Coast Guard decommissioned the base on June 17, 1946, and returned it to the National Park Service.

In accordance with the 1949 Developed Area Plan prepared by the NPS, the majority of the buildings remaining from the Navy base were dismantled or sold between 1951 and 1953. By 1952, the NPS had demolished or sold thirty-six buildings at the western end of Cockspur Island, including many buildings that were part of the quarantine station. In 1954, the quarantine station property, which the Navy had utilized, was formally transferred to the National Park Service.

Additional repair and preservation efforts were conducted during the late 1950s and early 1960s as a result of funding afforded by the National Park Service's Mission 66 program.

In the latter half of the twentieth century, various projects were undertaken at the West End bunkers, including the addition of an earthen ramp at the south bunker in the 1980s. At an unknown date, the glass block windows at the south bunker were infilled with brick, with a cementitious parge coating applied over the brick.

Treatment and Use

Although the West End bunkers are not listed in the National Register of Historic Places, the structures are managed as a cultural resource by the National Park Service. The administratively determined Management Category is "Must Be Preserved and Maintained" and the Ultimate Treatment is "Preservation," as characterized in *The Secretary of the Interior's Standards for Treatment of Historic Properties*. This treatment approach has been confirmed with the Park in preparation of this HSR.[2]

Ongoing monitoring, repair, and maintenance are required to ensure continued preservation and use of the bunkers.

Administrative Data

Locational Data

Building Names: North bunker (listed as World War II Bunker No. 2 in CRIS) and south bunker (listed as World War II Bunker No. 1 in CRIS)

Location: Fort Pulaski National Monument, Savannah, Georgia

UTM Information:

World War II Bunker No. 1 (South Bunker):
32.032997, -80.907429
UTM Zone: 17S
UTM Easting: 508740.69
UTM Northing: 3544096.92

World War II Bunker No. 2 (North Bunker):
32.033741, -80.907608
UTM Zone: 17S
UTM Easting: 508723.72
UTM Northing: 3544179.37

CRIS Numbers:

World War II Bunker No. 1: ID 000074
World War II Bunker No. 2: ID 000073

Structure Numbers:

World War II Bunker No. 1: ID HS-16
World War II Bunker No. 2: ID HS-15[3]

Related Studies

National Park Service, *Foundation Document, Fort Pulaski National Monument, Georgia*, August 2016.

Susan Hitchcock, National Park Service, *Cockspur Island Historic District, Fort Pulaski National Monument Cultural Landscape Report*, August 2011.

J. Faith Meader, New South Associates, and Cameron Binkley, National Park Service, editor,

2. The 2011 Cultural Landscape Report includes one statement related to treatment of the bunkers, noting, "Preserve the WWII batteries" in the treatment recommendations section; see Susan Hitchcock, *Cockspur Island Historic District, Fort Pulaski National Monument, Cultural Landscape Report*, (Atlanta, Georgia: National Park Service, Southeast Regional Office, Cultural Resources Division, August 2011), 124. No other baseline documentation has been identified that states the Management Category and Ultimate Treatment.

3. CRIS and HS feature identification numbers were obtained from the CRIS-HS Single Record Report for each bunker. The *Fort Pulaski National Monument Cultural Landscape Inventory* (2012) notes a feature identification number for each bunker: for World War II Bunker No. 1, the feature identification number is given as 150425, and for World War II Bunker No. 2, the feature number is given as 150427. Locational information (UTMs) was derived from online mapping.

Fort Pulaski National Monument Administrative History, December 2003.

Cultural Resource Data

The World War II bunkers have been determined eligible for listing in the National Register by the National Park Service. The Determinations of Eligibility for the two structures note that the bunkers are ". . . integral component[s] of the Fort Pulaski National Monument Property" and are eligible for listing in the National Register of Historic Places under Criterion C.[4] The Determinations of Eligibility also note that that the bunkers may be significant locally and at the state level under this criterion.[5]

Period of Significance: 1943–1946

Proposed Treatment: Preservation

Project Scope and Methodology

The goal of the HSR is to develop planning information for use in the repair, maintenance, and preservation of historically significant buildings and structures. First developed by the NPS in the 1930s, HSRs are documents prepared for a building, structure, or group of buildings and structures of recognized significance. They are developed to record and analyze the property's initial construction and subsequent alterations through historical, physical, and pictorial evidence; to document the performance and condition of the structure's materials and overall physical stability; to identify an appropriate course of treatment; and, following implementation of the recommended work, to document alterations made through that treatment. [6]

The HSR addresses key issues specific to the West End bunkers at Fort Pulaski National Monument, including the history of the structures; their design and construction; the existing physical condition of the structures; and their historic significance and integrity. The HSR consists of the management summary, history, description and condition assessment, and significance and integrity evaluation, followed by discussion of the treatment approach and recommendations. Three appendices are included: measured drawings, a structural analysis of the bunkers, and a laboratory materials study.

The following project methodology was used for this study.

Research and Document Review. Archival research was performed to gather information about the original construction of the West End bunkers and past modifications and repairs. This information was referenced in assessing existing conditions and developing treatment recommendations. Documents reviewed included maps, drawings, historic photographs, and other written and illustrative documentation about the history of construction and modifications to the West End bunkers. The research for this study built upon prior historical and archival research completed by the NPS and others. Primary reference material for this study was obtained from the Fort Pulaski National Monument archives. Additional research material was obtained from the National Park Service Technical Information Center (TIC) in Denver, Colorado, and the National Archives in College Park, Maryland.

Condition Assessment and Documentation. Concurrent with the historical research, a condition survey of the structures was performed and observations were documented with digital photographs, field notes, and annotation on baseline drawings prepared by the project team. The condition assessment addressed all visible

4. National Park Service, *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*
5. National Park Service, *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*
6. Deborah Slaton, *Preservation Brief 43: The Preparation and Use of Historic Structure Reports* (Washington, D.C.: National Park Service, Technical Preservation Services, 2005).

(above-grade) portions of the West End bunkers. Materials samples were removed for laboratory materials studies and inspection openings were made to support the structural assessment and analysis.

Development of History, Chronology of Construction, and Evaluation of Significance. Based on historical documentation and physical evidence gathered during the study, a context history and a chronology of design and construction were developed. An evaluation of the significance of the structure was also prepared, taking into consideration guidelines provided by the National Register Bulletin, *How to Apply the National Register Criteria for Evaluation*.[7] This evaluation of history and significance provided the basis for the development of recommended treatment alternatives.

Guidelines for Preservation. Based on the evaluation of historical and architectural significance of the structure, guidelines were prepared to assist in the selection and implementation of preservation treatments.

Treatment Recommendations. The Secretary of the Interior's Standards for the Treatment of Historic Properties guided the development of treatment recommendations for the significant features of the bunkers. Following the overall treatment approach of Preservation for the West End bunkers, the specific recommendations were developed to address the observed existing distress conditions as well as long-term preservation objectives.[8]

Preparation of Historic Structures Report. Following completion of research, site work, and analysis, a narrative report was prepared summarizing the results of the research and inspection and presenting recommendations for treatment. The management summary, history, condition assessment, and evaluation of significance comprise Part 1 of the HSR, while the treatment section of the report comprises Part 2. The HSR was compiled following guidance afforded by Director's Order NPS-28, *Cultural Resource Management Guideline*, and NPS Preservation Brief 43: *The Preparation and Use of Historic Structure Reports*, with modifications to organizational structure for purposes of this project.[9]

7. *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* (Washington, D.C.: National Park Service, National Register of Historic Places, 1997).
8. Anne E. Grimmer, *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings* (Washington, D.C.: National Park Service, Historic Preservation Services, 2017).
9. NPS-28, *Cultural Resource Management Guideline*, accessed May 2019, https://www.nps.gov/parkhistory/onlinebooks/nps28/28intro.htm; Slaton, *Preservation Brief 43: The Preparation and Use of Historic Structure Reports*.

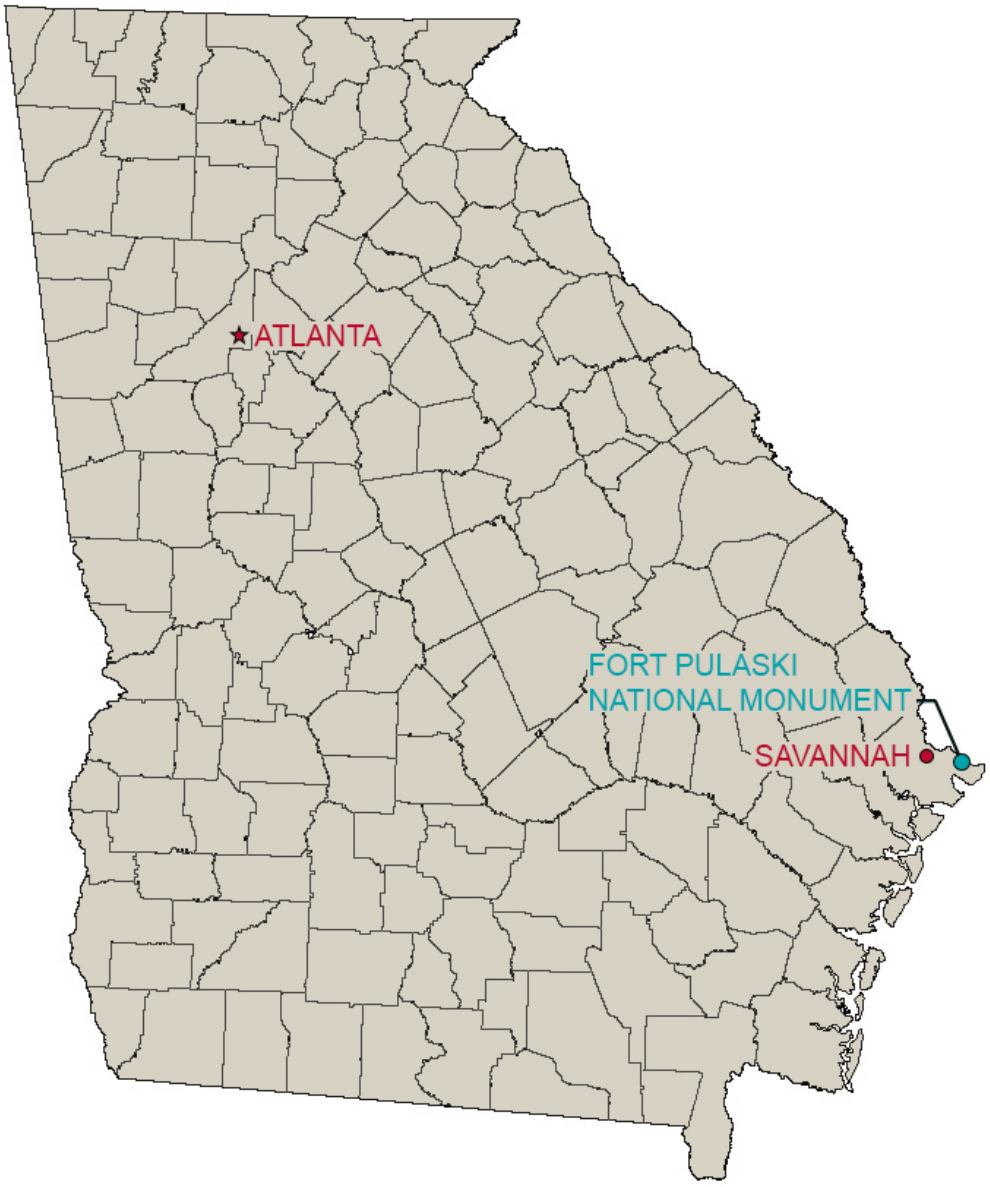


Figure 1. Map of Georgia showing location of Fort Pulaski National Monument on the coast near Savannah (not to scale). (Source: U.S. Census Bureau, modified by the authors)

Figure 2. Map of Fort Pulaski National Monument and surrounding areas showing the location of the West End bunkers. (Source: National Park Service, modified by the authors)

Figure 3. Aerial view of the West End bunkers and surrounding area. (Source: Google Earth, modified by the authors)

Developmental History

The following developmental history is organized in two primary sections. The first portion of the chapter provides a context history for Cockspur Island from earliest known occupation through the establishment of Fort Pulaski and its military uses during and after the Civil War. The second portion of the chapter begins with the establishment of Fort Pulaski National Monument and stewardship of the property by the National Park Service, including New Deal-era preservation efforts at the fort, followed by U.S. Navy occupation of the property, including construction of the two bunkers that are the subject of this Historic Structures Report. The second section concludes with discussion of the history of the bunkers following the war. As requested by the NPS project team and in response to the recent designation of Savannah and Chatham County as an American World War II Heritage City, additional context is provided about World War II activities in Savannah and military action along the Georgia coast.

Early History of Cockspur Island

Archeological studies have not yet been conducted to confirm prehistoric occupation of Cockspur Island. However, archeological studies at nearby Whitemarsh and Wilmington Islands have found evidence of human habitation during the Middle Woodland (500 BCE to 500 CE) and Late Woodland (500 CE to 1100 CE) periods.[10]

When Spanish explorers traveled along the Georgia coast during the early 1500s, the Euchee tribe inhabited nearby Tybee Island. By 1580, Franciscan missionaries from Spain began to establish missions along the southern Georgia coast. The northernmost mission established was the Mission Santa Catalina de Guale, which sat near the mouth of Ogeechee River, approximately 15 miles southwest of Cockspur Island. The Franciscan missions continued to thrive along the Georgia and Florida coast until the 1670s, when the British began to settle in the Carolinas. Colonization of the Carolinas by the British led to conflicts with the Spanish. A series of raids on the missions by American Indians allied with the British eventually caused the Spanish to leave Georgia and retreat into Florida. By 1686, Juan Márquez Cabrera, the Spanish Governor of Florida, ordered the removal of all missions north of Amelia Island.[11]

On January 30, 1733, six British ships led by Gen. James Oglethorpe sailed into the Savannah River, passing Cockspur Island (then known as Peeper Island) before landing and establishing Savannah at Yamacraw Bluff. Oglethorpe led several subsequent expeditions to Savannah from England. On a later voyage in 1736, Oglethorpe's party, which included John Wesley, the founder of

10. J. Faith Meader, and Cameron Binkley, eds., *Fort Pulaski National Monument Administrative History* (Atlanta, Georgia: National Park Service, 2003), 3, citing John H. Jameson Jr., *Archeological Issues at Fort Pulaski National Monument, Georgia* (Tallahassee, Florida: Southeast Archeological Center, National Park Service, 1998).
11. Susan Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report* (Atlanta, Georgia: National Park Service, 2011), 5.

the Methodist movement, stopped at Cockspur Island on its way up the Savannah River.

In 1758, William DeBrahm and Henry Yonge, joint surveyors-general for the Georgia colony, surveyed Cockspur Island following the purchase of 150 acres by Charleston planter Jonathan Bryan. At this time, twenty acres of land at the eastern end of the island were reserved for public use.[12]

During the French and Indian War (known in Europe as the Seven Years' War) in 1756–1763, colonial leaders were concerned by the possibility of an attack on Savannah by the Spanish based in St. Augustine. These concerns led to the construction of Fort George on the east end of Cockspur Island, beginning in 1761. The fort consisted of a small wooden palisade with a blockhouse in the center. While the fort served as protection for Savannah, it was also utilized for customs and quarantine enforcement. The fort was abandoned in 1776 at the beginning of the Revolutionary War.[13]

Several high-ranking British officials, including James Wright, the Royal Governor of Georgia, took refuge on Cockspur Island during the Revolutionary War. For a short time, the island was the Loyalist capital of the Georgia colony, until the British reoccupied Savannah in 1778. At that time, the island was once again abandoned.[14]

Following the conclusion of the Revolutionary War, the United States sought to establish a coastal defense system. In 1794, Congress passed legislation calling for a system of fortifications known as the "First American System of Fortifications." Soon, the Secretary of War ordered new forts to be built to protect the major coastal cities. The new forts would be wood structures consisting of batteries, magazines, and barracks or blockhouses. Small cannon were placed on the upper stories of the structures.[15]

As part of this new coastal defense system, a new fort was constructed on Cockspur Island to protect Savannah. Named after Revolutionary War hero Nathanael Greene, Fort Greene was constructed between 1794 and 1795 somewhere on the island's northeast corner.[16] As of 1800, sixty-five officers occupied Fort Greene, which was largely used as a quarantine station. In 1804, a hurricane struck Cockspur Island, destroying Fort Greene and killing half of the soldiers stationed at the island.[17]

In 1807, fearing an attack by the British, Congress authorized the construction of the "Second American System of Fortifications." The new defense system would consist of fortifications with high stone and masonry walls and multilevel tiers with internal casemates and gun positions. The second defense system was under development when the War of 1812 broke out.[18]

Planning and Construction of Fort Pulaski

The War of 1812 occurred in part as a result of issues unresolved at the conclusion of the Revolutionary War in 1783. On June 18, 1812, the

12. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, 6, citing Guy Prentice, "Trip Report on Site Condition Assessments, Fort Pulaski National Monument, GA, November 28–December 2, 2005" (Tallahassee, Florida: Southeast Archeological Center, 2006), 49.
13. National Park Service, *Cultural Landscape Inventory (CLI) Fort Pulaski National Monument* (Atlanta, Georgia: Southeast Regional Office, 2000), 5.
14. Ralston Lattimore, *Fort Pulaski National Monument* (Washington, D.C.: National Park Service, 1954), 2.
15. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, 8, citing Prentice, 2006, 52.
16. Correspondence with the NPS, Interior Region 2, June 2023.
17. Lattimore, *Fort Pulaski National Monument*, 3.
18. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 5–6, citing John Whiteclay Chambers, ed., *The Oxford Companion to American Military History* (Oxford: Oxford University Press, 1999), 275–276.

United States declared war on Great Britain in response to British attempts to restrict trade (in part brought about by Britain's ongoing war with France), the British Royal Navy's impressment of American seamen, and Britain's support of American Indian tribes' resistance to territorial expansion by the United States. The war was fought partly at sea and partly on the Great Lakes and Lake Champlain, and involved British blockades of the Atlantic Coast and attacks on coastal resources. Fighting also occurred on both sides of the U.S.-Canada border, along the Gulf Coast of the United States, and in the Mid-Atlantic region. The war ended with the Treaty of Ghent, signed on December 24, 1814, but not ratified until February 1815.

The war resulted in significant damage to the United States' coastal defense system, including the new fortifications under development. As a result, Congress created the Board of Fortifications for Sea Coast Defense in 1816. Shortly thereafter, the federal government engaged French military engineer Gen. Simon Bernard, who along with U.S. Army engineers designed a new coastal defense system known as the "Third System of Coastal Defense." The defense system would include the construction of 200 permanent, modern masonry fortifications along the Atlantic and Pacific coasts. In September 1828, the Board of Fortifications for Sea Coast Defense approved Bernard's recommendation to construct a fort on Cockspur Island near the mouth of the Savannah River.

Early plans, completed in 1827, called for a two-level fort to be constructed. However, the final plans, approved by the Board of Fortifications in September 1831, proposed a single-level fort topped with an open terreplein (Figure 4). The fort was five-sided in plan, with the gorge containing personnel quarters along the west side. The new fort was named for Polish Count Casimir C. Pulaski in recognition of his role during the Siege of Savannah during the American Revolution.

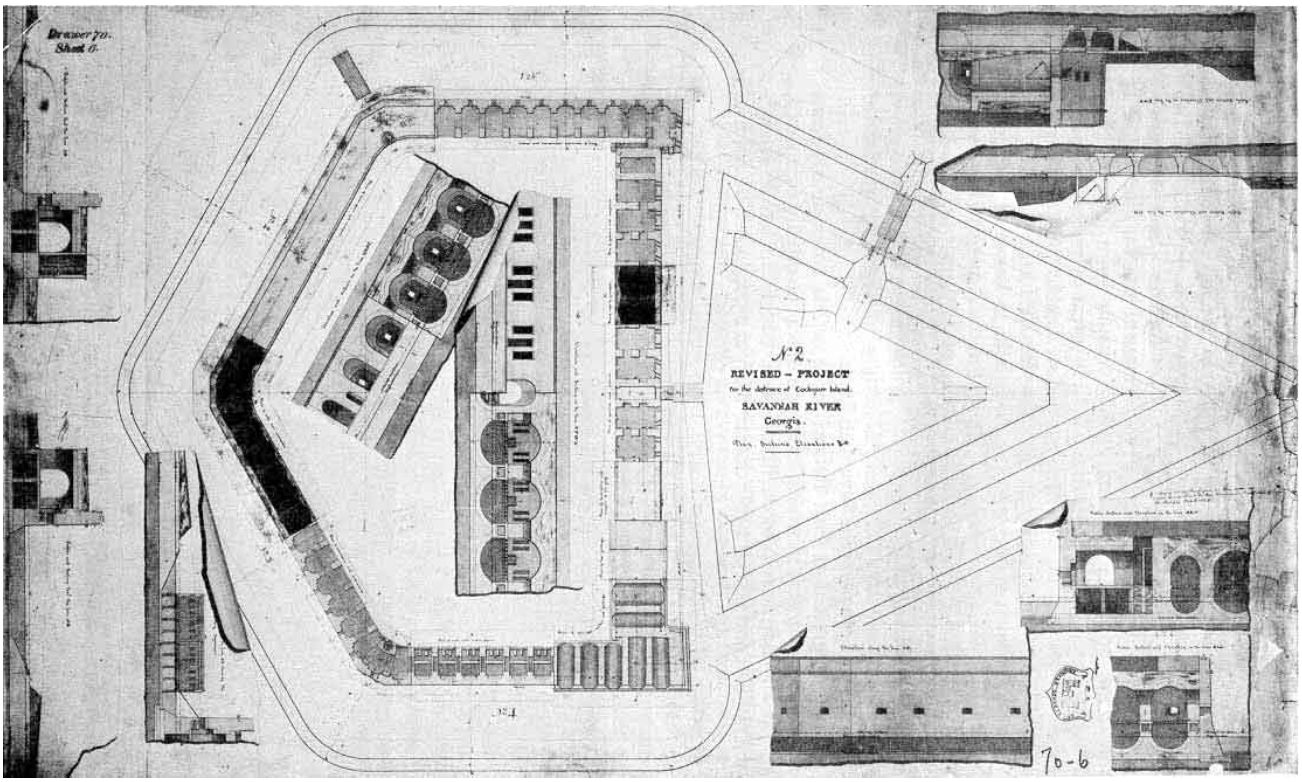


Figure 4. 1831 plan of Fort Pulaski, showing the fort as it was constructed. (Source: Fort Pulaski National Monument)

The fort was constructed using enslaved labor from nearby rice plantations. In addition, military servicemen as well as skilled masons and carpenters, many of whom were recruited from northern states, participated in construction.[19] Frequent storms and the inability of Congress to appropriate funds delayed construction of the fort. The fort was finally completed in March 1847.

Fort Pulaski during the Civil War, 1861–1865

After the election of Abraham Lincoln, southern states began to consider secession from the United States. As Georgia considered whether to secede, on January 3, 1861, the state militia seized Fort Pulaski and began to prepare it for possible Federal attack (Figure 5). By the end of January, Georgia had officially seceded and on February 8 became one of the founding states of the Confederate States of America. The war began with shelling of Fort Sumter on April 12, 1861, and during the following summer U.S. forces developed plans for a naval blockade of the South that included recapturing the southern seacoast fortifications.[20] General Robert E. Lee returned to Fort Pulaski in November 1861. In an attempt to strengthen the Confederacy's coastal defense system, Lee had his forces dismantle an artillery battery at nearby Tybee Island and move its heavy guns to Fort Pulaski.[21] Following the abandonment of Tybee Island by Confederate forces, Federal troops occupied the island and established a permanent garrison by the end of 1861. Following the occupation of the island, Federal troops prepared for an attack on Fort Pulaski.[22] By the end of February 1862, Federal troops had completed the blockade of Fort Pulaski and destroyed the telegraph line between Savannah and Cockspur Island.[23]

Figure 5. Drawing of Fort Pulaski after bombardment,1861. (Source: "Confederates prepare Fort Pulaski for battle. Contemporary drawing made after bombardment for *Harper's Pictorial History of the War of 1861*," Record Group 79, Prints and Historic Photographic File, Charles Porter Collection, 1928–1962, Box 4, Folder 79-G-4F, National Archives, College Park, Maryland)

19. Meader and Binkley, *Fort Pulaski National Monument Administrative History*.
20. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 17–19.
21. Meader and Binkley, *Fort Pulaski National Monument Administrative History*.
22. Quincy A. Gillmore, *Siege and Reduction of Fort Pulaski National Monument* (1862; reprint, Gettysburg: Thomas Publications, 1988).
23. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 23–24.

The defenders of Fort Pulaski believed that the fort's solid masonry walls could not be breached. The surrounding marshes made it impossible for ships to safely come within shooting range of the fort. Tybee Island, 1 to 2-1/2 miles away, was thought to be too far away from the fort for land batteries to be effective. At this time, smoothbore guns and mortars were not capable of breaching a heavy masonry wall at a distance beyond 700 yards.[24] However, Gen. Quincy Adams Gillmore was convinced that the new rifled gun, with which the U.S. Army had been experimenting since 1859, could breach the walls of Fort Pulaski from Tybee Island.[25]

Beginning on the morning of April 10, 1862, Federal forces fired mortar shells at Fort Pulaski from batteries on Tybee Island. The slow bombardment, which inflicted significant damage on the masonry walls of the fort, continued the next morning. By shortly after noon, the southeast angle of the fort was in ruins (Figure 6 and Figure 7).[26] By the afternoon of April 11, the fort was once again under Federal control.[27]

Figure 6. The southeast corner of Fort Pulaski following the attack, 1862. (Source: Fort Pulaski National Monument. Photograph by P. Haas)

Figure 7. Fort Pulaski, 1862, showing damaged casemate masonry at the southeast corner. (Source: Fort Pulaski National Monument)

Federal forces maintained a garrison at Fort Pulaski throughout the war. In December 1864, Gen. William T. Sherman secured the surrender of Savannah. On April 29, 1865, Federal forces fired 200 guns from the ramparts of Fort Pulaski to celebrate the surrender of Gen. Robert E. Lee and the end of the Civil War.

Fort Pulaski after the Civil War, 1865–1898

Following the war, the U.S. Army sought to modernize the fort in response to its failure to withstand the Federal fire in 1862. Between 1869 and 1872, the U.S. Army Corps of Engineers under the direction of General Gillmore "remodeled the demilune, constructing underground magazines and passageways and emplacements for heavy guns."[28] Funds were also made available to make

24. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 25–28.
25. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 28.
26. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 34.
27. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 34.
28. Ralston B. Lattimore, *Fort Pulaski National Monument, Georgia*, National Park Service Historical Handbook Series No. 18 (Washington, D.C., National Park Service, 1954, reprinted 1961).

repairs to the drawbridge wharf, seawalls, and roads.[29]

In October 1873, the remaining Army units stationed at Fort Pulaski were withdrawn, and on October 25, the fort was officially closed. In 1875, the Army acquired land on Tybee Island for a new fort. By 1880, only an Army ordnance sergeant serving as a caretaker remained at Fort Pulaski, together with two keepers at the lighthouse. The fort was set aside by the Army as a military reservation for potential future use.[30]

In 1884, the U.S. Army Corps of Engineers assumed responsibility for the maintenance of Fort Pulaski.

In 1885, President Grover Cleveland appointed a National Board of Fortifications, headed by Secretary of War William C. Endicott and composed of Army and Navy members, whose duty it was to conduct a complete review of the coastal defenses of the United States and to make recommendations for a new program. Not since 1816, when a four-man board headed by General Simon Bernard of France resulted in the Third System of coastal fortification, had fortifications, the type of armaments, and other features been so intensely scrutinized and studied.[31] The Endicott Board on Fortifications made its final report on January 23, 1886.

The Endicott Board's findings included recommendations for a completely new system of artillery fortifications to be constructed at twenty-seven ports or harbors in the continental United States, supplemented with submarine minefields, floating batteries, and small torpedo boats.[32] The operational defensive theory of the Endicott fortification system was based on four components: heavy, rifled guns, mounted on disappearing carriages; submarine minefields at the entrances of harbors and rivers; fast-gun batteries; and low-profile, widely scattered concrete fortifications. Funds were approved "for the defense of Tybee Roads and the Savannah River" in 1893.[33]

Despite being unable to resist attack by rifled cannon during the Civil War, Fort Pulaski was still militarily important as a result of its location, and elements of the new Endicott coastal fortification system were placed on Cockspur Island. The Endicott Board's reports in 1886 and 1902 included Savannah as a location to receive funding, indicating that Savannah remained a significant port.[34] By 1893, the Endicott plans completed by the Board of Engineers for Tybee Roads and the Savannah River included the construction of Fort Screven, with seven batteries with various sizes of guns and a submarine mine casemate.[35] As part of the Endicott defense of Savannah Harbor, a submerged minefield was installed to guard the harbor entrance. To provide additional protection of the minefield, Battery Hambright was constructed, as part of Fort Screven across the river, in 1899–1902.[36]

Establishment and Early Years of the New Quarantine Station

The precedent of Fort Greene in 1794–1795, constructed on Cockspur Island primarily to serve as a quarantine station, was known in the years after the Civil War when the city of Savannah

29. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 13, citing Quartermaster Gen. to Belknap, Secretary of War, December 4, 1869, Townsend, Adj. Gen., to Maj. Gen. Halleck, August 25, 1870.
30. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 13, citing *Preliminary Inventory of the Records of U.S. Army Continental Commands, 1821–1920*, Volume IV, Military Installations, 1999, Record Group 393, National Archives Building, Washington, D.C.
31. Charles W. Snell, *Battery Horace Hambright, Historic Structure Report, Historical Data Section, Fort Pulaski National Monument, Georgia (Draft)* (Denver, Colorado: National Park Service, Denver Service Center, 1977), 3.
32. Snell, *Battery Horace Hambright, Historic Structure Report (Draft),* 3.
33. Snell, 7, *Historic Structure Report (Draft),* citing ARCE for Fiscal Year, 1893, Serial no. 3199, 4.
34. "Seacoast Fortification - Endicott System," n.p.
35. Snell, *Historic Structure Report (Draft),* 10.
36. Snell, *Historic Structure Report (Draft),* 10.

recommended the establishment of a permanent new quarantine station on the island.[37] Fort Pulaski had declined and dredging on the north side of Cockspur Island shifted environmental conditions such that the river's main shipping channel was rendered impassable and of minimal military value. By May 1889, the City had leased part of the northwestern end of Cockspur Island from the War Department to establish the station. Within four years, a Caribbean-style raised cottage residence for the Quarantine Officer, as well as wharves, houses, a disinfecting plant, and a hospital store, had been constructed.[38]

The U.S. Public Health Service assumed oversight of the Cockspur Island quarantine station in 1899, and by 1903 the station had expanded to include nine buildings, all of which remained perennially vulnerable to flooding despite continued deposits of dredged materials. The station was expanded again in 1911, bringing its acreage to approximately 130 acres. New facilities at the site by that date included a kitchen and dining hall, barracks, living quarters, and wharf. Prior to the arrival of German prisoners of war in 1918 and 1919, decontamination facilities were also built. By the end of the 1920s, twenty more buildings had been constructed, comprising an extensive complex.[39]

Early Preservation of Fort Pulaski, 1898–1924

By the early twentieth century, Fort Pulaski was showing signs of deterioration, and the parade ground, terreplein, and demilune were becoming overgrown with vegetation (Figure 8). In 1913, an inspection of the fort was undertaken. The inspection found that the lighthouse keeper had vacated the fort, leaving the structure without a caretaker. As a result, efforts were made to find a full-time custodian, as well as to procure funding to make repairs to the fort. Col. Dan C. Kingman of the Corps of Engineers described the condition of Fort Pulaski in a letter to the Adjutant General at Governor's Island:

> Fort Pulaski is a fine specimen of a brick fort. . . . The wet ditch is filled with mud and grown up with weeds, the drawbridge is gone, and the gates are in such condition as would hardly exclude anyone who cared to enter it. I think that all these forts should be maintained. The time may come when they will be found useful . . . it seems a pity to see the forces of nature gradually destroying them.[40]

Following the inspection of the fort and the plea for funding, a caretaker position was established for Fort Pulaski. The caretaker received no pay but was permitted to reside in the home situated on the terreplein of the fort in exchange for maintaining the house and adjacent grounds while preventing trespassers from entering the fort.[41]

37. Tommy H. Jones, *Fort Pulaski National Monument Quarantine Attendants' Quarters Historic Structure Report* (Atlanta, Georgia: National Park Service, Southeast Regional Office, Historical Architecture, Cultural Resources Division, March 2004), 5.
38. Jones, *Fort Pulaski National Monument Quarantine Attendants' Quarters Historic Structure Report,* 11; Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 15.
39. Jones, *Fort Pulaski National Monument Quarantine Attendants' Quarters Historic Structures Report*, 17.
40. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 15–16, citing Col. Kingman to Adjutant General, Headquarters Eastern Division, Governors Island, New York, February 18, 1913, Record Group 77, Box 1, National Archives, Atlanta.
41. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 15–16.

Figure 8. Aerial view of Fort Pulaski, before 1925. Note the overgrowth of trees and shrubs at the parade ground and demilune, low plants in the former moats, caretaker's house atop the terreplein, and small outbuilding on the parade ground. (Source: Fort Pulaski National Monument)

On July 17, 1915, the War Department announced that Fort Pulaski had been selected for consideration as a national monument under the American Antiquities Act. However, efforts to preserve the site were postponed due to World War I.[42] In 1917, after visiting the fort, Col. John Millis, the District Engineer of the Corps of Engineers in Savannah, recommended its immediate preservation. Millis, with the help of Thomas Purse, Secretary of the Savannah Board of Trade, sought War Department funds to be used for the improvement of Fort Pulaski. In December 1917, $500 was made available, allowing the ridge around the fort to be cleared, affording visitors arriving at the site by boat a better view of the fort.[43] In 1918, an additional $2,300 was made available for the "Preservation and Repair of old Fort Pulaski."[44]

42. Lattimore, *Fort Pulaski National Monument*, 43.
43. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 18, citing Thomas F. Lynch to District Engineer's Office, Savannah, December 11, 1917, Record Group 77, Box 1, National Archives, Atlanta.
44. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 15–16, citing Millis to Lynch, February 26, 1918, Record Group 77, Box 1, National Archives, Atlanta.

Establishment and Early Stewardship of Fort Pulaski National Monument, 1924–1933

On October 15, 1924, Fort Pulaski was designated a national monument by President Calvin Coolidge.[45] The fort was to be managed by the U.S. War Department, which also maintained other Civil War sites such as Antietam, Gettysburg, and Shiloh national military parks. In August 1925, supervision of Fort Pulaski was transferred from the Corps of Engineers office in Savannah to the Quartermaster Department of the Army. As a result, the Quartermaster at Fort Screven on Tybee Island was placed in charge of Fort Pulaski.[46]

In January 1926, Congressman Charles G. Edwards introduced legislation that would transfer the fort to the City of Savannah, while providing an appropriation of $100,000 for the preservation of the structure.[47] The War Department opposed the bill, wanting to retain the fort for future use. As a result, the bill failed. A second bill for an appropriation that would include salary for a caretaker and maintenance of the fort for one year was also rejected by Congress.[48]

On June 10, 1933, President Franklin D. Roosevelt signed Executive Order 6166, through which the National Park Service gained jurisdiction over all historic sites, battlefields, monuments, and parks previously administered by the War Department, the Department of Agriculture, and the Office of Public Buildings and Public Parks of the National Capital.[49] As a result, Fort Pulaski National Monument and approximately 20 acres of adjacent land were placed under the administrative responsibility of the National Park Service.

Following the transfer of Fort Pulaski to the National Park Service, the State of Georgia donated 297.39 acres to the Department of the Interior in 1935. This included the east end of Cockspur Island, as well as portions of the former right-of-way of the Central of Georgia Railroad on McQueen's Island, south of Cockspur Island. An act of Congress extended the western boundary of the monument to the eastern property line of the U.S. Public Health Service Quarantine Station situated on the west end of the island. This expanded the size of the monument to nearly 500 acres in size. The legislation also authorized the Secretary of the Interior to accept lands, easements, and improvements on nearby McQueen's and Tybee islands. A bridge was also to be constructed between Cockspur Island and McQueen's Island.[50]

New Deal Programs at Fort Pulaski, 1933–1941

At the time the National Park Service gained jurisdiction over Fort Pulaski, several new agencies were created as part of Franklin Roosevelt's New Deal program. These agencies, including the Civil Works Administration (CWA), the Civilian Conservation Corps (CCC), and the Public Works Administration (PWA), all contributed to the preservation of Fort Pulaski during the 1930s.

45. Lattimore, *Fort Pulaski National Monument*, 43.
46. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 20, citing "Fort Pulaski in Charge Quartermaster," *The Savannah Press*, 13 August 1925, RG 77, Box 1, National Archives, Atlanta.
47. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 20, citing "Edwards Wants to Save Fort Pulaski," *The Savannah Press*, 7 January 1926, RG 77, Box 1, National Archives, Atlanta.
48. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 20, citing "Introduces Bill for Fort Pulaski," *The Savannah Morning News*, January 19, 1927, Record Group 77, Box 1, National Archives, Atlanta.
49. Barry Mackintosh, *The National Parks: Shaping the System* (Washington: D.C. U.S. Department of the Interior, 1991), 24.
50. Farris Cadle, "Title Abstract for Cockspur Island," 2000. Park files, Fort Pulaski National Monument.

The CCC was established on March 31, 1933, under the Federal Unemployment Relief Act. The goal of the CCC was to mobilize unemployed labor forces to perform work such as reforestation, land reclamation, and building of roads and trails. The national park system, together with state parks, was the beneficiary of much CCC work. By October 1933, there were 102 CCC camps in national parks around the country.

Established in November 1933, the CWA was intended to employ four million American workers in the winter of 1933–1934.[51] In December 1933, a unit of 212 CWA personnel began work at Fort Pulaski and elsewhere on Cockspur Island.

At the end of January, an official press release announced that, "The old splendor of Fort Pulaski National Monument, will be restored under an allotment of $153,500, from Public Works funds." Of these funds, $75,000 was allocated for repairing the fort; $2,500 was to improve the grounds; $8,000 was intended for the construction of a caretaker's residence, as an earlier residence had been destroyed in a recent fire; an additional $8,000 was allocated for the construction of "an office, recreation house, comfort station and water and sewer system"; $10,000 was intended for wharf building; and $50,000 was to address the construction of 2 miles of roads to improve access to the site.[52] By late April 1934, the CWA had completed several small projects, including construction of a landing walk for ferry transport on the south channel. Ferry service between Cockspur Island and Lazaretto Creek Landing along the Tybee Highway (U.S. Highway 80) operated regularly from May 1934 to May 15, 1938, when the bridge over the south channel was opened. CCC enrollees operated the ferries (Figure 9).[53]

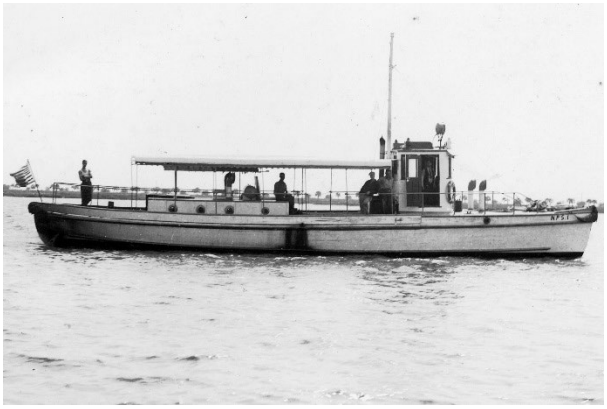


Figure 9. The 67-foot diesel motorboat, known as "NPS-1," used for regular ferry service, 1934–1938. (Source: Fort Pulaski National Monument)

In May 1934, CCC Camp 460 was established along the northwest shore of Cockspur Island. Initially, 175 CCC workers were part of the camp. By mid-1934, the number of CCC enrollees at Fort Pulaski had fallen to thirty. The size of the CCC camp rose to 242 workers in January 1935, following a request by the superintendent of Fort Pulaski for the continuation of the CCC program at the fort. Although the CCC enrollees continued their work on the island, a substantial portion of funds and labor was taken from the Fort Pulaski camp and reallocated to the CCC camp at Robert Fechner Park, located southeast of Savannah, in 1938. As a result, major work at the fort was left unfinished, and maintenance of the park declined. The CCC continued to have a presence at Fort Pulaski until May 1941, when CCC Camp 460 was transferred to Florida.[54]

Projects undertaken by the CCC at Fort Pulaski included landscape and drainage work, in addition to mosquito control.[55] Following the restoration

51. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 24, citing "Superintendent's Annual Report," 1937. Park files, Fort Pulaski National Monument.
52. "Fort Pulaski 618-613-02," Press Release, January 23, 1934, Record Group 79, Folder 618, National Archives at College Park, College Park, Maryland.
53. Summary of Accomplishments of Civilian Conservation Corps, June 5, 1940. Park files, Fort Pulaski National Monument.
54. Superintendent's Annual Reports, 1938, 1939. Park files, Fort Pulaski National Monument.
55. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 26, citing "Cockspur Island Now Modernized," *Savannah Morning News*, October 21, 1934, in "The Story of Fort Pulaski, Savannah River,

of the outer dike and the installation of new tide gates, salt water was reintroduced to the moat at Fort Pulaski in December 1935 (Figure 10).[56]

Figure 10. The moat and west elevation of the fort following restoration, 1936. Note the dredging steam shovel in the background at left. (Source: HABS, image GA-2158-9)

The PWA was created by the National Industrial Recovery Act signed into law by President Franklin Roosevelt on June 16, 1933, and oversaw the construction of large public works projects, such as buildings, bridges, dams, and housing, as well as efforts that required special expertise in historic building repair and restoration.[57] PWA workers, who were generally skilled craftsmen, began restoration work at Fort Pulaski in September 1934.[58]

Construction of a bridge to Cockspur Island began on January 9, 1937, using PWA funds. The NPS acquired 278 acres of land on the south side of the river on McQueen's Island for the bridge approach.[59] On April 23, 1938, the concrete and wood bridge was completed. It opened to traffic on May 13.[60] The PWA extended water and sewer systems and electricity service to the national monument beginning in late December 1938.[61]

On August 11–12, 1940, a hurricane struck Cockspur Island, resulting in damage to the dikes and earthworks. The damage was repaired by CCC labor in the fall and winter of 1940.[62]

The Quarantine Station during the New Deal Era

In 1936, $75,000 was allocated for improvements to the deteriorating quarantine station on Cockspur Island, but changing trends in—and understanding of—public health and public health practices as well as the opening of a new headquarters in Savannah prompted the Bureau of Public Health to close the Cockspur Island station in March 1937.[63] The War Department transferred ownership of the site to the Department of the Interior in August of that year.[64]

Georgia," 1945, The Gamble Collection, Savannah Public Library, Savannah.

56 Narrative report by Ralston B. Lattimore, August 18, 1935.

57. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 28, citing Michael S. Holmes, *The New Deal in Georgia: An Administrative History* (London: Greenwood Press, 1975).

58. Wiss, Janney, Elstner Associates, Inc., *Fort Pulaski National Monument, Fort Pulaski Historic Structure Report*, 2014.

59. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 29, citing "General Information Report, Fort Pulaski National Monument," 1940, microfiche files, NPS-SERO.

60. Superintendent's Annual Report, 1937. Park files, Fort Pulaski National Monument.

61. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 29, citing "Superintendent's Monthly Report," October, November 1940. Park files, Fort Pulaski National Monument. Lattimore, 54.

62. Supplemental Application, Form 10-352, Job No. 135, Hurricane Damage Repairs at Fort Pulaski National Monument, James W. Holland, Superintendent, January 25, 1941.

63. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 15.

64. Jones, *Fort Pulaski National Monument Quarantine Attendants' Quarters Historic Structures Report*, 17.

During this period, the U.S. Army Corps of Engineers was undertaking significant work on the primary shipping channel along the Savannah River, necessitating the removal of portions of Cockspur Island on which the quarantine station had been built. In 1939, the Corps of Engineers began demolishing two utility buildings, an old hospital, and an old wharf, and constructing a new wharf in their place. The CCC at this time also began removing buildings associated with the station, but wartime efforts reshaped initial redevelopment plans by the National Park Service as preparations were made instead to adapt the site as a U.S. Navy section base.[65]

Fort Pulaski during World War II, 1939–1945

After war commenced in Europe in September 1939, the United States began to provide military supplies and other support to countries at war with Germany. President Franklin D. Roosevelt sought to help countries, in particular the United Kingdom, that needed military equipment, food, and raw materials but lacked hard currency. The United States had enacted several laws during the 1930s that limited Roosevelt's options in this regard. The Neutrality Act of 1935 established an embargo on sending arms to nations involved in the conflict, while the Neutrality Act of 1937 prohibited American merchant ships from transporting arms to those nations. The Neutrality Act of 1939 allowed warring nations, especially Great Britain and France, to purchase war materiel from the United States, but only upon cash payment.[66] The Johnson Act of 1934 also prohibited the extension of credit to countries—including Great Britain—that had not repaid U.S. loans made to them during World War I. American military leaders opposed sending war materiel to the United Kingdom out of concern that these supplies would fall into German hands if Britain surrendered following the collapse of France, and also argued that military supplies should be reserved for the defense of the Western Hemisphere. In addition, the American public was generally resistant to the United States becoming involved in the European conflict.[67]

On September 2, 1940, President Roosevelt signed an agreement that provided the British with more than fifty obsolete destroyers in exchange for ninety-nine-year leases to territory in Newfoundland and the Caribbean, which would be used as U.S. air and naval bases. On December 17, 1940, after Prime Minister Winston Churchill warned that the British would no longer be able to pay for supplies, Roosevelt proposed a new initiative. Through this program, known as Lend-Lease, the United States would "lend" Great Britain the supplies it needed. Instead of requiring immediate payment, the United States would receive a "consideration," which would primarily consist of ". . . joint action directed towards the creation of a liberalized international economic order in the postwar world."[68]

The Lend-Lease program:

> . . . was designed to serve America's interest in defeating Nazi Germany without entering the war until the American military and public was prepared to fight. At a time when the majority of Americans opposed direct participation in the war, Lend-Lease represented a vital U.S. contribution to the fight against Nazi Germany. Moreover, the joint action called for under

65. Jones, *Fort Pulaski National Monument Quarantine Attendants' Quarters Historic Structures Report*, 17.
66. U.S. Department of State, Office of the Historian, "The Neutrality Acts, 1930s," accessed August 2023, https://history.state.gov/milestones/1921-1936/neutrality-acts#:~:text=After%20a%20fierce%20debate%20in,transporting%20goods%20to%20belligerent%20ports.
67. U.S. Department of State, Office of the Historian, "Lend-Lease and Military Aid to the Allies in the Early Years of World War II," accessed April 2023, https://history.state.gov/milestones/1937-1945/lend-lease.
68. U.S. Department of State, Office of the Historian, "Lend-Lease and Military Aid to the Allies in the Early Years of World War II."

> Article VII of the Lend-Lease agreements signed by the United States and the recipient nations laid the foundation for the creation of a new international economic order in the postwar world.[69]

Following the Japanese bombing of Pearl Harbor on December 7, 1941, the United States declared war on Japan. Germany and Italy declared war on the United States, and on December 11, 1941, the United States declared war on both countries. The entrance of the United States into the war prompted the termination of New Deal-era programs such as the CCC and PWA, and the closure of all CCC camps not supporting the war effort. At Fort Pulaski:

> Ultimately, the CWA, CCC, and PWA contributed over a quarter million dollars into restoring the fort, constructing administrative offices, a museum, and a bridge to the island. While World War II unfolded, the CCC at Fort Pulaski took on one last project: installing a visitor welcome sign at the park entrance. Almost immediately afterward, Cockspur Island was taken over by the United States Navy for use during WWII and Fort Pulaski was closed to the public. . . .[70]

(See further discussion of U.S. Navy occupation and use of the site, below.)

Savannah during World War II

As noted in the World War II Heritage City designation:

> World War II permeated every aspect of American life and resulted in a large migration of people within the United States. Individuals and families relocated to industrial centers for good paying war jobs and out of a sense of patriotic duty. Many industrial centers became "boom towns," growing at phenomenal rates. Workers from around the nation had to intermingle with each other and overcome differences in order to meet war demands, forever changing the cultural landscape of the United States.[71]

Savannah and Chatham County, Georgia, were an important center for wartime production and shipping:

> During World War II, port facilities in Chatham County, Georgia, along the Savannah River shipped out 1.24 million tons of war materiel produced by local companies and served as the port of embarkation for supplies produced farther inland and shipped through Savannah by rail and then ship. Local factories produced asphalt, boxes, paper, bomb casings, and tractor trailers for military use. Local shipbuilders produced various auxiliary craft, 25 minesweepers, and 85 Liberty transport ships. The 400-acre Savannah Quartermaster Depot distributed over 1 million pounds of supplies each year during the war. The area's important maritime facilities were protected by the U.S. Coast Guard with assistance from local civil defense volunteers. Hunter Field was integral for the training of 70,000 airmen and the equipment of 9,000 aircraft scheduled for deployment with the Eighth Air Force.[72]

During the war, Savannah Harbor:

> . . . consisted of the lower twenty-two miles of the Savannah River and seven miles of channel across the bar to the Atlantic Ocean . . . . The main harbor spanned the width of the Savannah River from 2-3/4 miles below the city . . . to 5-1/2 miles above the city. Port facilities included about 15,600 feet of developed waterfront with 51 wharves and piers (owned and operated by private interests, principally

69. U.S. Department of State, Office of the Historian, "Lend-Lease and Military Aid to the Allies in the Early Years of World War II."
70. National Park Service, "The Eve of World War II," accessed April 2023, https://www.nps.gov/fopu/preservation.htm.
71. National Park Service, "American World War II Heritage City Program," accessed April 2023, https://www.nps.gov/subjects/worldwarii/americanheritagecity.htm. In recognition of the region's contribution to the historic war effort, Savannah and Chatham County have been designated an American World War II Heritage City by the Secretary of the Interior.
72. National Park Service, "American World War II Heritage City Program."

the railroads, and a small portion by the City of Savannah). [73]

Multiple railroad companies and a steamship company serviced the port facilities.

With the passage of the Merchant Marine Act of 1936, a shipbuilding program began to replace and augment the obsolete cargo and passenger vessels of the U.S. Merchant Marine that remained following World War I. As World War II began, these efforts led to a shipbuilding program that produced 5,500 vessels, among which were 2,710 Liberty ships. The Liberty ships, however, were too slow and too small to carry the supplies needed by the United States and its allies. In 1943, a new shipbuilding program began to construct the faster and larger Victory ships, which would be able to carry cargo after the war ended.[74]

The first of eighty-five Liberty transport ships constructed at port facilities in Chatham County was the SS *James Oglethorpe*, built by the Southeastern Shipbuilding Corporation under contract with the United States Maritime Commission. The ship was launched on November 20, 1942, and departed with a convoy from New York to Liverpool on March 6 (Figure 11). The SS *James Oglethorpe* sank after being torpedoed by a German U-boat on March 16, 1943, with forty-four of her seventy-four-man crew lost.[75]

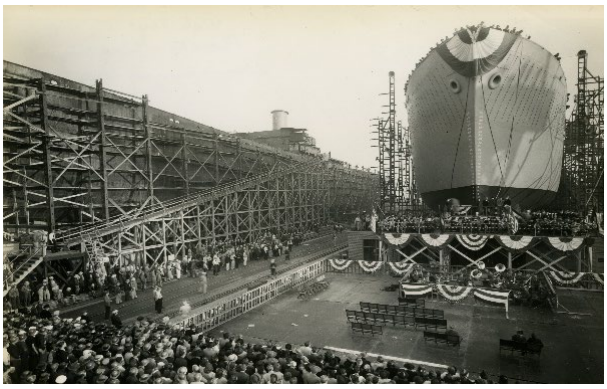


Figure 11. SS *James Oglethorpe* at launching on November 20, 1942. (Source: Georgia Historical Society, Cordray-Foltz Collection MS 1360-30-08-04)

Residents of Savannah and Chatham County contributed to civil defense during the war, including participation in multiple civilian groups and the Georgia State Guard. Local citizens also subscribed to war bonds to purchase a B-17 bomber, the *City of Savannah*.

The War along Georgia's Coast

Although World War II was primarily fought in Europe and Asia, with fighting also occurring in North Africa, the Mediterranean, and the Middle East—the Atlantic Coast of the United States and portions of the Pacific Coast and Alaska formed the American Theater of the war.[76] When the United States entered the war, the Georgia coastline was initially considered an unlikely target for enemy submarine attacks because of the relatively short length of the state's coastline and the shallow waters adjacent to it, which provided little cover for U-boats. [77] The coastline and shipping were vulnerable to attack, however,

73. City of Savannah Research Library and Municipal Archives, *World War II on the Savannah Waterfront in the American Theater of Operations: Wartime Production and Service in Savannah,* prepared by L. Spracher, August 29, 2008.
74. National Park Service, "Liberty Ships and Victory Ships, America's Lifeline in War," accessed April 2023, https://www.nps.gov/articles/liberty-ships-and-victory-ships-america-s-lifeline-in-war-teaching-with-historic-places.htm.
75. Georgia History, "SS *James Oglethorpe* and the Battle of the Atlantic," accessed April 2023, https://georgiahistory.com/marker-monday-s-s-james-oglethorpe-and-the-battle-of-the-atlantic/.
76. City of Savannah Research Library and Municipal Archives, *World War II on the Savannah Waterfront in the American Theater of Operations: Wartime Production and Service in Savannah.*
77 . John Vanzo, "U-boat Attacks during World War II," *New Georgia Encyclopedia*, last modified May 9, 2019, accessed April 2023, https://www.georgiaencyclopedia.org/articles/history-archaeology/u-boat-attacks-during-world-war-ii/.

especially in the first year of the war when anti-submarine patrols were "sporadic and uncoordinated," and coastal communities often ignored orders for nighttime blackouts.[78]

In January 1942, the German submarine *U-123* torpedoed and sank the 5,200-ton freighter *City of Atlanta* off the coast of Cape Hatteras, North Carolina, with the loss of forty-three sailors. Two months later, the *U-123* left its base at Lorient, France, and sailing southward along the East Coast of the United States, sank four ships before entering Georgia's waters. From a position in the shallow waters just off St. Simons Island, in the early morning hours of April 8, 1942, the *U-123* torpedoed and sank the 9,200-ton oil tanker *Oklahoma*, followed soon after by the 8,000-ton *Esso Baton Rouge*. The following morning, the *U-123* sank the steamship SS *Esparta*, about 14 miles south of Brunswick. A total of twenty-three crewmen aboard the three vessels sunk in Georgia waters were killed in the attacks. Survivors from the ships were rescued and brought to shore by several U.S. Coast Guard ships and a private yacht owned by Charles Howard Candler, the son of Coca-Cola Company founder Asa Candler.[79] The German submarine sank four more ships in Florida waters before returning to base.[80]

In response to the U-boat threat along the Atlantic Coast, the U.S. Navy adopted the British system of convoying ships. Air and naval patrols were increased. In Georgia, where several large military bases had been established in recognition of the state's economic and industrial importance to the American war effort, resources included anti-submarine facilities.

> Most important to the antisubmarine effort were Chatham and Hunter airfields, both located near Savannah. One of the most effective military bases in the U-boat war was Glynco Naval Air Station, located near Brunswick and home to both fixed-wing and lighter-than-air antisubmarine aircraft. The port of Savannah itself hosted an assortment of small coastal patrol and antisubmarine warships.[81]

During the summer of 1943, two more American tankers were sunk approximately 150 miles east of Brunswick. However, anti-submarine measures were effective and the U-boat threat to ships in Georgia waters soon ended.

The U.S. Navy on Cockspur Island

Immediately after the United States entered the war, the U.S. Navy issued a call for recruits for its local defense force in Savannah, the U.S. Naval Reserve Inshore Patrol, Class M-2. Lt. Cmdr. Robert P. Erdman received the assignment of special recruiting officer for the Naval Reserve. Lieutenant Commander Erdman, who had led the U.S. Navy Branch Hydrographic Office in Savannah, was to become the first commander of a new patrol base to be established on Cockspur Island.[82]

As early as June 1941, Cockspur Island was reported to be the possible future site of a naval control base. While two other possible locations were proposed—at Lazaretto Creek, between Tybee Island and McQueen's Island and at the Candler Yacht Basin at Thunderbolt, a few miles east of Savannah—officials ". . . believe[d] that all practical considerations point to the selection of the Cockspur Island location."[83]

On November 1, 1941, the Department of the Interior issued a special use permit to the Secretary of the Navy to establish Section Base 20 at Cockspur Island. The location was chosen because of its deep-water access and docking facilities, available structures (the quarantine station and CCC buildings), and its proximity to a nearby

78. Vanzo, "U-boat Attacks during World War II."
79. Vanzo, "U-boat Attacks during World War II."
80. Vanzo, "U-boat Attacks during World War II."
81. Vanzo, "U-boat Attacks during World War II."
82. Gordon B. Smith, Savannah, Georgia, "Volunteers for Victory: The Savannah-Chatham County Area in World War II," 52.
83. Memorandum from James W. Holland to the Director, June 19, 1941, National Archives at College Park, College Park, Maryland, Record Group 79, Box 2205, Folder 501.

highway.[84] The permit noted that the U.S. Navy would use and occupy the island "for the purpose of construction and maintaining a Section Base for the Inshore Patrol," including a utility group area and a quarters group area. The permit stated that "precaution shall be taken to preserve and protect all objects of a historical nature," and that the Navy ". . . shall undertake to maintain and keep in a state of repair at its expense . . . all buildings and improvements now located upon the land covered by this permit, in a manner acceptable to the Secretary of the Interior."[85]

On January 31, 1942, Fort Pulaski National Monument Superintendent James W. Holland noted in his monthly report, "Much of the month was devoted to arranging details of Navy occupation as part of Cockspur Island under special permit and to making adjustments in NPS routine necessitated thereby."[86]

Three months later, in his monthly report dated March 31, 1942, Superintendent Holland described the closing of Fort Pulaski National Monument:

> At exactly 11:10 a.m. on March 19, Fort Pulaski National Monument was closed to public visitation for the remainder of the war. This drastic action resulted from the transfer, on revocable permit, all of Cockspur Island to the Navy Department for the duration of the war. From evidence available in the field office it seems apparent that the Navy is not interested in the active use of the historic fortification but merely desired control in order to keep the public away from this place where Naval and other maritime activities of Savannah harbor may so easily be observed.
>
> So closed a chapter, if not the entire book, in the colorful history of Fort Pulaski as a national monument. While we leave with regret, nevertheless we are glad that our efforts in past years in building dikes, ditches, roads, providing the island with utilities, and, in general, making it tenable and habitable, are providing of positive benefit to the Nation's defenders in this time of great peril.
>
> When a hard-won victory has been achieved, we hope that the century-old doors of this fortress may again swing open for the instruction and inspiration of our people. Perhaps by that time another dramatic story may have been added to the lively annals of Cockspur Island.[87]

Holland also noted that closing day, March 19, 1942, featured "perfect spring weather." He added that the local newspapers reflected the changing fortunes of the monument. Headlines in the *Savannah Evening Press*, for example, noted on February 28 that "Fort Pulaski is Attracting Crowds," and on March 19, "Fort Pulaski is Closed to the Public." In a postscript to the monthly report, Holland added:

> We hope to get things "squared away." As our friends in the Navy say, about May 1. The staff, therefore, probably will be here during the entire month of April, tugging, puffing and sweating over the big moving job. . . . We are leaving Fort Pulaski now, but we'd like to come back.[88]

84. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, 18; United States Department of the Interior, "Special Use Permit Authorizing Use of Land in the Fort Pulaski National Monument, Georgia, by the Navy Department for National Defense Purposes," November 17, 1941.
85. United States Department of the Interior, "Special Use Permit Authorizing Use of Land in the Fort Pulaski National Monument, Georgia, by the Navy Department for National Defense Purposes," November 17, 1941.
86. James W. Holland, Superintendent, Fort Pulaski National Monument, *Superintendent's Monthly Report*, January 31, 1942. Memorandum for the Director, through Coordinating Superintendent C. R. Vinten, Southeastern National Monuments.
87. James W. Holland, Superintendent, Fort Pulaski National Monument, *Superintendent's Monthly Report*, March 31, 1942. Memorandum for the Director, through Coordinating Superintendent C. R. Vinten, Southeastern National Monuments.
88. Holland, *Superintendent's Monthly Report*, March 31, 1942.

The base, commissioned on July 8, 1942, served as the supply and training base for the patrol, with fuel, provisions, and barracks. It needed to provide shops for the repair and maintenance of gas, diesel, and electrical machinery required for the patrol vessels and minesweepers based there. The Savannah Section Base Inshore Patrol was responsible for patrolling the coastal waters of Georgia and South Carolina, while the intracoastal waterways were patrolled by the United States Coast Guard.[89]

The Navy determined that the west end of the island best met its needs and cordoned off Fort Pulaski itself. Fort Pulaski National Monument Superintendent James Holland quickly arranged for the transfer of museum materials, park files, and tools and equipment to storage facilities at Ocmulgee National Monument in Macon. At Holland's insistence, a maintenance worker remained as caretaker at Fort Pulaski throughout the Navy's occupation of Cockspur Island.[90]

The Navy carried out a number of changes to the west end of the island during its occupancy of the site, primarily improvements to accommodate use as a military base. Figure 12 through Figure 14 are aerial views of the U.S. Navy Section Base in 1943. During the course of the war, the Navy spent about $2 million to renovate existing buildings and construct additional structures to house and support its men and equipment. New structures included barracks, an administrative office, an air-cooled movie auditorium, club rooms, cooking facilities, an officer's club, a gymnasium, and an athletic field and tennis court. Figure 15 is a Developed Areas Plan prepared by the National Park Service in 1939, annotated in 1943 to illustrate use of the west end of Cockspur Island by the U.S. Navy. Figure 16 is a list of buildings present on site in 1948, which indicates buildings constructed by the U.S. Navy for its section base, as well as earlier buildings that remained throughout the Navy's use of the property. [91]

At the southwest corner of the island, the Navy constructed nine magazines to store munitions, two of which are located on what is now park property.[92] Seven of the original structures remain on property now owned by the Georgia Department of Transportation.

89. City of Savannah Research Library and Municipal Archives, *World War II on the Savannah Waterfront in the American Theater of Operations: Wartime Production and Service in Savannah;* Lt. Cmdr. Robert P., Erdman, USN, "Navy Pushes Program to Protect Port; Naval Ships Be Built Here," *Savannah Evening Press* (19 November 1941); "Inshore Patrol Base Inactivated," *Savannah Morning News* (4 June 1944), 24:6; "Navy Shore Patrol Here to Close July 1," *Savannah Morning News* (16 June 1946), 28:5.
90. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report.*
91. National Park Service, *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*
92. Although some reports note that the U.S. Navy constructed a total of ten magazines at Fort Pulaski, review of archival documentation suggests that only nine were constructed. (See Ralph W. Emerson, Regional Landscape Architect, United States Department of the Interior, National Park Service, Region One, Richmond, Virginia, "Memorandum for the Regional Director," June 18, 1946, which documents a site visit conducted by National Park Service representatives on June 11, 1946, to review the buildings and structures constructed by the U.S. Navy at the site during the war.)

Figure 12. Aerial view of the U.S. Navy Section Base at Savannah located at the old quarantine station at the west end of Cockspur Island, April 21, 1943. The location of the bunkers is out of view. (Source: "Aerial of Savannah Section Base at Savannah, Ga. Alt. 2,470'; F.L. 8.25',” Number JACK 10756, April 21, 1943, General Records of the Department of the Navy, 1795–1947, General Photographs, 1913–1945 (Prints), 70300–70501, Box 309, National Archives at College Park, College Park, Maryland)

Figure 13. Aerial view of the U.S. Navy Section Base at Savannah, April 21, 1943, showing the development on the west end of Cockspur Island. The location of the West End bunkers is noted by the red circle. (Source: "Aerial of Savannah Section Base at Savannah, Ga. Alt. 2,470'; F.L. 8.25'," Number JACK 10756, April 21, 1943, General Records of the Department of the Navy, 1795–1947, General Photographs, 1913–1945 (Prints), 70300–70501, Box 309, National Archives at College Park, College Park, Maryland)

Figure 14. Aerial view of the U.S. Navy Section Base at Savannah, April 22, 1943, showing the development on the west end of Cockspur Island. The general location of the West End bunkers is noted by the red circle. (Source: "Aerial of Savannah Section Base at Savannah, Ga. Alt. 2,500'; Looking north'," Number JACK 10236, April 22, 1943, General Records of the Department of the Navy, 1795–1947, General Photographs, 1913–1945 (Prints), 70300–70501, Box 309, National Archives at College Park, College Park, Maryland)

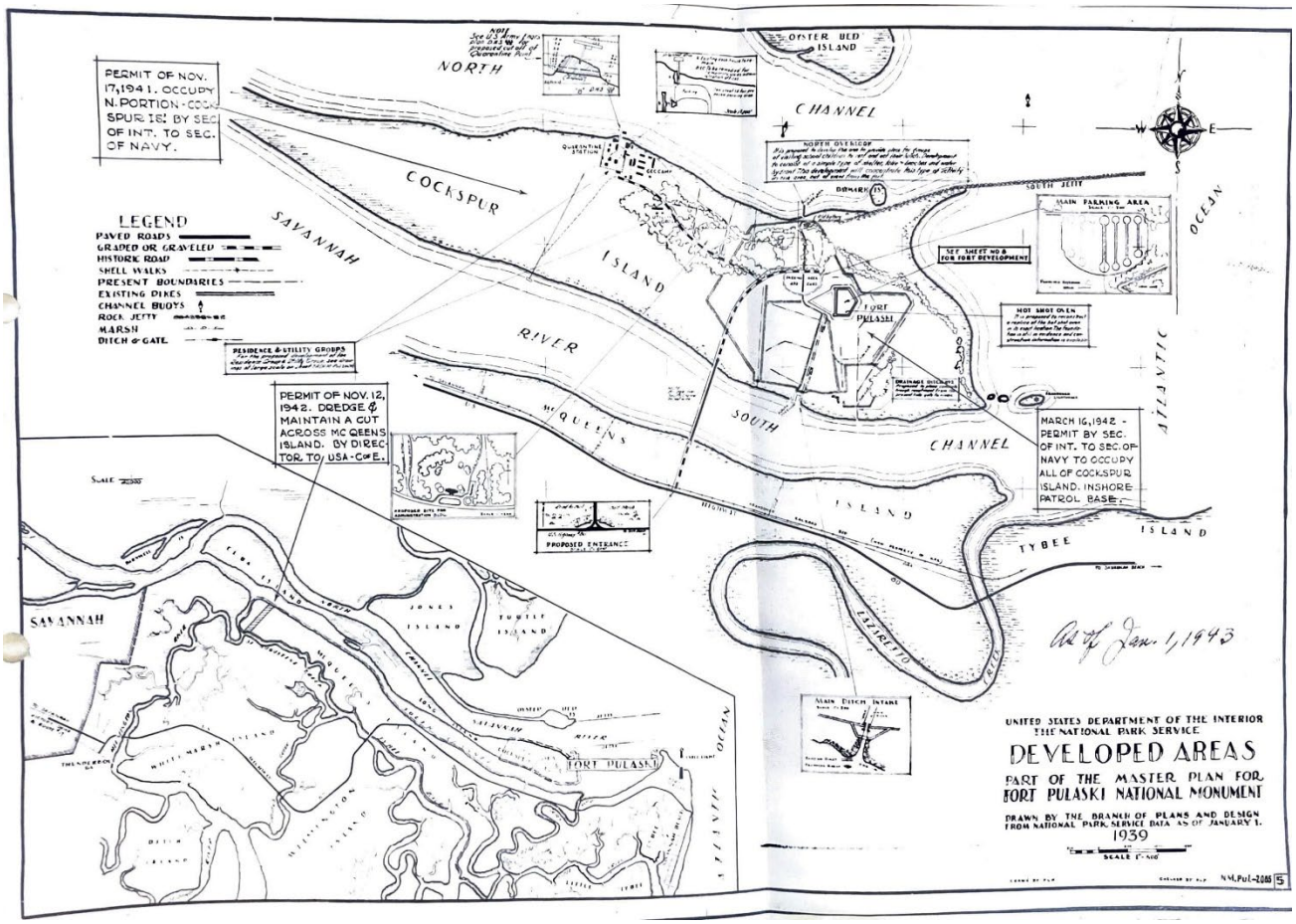


Figure 15. Developed areas plan, prepared as part of the Master Plan for Fort Pulaski National Monument, National Park Service Branch of Plans and Design, 1939, annotated as of January 1, 1943, to reflect use of Fort Pulaski as a U.S. Navy Section Base. (Source: "U.S. Department of the Interior, National Park Service, Developed Areas, Part of the Master Plan for Fort Pulaski National Monument," National Archives at Philadelphia, Philadelphia, Pennsylvania)

COPY

[1/9/48 - rnp]

CG PERSEPCEN NO. 6
Cockspur Island
Savannah, Georgia

LIST OF BUILDINGS BY NUMBER

		Year Built
1.	Executive Officer's Residence	1906
2.	Administration Building	1906
3.	Commanding Officer's Residence	1905) 1942)
4.	Communications Building	1906
5.	Machine & Carpenter Shops	1942
6.	Bachelor Officers Quarters	1905
7.	Additional Spar Barracks	1906
8.	Pilots Quarters	1905
9.	Officers Mess	1923) 1943)
10.	Electrical Shop & Bos'n Locker	1905) 1906)
11.	Fire Pump House	1942
12.	Transformer House	1920
13.	Mess Hall & Galley	1942
14.	Crews Barracks	1942
15.	Canteen	1942) 1944)
16.	Signal Tower	1942
17.	Garage & Fire House	1942
18.	Boiler House & Brig	1943
19.	Barracks Hot Water Tank	1942
20.	Spar Barracks	1942
22.	Marine Lift & Dock	
29.	Gasoline Tank	
30.	Fuel Oil Tank	
31.	Radio Towers	
35.	Marine Lift Cable House	1943
36.	Dock House	1942
37.	Dispensary	1942
38.	Mineograph & Laminating Bldg.	1943
39.	Pay & Supply & Warehouse	1943
40.	Separation Center	1943
41.	Paint Locker	1942
42.	Operations Building	1942
43.	Lumber Shed	1942
44.	Spar Lounge	1943
46.	Transformer Vault	
47.	Grease Rack Foundation	
48.	Water Pump House	1943
49.	Water Tower	
50.	Storage Shed	1906
51.	Ice House	1942
52.	Gymnasium	1943
53.	Blacksmith Shop	1942
54.	Emergency Generator House	1943
55.	Boat Electrician Shop	1943
56.	Marine Life & Storage (Off.)	1944
57.	Dock Wash House	1944
58.	Oil Clarification Bldg.	1944
59.	Gasoline & Fuel Oil / Pump House	1942
60.	Vehicle Storage Shed	1943
61.	Storage Shed	1943
62.	Storage Shed	1943
64.	Lube Oil Storage	1945
65.	Gas Cylinder Storage	1944

COPY

Figure 16. List of buildings present on site in 1948 indicates structures added by the U.S. Navy during the war, as well as earlier structures that remained at the time the U.S. Navy left the property. (Source: "CG PERSEPCEN No. 6, Cockspur Island, Savannah, Georgia, List of Buildings by Number," National Archives at Philadelphia, Philadelphia, Pennsylvania)

Of the two bunkers that are part of the National Monument, the larger, south structure was used to store small arms and the smaller, north bunker to store black powder (Figure 17).[93] Both bunkers were constructed of cast-in-place concrete and each was covered, except for the entrance facade of the south bunker and the entrance to the north bunker, with an earthen berm with turf. The larger bunker, located south of the service road, measured approximately 130 feet wide by 50 feet deep, and featured four glass block windows on the north wall. The smaller bunker, located north of the service road, measured approximately 22 feet by 20 feet in plan.

At the end of January 1943, G. S. Burrell, the District Public Works Officer, issued a memo to the Chief of the Bureau of Yards and Docks concerning settlement in six earth-covered magazines constructed by the Southeastern Construction Company at the Cockspur Island Section Base. Three of these magazines were small and intended for the storage of "fuses and detonators, Y-gun charges, and pyrotechnics."[94] Two, each measuring 35 feet by 52 feet, were designed for ammunition storage; and a sixth, measuring 25 feet by 20 feet, was built as a "High Explosive Magazine." At the time, the magazines were "empty or practically so," indicating that the settlement was the result of poor construction as opposed to the weight of the contents within the magazines. The settlements ranged from 6-3/4 inches in the front of the "Small Arms Ammunition" magazine to 1 foot 10-1/2 inches in the rear of the "Fixed Ammunition" magazine.[95]

Figure 17. Undated image of the south bunker at the west end of Cockspur Island. (Source: Fort Pulaski National Monument, Image 3-94.jpg)

93. National Park Service, *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*
94. Memorandum from G.S. Burrell, District Public Works Officer to the Chief of the Bureau of Public Yards and Docks, January 28, 1943, National Archives, Atlanta, Record Group 181, 6th Naval Division Formerly Classified General Correspondence, 1940–1944, Box 5, Folder 3, ID 1419.
95. Memorandum from G.S. Burrell, District Public Works Officer to the Chief of the Bureau of Public Yards and Docks, January 28, 1943, National Archives, Atlanta, Record Group 181, 6th Naval Division Formerly Classified General Correspondence, 1940–1944, Box 5, Folder 3, ID 1419.

Because the structures were settling, standing water began collecting at the entrances to the magazines. This prompted Burrell to recommend the regrading of ". . . the concrete approach floors outside the doors to obviate the water standing in the approaches." The problem, Burrell surmised, resulted from the decision to rely on spread footing as opposed to piles in the original construction, writing:

> In the magazines the floors have settled closely in keeping with the walls. The indications are that on the whole the underlying "mud marsh" (or "soft clay") has probably squeezed out laterally, with the buildings settling as a while. This has been accentuated by the heavy earth embankment on three sides. This explains the greater settlements at the rears.[96]

Two solutions to the problem were suggested. The preferred solution recommended:

> Obtain the materials for three 25 x 50 ft. corrugated metal arch type magazines and one barricade. Erect these to form one 25 x 20 magazine with barricade for depth charges, and two magazines 25 x 64 ft. for fixed and small arms ammunition. . . . All three would be earth-covered, with pile foundations and pile-supported floors. The estimated cost is $36,000, time 2 1/2 months.[97]

The north and south bunkers that are the subject of this Historic Structures Report do not exhibit settlement problems, and the foundations were not exposed for inspection as part of this study. The two bunkers may have been constructed after the settlement problems encountered had been addressed. Nine munitions storage structures were constructed in total, and six had been constructed at the time the settlement issue was discussed in the correspondence referenced above. The correspondence from January 28, 1943, regarding settlement issues referenced an enclosed "proposed magazine layout" dated February 14, 1942. Although the layout was not part of the document reviewed for this study, the date of the layout drawing and the letter regarding settlement suggested that the first six bunkers were constructed after February 1942 and that the remaining bunkers, including those that are the subject of this study, were constructed in 1943.

The bunkers were part of a complex that supported U.S. Navy activities at the section base on Cockspur Island. One of the responsibilities of the section base personnel was to patrol coastal waters for submarines. (Even before the National Park Service turned the site over to the Navy for use as a section base, rumors of submarine activity had reached the park. For example, in January 1942, the Superintendent reported ". . . a wild-eyed rumor in Savannah that the locally-stationed Coast Guard cutter had captured a German submarine and had her tied up at the Fort Pulaski dock."[98] The superintendent noted that ". . . we would much rather all persons would heed the Navy Department's injunction to silence."[99])On July 13, 1942, a minesweeper spotted the periscope of a German submarine 2 miles from the Savannah lightship. Navy vessels, together with Army bombers and a patrol bomber, searched for the submarine for twenty-two hours but did not find it.[100] The Coast Guard also used Cockspur Island as a station for air-sea rescue duty.[101]

By June 1943, the U.S. Navy was considering closing some of its section bases in the United States, by either eliminating the base or reducing its staffing and equipment. For the section base at

96. Memorandum from G. S. Burrell to the Chief of the Bureau of Public Yards and Docks, January 28, 1943.
97. Memorandum from G. S. Burrell to the Chief of the Bureau of Public Yards and Docks, January 28, 1943.
98. James W. Holland, Superintendent, Fort Pulaski National Monument, *Superintendent's Monthly Report*, January 31, 1942.
99. James W. Holland, Superintendent, Fort Pulaski National Monument, *Superintendent's Monthly Report*, January 31, 1942.
100. U.S. Navy, Section Base, Savannah, Georgia, Area, Inshore Patrol, Sixth Naval District, Savannah, Ga., *War Diary*, July 13, 1942.
101. City of Savannah Research Library and Municipal Archives, *World War II on the Savannah Waterfront in the American Theater of Operations: Wartime Production and Service in Savannah.*

Savannah, as well as those at Southport and Mayport, guidance stated, "Increased use of these bases should be made, possibly for shakedown and training work with newly commissioned vessels. Otherwise, the authorized officer and enlisted complements should be substantially reduced."[102] By May 1944, plans were in place ". . . to close the Section Base, Savannah, Georgia, and to place it in a caretaker status pending inquiry into possible alternative use for the Base."[103] By June 2, 1944, correspondence indicated that planning was underway for decommissioning of the U.S. Naval Section Base at Savannah at the end of that month.[104]

World War II in Europe came to an end with the surrender of Germany to the Allies on May 8, 1945. The war in Asia ended with the surrender of Japan on September 2, 1945, after the atomic bomb was dropped on Hiroshima and Nagasaki.

In mid-1945, the U.S. Navy turned over the base to the U.S. Coast Guard for use as one of several Coast Guard separation centers set up across the country to facilitate the demobilization process (Figure 18). The Coast Guard needed to reduce its active-duty force from 172,384 to 34,900, at a planned demobilization rate of 13,800 men a month. The Coast Guard separation center on Cockspur Island handled the Coast Guard discharges from the Sixth and Seventh Naval Districts, which included North Carolina, South Carolina, Georgia, and Florida.

Figure 18. The Naval Base on Cockspur Island, view from south, June 1946. The Crews Quarters and Recreational facilities on right, with paint locker on left. (Source: "Fort Pulaski National Monument, Naval Buildings Erected Under War-Use Permit, Photos – June 1944," National Archives at Philadelphia, Philadelphia, Pennsylvania)

Fort Pulaski after World War II, 1946–1956

Following completion of its use as a separation center, the Coast Guard decommissioned the base on June 17, 1946, and returned it to the National Park Service.[105]

The Navy Inshore Patrol maintained offices in Savannah until it was demobilized in June 1946.[106]

In On 11, June 1946, NPS Regional Landscape Architect Ralph W. Emerson, Fort Pulaski Coordinating Superintendent Vinten, and representatives of the University of Georgia

102. Confidential memo from Vice Chief of Naval Operations W. S. Farber, Navy Department, Washington, D.C., to the Commander, Eastern Sea Frontier, subject: Section Bases in the United States – Abandonment or consolidation with other activities, June 12, 1943.
103. Secret memo from Sub Chief of Naval Operations W. S. Farber, Navy Department, Washington, D.C., to ComSix, subject: U.S. Naval Section Base, Savannah, Georgia, closing of, May 29, 1944.
104. Confidential memo from Disbursing Liaison Officer J. K. Byrd, Sixth Naval District, to Chief of Field Branch, Bureau of Supplies and Accounts, Cleveland, Ohio, subject: U.S. Naval Section Base, Savannah, Georgia, decommissioning of, June 2, 1944.
105. City of Savannah Research Library and Municipal Archives, *World War II on the Savannah Waterfront in the American Theater of Operations: Wartime Production and Service in Savannah.*
106. City of Savannah Research Library and Municipal Archives, *World War II on the Savannah Waterfront in the American Theater of Operations: Wartime Production and Service in Savannah;* Lt. Cmdr. Robert P. Erdman, USN, "Navy Pushes Program to Protect Port; Naval Ships Be Built Here," *Savannah Evening Press* (19 November 1941); "Inshore Patrol Base Inactivated," *Savannah Morning News* (4 June 1944), 24:6; "Navy Shore Patrol Here to Close July 1," *Savannah Morning News* (16 June 1946), 28:5.

(which was interested in housing for students conducting research on Cockspur Island) inspected the "Naval Separation Center" created by the Department of the Navy on Cockspur Island. At the time, the facility was occupied by the U.S. Coast Guard. A memorandum of June 18, 1946, reporting on the site visit described the development as follows:

> The development consists of sixty-five buildings of varying types with attendant facilities such as utility structures, observation towers, channel range markers, fences, tennis courts, baseball diamond, etc. The explosive storage area containing nine magazines is located approximately 1,000 feet to the west of the main station. The entire area is honeycombed by a system of surfaced and unsurfaced roads and paths, and a maze of power lines and other utilities appear overhead. . . . The buildings for the most part are of temporary construction with concrete foundations or pier supports and frame construction. Some of the new buildings have asbestos siding and shingles, but the majority are enclosed with wooden siding or sheet composition material. . . .

The National Park Service and University of Georgia representatives considered reuse of some of the buildings that had been constructed by the Navy, noting (Figure 19):

> It was agreed tentatively that only six of the buildings offered reasonable possibility of being suitable to meet our requirements of use, even temporarily. The six considered for retention would provide an administrative building, utility shop building, storage building, and three residences of varying size, condition, and accommodation. These buildings, most of which are of the newer type of construction, would serve our immediate needs and gradual replacement could be made as their usefulness was outlived. . . . The thought being that retention of these buildings, with their utilities and certain sections of existing road, . . . would make it possible for us to operate without delay upon the termination of the agreement with the Navy Department.[107]

Figure 19. The Bachelor Officers Quarters, a building considered by the University of Georgia for reuse, June 1946. (Source: "Fort Pulaski National Monument, Naval Buildings Erected Under War-Use Permit, Photos – June 1944," National Archives at Philadelphia, Philadelphia, Pennsylvania)

It was also considered necessary to retain a building to house the Savannah Bar Pilots, who were stationed on Cockspur Island under the terms of a previous agreement, and in association with that function, a "small wash house on the wharf which is used by the colored crewmen."[108]

In September 1946, the Navy issued specifications for restoration of Fort Pulaski National Monument, including information on demolition of buildings and structures to be removed, as well as restoration of the site. The specifications note: "No demolition work is to be done in the Ammunition Storage Area with the exception of demolition of a weed building located in the southeast corner of the area."[109]

Written a decade after the war ended, the Mission 66 Master Plan for Fort Pulaski lamented the

107 . Ralph W. Emerson, Regional Landscape Architect, United States Department of the Interior, National Park Service, Region One, Richmond, Virginia, "Memorandum for the Regional Director," June 18, 1946.

108. Ralph W. Emerson, Regional Landscape Architect, United States Department of the Interior, National Park Service, Region One, Richmond, Virginia, "Memorandum for the Regional Director," June 18, 1946.

109. United States Navy, Office of Commandant, Sixth Naval District, Charleston, South Carolina, *Specifications for Restoration of Fort Pulaski National Monument, Cockspur Island, Georgia*, September 1946.

deterioration of the fort during the war and Navy occupation, noting that one maintenance person was left in charge of the fort. The Mission 66 Master Plan stated: "This man, through native ability and devotion to duty, did an outstanding job during the war years, but effective maintenance was more than one man could perform."[110] The condition of the National Monument was described as follows:

> During the war years the Fort had seriously deteriorated, walks were overgrown, ditches and canals filled in. . . . The Navy left behind a cluster of useless buildings, wharves, towers, and trash dumps, a fouled up water system, and an overhead maze of power and steam lines. [111]

Over the winter of 1946–1947, National Park Service staff at Fort Pulaski National Monument worked to address deterioration that had occurred during Navy occupation of the site. Initial efforts focused on the dikes and water management system. The fort was also cleared of debris prior to the return of artifacts stored at Ocmulgee National Monument since 1942.[112]

On August 1, 1947, Fort Pulaski National Monument reopened to the public (Figure 20). At that time, the park staff consisted of a superintendent, historical aide, cashier, and two laborers. Visitation to the fort soon doubled annual pre-war visitation to the park. [113]

On October 11, 1947, a ceremony was held in celebration of the one hundredth anniversary of Fort Pulaski.[114] The ceremony also commemorated Count Casimir Pulaski. In attendance was Elbert Cox, associate regional director of the National Park Service; representatives of the U.S. Army and Navy; the mayor of Savannah; and other dignitaries. The guest of honor was His Excellency Joseph Winiewicz, the Polish ambassador.

Figure 20. Fort Pulaski in the late 1940s, photographed by Frances Benjamin Johnston. (Source: Library of Congress Prints and Photographs Division, Washington, D.C., call number LC-J7-GA-1196)

On October 15, 1947, the Cape Sable Hurricane made landfall south of Savannah. The hurricane breached part of the fort's dike system, damaged roofs on park residences at the former quarantine station and blew down trees and uprooted shrubbery.[115]

On August 11, 1948, the Secretary of the Interior cancelled the special use permit that had been issued to the U.S. Navy six years earlier.[116]

As part of early efforts to restore the condition of the park after the war, the NPS prepared a

110. *Master Plan for the Preservation and Use of Fort Pulaski National Monument, Mission 66 edition*, September 1961.
111. *Master Plan for the Preservation and Use of Fort Pulaski National Monument, Mission 66 edition*, September 1961.
112. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, 18.
113. *Mission 66 for Fort Pulaski National Monument*, 3–4.
114. National Park Service, *Ceremonies in Celebration of the One-Hundredth Anniversary of Fort Pulaski*, October 11, 1947 (brochure).
115. *Superintendent's Monthly Report*, October 1947, Fort Pulaski National Monument archives.
116. *Fort Pulaski National Monument Administrative History*, citing Superintendent Ralston Lattimore to Regional Director, March 9, 1949, in Mike Capps, "Task Directive Administrative History Fort Pulaski," 1994, park files, Fort Pulaski National Monument.

"Developed Area Plan" in the late 1940s that proposed to remove many of the buildings constructed during Navy occupation of the site (Figure 21). As shown in the 1949 drawing, buildings to be retained by the NPS included the officers' quarters (indicated as building 1 on the drawing); commanding officer's residence (building 3); educational building (building 7); a garage and firehouse (building 17); a lumber shed (building 32); the north bunker (building 8), and the south bunker (building 23).[117]

In accordance with the 1949 Developed Area Plan (refer to Figure 21), the majority of the buildings remaining from the Navy base were dismantled or sold between 1951 and 1953. By 1952, the NPS had demolished or sold thirty-six buildings at the western end of Cockspur Island, including many buildings that were part of the quarantine station. As shown in an Existing Conditions Plan dated 1952, the NPS retained a small number of structures, including the north and south bunkers, for park purposes (Figure 22).[118]

During removal and sale of the surplus buildings in 1952, perspective bidders were advised that:

> . . . special attention shall be given the landscape features of the Park, and special care taken to protect the natural surroundings. The purchaser shall not deface, injure or destroy trees or shrubs, or remove or cut them without special authority.[119]

A NPS maintenance form dating to 1950 provides information on the south bunker (Figure 23). The form notes the concrete structure was in excellent condition at that time. It was also noted that glass block windows were present.

In 1954, the quarantine station property, which the Navy had utilized, was formally transferred to the National Park Service (Figure 24 and Figure 25).

A series of General Development Plans were created between 1949 and 1960 guiding the development efforts of the park following World War II (Figure 26). The final plan called for a picnic area to be constructed west of the fort along the road to the residence/administration group, and also showed the addition of the John Wesley Memorial north of the main parking area. A 1960 revision of the plan proposes the construction of a visitor center just west of the demilune.[120] The development plans refer to the south bunker as "warehouse." The north bunker is not annotated.

By October 1969, only two of the residences constructed by the Public Health Service remained as remnants of the quarantine station.[121]

117. The south bunker is identified on the 1949 drawing as the "black powder magazine," while the north bunker is identified as the "pilot's quarters," apparently an error on the drawing.
118. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report;* Superintendent, Fort Pulaski National Monument to Regional Director, Region One, October 17, 1951; Meador, 51; *Superintendent's Monthly Narrative Report*, May 1953; Existing Conditions After Building Sale, 348/2012 A-F, 1950–1956.
119. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, 62; Invitation for Bids and Specifications of Sale of Buildings and Fixtures, General Services Administration, undated, Fort Pulaski National Monument archives.
120. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report;* General Development Plan, 348/2010A-C, 1957-1960.
121. Jones, *Fort Pulaski National Monument Quarantine Attendants' Quarters Historic Structures Report*, 18–19.

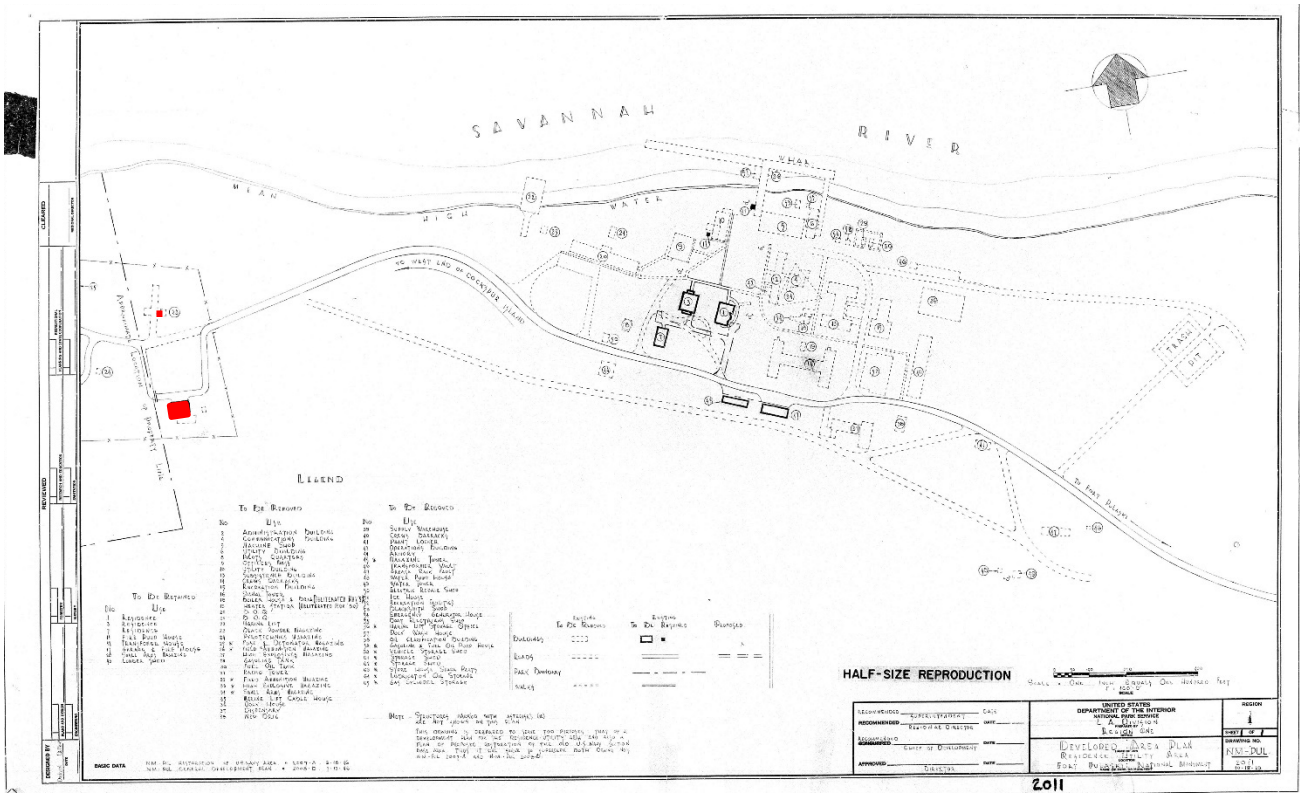


Figure 21. Developed Area Plan, Fort Pulaski National Monument, 1949. The West End bunkers are highlighted in red. (Source: Fort Pulaski National Monument Archives, 1949.19-1 FOPU 348/2011, annotated by authors)

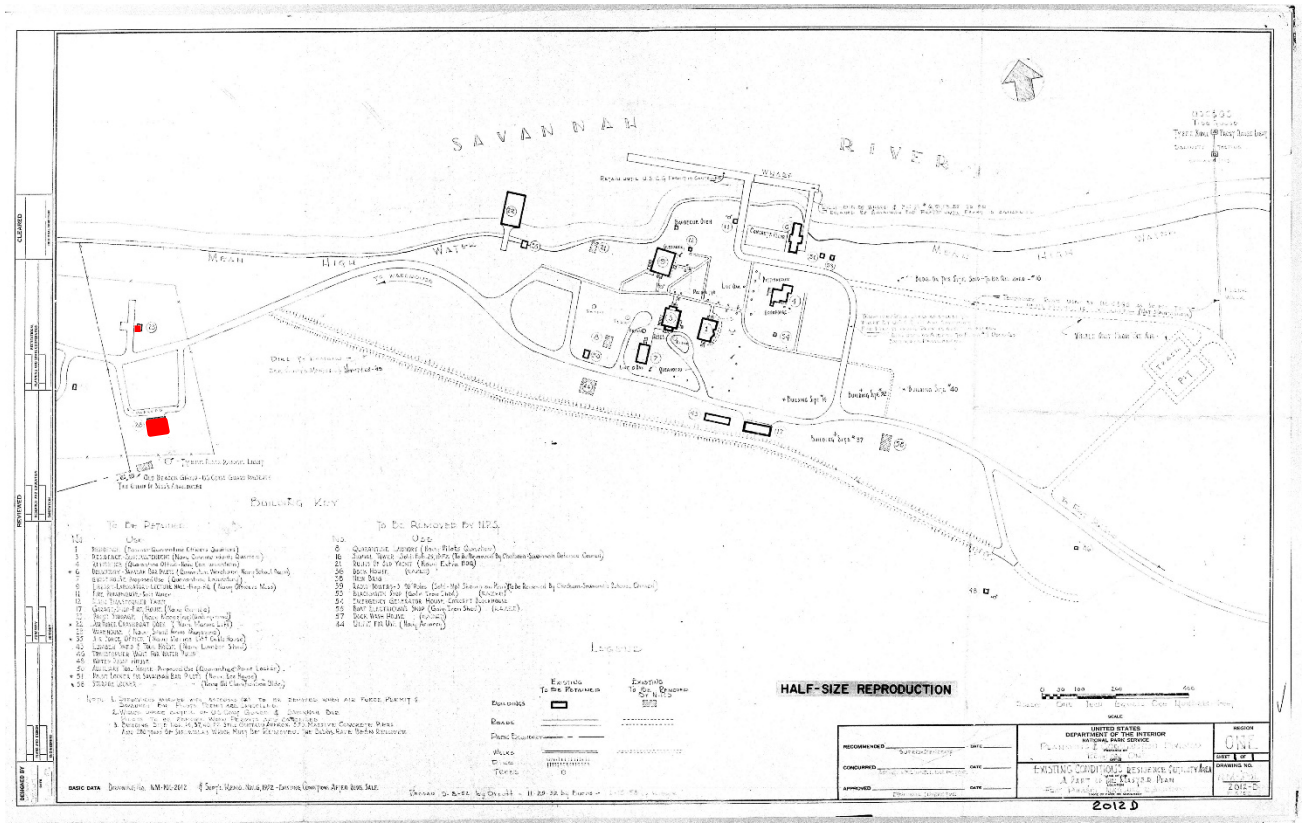
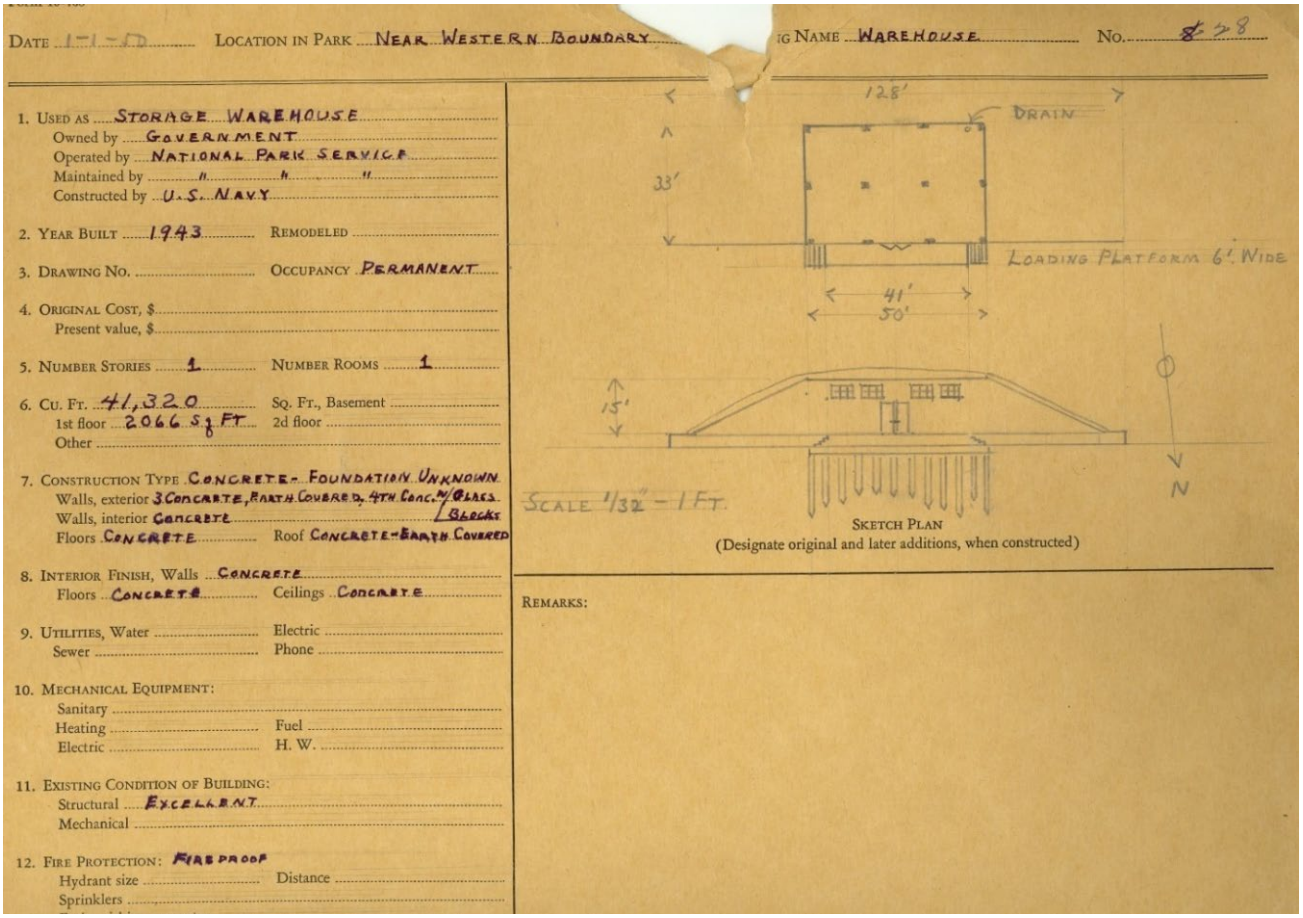


Figure 22. Existing Conditions Plan, Fort Pulaski National Monument, 1952. The West End bunkers are highlighted in red. (Source: Fort Pulaski National Monument Archives, 1952.11-1 FOPU 348/2012D, annotated by authors)



DATE 1-1-50 LOCATION IN PARK NEAR WESTERN BOUNDARY ...G NAME WAREHOUSE No. 8-38

1. USED AS STORAGE WAREHOUSE
Owned by GOVERNMENT
Operated by NATIONAL PARK SERVICE
Maintained by " "
Constructed by U.S. NAVY

2. YEAR BUILT 1943 REMODELED

3. DRAWING NO. OCCUPANCY PERMANENT

4. ORIGINAL COST, $
Present value, $

5. NUMBER STORIES 1 NUMBER ROOMS 1

6. CU. FT. 41,320 SQ. FT., BASEMENT
1st floor 2066 Sq FT 2d floor
Other

7. CONSTRUCTION TYPE CONCRETE - FOUNDATION UNKNOWN
Walls, exterior 3 CONCRETE, EARTH COVERED, 4TH CONC. W/ BLOCKS / BLOCKS
Walls, interior CONCRETE
Floors CONCRETE Roof CONCRETE-EARTH COVERED

8. INTERIOR FINISH, WALLS CONCRETE
Floors CONCRETE Ceilings CONCRETE

9. UTILITIES, Water Electric
Sewer Phone

10. MECHANICAL EQUIPMENT:
Sanitary
Heating Fuel
Electric H. W.

11. EXISTING CONDITION OF BUILDING:
Structural EXCELLENT
Mechanical

12. FIRE PROTECTION: FIRE PROOF
Hydrant size Distance
Sprinklers

128'
DRAIN
33'
LOADING PLATFORM 6' WIDE
41'
50'
15'
SCALE 1/32" - 1 FT.
N
SKETCH PLAN
(Designate original and later additions, when constructed)

REMARKS:

Figure 23. A NPS maintenance form describing the south bunker (referred to as a warehouse), 1950. (Source: Fort Pulaski National Monument, Form 10-768)

Figure 24. View of Quarantine Attendants' Quarters (right) and Quarantine Officer's Quarters (left), circa 1949. (Source: Fort Pulaski National Monument)

Figure 25. Superintendent's Residence, 1950s. (Source: Fort Pulaski National Monument)

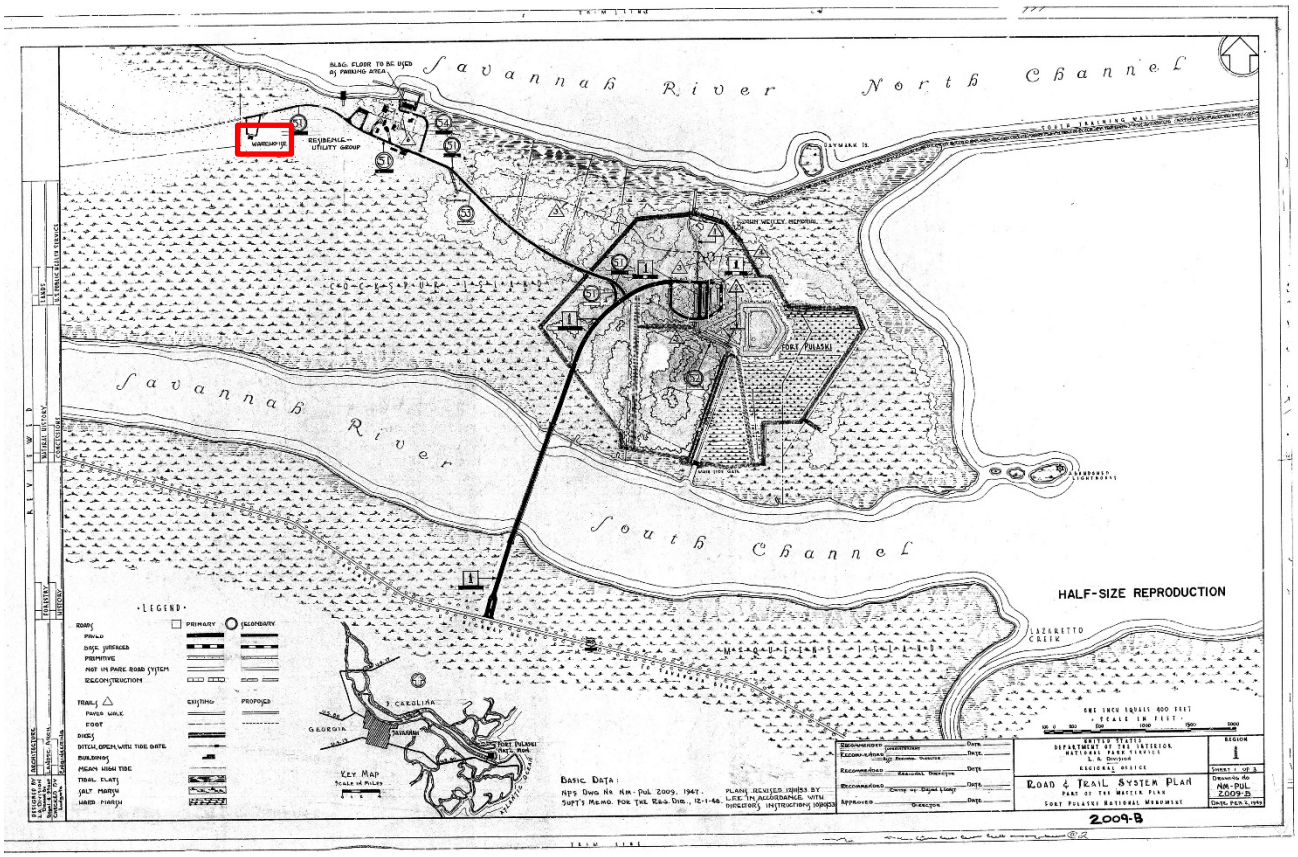


Figure 26. Road and Trail System Plan, Fort Pulaski National Monument, 1953. The south bunker is outlined in red. (Source: Fort Pulaski National Monument Archives, 1952.11-1 FOPU 348/2009D, annotated by authors)

Mission 66 at Fort Pulaski, 1956–1966

In the years following World War II, visitation at national parks grew significantly. In 1940, there were 17 million visitors to national parks; by 1955, there were over 55 million visitors. As park use grew, however, national park budgets remained unchanged.[122] By the 1950s, conditions in the national parks were generally in a state of deterioration. Improvements had not been made to public facilities since the New Deal-era programs of the 1930s. The desperate need for building maintenance and funding was further amplified by the rapid increase in visitors following World War II. At Fort Pulaski National Monument, the fort and its surroundings fell into a state of disrepair.[123]

In February 1955, Conrad Wirth, the director of the National Park Service, conceived a comprehensive conservation program to revitalize the national parks. The ten-year capital program, which would be called Mission 66, aimed to modernize and expand the national park system. Wirth put together a working committee as well as a steering committee to help outline the scope and budget of the program. He also instructed park superintendents to prepare lists of work that needed to be done in the various parks.[124]

The Mission 66 program sought to improve conditions at the parks not only through the construction of new roads, trails, and visitor

122. Ethan Carr, *Mission 66: Modernism and the National Park Dilemma* (Amherst: University of Massachusetts Press, 2007), 4.
123. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 24, citing *Superintendent Lattimore's Monthly Report*, August 1950.
124. Carr, *Mission 66: Modernism and the National Park Dilemma*, 10.

facilities but also through the establishment of increased operating budgets to maintain the parks in the future.

The *Mission 66 Final Prospectus for Fort Pulaski National Monument*, completed in 1956, noted that all park structures were to be properly maintained and made safe; proposed new interpretive services; and called for an increase in funds and personnel to allow for the proper maintenance and interpretation of the national monument.[125] The *Master Plan for the Preservation and Use of Fort Pulaski National Monument, Mission 66 edition*, dated September 1961 and signed December 17, 1962, noted that:

> Today's difficulties have their roots in deficiencies that fall into three categories: 1) inadequate protection; 2) inadequate maintenance; 3) inadequate interpretive facilities. The end product is confusion, vandalism, and serious deterioration of the physical structures of the Monument. [126]

The master plan also described conditions and staffing issues at the national monument at the time:

> The post-war staff included a superintendent, an historical aid, a clerk-cashier, and two laborers. In the 10 year period since the war, this small group has made considerable progress with resources available. Very nearly all evidence of the Navy occupation has been removed. Water and sewer systems have been reclaimed and the Cockspur Island power distribution system has been sold to a private power company. Roads and trails have been improved. Experiments have been conducted in multi-visual interpretive methods. And now major repairs are underway at the Fort. But what has been accomplished is not enough to safeguard the huge investment the Government has already made in Fort Pulaski. The small staff cannot protect the Government property from inroads of vandals nor can it provide adequate interpretive services to the public.[127]

The goal of the master plan was stated as follows: "Mission 66 promises to provide, within the next few years, the relief needed to put Fort Pulaski back on its feet."[128] Several Mission 66 projects were undertaken at Fort Pulaski National Monument beginning in the late 1950s. Some of the early projects included the reconstruction of the parking area; improvements to the water, power, drainage, dike, and telephone systems; and a series of repairs to the fort (Figure 27 through Figure 29).[129]

Figure 27. Masonry repairs on the south exterior wall, 1961. The wood portcullis at the sallyport was reconstructed in 1960.[130] (Source: *Completion Report of Construction Project, Repairs to Brickwork, Fort Pulaski*, second portion. July 14, 1961)

125. Meader and Binkley, *Fort Pulaski National Monument Administrative History*, 30; *Mission 66 for Fort Pulaski National Monument*, 1956. Park files, Fort Pulaski National Monument.
126. *Master Plan for the Preservation and Use of Fort Pulaski National Monument, Mission 66 edition*, September 1961, 4.
127. *Master Plan for the Preservation and Use of Fort Pulaski National Monument, Mission 66 edition*, September 1961, 4.
128. *Master Plan for the Preservation and Use of Fort Pulaski National Monument, Mission 66 edition*, September 1961, 4.
129. *Fort Pulaski National Monument, Mission 66 Final Prospectus*, 1956. Park files, Fort Pulaski National Monument.
130. Regional Administrative Officer, to Superintendent Fort Pulaski National Monument, February 20, 1961. Park files, Fort Pulaski National Monument.

Figure 28. The south face of the demilune covered with vegetation, circa 1959. (Source: *Completion Report of Construction Project, Restore Demilune and Battery Hambright*, November 20, 1960)

Figure 29. The south face of the demilune after clearing of woody vegetation and establishment of grass cover, 1960. (Source: *Completion Report of Construction Project, Restore Demilune and Battery Hambright*, November 20, 1960)

Construction of a new, freestanding visitor center began in late 1962, and the building was completed and opened to the public in October 1964. The one-story brick structure, which was circular in plan, was designed by the NPS Eastern Office of Design and Construction in Philadelphia.[131]

Other Mission 66 projects included improvements to the dike system, repairs to Battery Hambright and the South Channel Bridge, and road and parking area improvements. The development of the picnic area at the west end of Cockspur Island took place in June 1965. The final Mission 66 project was installation of a series of signs and markers posted along U.S. Highway 80.[132]

Maintenance of the World War II Bunkers, 1966 to the present

Following the conclusion of the Mission 66 program in 1966, maintenance became the primary priority at Fort Pulaski National Monument.

In 1983, the U.S. Coast Guard opened a Search and Rescue Station at the west end of Cockspur Island under an interagency agreement.[133]

In the 1980s, an earthen ramp was added to the front of the south bunker, reportedly to facilitate the use of the bunker for emergency storage during hurricanes. It is not known whether an earthen ramp was present previously, or if it was also installed to assist in use of the structure for metal artifact treatment, as discussed below.[134]

In 1984, Fort Pulaski contacted the Florida Department of Archives and History for advice on metal artifact treatment. In the following year, the U.S. Army Corps of Engineers set up a metal conservation lab and artifact storage facility at the west end of Cockspur Island. Helicopters from Hunter Army Airfield were used to airlift three cannon, three carriage reproductions, and a metal carriage from the fort terreplein to undergo

131. *Fort Pulaski National Monument, Mission 66 Final Prospectus*, 30–31, citing *Superintendent's Monthly Report*, October 1964. Park files, Fort Pulaski National Monument.
132. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, 19.
133. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, 20; *Superintendent's Annual Narrative*, 1983-1989, Fort Pulaski National Monument archives.
134. Correspondence with Fort Pulaski National Monument, June 2023, citing park personnel correspondence with Spec Hosti, former head of Facilities, Fort Pulaski National Monument.

electrolysis treatment as part of conservation of the artifacts. Four electrolysis tanks were located in the south bunker and were used to treat two cannon from Fort Pulaski, as well as two cannon and eighty projectiles from the Confederate ironclad vessel, the CSS *Georgia*, which defended Savannah from 1863 to 1864.[135] After completion of this project, Fort Pulaski retained two conservation tanks to conduct limited electrolysis. The facility was not activated after 1991.[136]

At an unknown date, the glass block windows were infilled with brick, with a cementitious parge coating applied over the brick. Undated photos show broken glass block units at the window openings (Figure 30 through Figure 33). Infill of the glass block windows was completed prior to 2005, as a photograph from that date shows the windows filled in (Figure 34).

Figure 30. An undated photograph of the north elevation of the south bunker. Note the glass block windows in place and the whitewash finish. (Source: Fort Pulaski National Monument, BX70_2153_FOPU.jpg)

135. Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, 73.

136. Meader and Binkley, *Fort Pulaski National Monument Administrative History*.

Figure 31. An undated photograph of the north elevation of the south bunker. Note the glass block windows in place and the whitewash finish. The earthen ramp has not yet been added to the front of the building. (Source: Fort Pulaski National Monument, BX70_2154_FOPU.jpg)

Figure 32. An undated photograph of the south bunker showing the broken glass block units. (Source: Fort Pulaski National Monument, BX70_2152_FOPU.jpg)

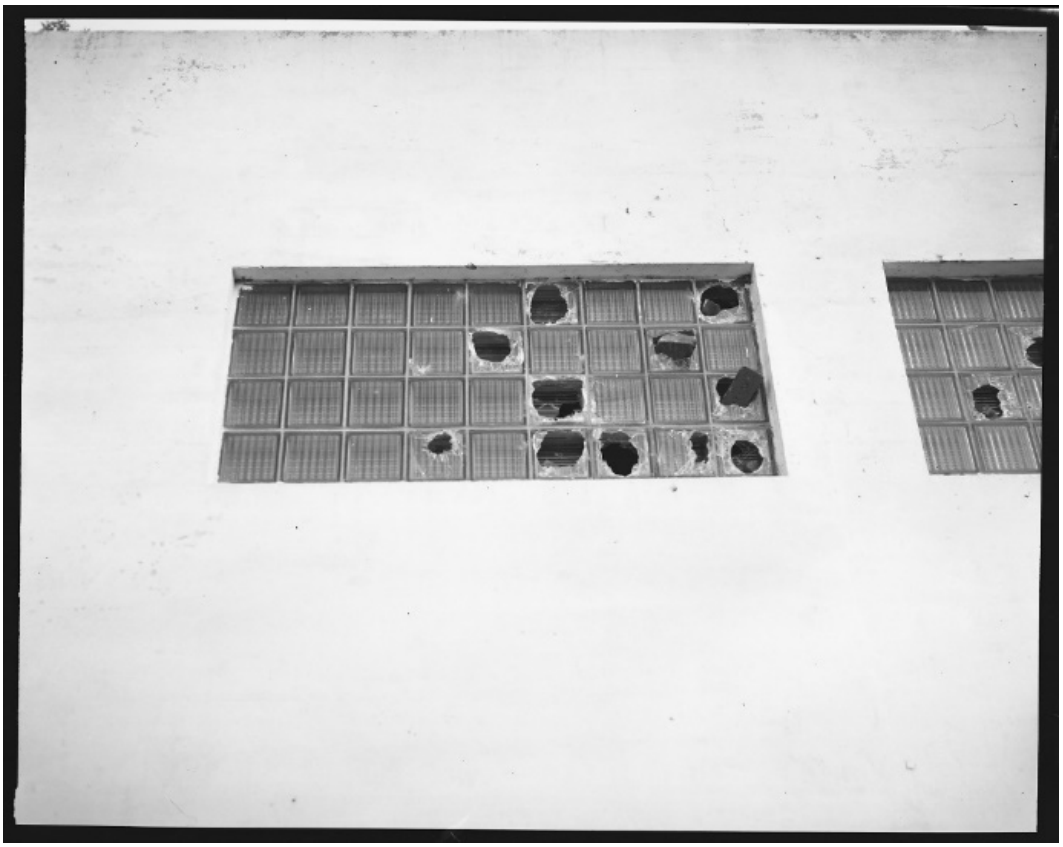


Figure 33. An undated photograph of the south bunker showing the broken glass block units. (Source: Fort Pulaski National Monument, BX70_2155_FOPU.jpg)

Figure 34. South bunker, 2005. (Source: *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*, Figure 152)

West End Bunkers Chronology

1761	Construction began on Fort George on the east end of Cockspur Island.
1794–1795	Fort Greene was constructed on Cockspur Island near the site of Fort George.
1828	The Board of Fortifications for Sea Coast Defense approved French military engineer Simon Bernard's recommendation to construct a fort on Cockspur Island.
1833	Construction on Fort Pulaski began with the driving of timber piles into the ground.
1839	The general structure of Fort Pulaski was completed.
1847	Construction of Fort Pulaski was completed.
1861	January 2: The State of Georgia held a special election for a state convention to consider secession. January 3: The Georgia militia seized Fort Pulaski. April 12: The Civil War began after shots were fired at Fort Sumter in Charleston Harbor.
1862	April 10: Federal forces attacked Fort Pulaski from nearby Tybee Island. April 11: Confederate troops surrendered following the breach of the walls of the fort. The fort would remain under Federal control for the remainder of the war.
1865	The Civil War ended.
1869–1872	The demilune was remodeled, and new underground magazines and passageways were constructed. Construction at Fort Pulaski was halted when the Corps of Engineers made plans to construct a new fort on Tybee Island.
1873	October 25: Fort Pulaski was officially closed.
1884	The Corps of Engineers assumed responsibility for the maintenance of Fort Pulaski.
1895	A new earth-sheltered magazine was constructed near the southeast corner of the demilune as the War Department bolstered coastal defenses.
1915	The War Department announced that Fort Pulaski had been selected for consideration as a national monument under the American Antiquities Act.
1924	President Calvin Coolidge signed a proclamation declaring Fort Pulaski a national monument.
1933	The National Park Service gained jurisdiction over Fort Pulaski.
1941	Section Base 20 was established by the U.S. Navy on Cockspur Island.

1942	Fort Pulaski National Monument was closed to the public on March 31, through the remainder of World War II. The U.S. Navy section base on Cockspur Island was commissioned in July 1942.
1942–1943	The U.S. Navy constructed nine bunkers, including the north and south bunkers addressed in this HSR, at the northeast corner of Cockspur Island. The bunkers were constructed to serve as magazines to store munitions. The two bunkers that are the subject of this study were constructed in 1943.
1945	The U.S. Navy turned over control of its base at Cockspur Island to the U.S. Coast Guard for use as a separation center following the war.
1946	The U.S. Coast Guard decommissioned its base on Cockspur Island and returned control of the property to the National Park Service.
1947	Fort Pulaski National Monument reopened to the public on August 1.
1951–1953	The majority of the buildings remaining from the Navy base were demolished or sold. The north and south bunkers, as well as the other bunkers now on Georgia Department of Transportation property, were retained.
1954	The quarantine station was transferred to the National Park Service.
1964	A freestanding visitor center was completed adjacent to the fort as part of the Mission 66 program.
1980s	An earthen ramp was constructed to facilitate moving equipment into and out of the south bunker.
1983	The U.S. Coast Guard opened a Search and Rescue Station at the west end of Cockspur Island near the bunkers.
1985	A metal conservation lab was established at the west end of Cockspur Island to allow for the conservation of artifacts. The lab included four electrolysis tanks, which were housed in the south bunker.

Left Blank Intentionally

Physical Description and Condition Assessment

Site

The West End bunkers are situated on Cockspur Island at the western edge of Fort Pulaski National Monument. The bunkers are accessed via Cockspur Island Road, which terminates immediately east of the structures (Figure 35). A chain-link fence at the end of Cockspur Island Road restricts access to the area where the bunkers are located. A gravel-paved drive extends west from the chain-link fence (Figure 36). A small wood-clad shed, owned by the U.S. Coast Guard, is located on the north side of the gravel drive, and will be relocated to U.S. Coast Guard property upon the completion of a separate construction project. The shed is to be moved off site by the Coast Guard when construction was complete. The area south of the gravel drive is used for storage.

Figure 35. Aerial view showing the two bunkers as well as Cockspur Island Road. (Source: Google Earth, modified by the authors)

Figure 36. Gravel drive leading toward bunkers, view from east. (Source: All photographs by the authors, March 2023, unless otherwise noted)

The north bunker is located north of the shed, set back from the gravel drive (Figure 37). The south bunker is situated beyond the storage area, south of the gravel drive (Figure 38). The landscape around the bunkers consists of a cut grass lawn with scattered trees and shrubbery (Figure 39). Heavier vegetation surrounds the area. Southwest of the bunkers are ruins associated with the Tybee Knoll Cut Range Lighthouse complex.

Figure 37. North bunker in background beyond shed, view from south.

Figure 38. South bunker as seen from gravel drive, view from northwest.

Figure 39. Area around the bunkers. Note the trees and shrubbery.

There are a number of small-scale features near the site that date from the U.S. Navy period of use. These include portions of an original fence with barbed wire topping and a steel-framed tower located south of the south bunker. Only metal fence supports and portions of the barbed wire topping remain (Figure 40). The steel tower, which sits on a concrete foundation, is largely intact (Figure 41). A steel-framed storage structure, with steel panels at the walls and roof, is present at the base of the tower (Figure 42).

Several other bunkers, also built by the U.S. Navy as part of the same complex, are located on adjacent property owned by the Georgia Department of Transportation (Figure 43 through Figure 46).

Figure 40. Metal fence support that remains south of the south bunker.

Figure 41. Steel tower located to the south of the south bunker.

Figure 42. A storage structure at the base of the steel tower.

Figure 43. Entrance to one of the bunkers on Georgia Department of Transportation property, which is similar to the north bunker.

Figure 44. Entrance to another bunker on Georgia Department of Transportation property, with concrete walls similar to those at the north bunker.

Figure 45. Large bunker on Georgia Department of Transportation property. This bunker is similar to the south bunker. Note the glass block remaining in the window openings.

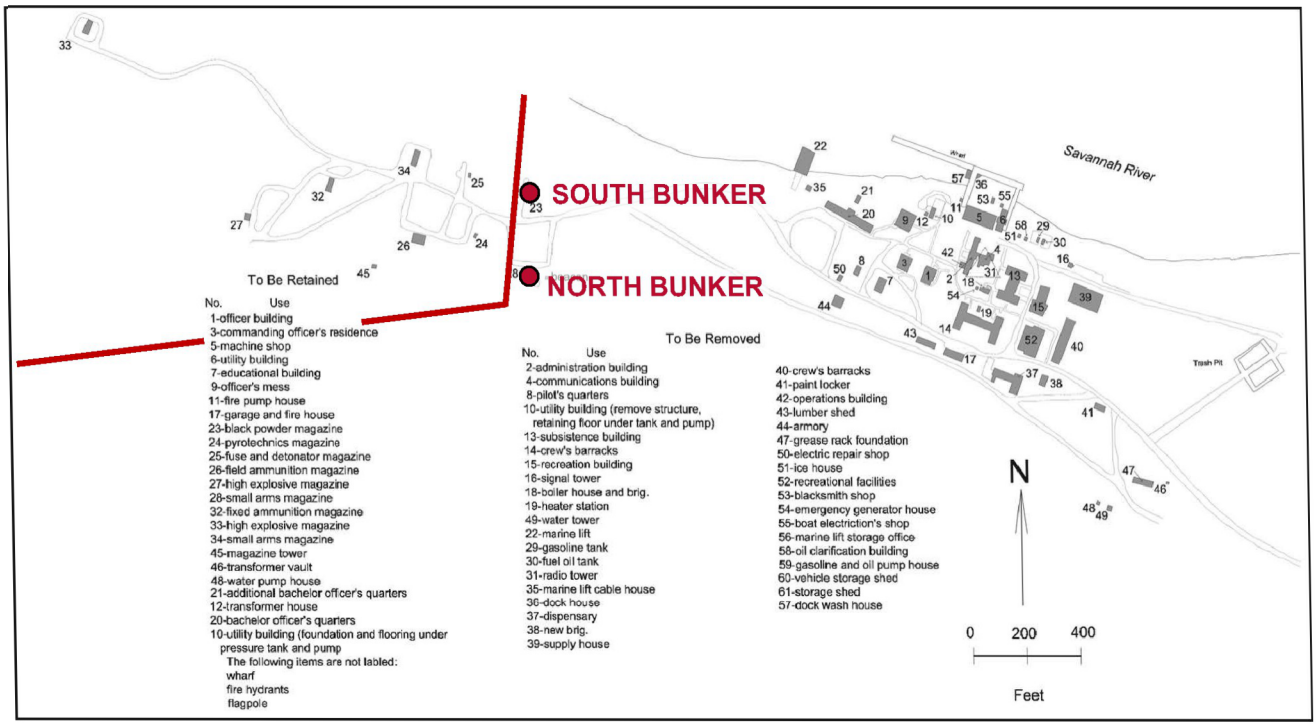


Figure 46. Reproduced 1946 map showing the location of other structures historically present at the west end of Cockspur Island. Red line is approximate location of Fort Pulaski National Monument boundary (Source: Hitchcock, *Fort Pulaski National Monument Cultural Landscape Report*, Figure 50, annotated by the authors)

North Bunker

Measured drawings of the north bunker are included in Appendix A.

Exterior

The north bunker is a cast-in-place concrete structure characterized by earthen fill that covers the north, east, and south elevations (Figure 47 through Figure 49). The exterior walls are constructed of board-formed concrete, with outlines of 4 foot by 8 foot plywood boards visible (Figure 50). A 1-inch chamfer is present at the top of the exterior walls.

The entrance to the bunker is located on the structure's west elevation and consists of concrete retaining walls with a concrete walkway in between (Figure 51). The concrete walk measures 5 feet 1/2 inch wide and 24 feet 5 inches long. The retaining walls at the north and south sides of the concrete walk consist of 4-foot-1-inch-tall return walls at the face of the elevation that slope up to 16 feet 1 inch in height at each side (Figure 52). The tops of the retaining walls are visible above the earthen fill at the north, east, and south elevations.

Figure 47. South elevation, north bunker.

Figure 48. East elevation, north bunker.

Figure 49. North elevation, north bunker.

Figure 50. Exterior wall at north bunker. Note the visible lines from the plywood formwork.

Figure 51. West elevation of north bunker showing the concrete walkway leading to the interior.

Figure 52. Detailed view of concrete walkway.

The north retaining wall is angled toward the north as it extends upward (Figure 53). The south wall is not angled and contains a steel door to the interior portion of the bunker at the east end of the wall (Figure 54).

Figure 53. The north retaining wall is angled.

Figure 54. Partial view of the south retaining wall. Note the door at the far left.

The steel door sits approximately 5-1/2 inches above the concrete walkway. The door opens outward, with the hinges at the east end of the door (Figure 55). The door measures 4 feet wide by 6 feet 7 inches tall, with a 4-inch steel frame. At the head of the door, a steel drip edge is face-welded to the steel frame (Figure 56). There are two steel hinges on the exterior door: one near the base and one near the top (Figure 57). Each hinge consists of a 3-inch-wide steel plate anchored to the door, that wraps around a 5/8-inch-diameter steel bolt, that connects to a steel plate attached to the door frame. Above the bottom hinge is a steel cable anchored to the door and the door frame (refer to Figure 57).

At the west jamb of the door are two steel bolt latches: one near the top of the door and one near the base (Figure 58). The latch consists of a 3/4-inch-diameter sliding bolt and three curved steel keeps that the bolt slides through. The door handle is at the center height of the door and consists of a steel plate latch that engages eye holes at the door frame (Figure 59 and Figure 60). Another latch is present above.

Figure 55. Steel door at south retaining wall.

Figure 56. Steel drip edge at door head.

Figure 57. Steel hinge at base of door. Note the steel cable above.

Figure 58. Steel bolt latch at the west jamb of the door.

Figure 59. Door handle and latch at west jamb of the door.

Figure 60. Eye holes at door frame.

The interior face of the door consists of steel angles at the perimeter with steel angle cross bracing (Figure 61). The angles are typically L2x2x3/8.

Figure 61. Interior face of steel door.

Directly east of the doorway is a vented opening (Figure 62). The vent is located 10 inches above the concrete walk and measures 12 inches wide by 8 inches tall with a steel screen and frame in the opening.

Figure 62. Vented opening east of the door.

West of the door and 3 feet 9-1/2 inches above the concrete walkway is a metal plate embedded into the concrete wall (Figure 63). The plate is 2-1/2 inches tall by 20 inches wide. A similar metal plate is embedded in the concrete adjacent to the doorway at the south bunker.

Figure 63. Embedded metal plate west of the door.

A terra cotta vent stack extends upward from the earthen fill above the interior of the bunker (Figure 64). The vent stack rises approximately 30 inches above the earthen fill and consists of a 3-1/2-inch-tall precast concrete cap, 12 inches in diameter, that sits atop a 7-inch-diameter shaft with a glazed finish. The shaft is wider at the base, measuring 10 inches in diameter.

Figure 64. Vent stack at southwest corner of the bunker.

Interior

The interior of the north bunker consists of a single room (Figure 65). The room is rectangular in plan, measuring 14 feet north to south and 10 feet east to west. Finishes in the room are exposed cast-in-place concrete walls, floor, and ceiling (Figure 66). The interior walls are constructed of board-formed concrete, with horizontal lines visible every 7 inches. The ceilings are constructed of board-formed concrete, with outlines of 4-foot-by-8-foot plywood boards visible. Cement paste is visible present at joints in the formwork. A whitewash is present on the walls of the bunker (refer to Figure 66).

Figure 65. Interior of the north bunker, view from north.

Figure 66. Whitewash at the interior walls of the bunker, view from northwest.

The door is located on the north wall of the bunker interior (Figure 67). The back side of the steel vent is visible near the floor at the north wall, east of the door (Figure 68). A metal screen is present on the inside face of the vent.

An 8-3/4-inch-diameter opening is present at the ceiling near the southwest corner of the bunker. This opening corresponds to the vent stack at the roof of the bunker, which is visible at the exterior.

Figure 67. Door and vent at north wall of bunker, view from southwest.

Figure 68. Vent at north wall of bunker, view from south.

South Bunker

Measured drawings of the south bunker are included in Appendix A.

Exterior

The south bunker is a cast-in-place concrete structure characterized by earthen fill that covers the roof and east, south, and west elevations (Figure 69 through Figure 71).

The exterior walls are constructed of board-formed concrete, with horizontal lines where the wood-board formwork was installed visible every 7 to 7-1/2 inches (Figure 72). Remnants of a whitewash are visible on the exterior wall at the north elevation (Figure 73). A 1-inch chamfer is present at the top of the concrete wall at the north elevation (refer to Figure 72).

Figure 69. East elevation of south bunker, with edge of sloping wing wall visible at right.

Figure 70. South elevation of south bunker.

Figure 71. West elevation of south bunker, with edge of sloping wing wall visible at left.

Figure 72. Lines are visible from the wood-board formwork used during construction of the bunker. Note the chamfer at the top of the wall.

Figure 73. Remnants of whitewash at the exterior of the south bunker.

The north elevation of the south bunker consists of the north wall of the bunker with sloping wing walls at each end (Figure 74). The bunker is approximately 17 feet 11 inches tall at the center of the north elevation, with the wing walls at each end sloping down to approximately 2-feet-7-inch-tall knee walls at the east and west edge of the structure (Figure 75). The knee walls are each 6 feet 6 inches wide.

The entrance into the bunker is centered on the north elevation and is raised above the adjacent grade with a concrete platform, approximately 2 feet 10 inches tall, extending along a portion of the north elevation (Figure 76). The raised platform is approximately 41 feet long and 6 feet wide, with concrete stairs at each end. The north face of the platform consists of board-formed concrete with horizontal lines every 7 to 7-1/2 inches where the edges of form boards were located during the construction process (Figure 77). A L4x4x3/8 steel angle is embedded in the concrete along the top edge of the platform (Figure 78). Equipment and containers are stored on the platform.

Figure 74. North elevation of the south bunker.

Figure 75. East wing wall at north elevation of the south bunker.

Figure 76. The entrance to the interior of the bunker and raised concrete platform.

Figure 77. Raised platform at the north side of the south bunker.

Figure 78. Embedded steel angle at the north edge of raised platform.

The stairs at each end of the raised platform consist of six risers, each approximately 6 inches in height, with 11-inch-deep treads (Figure 79). An earthen ramp leads from grade up to the platform (Figure 80).

The entrance door opening is approximately 8 feet 5 inches wide and 8 feet 8 inches tall and consists of a set of two steel doors set in a steel frame (Figure 81). An 8-inch-wide steel sill is nearly flush with the concrete platform at the exterior and the concrete floor at the interior (Figure 82).

Figure 79. Stair at west edge of raised platform.

Figure 80. Earthen ramp leading to the raised platform.

Figure 81. Set of doors at entrance to south bunker.

Figure 82. Embedded steel sill at doors.

Each door opens outward and measures 8 feet 5 inches tall by 3 feet 11-5/8 inches wide by 3-3/8 inches thick. The doors sit in a 2-1/8-inch-wide steel frame. A gap up to 1 inch wide is present between the doors (Figure 83). At the head of the door, a steel drip edge is face welded to the steel frame (Figure 84). There are three steel hinges on the exterior of each door: one near the base, one at mid-height, and one near the top. Each hinge consists of a 3-inch-wide steel plate anchored to the door that extends to the door frame, where it wraps around a 5/8-inch-diameter steel bolt that connects to a steel plate at the frame (Figure 85).

Figure 83. Gap between steel doors.

Figure 84. Steel drip edge at door head.

Figure 85. Typical hinge at steel doors at south bunker.

Remnants of a steel door latch are present at mid-height, where the doors meet (Figure 86). Extant latch elements include an eye hole attached to the west door and portions of a steel plate latch on the east door, which likely projected over a portion of the west door to engage the adjacent eye hole. An operable steel handle is situated above the steel plate on the east door.

At the lower portion of each door are operable ventilation panels (Figure 87). Each panel opens outward and measures approximately 2 feet 3/4 inches wide and 3 feet 1-1/8 inches tall. A 1/2-inch-diameter U-shaped steel handle, 5-1/2 inches tall, is centered on the inside edge of each panel (Figure 88). There are two steel hinges on the exterior of each panel: one near the base and one near the top. Each hinge consists of a 2-inch-wide steel plate anchored to the door that extends over the door and wraps around a steel bolt

connected to a steel plate attached to the face of the doors (Figure 89).

Figure 86. Remnants of steel door latch.

Figure 87. Operable ventilation panel at base of door.

Figure 88. U-shaped handle at operable ventilation panel.

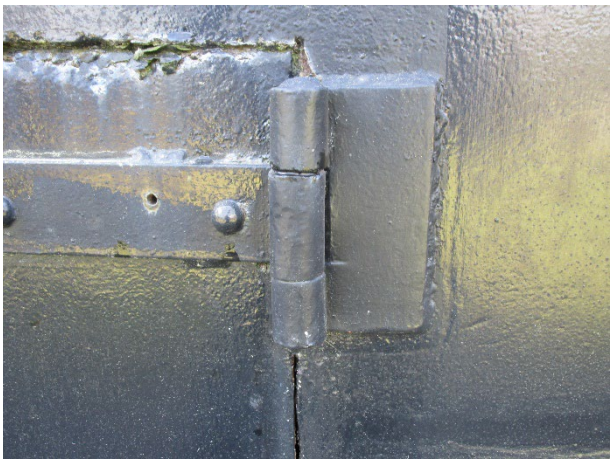


Figure 89. Hinge and ventilation panel.

The interior face of each door consists of steel panels with a ventilation screen at the base, corresponding with the operable panel at the exterior (Figure 90 and Figure 91). The screens consist of a 2-inch-wide steel frame set over the interior face of each door with a mesh screen over a steel security screen (Figure 92).

Figure 90. Interior face of the west door.

Figure 91. Interior face of east door.

Figure 92. Screen at interior side of ventilation panel.

At the interior of the west door, sliding steel latches are present at the top and bottom of the door (Figure 93). Holes in the door sill and frame at the head and sill engage the sliding latches (Figure 94).

Figure 93. Sliding steel latch at the top and bottom of the west door.

Figure 94. Sill at door. Note hole to engage sliding latch.

West of the door and 3 feet 8-1/2 inches above the concrete platform is a metal plate embedded into the concrete wall (Figure 95). The plate is 2-1/2 inches tall by 20 inches wide. A similar plate is embedded in the concrete adjacent to the doorway at the north bunker.

Two former clerestory window openings are present at each end of the north elevation (Figure 96). The openings are 6 feet wide by 2 feet 10 inches tall and are located approximately 8 feet 2 inches above the raised concrete platform below. The two windows at each side of the facade are located 1 foot 6 inches apart. The former openings have been infilled with brick with a cementitious parge coating applied to both the exterior and interior (Figure 97).

Figure 95. Embedded metal plate west of the door.

Figure 96. Infilled former clerestory windows at the east end of the north elevation.

Figure 97. Exposed brick infill at former window openings at the west end of the north elevation, viewed from the interior.

The sides of the wing walls are visible at the east and west elevations of the south bunker (Figure 98 and Figure 99). The walls are 8 inches thick at the base and extend to a thickness of approximately 20 inches at the top of each wall. The north wall of the bunker extends 2 feet 7 inches beyond the mostly covered roof of the structure. The top of the wall is 5 inches thick, gradually becoming wider as it goes down. The parapet wall meets the thicker wing walls at the east and west ends of the bunker (Figure 100). A reglet, located approximately 6-1/2 inches from the top of the parapet wall, extends the length of the wall (Figure 101). Based on the presence of an asphaltic membrane below the reglet, it appears the waterproofing at the roof likely terminated at the reglet (Figure 102).

Figure 98. Edge of the east wing wall, view from east.

Figure 99. Edge of the west wing wall, view from west.

Figure 100. The wing walls are wider than the parapet wall at the north elevation.

Figure 101. A reglet is present at the backside of the parapet wall.

Figure 102. Remnant membrane below the reglet.

While much of the bunker is covered with infill, portions of the walls and roof of the bunker are visible at the east and west elevations (Figure 103). The exposed walls are similar in appearance to the exposed north wall and are board-formed concrete, with horizontal lines where the wood-board formwork was installed visible every 7 to 7-1/2 inches (Figure 103). Remnant asphaltic waterproofing membrane is visible at exposed portions of the bunker roof (Figure 104).

Figure 103. Exposed portions of the bunker walls and roof.

Figure 104. Remnant waterproofing at the exposed bunker roof.

Near the southwest corner of the structure is a terra cotta vent stack that extends upward from the earthen fill above the bunker (Figure 105). The vent stack rises approximately 30 inches above the earthen fill and consists of a 4-inch-tall cap, 16 inches in diameter at the top, that sits atop a 14-inch-diameter shaft with a glazed finish. A series of openings, each 1-1/2 inches by 6 inches, is present at the top of the stack. The shaft is wider at the base, measuring 17 inches in diameter.

Figure 105. Vent stack near southwest corner of the bunker.

Interior

The interior of the south bunker is a single room measuring 49 feet 4 inches wide and 32 feet 1/2 inch deep (Figure 106). Finishes in the room are exposed cast-in-place concrete walls, floor, and ceiling (Figure 107). The walls are constructed of board-formed concrete, with horizontal lines where the wood-board formwork was installed visible every 7 to 7-1/2 inches, while the ceiling appears to have been constructed using plywood sheet formwork, with outlines of 4-foot-by-8-foot boards visible.

Two columns are located at the center of the interior space, with ten engaged columns at the perimeter walls (Figure 108). The columns and engaged columns are similarly sized, consisting of 16-1/4-inch-square columns with a sloping capital that extends 16 inches beyond the column with a shear cap above (Figure 109). The shear caps typically extend 1 foot beyond the capital. At the engaged columns, the columns project 2 inches from the adjacent wall (Figure 110).

Figure 106. Interior of the south bunker, view from northwest.

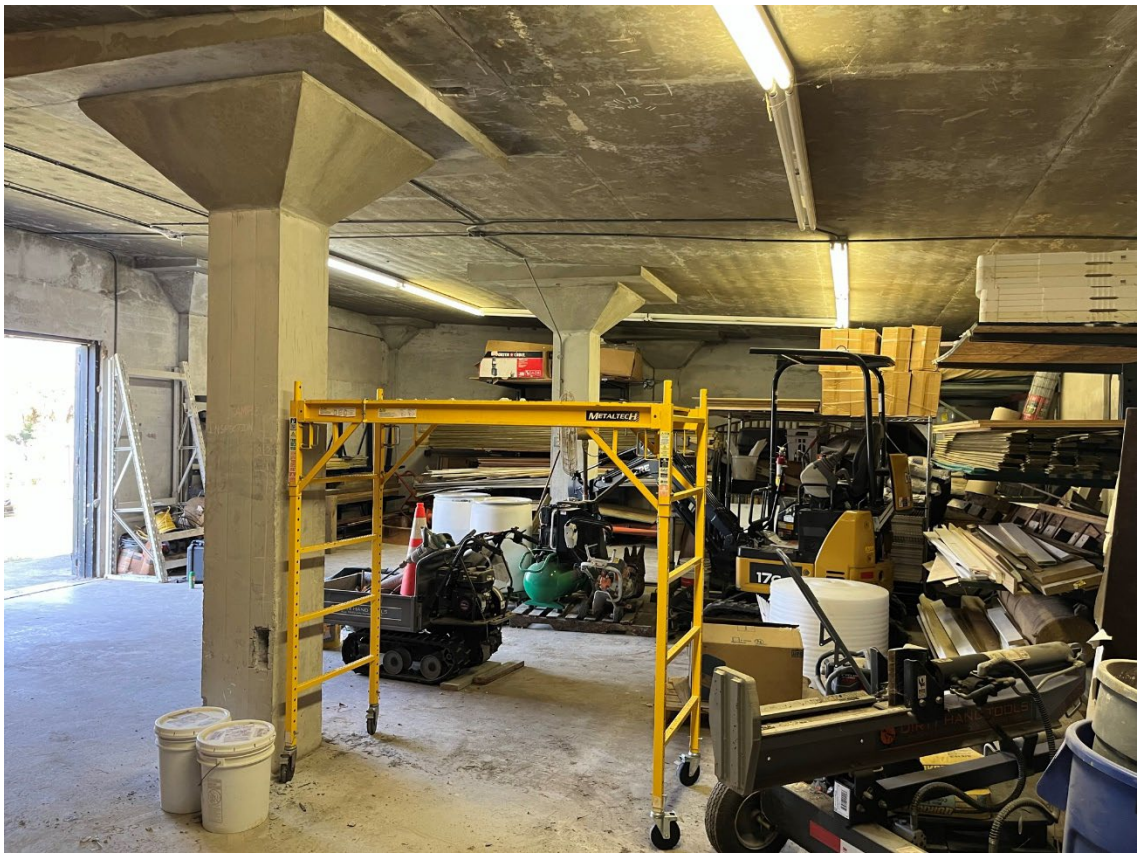


Figure 107. Interior of the south bunker, view from southwest.

Figure 108. Two columns near the center of the bunker interior, view from northeast.

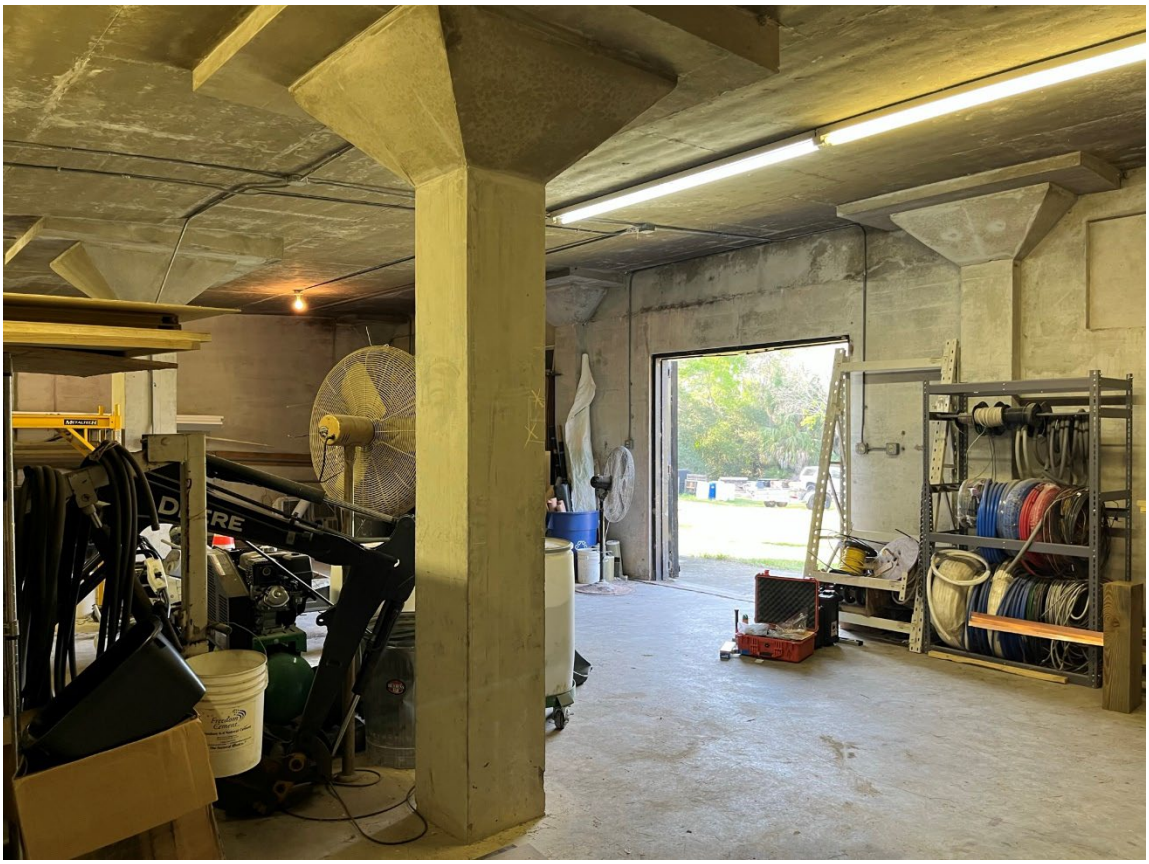


Figure 109. Typical column at bunker interior, view from southeast.

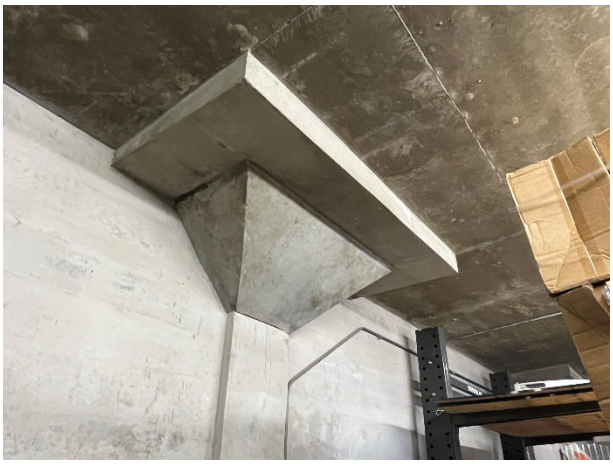


Figure 110. Capital and shear cap at engaged column.

Figure 111. Infilled window openings at the north wall, view from south.

The door is located on the north wall of the bunker interior, with the window openings at each side. A cementitious parge coating has been installed over the brick infill at the interior of the window openings (Figure 111).

An electrical panel thought to have been used with hydrolysis equipment previously operated in the bunker remains near the east end of the south wall (Figure 112).

An 11-inch-diameter opening is present at the ceiling near the southwest corner of the bunker. The opening corresponds to the vent stack at the

roof of the bunker, which is visible at the exterior (Figure 113).

A small drainpipe is located 3/4 inch above the floor in the southwest corner of the bunker, 48 inches on center from the west end of the south wall (Figure 114). The drain consists of a plastic tube extending through a hole in the wall. It is 1-3/8 inches in exterior diameter, 1 inch in interior diameter, and extends 2-1/8 inch from the face of the wall. The plastic tube indicates that the drain is a retrofit, although it is not known if it was installed when the bunker was used for the hydrolysis system or at another time. Although ponding water has been observed at this corner of the bunker, the drain is located above the level of water present during site visits for this study and is therefore not effective in removing ponding water. The drainage system on the exterior is not shown in documentation reviewed for this study. It is also not known if the drainpipe is letting water into the bunker.

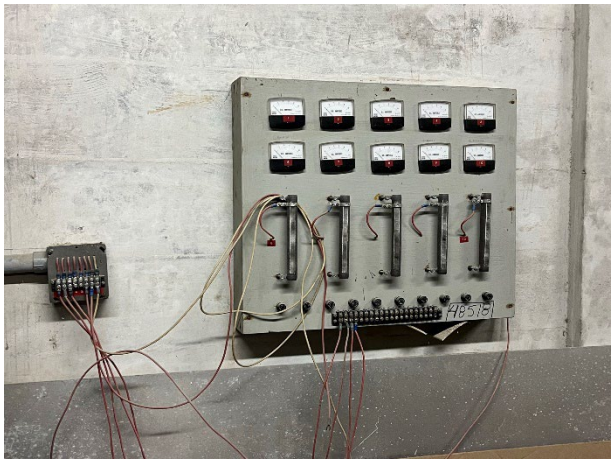


Figure 112. Electrical panel.

Figure 113. Opening at the ceiling near the southwest corner of the bunker.

Figure 114. Plastic drainpipe located near the southwest corner of the bunker. (Source: Fort Pulaski National Monument, August 2023)

Structural Analysis

As part of this study, WJE collected field measurements, conducted limited non-destructive evaluation, and completed inspection openings, with assistance from NPS personnel, to review the condition of selected structural components in support of a structural analysis. The findings of the analysis are included in Appendix B.

Methodology

Section strength and slab deflections were evaluated for minimum loadings, load combinations, and strength reduction factors per the requirements of the current governing code, the 2020 Georgia State Minimum Building Code based on the 2018 IBC with Georgia state amendments. Due to the limitations of this assessment, the effective strength has been evaluated with the observed as-built reinforcement.

Due to previous weather conditions and potential for future use of the south bunker as a tornado shelter, components of the south bunker were assessed for specifically general wind (hurricane) and tornado wind loading using the American Society of Civil Engineers *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, 2022 edition (ASCE 7-22). This standard has not yet been adopted by the state of Georgia but was referenced in the analysis due to the newly published tornado wind loading provisions.

Tornado shelter provisions differ from typical building code requirements as there are more stringent requirements and higher magnitude loading for tornado shelters. As we understand that the official occupancy of the bunkers is not currently undergoing a change, the tornado loads were assessed using the building code for typical structures and not as an official tornado shelter. If the structures are to change occupancy to a storm shelter, further analysis can be completed as to whether those requirements are met.

Assumed material properties and reinforcement detailing were used for portions of the analysis due to the limited scope of the assessment. Assumptions are both inferred from observed conditions and based on commonly available construction materials contemporary with the building's construction.

Findings

North Bunker Analysis

The section strengths of the roof slab and typical basement walls were evaluated and compared to the minimum required loading. The roof slab of the bunker was evaluated in Ram Concept, a finite element software program for the analysis and design of concrete slabs. The typical basement wall was evaluated as a simple span from the floor slab to the roof slab. Both elements were found to have adequate strength to resist applied loading.

South Bunker Analysis

The section strengths of the roof slab, typical basement walls, typical interior column, north wall, and the floor slab were evaluated and compared to the minimum required loading.

The roof slab of the bunker was evaluated as a two-way slab with drop panels and shear caps in the finite element software, Ram Concept. The roof slab was found to have adequate strength to resist applied loading.

The column was evaluated for the axial load applied per the slab finite element analysis, and the code minimum moment applied from the slab. Analysis results demonstrated that the column is non-slender and has adequate strength to meet the load demand, based on the assumptions above.

The basement wall was modelled as a 16-inch-thick wall supported as a simple span from the floor slab to the roof slab. The basement wall is found to have adequate flexural strength to resist the loading applied by the soil berm, based on the assumptions above.

The north wall was assessed for general wind loading (including hurricanes) and tornado loading conditions. The analysis showed that hurricane wind pressures were significantly

greater than the tornado wind pressures at this site. Location, terrain, size of structure, and developed wind speeds are among the factors used in determining the wind loads.

The structural framing of the door, beyond the sheet metal exterior, could not be confirmed through the limited visual assessment; therefore, further investigation is needed to complete a structural analysis of the as-built door assembly. Further investigation may include partially disassembling the existing door to examine and document elements of the door frame. However, design wind pressure applied to the door components and cladding was determined based on current code requirements. Assessment of the door framing should consider the need for the door to resist the wind pressures in provided in Appendix B. Based on discussion with the park, we understand that repair or replacement of the doors is a high-priority project.

Based on discussions with NPS representatives, heavy equipment is stored in the south bunker periodically. Based on the heavy equipment that NPS representatives identified to be stored (e.g., John Deere H180 tractor), the observed reinforcement and cover, and the prior use of the structure to store military equipment, the slab on grade is designed to adequately resist heavy equipment, especially equipment with pneumatic tires as provided by the specified tractor.

Conclusions

The north and south bunkers are bounded on three sides by earthen berms bearing against the basement (below-grade) retaining walls of the structure. The earthen berms on the east and west walls are equal in size and apply equal and opposite loads to the structure, thereby balancing each other for no net load on the structure. The earthen berms on the south face of the structure are not mirrored on the north face. However, the lateral loading applied to the north facade of both bunkers (e.g., wind loads) is restrained by the east and west walls acting as shear walls to resist lateral motion. The shear walls are located concentrically relative to the center of unbalanced earth pressure. Also, the buildings show no evidence of sliding or displacement due to this net lateral loading. Further analysis of the global stability of the structure is not warranted.

For the north and south bunkers, the visual assessment found isolated spalls and cracks. These items are isolated to a few localized conditions and are not sufficient in extent or severity to impact the overall structural systems. Concrete was observed to be in good condition, with no evidence of corrosion of embedded reinforcement or deterioration except in a few isolated locations. The visual assessment found no evidence of symptomatic deficiencies in the vertical or lateral framing system. At all inspection openings, the embedded steel reinforcement was found to be in good condition. However, the risk of future degradation of the reinforcement, in the form of corrosion, is dependent on chemical properties of the concrete and requires further material testing than that included in the current scope of investigation. The assumptions made about reinforcement layout and detailing may not be conservative and cannot be confirmed without a further intrusive investigation. However, the results of the analysis confirm the findings of the visual assessment that no structural deficiencies are evident. Through visual assessment and structural analysis, it is evident that the structural framing has adequate strength and stiffness to meet current code requirements for strength and deflection under current code minimum loading conditions. Although no reinforcement is present in the concrete pilasters along the perimeter walls of the south bunker, the walls have adequate capacity on their own and do not need reinforced pilasters to resist current loading conditions.

It is anticipated that hurricane wind loading governs over tornado wind loads at a coastal region in the Southeast, excluding tornado shelters. Based on commentary in ASCE7-16, which is referenced in the 2018 IBC, a basic wind speed for a Risk Category II structure corresponds to a 700-year return period and a Saffir-Simpson Hurricane Category 4. The Risk Category III tornado wind speed corresponds to a tornado with a 1,700-year return period. In the areas adjacent to Fort Pulaski, new structures are

designed in accordance with this standard to resist wind loads from a Category 4 hurricane with minimal structural damage due to wind pressures. The north wall of the south bunker was evaluated using the same new design standards and found to be sufficient to resists such loads.

Preliminary structural analysis of selected components of the bunkers suggests that damage is unlikely to occur to the main structural elements in the event of a high wind event, based on the assumptions made above and the as-built conditions observed.

These findings, however, do not indicate that additional loading may be applied to the structure. If the National Park Service intends to alter the loading on the bunker roofs or walls, additional investigation will be required to evaluate the capacity of the structural framing.

Regarding the south bunker metal door, which is more exposed to wind pressures than the north bunker metal door, additional structural analysis is recommended to determine adequacy to resist general wind pressures and can be performed once further investigation to document the structural elements of the doors is completed. Pending further documentation of their construction, repair or replacement of the doors has not been determined at this time. However, conceptually, structural repairs may include adding more ribs at tighter intervals within the door (between the outer and interior sheet metal cladding of the doors), which would not be visible, and/or adding more anchors between the door frame and the adjacent concrete at the jambs, so that the door is fastened to the concrete at tighter intervals, to increase strength for wind resistance.

Laboratory Materials Studies

As part of this study, materials studies were conducted on samples removed from both the north and south bunkers during field work by the HSR project team in March 2023. The purpose of the laboratory studies was to characterize the concrete and waterproofing, and to provide information for the structural assessment and treatment recommendations.

Sample locations were selected in coordination with park personnel on site, and Fort Pulaski facilities personnel provided assistance with sample removal. At the north bunker, four concrete samples were taken. One sample was taken at the exterior on the north retaining wall, and three at the interior: one at the underside of the roof in the northeast corner, one at the floor slab in the northeast corner, and one at the south wall. At the south bunker, five concrete samples were taken. On the exterior, one sample was taken at the east wing wall and a second sample was taken at the top side of the roof. At the interior, samples were taken at the floor slab near the southwest corner, at the interior of the west wall, and at the underside of the roof. Samples of the rooftop waterproofing material were also obtained from the south bunker.

Methodology

Samples removed from the West End bunkers at Fort Pulaski National Monument were forwarded for evaluation by the WJE Janney Technical Center laboratory in Northbrook, Illinois. The laboratory report describing methodology and findings is provided in Appendix C of this HSR.

The samples were examined in their as-received condition, and polished cross sections of each sample were prepared. The as-received samples and the lapped cross sections were examined using a stereomicroscope at magnifications of 6X to 40X. Blue dye epoxy-injected thin sections were fabricated from select samples (samples from the exterior wall north, floor slab, and interior wall south of the north bunker, and samples from the ceiling, interior column, and roof slab of the south bunker) to further examine the microstructure and study the cementitious materials present in the concretes removed from various elements in the bunkers. The thin sections were examined using a petrographic (polarized light) microscope at magnifications of 25X to 200X. Petrographic studies were completed in accordance with ASTM C856, *Standard Practice for Petrographic Examination of Hardened Concrete*.

The waterproofing membrane sample removed from the rooftop of the south bunker was subjected to chemical analysis by Fourier transform infrared (FTIR) spectroscopy to determine its general composition.

Findings

Laboratory studies revealed that the ten concrete samples appear similar and represent normal weight concrete with a crushed siliceous coarse aggregate and natural siliceous fine aggregate in non-air entrained portland cement paste. (Refer to Appendix C for a detailed description of the individual samples examined and findings of the laboratory studies.) The bulk concrete examined as part of the studies appears similar between samples and contains crushed particles of granite composition coarse aggregate and natural siliceous sand dispersed in non-air entrained portland cement paste. The maximum size of the coarse aggregate particles differs between samples.

The concrete contains granite composition coarse aggregate. The coarse aggregate is primarily white and black in color, and contains quartz, feldspars, mica, and hornblende minerals. Some particles also contain orange to pink feldspar particles. The sand represents a natural siliceous sand that is subround to subangular and is composed of almost pure quartz, with trace amounts of feldspar and mica. Some of the coarse aggregate is slightly metamorphosed, based on the alignment of minerals. No deleterious reactions, such as alkali silica reactivity, were observed in the concrete.

The paste portion of the examined samples contains portland cement with no supplementary cementitious materials such as slag cement or fly ash present. Some samples, further explained in the next sections, exhibit layers of cement-rich paste along the exterior surface of the concrete. These cement-rich areas may be indicative of cement worked into the surfaces of the concrete. Overall, the concretes in each sample exhibit features consistent with moderate water to cement ratios.

The concrete is non-air entrained and is generally well consolidated with little to no air. Secondary deposits were not observed in air voids in any samples. Paste discoloration is due to typical carbonation of the concrete, except for the top of roof slab sample from the south bunker that also contained discoloration from the applied bituminous roofing materials.

The waterproofing sample was subjected to a chloroform extraction. The spectrum obtained from the FTIR analysis of the chloroform-soluble residue was most closely matched to a reference spectrum of asphalt, indicating that the waterproofing material is asphaltic.

Conclusions

The examined concrete samples are similar in composition. The concrete represents up to 3/4 inch maximum sized particles of crushed granite coarse aggregate and natural siliceous sand fine aggregate dispersed in non-air entrained portland cement paste. The concrete in each sample is estimated to represent a moderate water to cement ratio.

No evidence of deterioration mechanisms such as alkali silica reaction, sulfate attack, or cracking due to cycles of freezing and thawing were observed. The sample removed from the exterior wall west in the north bunker exhibited sub-parallel cracking in a mortar material present along the exterior of the concrete, which may represent a single freezing event or application of a stiff material. The adjacent concrete is intact and does not exhibit any cracking.

The substrate concrete in the sample from the exterior wall west in the north bunker was poorly consolidated and non-uniformly mixed. Large voids were present between coarse aggregate particles, and large areas of paste without aggregate were present, and exhibited microcracking due to shrinkage. The mortar applied to the exterior surface of the substrate concrete may have been an effort to fill in gaps in the wall surface. (This condition was noted only in one sample examined, and during the field assessment, poorly consolidated concrete with honeycombing present was observed only in localized areas of the walls.)

Multiple samples exhibit a higher cement content along their exterior surfaces. In the sample removed from the floor slab in the north bunker, a layer of paste with a high cement content, with normal hydration of the cement, was present along the top surface. Beneath this layer, the substrate concrete exhibits almost complete hydration of the portland cement from exposure to moisture over time; this condition is not a sign of deterioration or distress and is beneficial to the properties of the concrete.

Beige discoloration observed in the samples is due to typical paste carbonation. Carbonation occurs when concrete is exposed to carbon dioxide, resulting in a change in a mineral within the concrete. The presence of carbonation is not deleterious, but can cause depassivation if it reaches the depth of reinforcing steel (e.g., where concrete cover is limited), making it more vulnerable to corrosion. (Very limited spalling or exposed steel reinforcement was observed on site, as further discussed in this chapter of the HSR.)

The samples represent non-air entrained concrete. If the concrete becomes critically saturated and subjected to cycles of freezing and thawing, cracking may occur. However, freezing temperatures rarely occur at the project location, and no evidence of cracking due to cyclic freezing and thawing of water was observed in the examined samples.

Condition Assessment

North Bunker

The following conditions were observed at the north bunker:

Exterior

- Cracks were observed in the concrete walkway, with vegetation growing up through the cracks (Figure 115).
- Biological growth was observed at the exterior concrete walls (Figure 116). This condition is most prevalent on the north retaining wall.

Figure 115. Crack at concrete walkway with vegetation growing up through the crack.

Figure 116. Biological growth at the north retaining wall.

- Isolated cracks are present in the concrete retaining walls on either side of the concrete walkway (Figure 117).

- Isolated honeycombing is present at the concrete retaining walls (Figure 118).
- Isolated efflorescence was observed along the base of the north retaining wall (Figure 119).
- A formed notch is present at the top of the south retaining wall above the door (Figure 120). The purpose of the notch is not known, nor is it known if this is an original feature, or something added.

Figure 117. Isolated cracking at the top of the concrete retaining walls.

Figure 118. Honeycombing at the exterior face of the concrete retaining walls.

Figure 119. Efflorescence at the base of the north retaining wall.

Figure 120. A formed notch at the top of the south retaining wall (yellow arrow).

- Corrosion, including limited section loss, is present at the steel door and associated frame (Figure 121). Isolated section loss was noted near the base of the steel frame (Figure 122).
- Biological growth was observed at the exterior of the steel door (Figure 123). This is most prevalent at the base of the door.
- The steel cable near the base of the door is broken (Figure 124).

Figure 121. Corrosion at the base of the steel door frame and door.

Figure 122. Corrosion at the base of the steel door frame.

Figure 123. Biological growth at the base of the exterior face of the door.

Figure 124. Broken steel cable near the base of the steel door.

Interior

- Standing water was observed at the southeast corner of the bunker interior (Figure 125). Moisture-related staining and deterioration of the whitewash was observed on the adjacent walls (Figure 126).

  Staining at the concrete floor is present at the north side of the bunker interior (Figure 127). The staining appears to be related to past water infiltration in the space.

  Although the park does not have specific documentation of occurrences of water infiltration, park personnel noted that water is present in the bunker only after very heavy wind-driven rains. When present, water has reportedly entered the bunker primarily through any gaps at the door and potentially through the vent openings in the walls of the north bunker. Active leakage through the roof, walls, or floor has not been observed. When present, ponding water is typically observed at low points in the bunker, especially at the southwest corner.

Figure 125. Standing water at the southeast corner of the bunker.

Figure 126. Deteriorated whitewash adjacent to standing water at the southeast corner of the bunker.

Figure 127. Staining at the interior floor of the bunker.

- Corrosion was observed at exposed steel elements located at regular intervals at the base of the bunker walls (Figure 128). The corrosion points are typically 2 inches to 3 inches in diameter and are approximately aligned with the location of vertical reinforcement in the wall (Figure 129). This condition is most prevalent along the south wall of the bunker.
- Isolated honeycombing is present in the concrete walls (Figure 130).
- Insect nests are prevalent at the top of the bunker walls, immediately adjacent to the ceiling (Figure 131).

Figure 128. Corrosion along the base of the south wall of the bunker interior.

Figure 129. Corrosion at the base of the wall at the bunker interior.

Figure 130. Isolated honeycombing at the interior concrete walls.

Figure 132. Staining and biological growth at the north elevation.

Figure 131. Insect nests at the top of the interior walls.

Figure 133. Staining at the top of the east wing wall.

South Bunker

The following conditions were observed at the south bunker.

Exterior

- Staining and biological growth were observed at the exterior walls (Figure 132). This condition is most prevalent near the center of the north elevation, as well as along the top of the wall at the north elevation (Figure 133).
- Deterioration of the whitewash was observed at the north elevation of the bunker (Figure 134). The whitewash appears most intact at the east and west wing walls at the north elevation (Figure 135).

Figure 134. Deterioration of whitewash at the north elevation.

Figure 135. The whitewash is largely intact at the east wing wall.

- Vines are present along the wall at the north elevation of the bunker (Figure 136). It appears that some vines have been cut at the base of the wall but not yet removed (Figure 137).
- Two cored holes are present at the east side of the north elevation (Figure 138). The holes extend through the full thickness of the wall and are approximately 2 inches in diameter.
- Craze cracking was noted at the north elevation (Figure 139). Efflorescence was noted at the cracks.

Figure 136. Vines at the north elevation of the bunker.

Figure 137. Portions of the vines have been cut at the base of the wall.

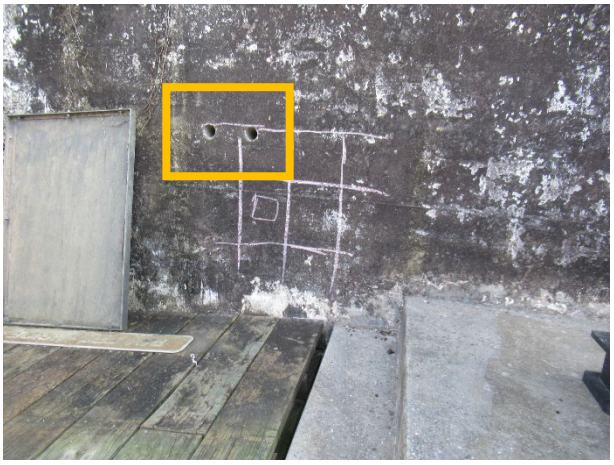


Figure 138. Two core holes at the north elevation, east of the door (yellow rectangle).

Figure 139. Craze cracking at the north elevation. Note the efflorescence at the cracks.

- The embedded steel angle at the raised platform exhibits surface corrosion (Figure 140).

- Isolated cracking was observed at the top of the raised platform, particularly near the door to the bunker interior (Figure 141).
- Abandoned steel anchors are present east of the steel door (Figure 142). It appears the anchors previously supported a sign. Corrosion staining is also present at the anchor locations.
- Spalling at the south face of the west wing wall has exposed steel reinforcing bar (Figure 143). The exposed reinforcing bar is corroded with section loss.
- Minor concrete spalling has occurred at the reglet along the south face of the parapet at the north wall (Figure 144).
- Vertical cracks were observed in the parapet wall in multiple locations (Figure 145).

Figure 140. Corrosion at the embedded steel angle at the north edge of the raised platform.

Figure 141. Cracking at the top of the raised platform.

Figure 142. Abandoned anchors at the north elevation, east of the door.

Figure 143. Spalled concrete and exposed rebar. Note the corrosion at the rebar.

Figure 144. Minor spalling along the top edge of the reglet at the south face of the parapet wall.

Figure 145. Vertical cracks at the parapet wall (yellow arrow).

- The doors to the bunker do not fully close (Figure 146). As a result, a gap of up to 1 inch is present between the doors.
- A portion of the steel drip edge at the door head is bent and detached (Figure 147).
- Biological growth is present at the base of the steel doors (Figure 148).
- Corrosion of steel door elements is prevalent. Corrosion was noted at the ventilation panel handles (Figure 149).
- Section loss was noted at the steel panels that make up the interior and exterior face of the doors (Figure 150 through Figure 152).
- The west portion of the steel door latch at the east door is missing (Figure 153). The latch originally would have extended over the west door, engaging the eye hole.
- The stops at the head of the door frame are detached and bent (Figure 154).
- The screen at the ventilation panel is torn (Figure 155).

Figure 146. The doors to the bunker do not fully close. Note the gap between the doors.

Figure 147. The steel drip edge at the head of the door is bent and detached.

Figure 148. Staining and biological growth at the base of the door.

Figure 151. Section loss at the steel panels on the interior face of the door.

Figure 149. Corroded handle at the ventilation panel.

Figure 152. Section loss at the steel panels on the interior face of the door.

Figure 150. Section loss at the steel panels on the exterior face of the door.

Figure 153. Steel latch at east door. Note that the latch does not extend over the west door to engage the eye hole.

Figure 154. Displaced and detached stops at the door head.

Figure 156. Exposed portion of the roof showing the deteriorated membrane.

Figure 155. Tears in the mesh screen at the interior of the ventilation panel.

Figure 157. Cracked and missing pieces of terra cotta at the vent stack.

- Portions of the bunker roof are exposed. In these locations, the asphaltic membrane applied to the topside of the roof is deteriorated, exposing the concrete below (Figure 156). Soil was removed from a small portion of the bunker roof, exposing the membrane. The membrane appeared intact in this location.
- The terra cotta vent stack is cracked, with pieces of terra cotta missing where ventilation openings were present (Figure 157).

Interior

- Staining was observed at the ceiling and top of the wall of the northwest corner of the bunker (Figure 158). A formed hole, approximately 3/4 inch by 1-1/2 inch, is located at the top of the wall where the staining is present. The staining appears to be related to droppings, potentially from small lizards that were observed at the formed hole.
- The cementitious parge at the former window opening is spalled, exposing the brick infill (Figure 159). The spall occurs at the location of a through-wall electrical conduit.
- Isolated cracking was observed at the floor slab at the interior of the bunker (Figure 160).
- Isolated spalling was observed at the concrete floor slab (Figure 161).

- Although the park does not have specific documentation of occurrences of water infiltration, park personnel noted that water is present in the bunker after very heavy wind-driven rains, in which case the water enters the bunker primarily through the gap between the doors. Active leakage through the roof, walls, or floor has not been observed. When present, ponding water is typically observed at low points in the bunker.

Figure 158. Staining at the northwest corner of the bunker (yellow arrow).

Figure 159. Spalled parge coating over the brick infill at the former window.

Figure 160. A crack at the interior floor slab.

Figure 161. Spalled concrete at the interior floor slab.

Left Blank Intentionally

Significance and Integrity

National Register of Historic Places

The National Register of Historic Places is the official list of the nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources.[137]

The significance evaluation identifies the important historical associations of the property, and comments on its architectural, archeological, and social value as they relate to the National Register of Historic Places. A property's significance is tied to a discrete period of time in which its important contributions were made and to relevant national, state, and local historic contexts.

Significance Criteria

In order for a property to be eligible for inclusion in the National Register of Historic Places, it must possess significance under one of four criteria. The Criteria for Evaluation for listing in the National Register of Historic Places state:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> A. That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B. That are associated with the lives of persons significant in our past; or
>
> C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> D. That has yielded, or may be likely to yield, information important in prehistory or history.[138]

In addition, the Criteria for Evaluation identify Criteria Considerations that address cemeteries, birthplaces, graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past fifty years that are not considered eligible for the National Register—but which will qualify for the National Register if they fall within certain categories. The Criteria Considerations do not pertain to this property, thus are not further discussed here.[139]

137. National Park Service, "National Register of Historic Places," accessed April 2023, https://www.nps.gov/subjects/nationalregister/index.htm.
138. *Code of Federal Regulations*, Title 36, Part 60, "The National Register Criteria for Evaluation."
139. National Park Service, "National Register of Historic Places."

National Register Significance Evaluation

Fort Pulaski National Monument was administratively listed in the National Register of Historic Places on October 15, 1966, under the National Historic Preservation Act. Documentation of Fort Pulaski was added to the National Register of Historic Places on December 9, 1975, and indicates that the historic district is significant in the areas of Architecture, Engineering, and Military History. Although the nomination does not cite the National Register criteria in its assessment of the significance of Fort Pulaski, the fort is considered significant under Criteria A, C, and D.

As noted in the 1975 National Register of Historic Places nomination:

> Fort Pulaski is the best preserved and most original of a system of eastern coastal forts designed by the French military engineer Simon Bernard, while in the employ of the United States Army Corps of Engineers. Its massive brick walls, backed by heavy piers, and casemated rooms reflected the continuing search for security against increasingly large caliber smoothbore cannon of the period. The best military engineering principles, and finest joinery and masonry techniques of the day were used in its construction. Yet the siege and rapid reduction of Fort Pulaski in 1862 by heavy rifled artillery of the Federal Army, which had no precedent, immediately made obsolete all masonry forts everywhere. Most of the construction features and extensive siege damage are visible and are interpreted to the public today.
>
> Ancillary structures include: numerous cisterns, workmen's village house foundations and a stone pier, all associated with the fort's construction; Cockspur Island Lighthouse (1840), prominent in local navigational history and architecturally significant; Battery Hambright (1895), which represents the continuing evolution of coastal fortifications; and, the park residence (1896), once headquarters of the U. S. Quarantine Station on the island.
>
> The Fort Pulaski complex is significant in the areas of architecture, engineering and military history of the U.S. . . . All of the above structures and sites represent the long and important role of Cockspur Island in the nation's military, architectural and maritime history. . . .[140]

The World War II bunkers at the west end of Cockspur Island are not currently listed in the National Register of Historic Places but are managed as cultural resources by the National Park Service. The bunkers have been determined eligible for listing in the National Register by the National Park Service. The Determinations of Eligibility note that the bunkers are "integral component[s] of the Fort Pulaski National Monument Property" and are eligible for listing in the National Register of Historic Places under Criterion C.[141] The Determinations of Eligibility note that that the bunkers may be significant locally and at the state level under this criterion.[142] During World War II, existing buildings were renovated, and a number of new buildings constructed by the U.S. Navy to support its use of

140. Edward L. Trout, Park Historian, *National Register of Historic Places Nomination Form: Fort Pulaski National Monument*, December 9, 1975. (As noted in the Historic Structure Report for Fort Pulaski, further research would be required to assess the significance of the fort under Criterion B. Wiss, Janney, Elstner Associates, Inc., *Fort Pulaski National Monument, Fort Pulaski Historic Structure Report*, 2014.) At the time the National Register nomination for Fort Pulaski National Monument was prepared in the 1970s, World War II had ended only thirty years earlier and the bunkers were less than thirty-five years old, which contributed to their not being addressed in the documentation at the time.
141. National Park Service, *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*
142. National Park Service, *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*

the west end of Cockspur Island as a military base. New structures included barracks, an administrative office, an auditorium, club rooms, cooking facilities, an officer's club, gymnasium, athletic field, and a tennis court, as well as the two bunkers. All of these structures except the bunkers were dismantled or demolished after the base was decommissioned and the property returned to the National Park Service. Of the buildings adapted or constructed by the Navy, only the magazines, the officer's quarters (formerly the quarantine station's attendant's quarters), and a garage/storage building still stand today.[143] The NPS Determinations of Eligibility note that each bunker is ". . . a relic of a by-gone era in military history . . . a visible reminder and tangible legacy of the site's development and military history."[144]

Research conducted for this Historic Structures Report also suggests that the bunkers are significant as representative of the military importance of the area surrounding Savannah during World War II. In recognition of the region's contribution to the historic war effort, Savannah and Chatham County have been designated an American World War II Heritage City by the Secretary of the Interior. As noted in the World War II Heritage City designation, Savannah and adjacent Chatham County became a ". . . major port for both supplies and maritime construction, a hub for manufacturing and civil defense, training facilities for 70,000 airmen, and deployment of 9,000 aircraft, with the Eighth Air Force."[145] The U.S. Navy Section Base on Cockspur Island, of which the bunkers were a part, was an important component of the coastal defense system established during the war.

Period of Significance

The recommended period of significance for the World War II bunkers at Fort Pulaski is 1943–1946, beginning with the date of construction of the bunkers, and concluding with decommissioning of the site by the U.S. Navy.

Although the period of significance for the bunkers is clearly defined, it may also be helpful to review this period as it relates to the period of significance identified for the overall Fort Pulaski property.

The National Register nomination identifies the period of significance of Fort Pulaski as the nineteenth century (as indicated in the nomination form in use when the documentation was prepared), highlighting specific dates of 1829–1847, 1861–1872, and "briefly 1890s."[146] The more recently completed Cultural Landscape Report for Fort Pulaski National Monument Cockspur Island Historic District identifies a period of significance of 1829–1895, spanning the period from the initial construction of Fort Pulaski to completion of the southeast magazine at the demilune.[147] This latter construction represents the completion of the physical fortification as it exists today, and the last modification constructed in response to the military use of the fort. The Cultural Landscape

143. National Park Service, *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*
144. National Park Service, *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*
145. "American World War II Heritage City Program," accessed April 2023, https://www.nps.gov/subjects/worldwarii/americanheritagecity.htm. The American WWII Heritage City designation narrative for Savannah and Chatham County, Georgia, notes numerous commemorative markers recognizing places and events associated with the war, including the U-boat sinking of the SS *James Oglethorpe* in 1943; the McKelvey-Powell Building, which served as a USO facility for Black servicemen; Hunter Field, the "Birthplace of the Eighth Air Force"; and many others. The Navy section base, and the bunkers that remain to represent it, are not acknowledged in the designation narrative provided on the web site.
146. Trout, *National Register of Historic Places Nomination Form: Fort Pulaski National Monument*.
147. Susan Hitchcock, *Fort Pulaski National Monument Cockspur Island Historic District Cultural Landscape Report*. (Atlanta, Georgia: National Park Service, 2011).

Report also defines a secondary period of significance, 1933–1942, covering the time in which the New Deal-era agencies were active at Fort Pulaski and on Cockspur Island.

Although the National Register nomination and the Cultural Landscape Report identify periods of significance related to military use of the site, neither document incorporates in the period of significance the dates that pertain to the Endicott-era construction at Fort Pulaski, including Battery Hambright. The period of significance as recommended by the Historic Structure Report prepared for the battery begins with the start of construction of the battery in 1899 and continues through CCC work completed at the battery in the 1930s.[148] If added to the period of significance identified for Fort Pulaski National Monument, these dates would link the primary and secondary periods established by the Cultural Landscape Report, although concluding prior to the period pertaining to the World War II bunkers. [149] The National Register nomination for Fort Pulaski National Monument/Cockspur Island Historic District is currently being updated, affording an opportunity to define a continuous period of significance linking the primary and secondary periods identified by the Cultural Landscape Report, and extending the end date of the secondary period. This end date could be extended to include the period recommended for the World War II bunkers, reflecting the historical and continuous military significance of Cockspur Island and its various fortifications. If the period of significance is extended to end in 1946, when use of the site by the U.S. Navy concluded, this would also reflect military activities at Cockspur Island within the context of World War II efforts in Savannah and Chatham County.

Character-Defining Features

The historic nature of significant buildings and structures is defined by their character, which is embodied in their identifying physical features. Character-defining features can include the shape of a building; its materials, craftsmanship, interior spaces, and features; and the different components of its surroundings.[150]

The following list identifies existing character-defining features of the bunkers:

- Orientation, configuration, and setting of the bunkers.
- Earthen berm covering over both bunkers.
- Low profile of the bunkers as related to the adjacent site.
- Simple, utilitarian aesthetic and simple finishes (exterior and interior) of both bunkers.
- Exposed concrete on the exterior and interior of both bunkers.
- Doors on both bunkers.
- Window openings on the north bunker.
- Open spaces and exposed structural elements on the interior of both bunkers.

Assessment of Integrity

Assessment of integrity is based on an evaluation of the existence and condition of the physical

148. Panamerican Consultants Inc., with Wiss, Janney, Elstner Associates, Inc., *Fort Pulaski National Monument, Battery Horace Hambright Historic Structure Report* (2019).
149. The Fort Pulaski Visitor Center is considered significant for its association with the Mission 66 program and its design in the Park Service Modern style, with a recommended period of significance of 1964 (the year of completion of its construction). However, the visitor center is not associated with the military use of the site. Panamerican Consultants, Inc., with Wiss, Janney, Elstner Associates, Inc., *Fort Pulaski National Monument, Mission 66 Visitor Center Historic Structure Report* (2019).
150. Lee H. Nelson, FAIA, *Preservation Brief 17: Architectural Character: Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character* (Washington, D.C.: National Park Service, Technical Preservation Services, 1988).

features which date to a property's period of significance, taking into consideration the degree to which the individual qualities of integrity are present. The seven aspects of integrity as defined in the National Register Criteria for Evaluation are location, design, setting, materials, workmanship, feeling, and association. As noted in the National Register Bulletin, *How to Apply the National Register Criteria for Evaluation*:

> Location is the place where the historic property was constructed or the place where the historic event occurred. . . . Design is the combination of elements that create the form, plan, space, structure, and style of a property. . . . Setting is the physical environment of a historic property. . . . Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property. . . . Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory. . . . Feeling is a property's expression of the aesthetic or historic sense of a particular period of time. . . . Association is the direct link between an important historic event or person and a historic property.[151]

The property must retain the essential physical features that enable it to convey its historical significance. The essential physical features are those features that define both why a property is significant (National Register criteria) and when it was significant (period of significance). The National Register Bulletin, *How to Apply the National Register Criteria for Evaluation*, defines integrity as "the ability of a property to convey its significance."[152]

Integrity of Location. The bunkers retain integrity of location. The location of the structures has remained unchanged since original construction.

Integrity of Design. The bunkers retain integrity of design. Both bunkers reflect their original design. Modifications that have occurred since construction, including the addition of the earthen ramp at the front of the south bunker and the electrical features installed to serve the hydrolysis system at the south bunker, are minor and do not noticeably diminish integrity of design.

Integrity of Setting. The bunkers retain integrity of setting, although diminished by the loss of other structures constructed by the U.S. Navy in the vicinity. In addition to missing structures, deterioration and potential loss of small-scale features that were part of the landscape, such as the fence and metal tower, and overgrowth of vegetation contribute to diminished integrity of setting.

Integrity of Materials and Workmanship. The bunkers retain integrity of materials and workmanship, although integrity of the south bunker is slightly diminished by closure of the windows. Whitewash visible on the exterior concrete in archival photos has deteriorated over time. While it is not known if this surface treatment is original, if historic then its deterioration slightly diminishes integrity of materials and workmanship.

Integrity of Feeling. The bunkers retain integrity of feeling. They continue to convey their historic character and purpose, although the south bunker is no longer used for munitions storage.

Integrity of Association. The bunkers retain integrity of association, although somewhat diminished by the loss of other structures constructed by the U.S. Navy during World War II. Although the south bunker is now used for park storage, the north bunker continues to be used for black powder storage as it was historically.

151. *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* (Washington, D.C.: U.S. Department of the Interior, National Park Service, National Register, History and Education, 1990, rev. 1995), 44–45.
152. *National Register Bulletin: How to Apply the National Register Criteria for Evaluation*.

Left Blank Intentionally

Treatment and Use

Requirements for Treatment and Use

The following discussion of treatment and use for the West End bunkers at Fort Pulaski National Monument has been prepared based on historical research, condition assessment, and discussion with the National Park Service. Although not listed in the National Register of Historic Places, the World War II bunkers at the west end of Cockspur Island are managed as cultural resources by the National Park Service.

As such, treatment and use of the bunkers should be considered within the context of the legal mandates and policy directives established by the National Park Service *Cultural Resources Management Guideline* (Director's Order 28) for the protection of cultural resources. The structures are expected to be preserved while continuing to be used for storage.

Laws, Regulations, and Functional Requirements

Key laws, regulations, and functional requirements that apply to the recommended work include the following:

- National Park Service *Cultural Resources Management Guideline* (Director's Order 28), which requires planning for the protection of cultural resources on park property.
- Section 106 of the National Historic Preservation Act, which mandates that federal agencies, including the National Park Service, take into account the effects of their actions on properties listed or eligible for listing in the National Register of Historic Places and give the Advisory Council on Historic Preservation a reasonable opportunity to comment.

Treatment of the structures and site are also to be guided by the following:

- *Secretary of Interior's Standards for the Treatment of Historic Properties*
- Architectural Barriers Act Accessibility Standards (ABAAS)
- International Building Code (IBC), 2021
- International Existing Building Code (IEBC), 2021
- NPS Guiding Principles of Sustainable Design

The State of Georgia has adopted the 2018 IBC with Georgia amendments dated 2020 and 2022. The 2018 IEBC has been adopted as a permissive code by the State of Georgia with Georgia amendments dated 2021. The National Park Service is self-regulating in terms of enacting and enforcing building code standards. Fort Pulaski National Monument is, therefore, not legally subject to local or state building code requirements. When undertaking repairs to buildings and structures, the National Park Service endeavors to have the work comply with model building code standards. At this time, the 2021 IBC is the model building code used by the National Park Service for design and construction. The NPS Denver Service Center also references the 2021 IEBC, with appendices.

With historic structures, attempts to achieve strict conformance with model building code standards that are intended for new buildings can lead to destruction of the historic fabric. Alternative compliance procedures, such as Chapter 12 of the IEBC relating to historic buildings, should be referenced in determining code compliance.

Alternatives to full prescriptive legislative and code compliance should be considered where such compliance would compromise the integrity of the structure.

The 2021 IEBC includes the following statements in Section 507, Historic Buildings:

> 507.1 Historic buildings. The provisions of this code that require improvements relative to a building's existing condition or, in the case of repairs, that require improvements relative to a building's predamage condition, shall not be mandatory for *historic buildings* unless specifically required by this section.
>
> 507.2 Life safety hazards. The provisions of this code shall apply to *historic buildings* judged by the building code official to constitute a distinct life safety hazard.
>
> 507.3 Flood hazard areas. Within flood *hazard areas* established in accordance with Section 1612.3 of the *International Building Code*, or Section R322 of *the International Residential Code*, as applicable, where the work proposed constitutes *substantial improvement*, the building shall be brought into compliance with Section 1612 of the *International Building Code*, or Section R322 of the International Residential Code, as applicable:
>
> Exception: *Historic buildings* meeting any of the following criteria need not be brought into compliance:
>
> 1. Listed or preliminarily determined to be eligible for listing in the National Register of Historic Places.
>
> 2. Determined by the Secretary of the U.S. Department of Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined to qualify as an historic district.
>
> 3. Designated as historic under a state or local historic preservation program that is approved by the Department of Interior.
>
> 507.4 Structural. Historic buildings shall comply with the applicable structural provisions in this chapter.
>
> Exceptions:
>
> 1. The *code official* shall be authorized to accept existing floors and existing live loads and to approve operational controls that limit the live load on any floor.
>
> 2. Repair of *substantial structural damage* is not required to comply with Sections 405.2.3, and 405.2.4. *Substantial structural damage* shall be repaired in accordance with Section 405.2.1.[153]

The IEBC exceptions noted above pertain to the West End bunkers as structures considered eligible for nomination to the National Register of Historic Places and managed as a cultural resource.

In addition, the National Park Service provides guidance on sustainability in work on historic structures, in terms of energy efficiency, technology, and sustainable preservation in practice, as described in *The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings*.[154]

Guiding documents include the park's *Foundation Document* (2016).

Alternatives for Treatment and Use

The National Park Service has developed definitions for the four major treatments that may be applied to historic structures: preservation,

153. International Code Council, Inc., International Existing Building Code 2021 (Country Club Hills, Illinois: International Code Council, 2017).
154. Anne E. Grimmer, *The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings* (Washington, D.C.: U.S. Department of the Interior, National Park Service, Technical Preservation Services, 2017).

rehabilitation, restoration, and reconstruction. The four definitions are as follows:

> **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, new exterior additions are not within the scope of this treatment. The Standards for Preservation require retention of the greatest amount of historic fabric along with the building's historic form.
>
> **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. 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.
>
> **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 plumbing systems and other code-required work to make properties functional is appropriate within a restoration project. The Restoration Standards allow for the depiction of a building at a particular time in its history by preserving materials, features, finishes, and spaces from its period of significance and removing those from other periods.
>
> **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. The Reconstruction Standards establish a limited framework for recreating a vanished or non-surviving building with new materials, primarily for interpretive purposes.[155]

Of the four treatment approaches, *preservation,* which involves sustaining the building or structure in its existing form, is most appropriate for the West End bunkers.

Within the overarching preservation approach for the bunkers, this study recommends making the repairs necessary to maintain and preserve the structures in their existing state for continued use by the park. Repair or replacement of the doors at the south bunker will be necessary, as further discussed under Recommendations, below. Consideration may also be given to restoring the glass block windows at the north facade of the south bunker.

(Refer to the Developmental History and the Significance and Integrity chapters for further discussion of character-defining features.)

Future use of the bunkers is anticipated to be similar to their current function—storage of black powder at the north bunker and general storage at the south bunker. The park also stores heavy equipment in the south bunker during hurricanes (emergency storage) and is interested in considering use of the south bunker as a safe shelter during tornadoes, if structurally appropriate.

Ultimate Treatment and Use: Standards and Guidelines for Treatment

The guidelines and requirements for treatment included later in this chapter have been defined based on the preservation objectives and

155. Grimmer, *The Secretary of the Interior's Standards*.

requirements for treatment and use outlined above for the West End bunkers at Fort Pulaski National Monument. All treatment guidelines and recommendations were developed in accordance with the Secretary of Interior's Standards for Preservation. (*The Secretary of the Interior's Standards for the Treatment of Historic Properties* were referenced in development of treatment guidelines and recommendations for any landscape features addressed in this study.)

The Secretary of the Interior's Standards for Preservation are as follows:

1. A property will be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken.

2. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color, and texture.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.[156]

Guidelines for implementing the treatment recommendations provided herein are as follows:

- Undertake all work on the structure in compliance with the *Secretary of the Interior's Standards for Preservation*.
- Retain the character of the historic structures and environs by protecting the bunkers and surrounding site.
- Protect adjacent natural resources during any construction activities.
- Document through detailed as-built drawings, photographs, and written narrative all changes and treatments to the structures and the immediate site. Maintain records of treatments and preserve documentation according to professional archival standards. Maintain a copy of records in the NPS archives.
- Retain features and materials that survive from the period of significance to the greatest extent possible.
- Incorporate sustainable design principles in all future projects that respect the preservation principles listed above.

156. Grimmer, *The Secretary of the Interior's Standards*. The guidelines that accompany the Standards also note that new materials should be distinguishable from old.

Recommendations

The following specific recommendations for treatment of the bunkers follow the overarching treatment approach of *preservation*.

Site

- Retain the bunkers in their current location and avoid constructing new features at the site that would interfere with views of the structures.
- Continue to maintain the site around the structures. Conduct regular clearing so that the site around the structures is free of trees and heavy ground vegetation. Monitor trees near the bunkers to identify potential hazards to the structures and persons using the structures, such as limb falls, and address as needed.
- Remove vines and other vegetation growing on the structures.
- Protect and preserve nearby features within the park boundary that are associated with the U.S. Navy use of the site during World War II, such as the fence topped with barbed wire and the metal tower.
- Consider ways to interpret the history of the site, the presence of the U.S. Navy at Fort Pulaski during World War II, and the role of the NPS in preserving the historic resources before and after the war.

Concrete

Concrete deterioration and distress should be repaired using concrete repair techniques and procedures that include the following steps:

Cleaning

- The concrete should be cleaned with a biocide/detergent at affected areas to remove organic growth. Prior to implementation, cleaning mock-ups should be performed to evaluate cleaning systems to be used and to determine the concrete appearance for matching of any concrete repair materials. The gentlest effective cleaning system should be used. Cleaners containing strong acids (hydrofluoric acid, hydrochloric acid, ammonium bifluoride) should not be used.

  Three general types of cleaning systems are available for removal of soiling and staining from building facades: microabrasive, chemical, and water methods. The selection of a cleaning method must take into consideration both the type of soiling to be removed and the nature and condition of the substrate.

  The removal method selected should be based on successful trials and should follow the *Secretary of the Interior's Standards for the Treatment of Historic Properties*, which states that the gentlest, most effective cleaning methods should be selected. Methods and materials that result in damage to the substrate or that are harmful to humans, animals, and the environment should not be used.

  Microabrasive methods include the physical removal of soiling from the surface. Microabrasive methods commonly used in facade cleaning include a variety of abrasive media delivered to the surface at very low pressures, either in a stream of water used to soften the soiling and buffer the impact of the media, or dry. Although these techniques are typically not damaging to sound concrete, trials are required to confirm the effectiveness of the system and also that it will not damage the substrate. (Some microabrasive techniques, such as "soda blasting," have been found to be damaging to substrates.)

  A wide range of chemical cleaning products are available to address atmospheric soiling, biological growth, and coating removal. The chemicals selected should not result in damage to the substrate material and should not be hazardous to workers or the environment. Poultices—an active chemical mixed with an inert vehicle such as clay or diatomaceous earth—are generally effective in removing deep set or severe localized staining, such as corrosion staining. Specific chemical cleaners are effective in removing particular staining

types; for example, efflorescence deposits (calcium carbonate leaching at locations of water movement through cracks) can usually be removed with mild acidic cleaners. Localized ferrous (rust) staining, such as that present at localized areas of the north bunker interior walls near the floor, can typically be removed by an oxalic acid solution or poultice. Biological growth can be removed by chemical cleaners; however, treatment with a biocide will inhibit recurrence of the biological growth. It should be noted that the biocide will need to be reapplied on a cyclical basis to continue to inhibit new growth.

Water methods typically include low pressure washing, steam cleaning, and hot water pressure washing. These methods can be effective on light soiling.

Concrete Repair

- Concrete repair mixes should be developed to match the color, finish, and texture of the original concrete.
- Trial repairs and mock-ups should be performed to determine the exact concrete mix designs and repair techniques. Multiple samples of various mixes are typically required. Initial small samples should be prepared off-structure and in unobtrusive locations on-structure, followed by mock-ups of selected repair mixes and techniques on the bunkers, as needed to achieve a match to original surface finishing, texture, and color.
- Concrete at areas of spalling should be removed and proper repairs installed (see previous item). The concrete repair material should be placed within formwork constructed for the specific repair location; trowel-applied patches should not be used, as these will be less durable than formed and placed repairs.

  Repair of localized concrete deterioration requiring patch repairs should include the following steps:

  A 3/4-inch-deep sawcut should be made around the entire perimeter of each repair area, close to the perimeter of the spall in order to retain as much sound concrete beyond the spalled area as possible. The sawcut may align with edges of the formboard profile when appropriate.

  Chipping hammers should be used to remove concrete within the spalled area to a depth of at least 3/4 inch beyond the exposed reinforcing steel. (Sound concrete beyond the repair area should be protected during this work.)

  The exposed concrete surfaces and exposed reinforcing steel within the repair area should be abrasively blasted and air blasted to remove corrosion and roughen and clean the surface. (Sound concrete beyond the repair area should be protected during this work.)

  The exposed steel reinforcing bars should be inspected for loss of section due to corrosion and repaired, supplemented, or replaced as necessary.

  After cleaning, the exposed steel reinforcing bars should be immediately covered with two coats of a corrosion-inhibiting coating in accordance with the coating manufacturer's recommendations.

  Formwork should be installed to match the original profile of the surface, including matching the original board form finish.

  Repair concrete, customized to match the original concrete color, finish, and texture (as discussed above), should be placed and consolidated.

  The concrete repair should be wet cured.

Repair of spalls and severe cracks not associated with embedded steel would follow the same process as described above, although preparation and treatment of embedded reinforcing would not be required. Small, shallow spalls not associated with embedded steel do not require repair.

Note that formed concrete repairs are not required at very shallow spalls. At the few

localized areas where corroded reinforcement is exposed at deeper spall locations, the above process should be followed.

- Where corroded ends of reinforcement (possibly dowels) are visible near the base of the walls in the north bunker, corrosion of the steel appears to be on the surface only and no spalling of the adjacent concrete was observed. As noted above, ferrous staining of concrete can be addressed by cleaning. The exposed end of the reinforcement could be cleaned and painted with a rust-inhibitive coating. Other repairs at this location are not required. (If desired, a small opening could be made at a single staining location to assess the condition of the embedded reinforcement; the exposed bar could be cleaned, painted with a rust-inhibitive coating, and the concrete repaired. However, given the lack of spalling of the adjacent concrete, further investigation is not required.)
- Abandoned ferrous anchors should be removed (e.g., by coring) and the concrete repaired as described above.
- Cracks should be repaired by installation of a cementitious patch material. The type of repair will need to be determined by the size of the cracks; generally smaller non-moving cracks may be repairable by cementitious grout. Hairline cracks do not require repair.
- Examples of cracks to be repaired as described above include cracks at the top of the platform in front of the south bunker and at the parapet of the south bunker. Although a cementitious patch material would need to be renewed periodically if the crack reappears, this approach is preferable to routing and sealing cracks, which is not necessary to address observed conditions and which would be visually very intrusive.
- No repairs are required at the formed notch in the wall at the north bunker or at the pilasters in the south bunker.
- Although not required to protect the concrete, consideration could be given to renewing the whitewash that remains in some areas on the exterior concrete as seen in archival photos. (It is currently not known if the whitewash is part of the original construction or if it was added later.) If renewal of the whitewash is desired, a limewash or similar treatment should be evaluated through mock-ups prior to overall application. Use of limewash or a similar treatment is recommended rather than a film-forming coating.

Parge Coat Repair

- Although the parge coating at the former window openings on the south bunker is non-original, it is largely intact and provides protection for the brick infill beyond. Although no cracking or deterioration was noted at the exterior of the structure, spalling was noted at the interior of the bunker. Given its location on the interior of the bunker, repair is not required.

  If future deterioration of the parge coating occurs, particularly at the exterior, the deteriorated and debonded patch material should be removed and the original brick substrate examined to determine its condition and whether it requires repair.
- Develop a protocol for removal of the failed parge coating at trial areas to inform future planning.

  The spalled areas of parge coat could be replaced with a compatible render, matching the existing parge coating appearance in color, texture, and finish.

  Very fine crazing and hairline cracks in the parge coat may be left unrepaired, as these conditions do not permit moisture to enter the coating.

Waterproofing at Concrete Roof Surface

- While exposed portions of the waterproofing at the roof are deteriorated, no water infiltration has been reported through the roof. As a result, exploratory openings should be made at the infill over the roof at selected locations to assess the condition of the waterproofing. If the membrane is only

deteriorated where currently exposed, localized replacement of the waterproofing can be considered.

If widespread deterioration is observed, consideration could be given to removing the existing waterproofing and installing a new waterproofing system to provide protection for the concrete roof slab and the interior of the bunker. Removal of the existing membrane would require temporary removal of the earthen fill at the top of the structure. Following application of a new waterproofing system, the fill should be returned and spread over the top of the bunker, incorporating a drainage medium if required by the manufacturer of the waterproofing system.

The new waterproofing system should be bituminous, as other modern waterproofing membrane types are not considered suitable for use on the historic structure, as they would be visually intrusive through termination details required for performance reasons.

Restoration of Glass Block at Windows

The park may wish to consider removing the parge coat and brick infill, and restoring the glass block windows to return the facade to its historic appearance. Further study is required to determine whether the windows would be suitable under storm conditions. If desired, the following steps are recommended:

- Develop a conceptual design for restoration of glass block and the windows. Conduct structural analysis to determine if glass block would resist wind and impact loads likely to occur under storm (e.g., tropical storm, hurricane, or tornado) conditions. An impact-resistant glass panel could be provided on the interior of the windows if needed to provide additional protection, while retaining the historic appearance of the glass block on the exterior. If determined to be appropriate structurally, obtain samples of replica glass block for evaluation on site. Refer to available archival photographs of the south bunker, as well as to remaining glass block infill on other bunkers on Georgia Department of Transportation property, for the size, configuration, texture, and appearance of original glass block.
- If it is determined that glass block windows are not appropriate structurally, consider a different type of infill that would provide adequate performance during storm conditions and would reflect the historic glass block appearance more closely than the current brick and parge coat infill.

Drainage for Bunker Interiors

As discussed in the Existing Conditions section of this HSR, water has been observed on the floors of the bunkers and ponding in some locations after heavy wind-driven rain. During normal weather conditions, water is not observed in the bunkers. The park has noted that the primary source of water entry is the doors on the bunkers, especially the gap between the two doors on the south bunker. The vent openings in the walls of the north bunker may also be allowing water entry during heavy wind-driven rain. Water entry through the vent stacks has not been reported. Water entry through the concrete walls or floor slab has also not been observed.

As also discussed in the Existing Conditions chapter, a small drainpipe is present in the south wall near the southwest corner of the south bunker, but does not appear to be effective.

The following measures are recommended related to drainage for the bunker interiors:

- Continue to monitor both bunkers for the presence of water, including wet surfaces and ponding water. Confirm that the doors are the primary source of water entry. If other sources of water entry are identified, investigate and address those sources.
- Provide small diverters to deflect water entering the north bunker through the vent openings. Diverters should be designed in a non-corrosive metal material (e.g., stainless steel), to be as visually inobtrusive as possible, and detailed to minimize damage to the

original concrete. It may be possible to install diverters on the interior for this purpose. These openings should not be closed or covered over, and should continue to provide for air flow.

- Following repair or replacement of the doors to a more watertight condition, monitor both bunkers for the presence of water.
- If the interiors of the bunkers remain dry during normal conditions and receive minimal water during heavy wind-driven rains, measures to provide drainage are not required. (Minimal water after heavy wind-driven rains, e.g., tropical storm or hurricane, would be an amount that the park can address by sweeping the interior, or by use of portable pumps if the park determines that this maintenance approach is feasible.) The existing drainpipe can be removed from the wall and the surrounding hole repaired with concrete to match the adjacent wall.
- If after the doors are repaired or replaced, water accumulates in either bunker, consideration could be given to investigating the drain system present in the south bunker. This would involve making an opening in the wall at the drainpipe location, and selective excavation on the exterior to determine the path of the drain system. If it is determined that a drain is necessary, a new drain or drains would need to be installed to effectively drain water from the lowest points on the interior, where ponding water occurs. A similar drain could be considered for the north bunker. Interior trench drains at the perimeter of the floor could also be considered if water infiltration is determined to occur through the floor or walls, which at present does not appear to be the case. Given the park's observation that the doors are the primary source of water entry, it is anticipated that repairs to the doors will address the water infiltration issue to a great extent, if not completely.

Terra Cotta

Deterioration and distress at the terra cotta stack vents should be repaired using repair techniques and procedures that include the following steps:

- Any intact terra cotta pieces should be retained and repaired. At locations where spalling of the glazed has occurred, a terra cotta glaze spall coating that matches the existing in color and sheen should be used.
- Where terra cotta units are severely deteriorated with missing material, new terra cotta units should be fabricated to match the existing feature.

  Where replacement is required, the existing in-place unit should be documented and measured. Following documentation, remove unit for sample of existing finish and for use in preparation of molds for fabrication. Temporarily stabilize or store adjacent units and protect any openings to prevent moisture penetration into the structure.

Steel Doors

To allow for continued use of the bunkers for storage and to provide protection during storms, the existing doors should be repaired, if possible, to be made operable with as much original material preserved as possible, using repair techniques and procedures that include the following steps:

- Temporarily remove the existing steel doors. Prior to removal, the doors should be documented. Once removed, the doors should be partially disassembled to allow for an assessment of any obscured elements and confirm whether the doors can be repaired and restored or if replacement is necessary. During this process, the doors should be documented and information necessary to perform a structural analysis of the doors should be gathered. Findings of a structural analysis may help inform the decision to repair or replace the doors.

- If it is determined the doors can be repaired and restored, the existing surface coating and rust scale should be removed to bare steel using abrasive blasting in preparation for a new coating system at elements where surface corrosion is present. (Note that abrasive blasting, while not appropriate for use on historic masonry, is considered appropriate for preparation of steel in historic structures prior to priming and coating. This preparation is needed to provide for removal of corrosion product and proper adhesion of the prime coat.) Containment will be necessary during the surface coating removal and preparation process and new coating application. Prior to paint removal, the existing coatings should be sampled to check for potentially hazardous materials, such as existing lead-containing paints. If hazardous materials are present, it may be necessary to first use chemical paint strippers and/or water blasting to remove the coating.

  The steel should be pressure washed to remove any chloride contamination.

  The steel should then be prepared and coated with a zinc-rich primer and high-performance coating system. Mock-ups of coating removal, surface preparation, and application of the new coating system should be performed to evaluate work processes and to serve as a standard for the overall work.

  Where severely deteriorated, steel door elements will likely require replacement. The replacement elements should be fabricated to match the existing features and coated to match the retained door elements.

  Any elements to be replaced should be carefully documented prior to replacement.

  The repair and restoration of the doors should be completed in a shop, to provide quality control measures that are not available in situ. Any repairs to the frame will need to be performed in the field and may include new weatherstripping and adjustments to door hardware to provide proper closure of the doors and enhance weathertightness. Based on discussion with the park, we understand that it is desirable to have the bunkers, and the doors in particular (as they are currently the primary source of water infiltration into the structures), be made as watertight as possible during heavy wind-driven rains or a storm surge.

  After further investigation, if strengthening of the existing door to resist higher wind loads is feasible, a design will need to be completed with repair drawings and material specifications. Conceptually, structural repairs may include adding more ribs at tighter intervals within the door (between the outer and interior sheet metal cladding of the doors), which would not be visible, and/or adding more anchors between the door frame and the adjacent concrete at the jambs, so that the door is fastened to the concrete at tighter intervals, to increase strength for wind resistance.

- If, after further investigation, it is determined the doors should be replaced, new doors matching the appearance of the original doors should be fabricated. While the exterior of the new doors should match the appearance of the original doors, the interior structure of the doors can be different, particularly if structural analysis determines the need to strengthen the doors. Modifications could also be made to make the door enclosures more watertight, if needed, though it is unlikely the bunkers would remain watertight if storm surge rose above the floor levels.

- In addition to repairing or replacing the existing doors, consideration could be given to adding a new set of doors inside or outside the existing doorway at the south bunker. However, based on the alterations that would be required to add a second set of doors, and the intrusion the doors would make on the historic appearance of the exterior as well as the amount of floor space on the interior, this option has not been considered further for purposes of this report.

Other Steel Elements

A steel angle is present at the outboard edge of the platform in front of the south bunker. The following treatment is recommended:

- Clean, prime, and paint the exposed surfaces of the angle with a corrosion-resistant coating system.

Current and Forthcoming Work

Based on discussions with the park, we understand that repair of the doors at the south bunker is the highest priority repair for the World War II bunkers and is anticipated to be completed in the near future.

Recommendations for Further Research

1. Partially disassemble the existing doors to examine and document elements of the door frame. This process will support further structural evaluation of the doors and help inform determination of whether the doors can be repaired and restored, or whether it is more appropriate to replace them with new doors matching the historic appearance.
2. If application of limewash to the exterior face of the concrete walls or a similar treatment is desired, a specification should be developed, and a mock-up completed prior to overall application. Further laboratory studies could be performed to characterize the existing whitewash.

Resilience to Natural Hazards

Climate change is anticipated to bring increasingly frequent strong storms and heavy rainfall to many areas, including the southeastern United States. As noted in the 2013 study, *Climate Change Impacts to Natural Resources in South Carolina*, by the South Carolina Department of Natural Resources: "A predicted result of climate change is the increase in intense storm events causing greater water inputs in shorter periods of time, affecting flood frequency and duration."[157] Coastal Georgia is similarly affected; studies indicate, for example, that sea levels have risen by 8 inches at Fort Pulaski since 1935.[158] The NPS has initiated several studies and programs in response to climate change, noting that "The overarching and omnipresent effects of a warming world challenge the traditional tenets of park management, and may force the reconsideration of some conservation goals."[159] The NPS Climate Change Response Strategy (2010) identifies four key pillars of effective response: science, adaptation, mitigation, and communication.[160] The *Natural Resources Stewardship and Science Directorate Climate Action Plan* (2021) reiterates the NPS commitment to sustainability and identifies several strategies for climate action, including reducing operational emissions, emphasizing communication and education, and evaluating progress. The *Action Plan* also discusses the Climate Friendly Parks program.[161]

Located near the Atlantic coastline, on low-lying terrain, Fort Pulaski National Monument is vulnerable to current and future threats associated with climate change. In particular, damage and flooding have occurred in the park following

157. Bob Perry, compiler and editor, *Climate Change Impacts to Natural Resources in South Carolina* (Columbia: South Carolina Department of Natural Resources, 2013), 16, accessed April 13, 2022, https://www.dnr.sc.gov/pubs/CCINatResReport.pdf.
158. University of Georgia, Georgia Sea Grant, "Sea Level Rise in Georgia," accessed 2016, http://georgiaseagrant.uga.edu/article/sea_level_rise_in_georgia/.
159. National Park Service, *Planning for a Changing Climate: Climate-Smart Planning and Management in the National Park Service* (Washington, D.C.: National Park Service, 2021).
160. National Park Service, *Climate Change Response Strategy* (Washington, D.C.: National Park Service, 2010).
161. National Park Service, *Natural Resources Stewardship and Science Directorate Climate Action Plan* (Washington, D.C.: National Park Service, 2021).

severe storms in early 2016, Hurricane Matthew in October 2016, a tornado in May 2017, and Hurricane Irma in September 2017.

Hurricane Matthew moved up the coast of the southeastern United States, making landfall on the South Carolina coast on October 8, 2016. The hurricane caused extensive flooding and damage from Florida to the Carolinas. The storm surge and concurrent high tide led to a record tide level and a storm surge of nearly 8 feet at Fort Pulaski. Wind speeds neared 100 miles per hour, and at least 300 trees were downed across Cockspur Island. At Fort Pulaski, in addition to lost trees and flooding of the landscape, damage included displacement of both of the fort's moat bridges and a majority of the wooden floors and flooding of interior spaces with mud and debris.

The West End bunkers appear to have survived numerous severe storms without damage since their construction. Based on correspondence with the park during preparation of this HSR, effects of storms have primarily included water migration to the interior of the bunkers after heavy wind-driven rain, primarily entering through gaps in the door assemblies. Trees currently present on the site surrounding the bunkers are vulnerable to damage or loss from high winds, which could potentially result in damage to the bunkers. Storm-related flooding could potentially damage the earthen berm that surrounds the bunkers in the long term, although erosion of the berms following severe storms has not been reported by the park to date. The park plans to continue using the south bunker for storage, including protection of park vehicles if a hurricane approaches, and is also interested in using the south bunker for safe shelter during tornadoes if determined to be structurally appropriate. The park also plans to continue using the north bunker for storage of black powder.

In response to Hurricane Matthew and resultant damage and flooding, Fort Pulaski National Monument was closed to the public while the National Park Service conducted extensive repair and clean-up efforts. The park reopened to the public in early November 2016. The park was again closed to the public in May 2017 following the aforementioned tornado, and for a month following Hurricane Irma in September 2017.

Each severe weather event was followed by assessment of damage by park personnel and incident teams, and intensive recovery work to repair damage to built resources, conduct site clean-up, and remove downed trees and branches. The park has also experienced flooding of the site and structures, with increasing periods during which standing water remains on site following a storm event (Figure 162 and Figure 163). Even after the park reopened following Hurricane Irma, potable water was not available, and some amenities such as public restrooms and hiking trails remained unusable due to flooding and other storm-related damage. Standing water remained present in some areas of the park for some time following Hurricane Irma in September 2017.

Figure 162. Aerial view of Fort Pulaski after Hurricane Irma, showing the dike system holding in floodwater. (Source: Fort Pulaski National Monument)

Figure 163. View of the dike south of the fort retaining floodwater after Hurricane Irma (channel is on right in photo). (Source: Fort Pulaski National Monument)

Because loss of historic resource integrity may occur as a result of the impacts of severe storms associated with climate change, documentation and analysis of change over time using data collection are anticipated to be an important part of the response to mitigating anticipated loss or diminishment. Data collected through documentation can also be used as a tool to plan for the impacts associated with climate change. This Historic Structures Report, including the historical narrative, condition assessment, and recommendations, together with photographs and measured drawings, is an example of the type of documentation that is relevant to this purpose. As part of future efforts to build on and update the documentation provided in this Historic Structures Report, the National Park Service is considering such approaches as more detailed documentation resulting from new three-dimensional scanning technology. Monitoring of weather-related deterioration will also support an understanding of what additional protection and repairs may be needed in response to ongoing and specific weather events.

Although documentation and monitoring of existing conditions are important, more immediate and active measures are required at Fort Pulaski National Monument in response to climate change. The 2011 Cultural Landscape Report for Fort Pulaski National Monument recommended preserving all historic landscape features and the historic dike and ditch system, and retaining water to a depth of 18 inches in the ditches.[162] Given the changes that have occurred within the site since the CLR was completed, including what appears to be accelerating evidence of climate change resulting in rising water levels, more frequent and severe storms, and associated flooding and periods of standing water, as well as impacts associated with shipping use of the river channel and related dredging efforts, the park is exploring alternatives for adaptation of the ditch and dike system to protect the site and its resources. As part of this effort, the park engaged a team of cultural landscape and restoration ecology consultants, through a memorandum of agreement between the National Park Service and the University of Georgia, which is working on an integrated management plan designed to help address the issues surrounding flooding and resource protection that will likely entail adaptations to the ditch and dike system.

Prior to implementing any adaptive strategies that may be proposed by the consultant cultural landscape and restoration ecology team, the park is working on cleaning out the ditches and providing a more effective tide gate. Using a survey prepared by the U.S. Army Corps of Engineers, the park is also adding fill to some low-lying areas that have been noted as vulnerable to flooding. The park is also researching previous strategies used to control flooding on the island. Recommendations in the Park archives dating from twenty years ago suggested breaching the outer part of the dike system and allowing it to become salt marsh. The goal of the effort was to enhance views, which had been lost due to tree growth once the National Park Service stopped allowing that area to be flooded. Current work by the University of Georgia consultants suggests that restoration of the salt marsh may serve as the most sustainable approach and an initial line of defense against flooding. Added benefits will include enhanced habitat for wildlife and plants.

The National Oceanic and Atmospheric Administration (NOAA) State Climate Summaries (2022 update) provides new information and

162. Hitchcock, *Cultural Landscape Report*, 122.

extends the historical climate record to 2020 for each state in the United States, as well as Puerto Rico and U.S. Virgin Islands. The summaries address historical climate variations and trends, future climate model projections of climate conditions during the twenty-first century, and past and future conditions of sea level and coastal flooding.[163] The summary for Georgia notes the following key points:

> Temperatures in Georgia have risen by 0.8°F, about half of the warming for the contiguous United States, since the beginning of the 20th century, but the warmest consecutive 5-year interval was 2016–2020. However, under a higher emissions pathway, historically unprecedented warming is projected during this century, including increases in heat wave intensity and decreases in cold wave intensity.
>
> Higher temperatures will increase the rate of soil moisture loss during dry spells, which could lead to more intense droughts and increased competition for the state's water resources.
>
> Global sea level has risen by about 7 to 8 inches since 1900 and is projected to rise another 1 to 4 *feet* [emphasis added] by 2100. Sea level rise will increase the frequency, extent, and severity of coastal flooding, posing a grave risk to developments along Georgia's coastline.[164]

The NOAA State Climate Summary for Georgia notes that sea level rise has caused a gradual increase in tidal floods at Fort Pulaski, with large projected increases extending to tidal flooding occurring nearly every day by the end of the twenty-first century.[165]

The State Climate Summary also notes that thunderstorms are common in the state during the spring and summer, and often bring heavy rains that can cause severe flooding. Tropical storm systems also bring heavy rains and strong winds to the state, even if they do not make landfall along the Georgia coast, as noted above for several major hurricanes.[166] All of the above factors, and in particular sea level rise and more frequent severe storms, will affect Fort Pulaski National Monument.

To address erosion along the north shore of the nearby shipping channel, the U.S. Army Corps of Engineers completed a beneficial dredge project of the channel in October 2015. The spoils from the dredging project were deposited near the shoreline associated with the park rather than the north side of the river as is usually done. This effort was conducted in consultation with the National Park Service Southeast Archeological Center, which oversaw the protection of significant historic features such as the north pier, to create a "berm" that would promote oyster colonization as a stabilization technique. The placement of the dredge spoils offshore in the north channel was intended to restore the underwater topography that helps to dissipate wave action from passing ships (Figure 164). Before the beneficial dredge placement, waves at high tide were lapping over the dike adjacent to the north. Following the project, plantings in the marsh area were coming back behind the deposit, and as of 2019, the new berm had retained about

163. National Oceanic and Atmospheric Administration, *NOAA National Centers for Environmental Information, State Climate Summaries 2022*, "Georgia," accessed August 2023, https://statesummaries.ncics.org/chapter/ga/.
164. National Oceanic and Atmospheric Administration, *NOAA National Centers for Environmental Information, State Climate Summaries 2022*, "Georgia."
165. National Oceanic and Atmospheric Administration, *NOAA National Centers for Environmental Information, State Climate Summaries 2022,* "Georgia," table entitled, "Observed and Projected Annual Number of Tidal Floods for Fort Pulaski, GA"; see also "Technical Details & Additional Information" in the above Georgia State Climate Summary, accessed August 2003, https://statesummaries.ncics.org/technicaldetails/.
166. National Oceanic and Atmospheric Administration, *NOAA National Centers for Environmental Information, State Climate Summaries 2022,* "Georgia."

40 percent of its overall size despite continued passage of ships in the channel. Even if erosion continues to occur, spoils placement can be repeated every few years when the Corps dredges the river. It is hoped that this will become part of a broader solution to addressing the flooding problem and maintaining the shoreline. [167]

Climate change poses challenges and potential disruptions that are only now beginning to be understood and anticipated. It will be necessary to consider and imagine a wide spectrum of possible responses to the threat, which may need to be implemented concurrently and nimbly, with the ability to refine and update regularly as conditions change.

Efforts conducted for Fort Pulaski National Monument will benefit from coordination with other planning and documentation projects to address effects of climate change under consideration or in the process of being implemented by the National Park Service in the Southeast Region. Future severe weather events, rising sea levels, and other impacts related to climate change should be anticipated and considered in planning for protection and maintenance of the site and its resources.

Figure 164. Container ship traveling along the north channel near Fort Pulaski. (Source: Fort Pulaski National Monument)

167. Correspondence by the authors with Superintendent Melissa Memory, Fort Pulaski National Monument, August 2017 and April 2018. Shoreline erosion resulting from large ships traveling along the north channel, already a significant concern, may become more severe in future. Increases in ship traffic are likely if a proposed new port is constructed across the channel from Fort Pulaski.

Left blank intentionally

Bibliography

Narrative Sources

An Act to extend the boundaries of the Fort Pulaski National Monument, Georgia, and for other purposes. Approved June 26, 1936. 49 Stat. 1979.

Cadle, Farris. "Title Abstract for Cockspur Island," 2000. Park files, Fort Pulaski National Monument.

Carr, Ethan. *Mission 66: Modernism and the National Park Dilemma*. Amherst: University of Massachusetts Press, 2007.

City of Savannah Research Library and Municipal Archives. *World War II on the Savannah Waterfront in the American Theater of Operations: Wartime Production and Service in Savannah*, prepared by L. Spracher, August 29, 2008.

Commanding Officer, United States Atlantic Fleet, Anti-Submarine Warfare Unit, Anti-Submarine Warfare Unit, memorandum to the Atlantic Fleet, subject: Anti-Submarine Warfare Bulletin No. 4, enclosures: A) Characteristics of German Submarine, B) Procedure in Salvaging a 500 ton U-Boat, June 24, 1942.

Commander in Chief, United States Atlantic Fleet, memorandum to the Atlantic Fleet, subject: Escort of Convoy Instructions (LuntFit 9A –Change No. 1), December 7, 1942.

Chief of Naval Operations, memorandum to Commanders, Eastern Sea Frontier, Gulf Sea Frontier, Caribbean Sea Frontier, Panama Sea Frontier, subject: Mercantile Atlantic Coastal Routing instruction (MACTRI), March 18, 1942.

Cornelison, John E., Jr. and Lou Groh. *Trip Report on Archeological Testing of the Fort Pulaski (FOPU) Dike System, June 4–6, 1997, SEAC Accession Number 1308.* 1997. Manuscript on file at Southeast Archeological Center, Tallahassee, Florida.

Developed Area Plan, Fort Pulaski National Monument, 1949. Fort Pulaski National Monument Archives, 1949.19-1 FOPU 348/2011.

Echoes from the Past: The Archeology of Fort Pulaski. Tallahassee, Florida: National Park Service, Southeast Archeological Center. Accessed September 9, 2013, http://www.nps.gov/seac/research/fp/fp00010/fp00010.htm.

Erdman, Lt. Cmdr. Robert P., USN. "Navy Pushes Program to Protect Port; Naval Ships Be Built Here." *Savannah Evening Press*, November 19, 1941.

Georgia History. "SS *James Oglethorpe* and the Battle of the Atlantic." Accessed April 2023, https://georgiahistory.com/marker-monday-s-s-james-oglethorpe-and-the-battle-of-the-atlantic/.

Gillmore, Brig. Gen. Quincy A. *Siege and Reduction of Fort Pulaski.* New York: D. Van Nostrand, 1862. Reprinted: Gettysburg, Pennsylvania: Thomas Publications, 1988.

Good, Albert H. *Park and Recreation Structures*. Washington, D.C.: U.S. Department of the Interior, National Park Service, 1938; reprinted New York: Princeton Architectural Press, 1999.

Grimmer, Anne E. *The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings.* Washington, D.C.: U.S. Department of the Interior, National Park Service, Technical Preservation Services, 2017.

Groh, Lou. *Archeological Investigations of Fort Pulaski National Monument, Chatham County, Georgia.* Tallahassee, Florida: National Park Service, Southeast Archeological Center, 1999.

————. *Fort Pulaski National Monument: Archeological Overview and Assessment.* Tallahassee, Florida: National Park Service, Southeast Archeological Center, 2000.

Hitchcock, Susan. *Cockspur Island Historic District, Fort Pulaski National Monument Cultural Landscape Report.* Atlanta, Georgia: National Park Service, Southeast Regional Office, Cultural Resources Division, August 2011.

Holmes, Michael S. *The New Deal in Georgia: An Administrative History.* London: Greenwood Press, 1975.

"Inshore Patrol Base Inactivated." *Savannah Morning News,* June 4, 1944.

Jameson, John. *National Archives Research Final Report, Background for Fort Pulaski General Management Plan.* 1997. Manuscript on file at Southeast Archeological Center, Tallahassee, Florida.

Jones, Tommy H. *Fort Pulaski National Monument Quarantine Attendants' Quarters Historic Structure Report.* Atlanta, Georgia: National Park Service, Southeast Regional Office, Historical Architecture, Cultural Resources Division, March 2004.

Lattimore, Ralston B. *Fort Pulaski National Monument, Georgia.* National Park Service Historical Handbook Series No. 18. Washington, D.C.: National Park Service, 1954, reprinted 1961.

————. *Siege and Surrender of Fort Pulaski.* Fort Pulaski National Monument, 1934.

LeBoy, John C. "Yearly Report for Restoration of Fort Pulaski National Monument," n.d. [1935].

Mackintosh, Barry. *The National Parks: Shaping the System.* Washington, D.C.: U.S. Department of the Interior, 1991.

McIntyre, Anna Louise. "U-Boats on the Horizon: Cockspur Island's Involvement in World War II." A non-Thesis project submitted to the faculty of the Department of History in partial fulfillment of the Degree Master of Arts and the Public History Certificate, Georgia Southern University, Statesboro, Georgia, April 2019.

Meader, J. Faith, New South Associates, and Cameron Binkley, editor, National Park Service. *Fort Pulaski National Monument Administrative History.* Atlanta, Georgia: National Park Service, Southeast Regional Office, Cultural Resources Division, December 2003.

National Park Service. "American World War II Heritage City Program." Accessed April 2023, https://www.nps.gov/subjects/worldwarii/americanheritagecity.htm.

———. *Climate Change Response Strategy.* Washington, D.C.: National Park Service, 2010.

———. *Cultural Landscapes Inventory: Fort Pulaski National Monument Landscape*. Atlanta, Georgia: National Park Service, 2012.

———. *Determination of Eligibility – FOPU World War II Bunker No. 1 (HS-16); Determination of Eligibility – FOPU World War II Bunker No. 2 (HS-15).*

———. *Director's Order No. 28. Cultural Resource Management Guideline.* U.S. Department of the Interior, National Park Service, June 11, 1998.

———. *Draft General Management Plan, Wilderness Study, and Environmental Impact Statement.* Savannah, Georgia: Fort Pulaski National Monument, March 2011.

———. "The Eve of World War II." Accessed April 2023, https://www.nps.gov/fopu/preservation.htm.

———. Fort Pulaski, vicinity of Savannah, Chatham County, Georgia, *Historic American Buildings Survey Documentation, GA- 2158*, 1935–1936, 1992, 1997, and 2002.

———. *Fort Pulaski National Monument, Mission 66 Final Prospectus*, 1956.

———. *Fort Pulaski National Monument, Georgia.* Visitor's guide book. National Park Service, no date [circa 1940s–1950s].

———. "Liberty Ships and Victory Ships, America's Lifeline in War." Accessed April 2023, https://www.nps.gov/articles/liberty-ships-and-victory-ships-america-s-lifeline-in-war-teaching-with-historic-places.htm.

———. *Long Range Interpretive Plan, Fort Pulaski National Monument.* National Park Service, August 2006.

———. *Master Plan for the Preservation and Use of Fort Pulaski National Monument, Mission 66 edition*, September 1961.

———. *Master Plan: Fort Pulaski National Monument.* Georgia: Fort Pulaski National Monument, November 1968, final approval, June 1971.

———. *National Register Bulletin: How to Apply the National Register Criteria for Evaluation*. Washington, D.C.: U.S. Department of the Interior, National Park Service, 1995.

———. *Natural Resources Stewardship and Science Directorate Climate Action Plan.* Washington, D.C.: National Park Service, 2021.

———. *NPS Management Policies.* Washington, D.C.: U.S. Department of the Interior, National Park Service, 2001.

———. *Planning for a Changing Climate: Climate-Smart Planning and Management in the National Park Service.* Washington, D.C.: National Park Service, 2021.

————. Summary of Accomplishments of Civilian Conservation Corps, June 5, 1940. Park files, Fort Pulaski National Monument.

————. Superintendent's Annual Reports, Fort Pulaski National Monument, 1939, 1939, 1940, 1941, 1942.

————. Supplemental Application, Form 10-352, Job No. 135, Hurricane Damage Repairs at Fort Pulaski National Monument, James W. Holland, Superintendent, January 25, 1941.

"Navy Shore Patrol Here to Close July 1," *Savannah Morning News,* June 16, 1946.

Nelson, Lee H., FAIA, *Preservation Brief 17: Architectural Character: Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character.* Washington, D.C.: National Park Service, Technical Preservation Services, 1988.

Panamerican Consultants Inc., with Wiss, Janney, Elstner Associates, Inc. *Fort Pulaski National Monument, Battery Horace Hambright Historic Structure Report*. Prepared for the National Park Service Southeast Region and Fort Pulaski National Monument, 2019.

————. *Fort Pulaski National Monument, Mission 66 Visitor Center Historic Structure Report.* Prepared for the National Park Service Southeast Region and Fort Pulaski National Monument, 2019.

Prentice, Guy. *Trip Report on Site Condition Assessments, Fort Pulaski National Monument, GA, November 28–December 2, 2005.* Tallahassee, Florida: National Park Service, Southeast Archeological Center, 2006.

Rogers, Edmund B., comp. *History of Legislation Relating to the National Park System through the 82nd Congress.* Washington, D.C.: U.S. Department of the Interior, 1958.

Salmond, John A. *The Civilian Conservation Corps, 1933–1942: A New Deal Case Study*. Durham, North Carolina: Duke University Press, 1967.

"Seacoast Fortification - Endicott System," n.p.

Schiller, Herbert M. *Sumter is Avenged! The Siege & Reduction of Fort Pulaski.* Shippensburg, Pennsylvania: White Mane Publishing, 1995.

Smith, Gordon B. "Volunteers for Victory: The Savannah-Chatham County Area in World War II." Savannah, Georgia.

Snell, Charles W. *Battery Horace Hambright, Historic Structure Report, Historical Data Section, Fort Pulaski National Monument, Georgia (Draft).* Denver, Colorado: National Park Service, Denver Service Center, 1977.

Taylor, Oliver G. *Final Report on Repairs to Fort and Adaption of Certain Space for Museum and Exhibition Purposes, Fort Pulaski National Monument, Savannah, Georgia, F.P. 545-A.* National Park Service, October 6, 1936.

To declare historic landmarks on military reservations as national monuments. Proclamation No. 1713, October 15, 1924, 43 Stat. 1968.

Trout, Edward L., Park Historian. *National Register of Historic Places Nomination Form: Fort Pulaski National Monument*. Savannah Beach, Georgia: Fort Pulaski National Monument, December 11, 1974. Received by the National Register, December 9, 1975.

University of Georgia, Georgia Sea Grant. "Sea Level Rise in Georgia." Accessed 2016, http://georgiaseagrant.uga.edu/article/sea_level_rise_in_georgia/

U.S. Department of State, Office of the Historian. "Lend-Lease and Military Aid to the Allies in the Early Years of World War II." Accessed April 2023, https://history.state.gov/milestones/1937-1945/lend-lease

————. "The Neutrality Acts, 1930s." Accessed August 2023, https://history.state.gov/milestones/1921-1936/neutrality-acts#:~:text=After%20a%20fierce%20debate%20in,transporting%20goods%20to%20belligerent%20port.

U.S. Navy, Section Base, Savannah, GA., Area, Inshore Patrol, Sixth Naval District, Savannah, Ga. *War Diary*, June 8, 1942; June 14, 1942; June 17, 1942; June 19, 1942; June 20, 1942; June 21, 1942; June 28, 1942; July 13, 1942; July 17, 1942; August 3, 1942; August 12, 1942; August 16, 1942.

Vanzo, John. "U-boat Attacks during World War II." *New Georgia Encyclopedia*, last modified May 9, 2019. Accessed April 2023, https://www.georgiaencyclopedia.org/articles/history-archaeology/u-boat-attacks-during-world-war-ii/.

Wiss, Janney, Elstner Associates, Inc., *Fort Pulaski National Monument, Fort Pulaski Historic Structure Report*, 2014.

Young, Rogers W. *The Arming of Fort Pulaski, 1828–1861.* National Park Service, 1935.

————. "The Construction of Fort Pulaski," *The Georgia Historical Quarterly* 20 (1936), 41–51.

Documents at Fort Pulaski National Monument Archives

A Summary of Work Accomplishments of the Civilian Conservation Corps at Fort Pulaski National Monument, Savannah, Georgia: May 10, 1934–June 5, 1940. Prepared by National Park Service, Fort Pulaski National Monument, June 5, 1940.

Completion Report of Construction Project, Restore Demilune and Battery Hambright. November 20, 1960.

Completion Report of Construction Project, Repairs to Brickwork, Fort Pulaski, first portion. November 20, 1960.

Completion Report of Construction Project, Repairs to Brickwork, Fort Pulaski, second portion. July 14, 1961.

Completion Report of Construction Project, Grade Reseed, and Fertilize Grass, Terreplein, Glacis, etc. July 22, 1961.

McBurney, J. W. "Report on Fort Pulaski." July 15, 1958.

National Park Service. "Fort Pulaski National Monument. Cockspur Island during WWII, site bulletin," n.d.

Superintendent's Annual Report, Fort Pulaski National Monument. Fiscal Year Ending June 30, 1936.

Superintendent's Annual Report, Fort Pulaski National Monument. Fiscal Year Ending June 30, 1937.

Superintendent's Annual Report, Fort Pulaski National Monument. Fiscal Year Ending June 30, 1938.

Superintendent's Annual Report, Fort Pulaski National Monument. Fiscal Year Ending June 30, 1939.

Superintendent's correspondence, 1947–1966.

Supplemental Application, Form 10-352, Job No. 135, Hurricane Damage Repairs, Cleanup, and Obliteration at Fort Pulaski National Monument, James W. Holland, Superintendent, January 25, 1941.

Documents at National Archives, Atlanta, Georgia

Memorandum from G.S. Burrell, District Public Works Officer to the Chief of the Bureau of Public Yards and Docks, January 28, 1943, Box 5, Folder 3, ID 1419, National Archives, Atlanta, Georgia.

Memorandum from J.C. Hilliard, Commandant, Sixth Naval District, to the Chief of the Bureau of Ordnance, March 23, 1943, Box 5, Folder 3, National Archives, Atlanta, Georgia.

Memorandum from G.S. Burrell, District Public Works Officer to the Chief of the Bureau of Public Yards and Docks, January 28, 1943. Record Group 181, 6th Naval Division Formerly Classified General Correspondence, 1940–1944, Box 5, Folder 3, ID 1419.

Documents at National Archives, College Park, Maryland

"Fort Pulaski 618-613-02." Press Release, January 23, 1934, Record Group 79, Folder 618.

Holland, James W., Superintendent, Fort Pulaski National Monument, Memorandum to the Director, June 19, 1941. National Archives at College Park, College Park, Maryland, Record Group 79, Box 2205, Folder 501.

_____. Superintendent, Fort Pulaski National Monument, Superintendent's Monthly Report, January 31, 1942. Memorandum for the Director, through Coordinating Superintendent C. R. Vinten, Southeastern National Monuments.

Documents at National Archives, Philadelphia, Pennsylvania

Byrd, J. K., Disbursing Liaison Officer, Sixth Naval District, confidential memo to Chief of Field Branch, Bureau of Supplies and Accounts, Cleveland, Ohio, subject: U.S. Naval Section Base, Savannah, Georgia, decommissioning of, June 2, 1944.

CG PERSEPCEN No. 6, Cockspur Island, Savannah, Georgia, "List of Buildings by Number," January 9, 1948.

Emerson, Ralph W., Regional Landscape Architect, United States Department of the Interior, National Park Service, Region One, Richmond, Virginia, "Memorandum for the Regional Director," June 18, 1946.

Farber, W. S., Vice Chief of Naval Operations, Navy Department, Washington, D.C., confidential memo to the Commander, Eastern Sea Frontier, subject: Section Bases in the United States – Abandonment or consolidation with other activities, June 12, 1943.

Farber, W. S., Sub-Chief of Naval Operations, Navy Department, Washington, D.C., secret memo to ComSix, subject: U.S. Naval Section Base, Savannah, Georgia, closing of, May 29, 1944.

"Fort Pulaski National Monument, Naval Buildings Erected Under War-Use Permit, Photos – June 1944."

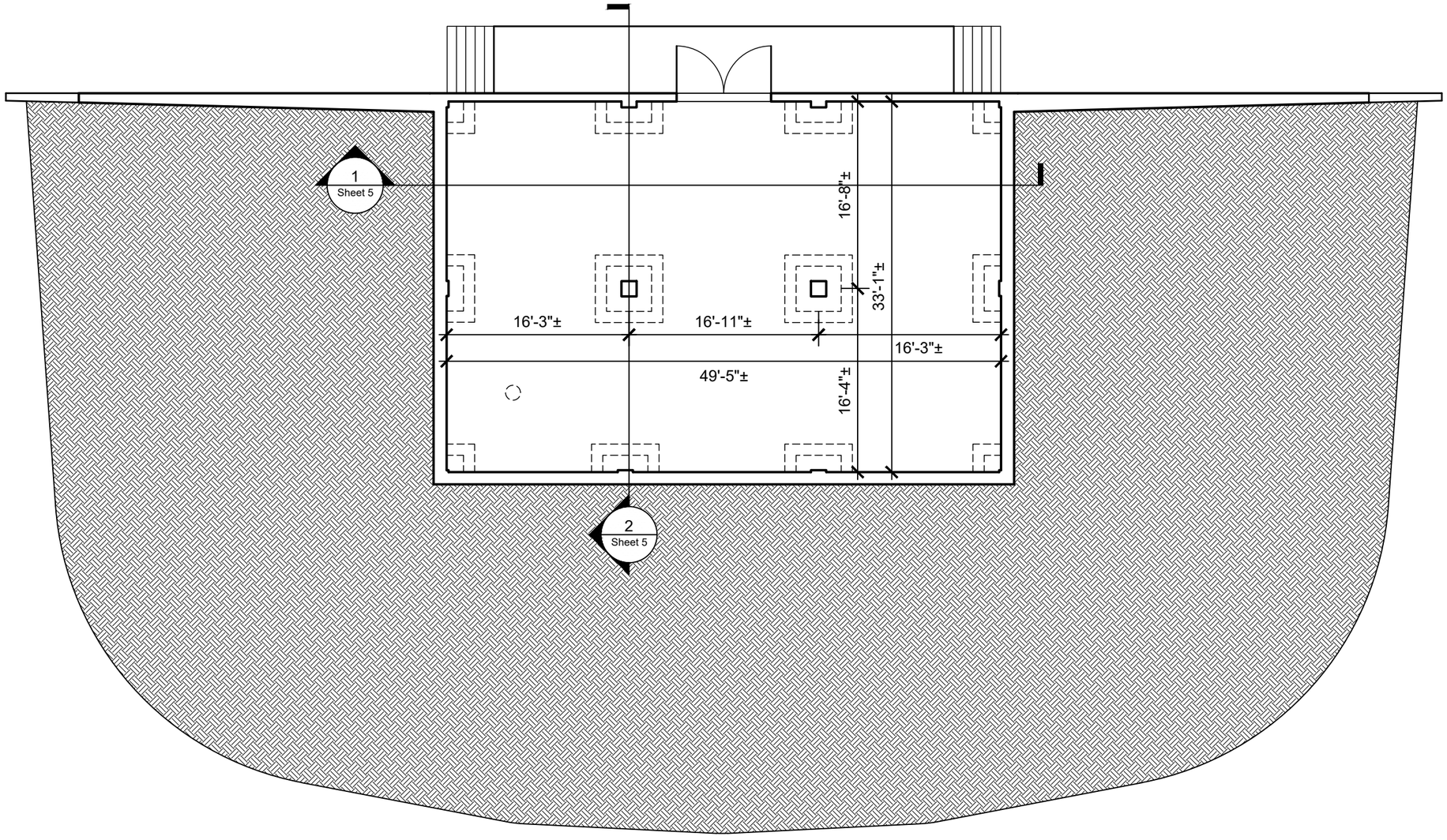
U.S. Department of the Interior, National Park Service. "Developed Areas, Part of the Master Plan for Fort Pulaski National Monument, 1939, annotated as of January 1, 1943."

United States Department of the Interior. "Special Use Permit Authorizing Use of Land in the Fort Pulaski National Monument, Georgia, by the Navy Department for National Defense Purposes," November 17, 1941.

United States Navy, Office of Commandant, Sixth Naval District, Charleston, South Carolina. *Specifications for Restoration of Fort Pulaski National Monument, Cockspur Island, Georgia*, September 1946.

Left blank intentionally

Appendix A: Measured Drawings



1 South Bunker Floor Plan
Scale: 3/32" = 1'-0"

N

DRAWN BY: WISS, JANNEY, ELSTNER ASSOCIATES, INC., AUGUST 2023

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR
SOUTHEAST REGIONAL OFFICE

WEST END BUNKERS

FORT PULASKI NATIONAL MONUMENT

SAVANNAH, GEORGIA

HISTORIC STRUCTURES REPORT

SHEET 1 OF 6

1 South Bunker Roof Plan
Scale: 3/32" = 1'-0"
N

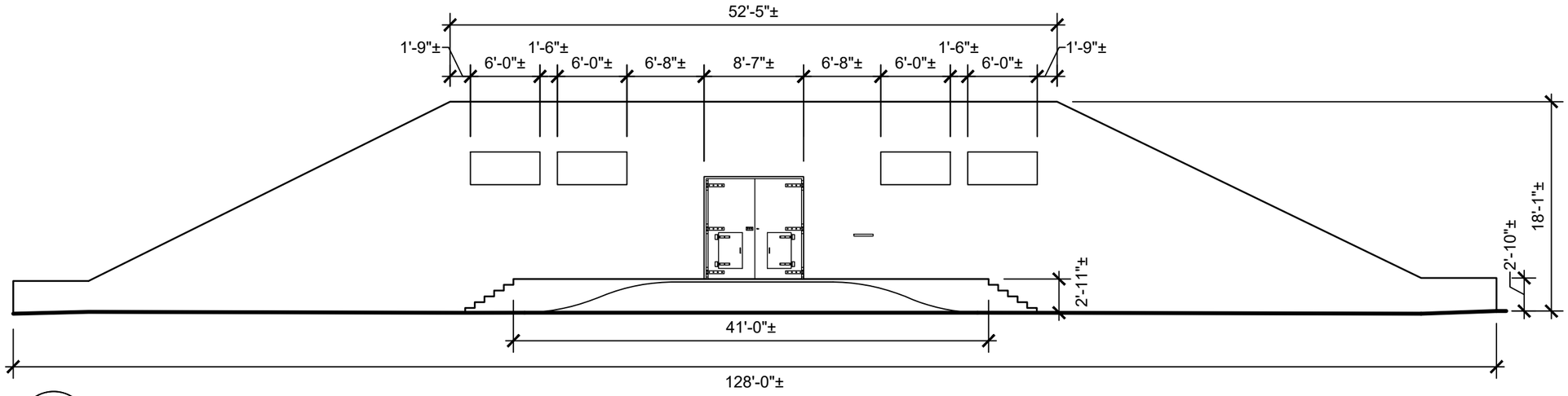
DRAWN BY: WISS, JANNEY, ELSTNER ASSOCIATES, INC., AUGUST 2023

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR
SOUTHEAST REGIONAL OFFICE

WEST END BUNKERS
FORT PULASKI NATIONAL MONUMENT
SAVANNAH, GEORGIA

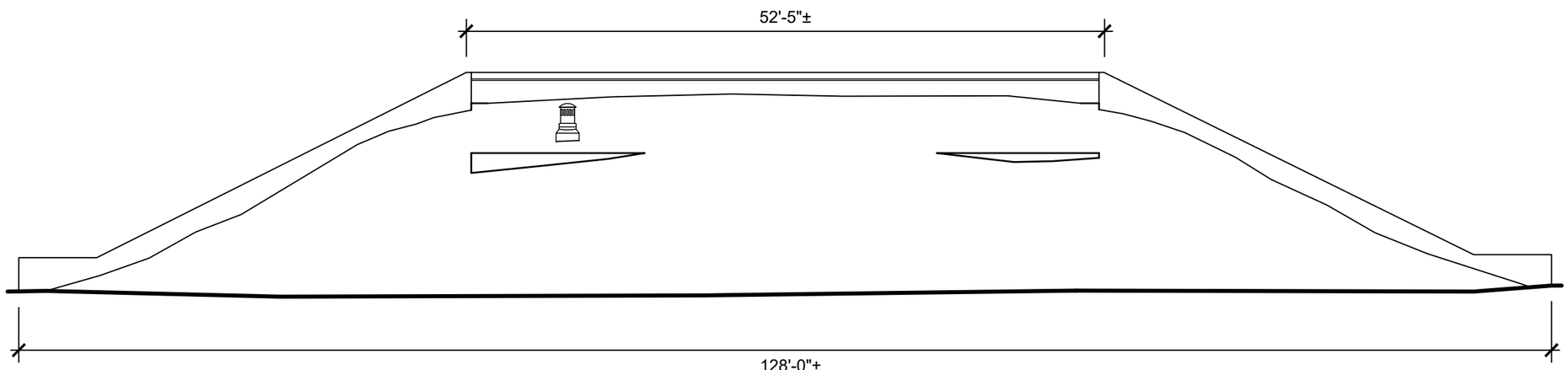
HISTORIC STRUCTURES REPORT

SHEET 2 OF 6



1 South Bunker North Elevation

Scale: 3/32" = 1'-0"



2 South Bunker South Elevation

Scale: 3/32" = 1'-0"

SHEET 3 OF 6

HISTORIC STRUCTURES REPORT

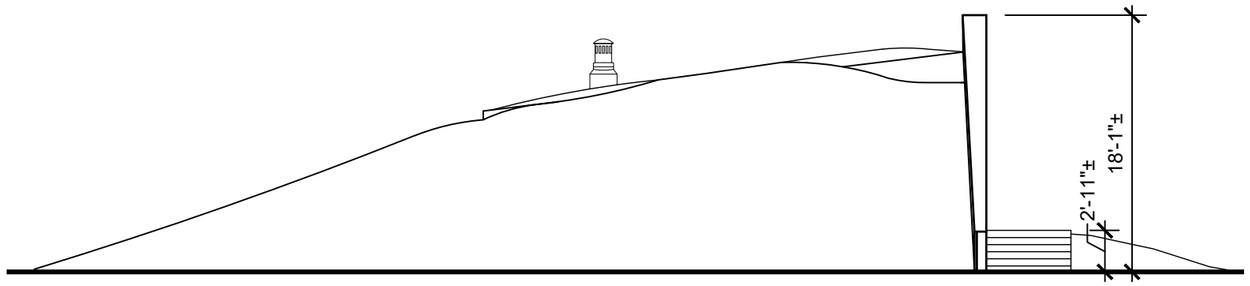
SAVANNAH, GEORGIA

WEST END BUNKERS

FORT PULASKI NATIONAL MONUMENT

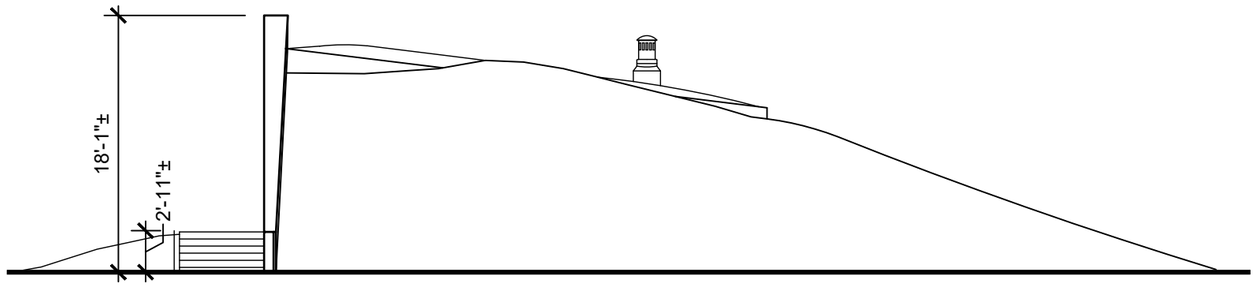
NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR
SOUTHEAST REGIONAL OFFICE

DRAWN BY:: WISS, JANNEY, ELSTNER ASSOCIATES, INC., AUGUST 2023



1 South Bunker East Elevation

Scale: 3/32" = 1'-0"



2 South Bunker West Elevation

Scale: 3/32" = 1'-0"

DRAWN BY: WISS, JANNEY, ELSTNER ASSOCIATES, INC., AUGUST 2023

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR
SOUTHEAST REGIONAL OFFICE

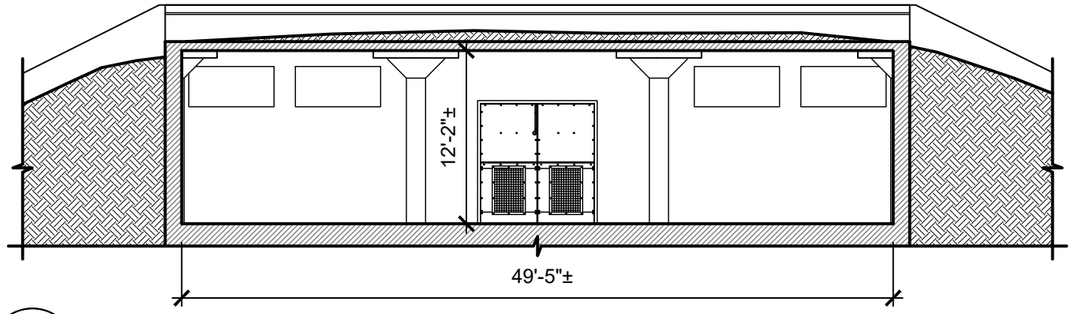
WEST END BUNKERS

FORT PULASKI NATIONAL MONUMENT

SAVANNAH, GEORGIA

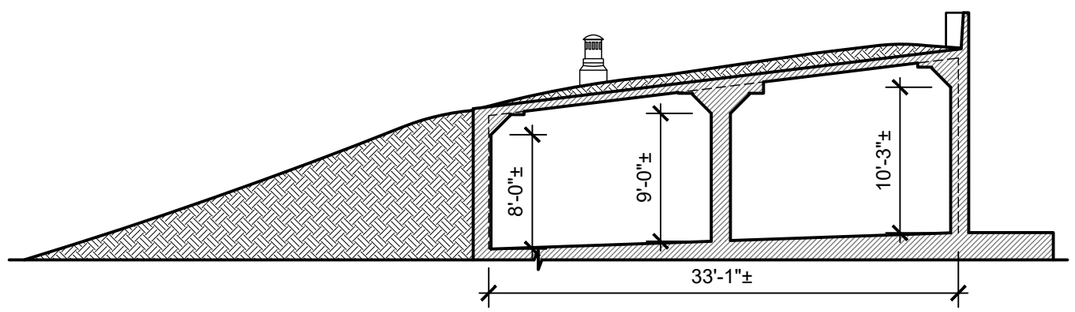
HISTORIC STRUCTURES REPORT

SHEET 4 OF 6



1 East-West Section

Scale: 3/16" = 1'-0"



2 North-South Section

Scale: 3/16" = 1'-0"

DRAWN BY:: WISS, JANNEY, ELSTNER ASSOCIATES, INC., AUGUST 2023

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR
SOUTHEAST REGIONAL OFFICE

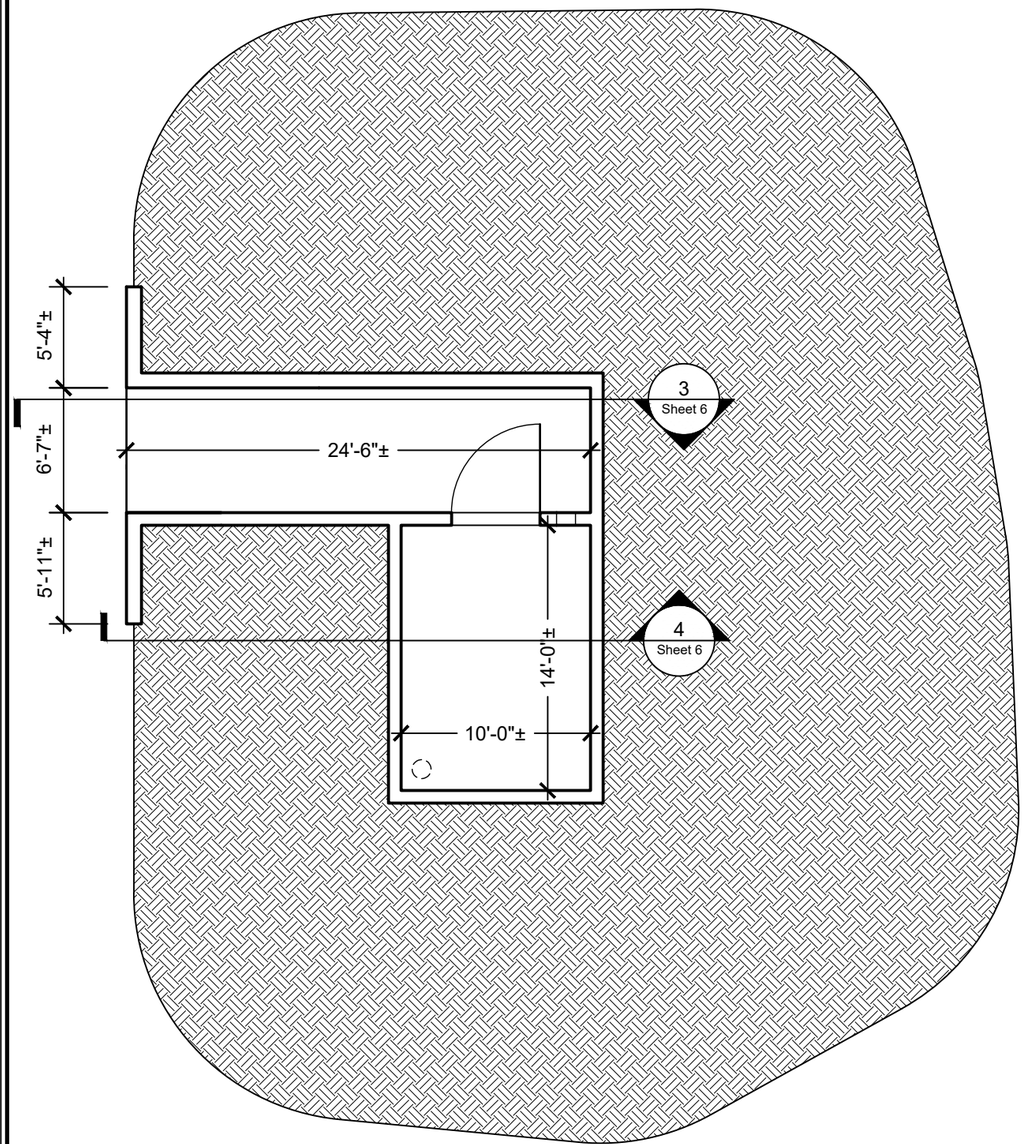
WEST END BUNKERS

FORT PULASKI NATIONAL MONUMENT

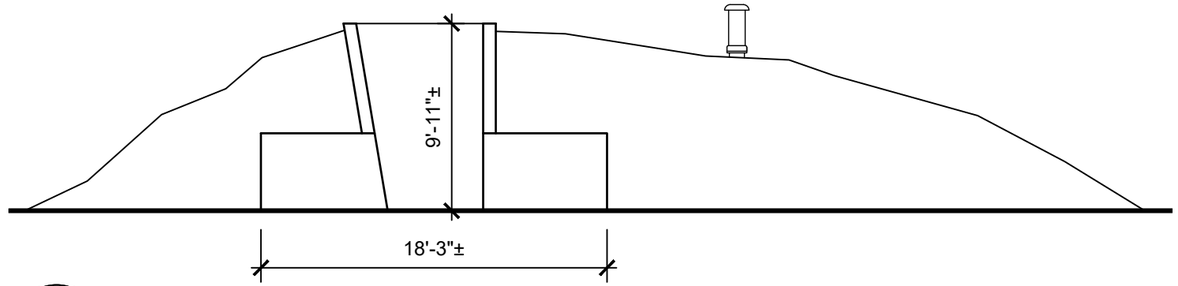
SAVANNAH, GEORGIA

HISTORIC STRUCTURES REPORT

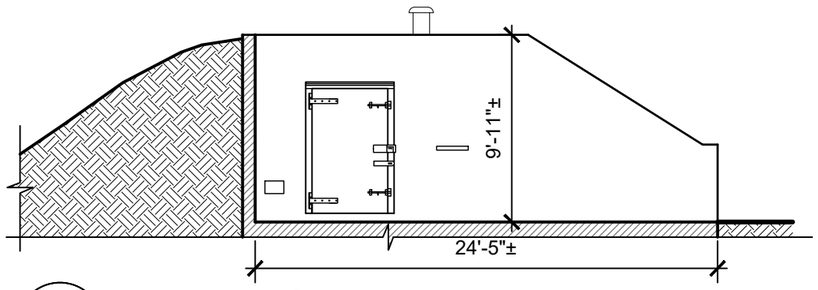
SHEET 5 OF 6



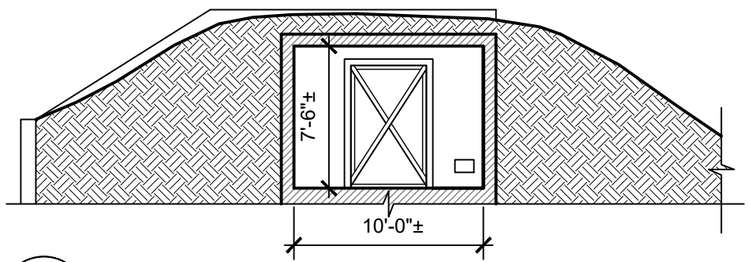
1 North Bunker Plan
Scale: 1/8" = 1'-0"
N



2 North Bunker West Elevation
Scale: 3/32" = 1'-0"



3 East - West Section Exterior
Scale: 1/4" = 1'-0"



4 East West Section Interior
Scale: 1/4" = 1'-0"

DRAWN BY: WISS, JANNEY, ELSTNER ASSOCIATES, INC., AUGUST 2023

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR
SOUTHEAST REGIONAL OFFICE

FORT PULASKI NATIONAL MONUMENT

WEST END BUNKERS

SAVANNAH, GEORGIA

HISTORIC STRUCTURES REPORT

SHEET 6 OF 6

Appendix B: Structural Analysis

Structural Analysis

Introduction and Background

On the west end of Cockspur Island, Georgia, two World War II-era bunkers (the West End bunkers) were constructed in 1943 at the present-day terminus of Cockspur Island Road. The north bunker (World War II Bunker No. 1, HS-16) and the south bunker (World War II Bunker No. 2, HS-15) are both concrete framed and covered with earthen berm and low growth vegetation. The south bunker was originally used for munitions storage and today is used for general storage. The north bunker is used for storage of munitions (black powder) used in park demonstrations. Figure 1 shows the overall site plan.

As part of work performed for the Historic Structures Report (HSR) to which this report is an appendix, Wiss, Janney, Elstner Associates, Inc. (WJE) collected field measurements, conducted limited non-destructive evaluation, and completed inspection openings, with assistance from NPS representatives, to review the structural condition of limited components. Material studies and structural analysis of representative structural elements were also performed by WJE. The purpose of the structural assessment discussed below is to provide the National Park Service with information regarding the structural characteristics of the bunkers, in support of recommendations developed for this HSR and for reference by the park in planning for continuing use of the structures.

Based on information provided by the park, the bunkers will not be undergoing a change of occupancy and no repair or alteration of the structural framing is intended at this time. Therefore, the current governing Georgia building code for existing buildings, IEBC 2018 with Georgia State amendments, does not apply to the evaluation work conducted in this investigation.

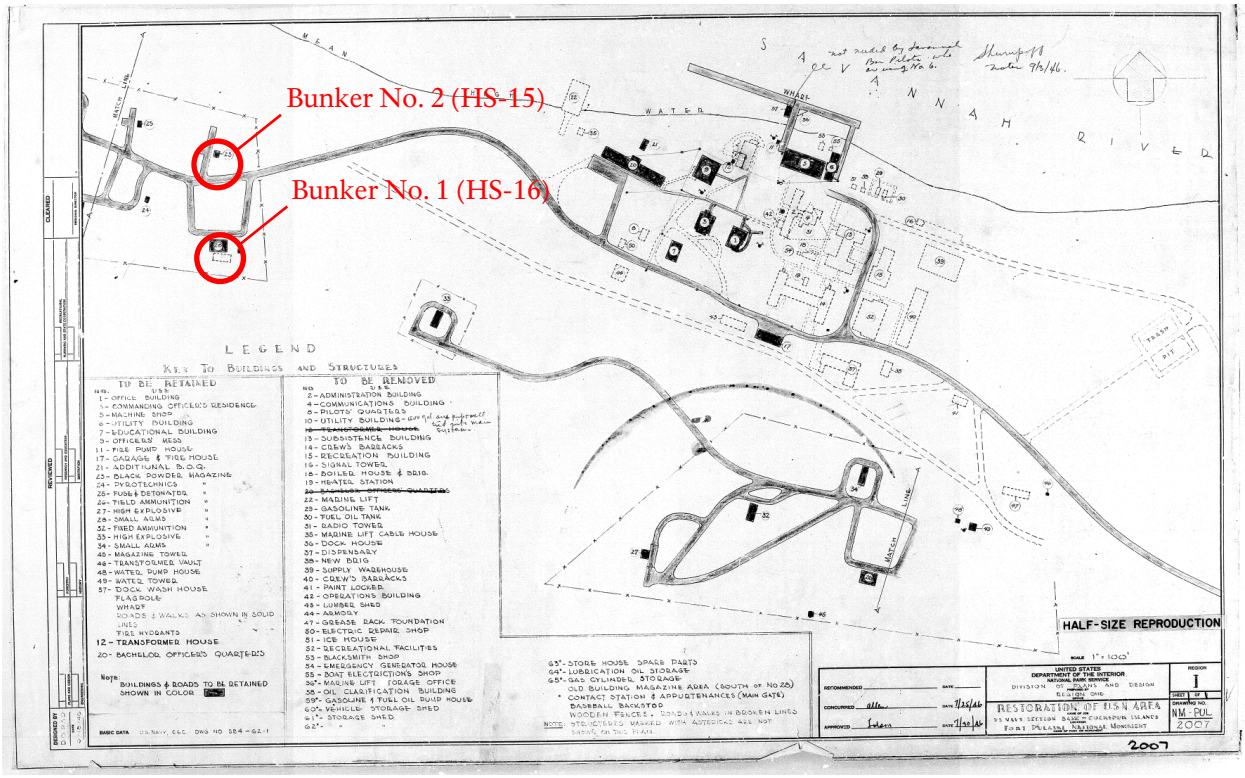


Figure 1. Overall site plan. (Source: Fort Pulaski National Monument, annotated by the authors)

Description of Structures

North Bunker

The north bunker is located north of the service road and consists of a single room, approximately 14 feet long by 9 feet 8 inches wide by 15 feet high. The north bunker roof is an approximately 18-inch-thick concrete one-way slab that bears on 18-inch-thick perimeter walls. The perimeter walls act as both the vertical structural support and basement walls retaining the soil berms covering the bunker. The entrance to the bunker is covered by a 48-inch-wide by 79-inch-tall steel door on the north side and is accessed through a 5-foot-wide, 9-foot-10-inch-deep trench formed with concrete retaining walls on each side.

South Bunker

The second bunker is located south of the service road. The bunker entrance, consisting of steel framed double doors, is located on the north face of the structure, centered in an exposed trapezoidal concrete wall. The steel doors consist of a built-up steel frame with sheet metal exterior and concealed steel framing elements. The sloped wings of the trapezoidal wall are retaining walls for the soil embankments that serve as the soil cover of the structure.

The gravity framing of the structure is laid out on a four-by-three grid, with two 17-foot-3-inch-wide bays in the north-south direction and three 17-foot-wide bays in the east-west direction. Two interior columns, each 16-1/4 inches square, are located at the two interior grid points. The perimeter of the structure is formed by concrete walls with pilasters aligned to grid points, with four equally spaced pilasters on the north and south walls and three equally spaced pilasters on the east and west walls. The basement walls on the east, west, and south of the bunker are approximately 16 inches thick and the roof slab is approximately 7-1/2 inches thick. The north wall was measured to be 10 inches thick.

The roof of the structure is a two-way concrete slab supported on the perimeter basement retaining walls and two interior columns. The roof slopes from the north side of the structure to the south. Six-foot-wide square drop panels are provided at each column and pilaster. Drop panels are formed with a level soffit, while the roof slab is sloped, so the drop panel depth varies from a minimum 3-1/2 inches at the south end to 8 inches thick at the north end, as a result of the sloping roof slab. Columns and pilasters are formed with tapered column capitals, measuring 4 feet square at the top and tapering at a 1:1 slope down to the square column face.

Condition Assessment

A visual condition assessment was conducted for both bunkers. Findings of the assessment are provided in the Physical Description and Condition Assessment chapter of the Historic Structures Report.

Non-destructive Evaluation

To evaluate the depth, spacing, and orientation of embedded steel reinforcement, WJE utilized the ground-penetrating radar (GPR) test method. GPR surveys performed on concrete structures allow for the detection of embedded objects, material interfaces, and assessment of some internal flaws. The testing method involves the use of a dipole radar antenna that transmits electromagnetic wave pulses along discrete scans from the surface of the structural element. The electromagnetic waves propagate through the material and reflect at material interfaces characterized by a change in dielectric properties. The reflected waves are collected by the antenna and are amplified, filtered, and displayed for subsequent interpretation. For this investigation, a Sir-4000 GPR control unit and a 2000 MHz frequency palm antenna, as well as a 2600 MHz StructureScan Mini GPR system, all manufactured by Geophysical Survey Systems, Inc., were used to assess the concrete structure.

North Bunker Scans

Due to the complete earth covering of the bunker structure, no scans could be taken for the top-side rebar in the roof slab, or the soil-side face of the basement retaining walls, or the exterior cantilever retaining walls. No data was collected for rebar

layout on the soil-facing wall surfaces and the soil-facing roof slab surface.

Underside of Roof Slab

Scans of the roof slab soffit showed a mat of bottom reinforcement with a bottom layer of reinforcement oriented in the north-south direction (the long direction) spaced at 12 inches on center on average, and a top layer of reinforcement oriented in the east-west direction (the short direction) spaced at 12 inches on center on average.

Basement Walls

Scans of the interior faces of the bunker basement retaining walls, or perimeter walls, found vertical reinforcement spaced at 12 inches on center on average, and horizontal reinforcement spaced at 12 inches on center on average.

Exterior Cantilever Retaining Walls

Scans of the inside face reinforcing showed horizontal bars spaced at 12 inches on center on average, and vertical bars spaced at 4 inches on center on average.

South Bunker Scans

Due to the earth covering, scans could not be conducted on the soil-facing surface of the retaining wall elements. Additionally, access was limited on the topside of the roof slab to a region in the southwest bay of the structure where the soil topping was missing, and an approximately 4-foot-wide square excavation located above the westernmost interior column.

Topside and Underside of Roof Slab

Scans of the roof soffit were performed in the middle of the northwest bay, the column strip west of the westernmost column, and the column strip south of the westernmost column. In the column strip zone, scans showed bottom reinforcement spaced at 5 inches on center, running parallel to the span direction. In the middle of the bay, scans showed bars set at 5 inches on center, placed in both primary directions.

Scans of the top of slab were limited to two locations. Scans in the top of slab above the westernmost column revealed continuous slab reinforcement spaced at 6 inches on center in both primary directions. Scans in the southwest bay showed bars spanning in the north-south direction at 6 inch spacing. Other intersecting bars were observed, but a regular spacing could not be determined with GPR. Inspection openings later revealed the intersecting bars were set on a diagonal from the north-south bars.

Columns

Scans of the two interior columns showed vertical reinforcing bars located at all four corners of the column and horizontal ties are spaced at 8 inches on center. Scans of the column capitals and drop panels showed no additional reinforcement in these elements.

Basement Walls

Scans were conducted at the south end of the west basement wall. Scans revealed the vertical reinforcement spaced at 10 inches on center with a 1 inch interior cover and horizontal reinforcement spaced at 3 inches on center with a 2 inch cover.

North Wall

Scans were conducted at the center length of the north wall and revealed that vertical and horizontal reinforcement was spaced at 10 inches on center and placed at mid-depth of the wall.

Pilasters

Scans of pilasters found no additional reinforcement placed in the pilasters. Scans revealed that vertical and horizontal reinforcement matched the layout of adjacent wall vertical and horizontal reinforcement, with the cover over the reinforcement higher in the pilasters by an amount corresponding to the thickness of the pilaster protrusion from the main wall surface. Thus, the reinforcement visible in scans is the wall reinforcement, and no additional vertical rebar or ties were used in the pilasters.

Floor Slab

Scans on the floor slab indicated one layer of reinforcement in each orthogonal direction. In the north–south direction, reinforcement spacing was 4 inches on center with a 3 inch cover. In the east/west direction, reinforcement spacing ranged from 3 to 4 inches on center with 2-3/4 inch cover. Measurement of the total depth of the floor slab was inconclusive from the GPR scans.

Inspection Openings

A total of seven inspection openings were made by the park staff while WJE was on site, to allow WJE to observe the condition and size of slab reinforcement. Inspection openings were approximately 3 inches by 6 inches and sufficiently deep to collect measurements of the near surface reinforcing bars, approximately 3 to 5 inches. The location and label of inspection openings are outlined in Figure 2 for the north bunker and Figure 6 for the south bunker.

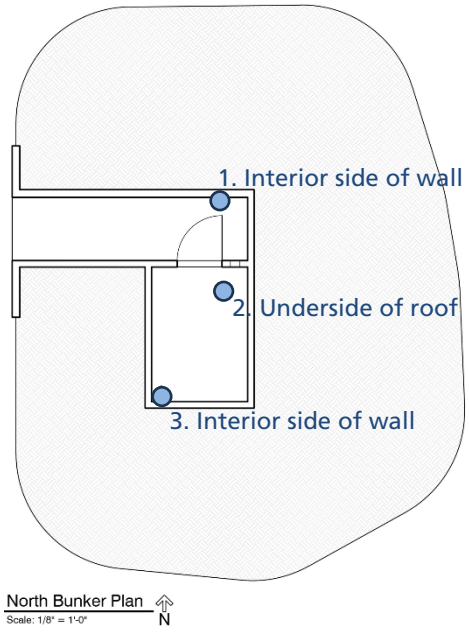


Figure 2. North bunker inspection opening plan.

North Bunker Inspection Openings

Exterior Retaining Wall (Inspection Opening No. 1)

An inspection opening was made at the inside face near the bottom of the north external cantilevered retaining wall (Figure 3). This opening was located to observe vertical and horizontal reinforcement in the inside face of the wall. Both vertical and horizontal reinforcement were observed to be 3/8-inch-diameter smooth uncoated reinforcing bars. Vertical bars were observed to have 2 inch clear cover and horizontal bars were observed to have 2-1/2 inch clear cover. The embedded reinforcement appeared to be in good condition with no surface corrosion.

Figure 3. North bunker exterior retaining wall inspection opening.

Roof Slab (Inspection Opening No. 2)

An inspection opening was cut in the soffit of the roof slab in the north bunker to observe the bottom reinforcement of the slab (Figure 4). Reinforcement in the north-south orientation was observed to be 3/8-inch-diameter smooth uncoated reinforcing bars with 2-1/4 inch clear cover. Reinforcement in the east-west orientation was observed to be 1/2-inch-diameter uncoated reinforcing bars with 2-3/4 inch clear cover. The embedded reinforcement appeared to be in good condition with no surface corrosion.

Wall Slab (Inspection Opening No. 3)

An inspection opening was cut in the inside face of the south basement retaining wall (Figure 5). Both vertical and horizontal reinforcement were observed to be 3/8-inch-diameter smooth

uncoated reinforcing bars. Vertical bars were observed to have 1-3/4 inch clear cover and horizontal bars were observed to have 2 inch clear cover. The embedded reinforcement appeared to be in good condition with no surface corrosion.

Figure 4. North bunker roof slab soffit inspection opening.

Figure 5. North bunker basement wall inspection opening.

South Bunker Inspection Openings

Underside of Roof Slab (Inspection Opening No. 4)

An inspection opening was cut in the soffit of the roof slab just south of the drop panel of the westernmost interior column (Figure 7). The inspection opening was located to observe the bottom reinforcement spanning in the north-south direction. These bottom reinforcing bars were observed to be 1/2-inch-diameter smooth uncoated reinforcing bars with 1-3/4 inch clear cover. The embedded reinforcement appeared to be in good condition with no surface corrosion.

Topside of Roof Slab (Inspection Opening No. 5)

An inspection opening was cut in the topside of the roof slab in the southwest bay of the structure (Figure 8). This opening was located to expose reinforcing in the top of slab. Bars spanning in the north-south direction were observed to be 5/8-inch-diameter smooth uncoated bars with one inch clear cover. Additional 1/2-inch-diameter smooth uncoated reinforcing bars were observed placed on the diagonal of the grid orientation with 1/2 inch clear cover. The embedded reinforcement appeared to be in good condition with no surface corrosion.

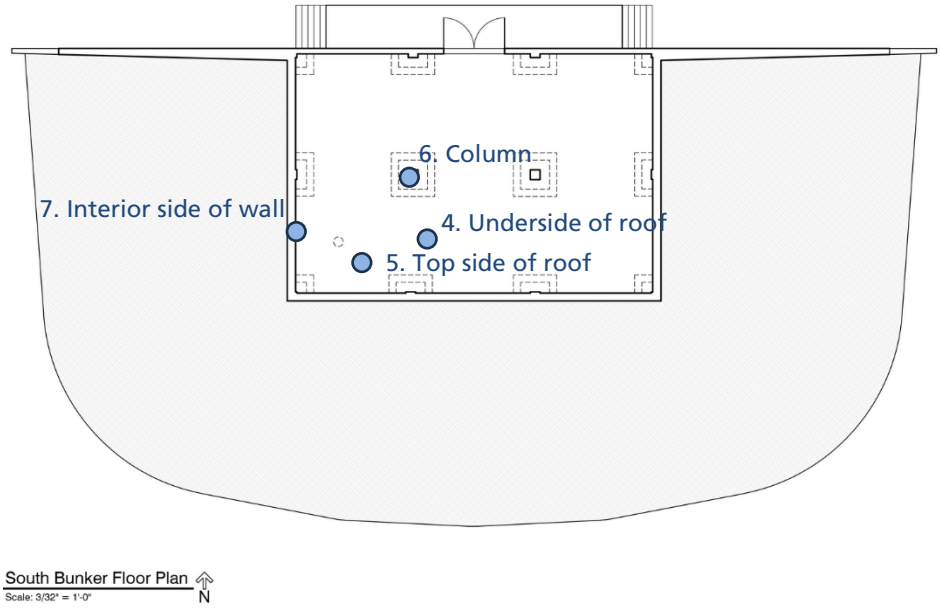


Figure 6. South bunker inspection opening plan.

Figure 7. South bunker roof slab soffit inspection opening

Figure 8. South bunker roof slab top side inspection opening.

Column (Inspection Opening No. 6)

An inspection opening was cut in the southwestern corner of the westernmost interior column (Figure 9). The inspection opening was located to expose the vertical reinforcement and column ties. Vertical reinforcement was observed

to be 7/8-inch-diameter smooth uncoated reinforcing bars with a minimum clear cover of 2-1/4 inches and ties were observed to be 1/4-inch-diameter uncoated smooth reinforcing wire with a minimum clear cover of 1-1/2 inches. The embedded reinforcement appeared to be in good condition with no surface corrosion.

Basement Retaining Wall (Inspection Opening No. 7)

An inspection opening was cut in the inside face of the western basement wall of the south bunker (Figure 10). This inspection opening was located to observe the inside face vertical and horizontal reinforcement. Vertical reinforcement was observed to be 1/2-inch-diameter smooth uncoated steel reinforcing bars with 1-1/4 inch clear cover. Horizontal reinforcement was observed to be 5/8-inch-diameter smooth uncoated steel reinforcing bars with 2-1/4 inch clear cover. The embedded reinforcement appeared to be in good condition with no surface corrosion.

Figure 9. South bunker column inspection opening.

Figure 10. South bunker basement wall inspection opening.

Preliminary Structural Analysis

Section strength and slab deflections were evaluated for minimum loadings, load combinations, and strength reduction factors per the requirements of the current governing code, the 2020 Georgia state minimum building code based on the 2018 IBC with Georgia state amendments. Due to the limitations of the assessment, the effective strength has been evaluated with the observed as-built reinforcement.

Due to previous weather conditions and potential for future use of the south bunker as a tornado shelter, components of the south bunker were assessed for tornado wind loading using the American Society of Civil Engineers *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, 2022 edition (ASCE 7-22). This standard has not yet been adopted by the state of Georgia but was referenced in the analysis due to the newly published tornado wind loading provisions.

Tornado shelter provisions differ from typical building code requirements as there are more stringent requirements and higher magnitude loading for tornado shelters. As we understand that the official occupancy of the bunkers is not currently undergoing a change, the tornado loads were assessed using the building code for typical structures and not as an official tornado shelter. If the structures are to change occupancy to a storm shelter, further analysis can be completed to determine whether those requirements are met.

Assumptions

Assumed material properties and reinforcement detailing were used for portions of the analysis due to the limited scope of the assessment. Assumptions are both inferred from observed conditions and based on commonly available construction materials contemporary with the building's construction. The following list of assumptions have been made.

Loading

- The structure is not assumed to be watertight or to act as a flood barrier. The building interior is assumed to flood concurrently with the exterior, so no net flood load for the walls is considered.
- The rooftop structure of both bunkers is evaluated for the following area loads:
  - Reducible live load of 20 pounds per square foot (psf), for a vegetated roof.
  - Unreducible live load of 70 psf for a total of 7 inches of saturated soil surcharge.
  - Superimposed dead load of 5 psf for waterproofing and mechanical attachments.
  - Dead load of the actual weight of structural framing elements is based on geometry and assumed concrete density.
- No geotechnical work was conducted as part of this investigation. The following soil values were assumed for analysis:
  - No soil cohesion.
  - Internal friction angle, Ø=30 degrees.
  - Saturated soil density γ=120 pcf.
  - Rankine active soil pressure coefficient Ka=0.33.

Geometry

- Footings could not be observed or inspected due to limited access. For the purposes of this analysis the following assumptions are made:
  - Column footings have sufficient width, breadth, thickness, and reinforcement to resist gravity loads applied.
  - Column footings do not resist significant overturning moments.
  - Top of column footings are 18 inches below finished floor elevation.
  - Wall footings have sufficient width, thickness, and reinforcement to resist axial loads applied from the structure and soil above.
  - Wall footings do not resist significant overturning moments.
- Wall thicknesses for retaining walls could not be directly measured due to limited access. Approximate thicknesses were determined based on differences in the exterior and interior building dimensions.
- Roof slab thicknesses could not be directly measured. Indirect measurements were used to achieve an approximate thickness.

Concrete

- Concrete is normal weight, with a density of 150 pounds per cubic foot (pcf), reinforced.
- Concrete is assumed to have a compressive strength of 3,000 pounds per square inch (psi).

Reinforcement

- Steel reinforcement yield strength is assumed to be 33,000 psi, the lowest commonly available reinforcing bar strength in the 1940s.
- Reinforcing bar modulus of elasticity was assumed to be 29,000,000 psi.
- The vertical reinforcing bar size in the north wall of the south bunker is the same as that in the west basement wall.

- Due to limited sizes of inspection openings, reinforcement lap splices and anchorages could not be observed.
  - Interior elevated slab bar lap splices are assumed to achieve a complete lap splice with full bar development.
  - Elevated slab bars at slab edges are assumed to be terminated with straight ends without hooks or bar terminators.
  - Vertical column reinforcing bars are assumed to have 90-degree hooks for development into the slab and the footing below.

Global Stability Considerations due to Lateral Loads

The north and south bunkers are bounded on three sides by earthen berms bearing against the basement retaining walls of the structure. The earthen berms on the east and west walls are equal in size and apply equal and opposite load to the structure, thereby balancing each other for no net load on the structure. The earthen berms on the south face of the structure are not mirrored on the north face. However, the lateral loading applied to the north facade of both bunkers (e.g., wind loads) is restrained by the east and west walls acting as shear walls to resist lateral motion. The shear walls are located concentrically relative to the center of unbalanced earth pressure. Also, the buildings show no evidence of sliding or displacement due to this net lateral loading. Further analysis of the global stability of the structure is not warranted.

North Bunker Analysis

Roof Slab Analysis

The roof slab of the bunker was evaluated in Ram Concept, a finite element software program for the analysis and design of concrete slabs. The slab was evaluated as a one-way slab spanning in the short direction between the basement retaining walls. Reinforcement in the soffit of the slab was modelled as 3/8-inch-diameter bars at 12-inch-on-center spacing, spanning each way. The diameter of the top bars was not determined in the field, but do not significantly affect the strength capacity of the one-way slab, so for the purposes of this analysis top bars were neglected.

With the assumed material properties and loading applied in the model, the slab was found to meet current code requirements for one-way shear strength, flexural strength, and deflection limits.

Basement Wall Analysis

The basement wall was evaluated as a simple span from the floor slab to the roof slab. No flexural restraint from the footing or roof slab was considered. Soil load was applied to the wall as a trapezoidal load corresponding to the active soil pressure and the depth below the top of soil elevation. A live load surcharge was applied to the wall as a uniform live load reduced by the active soil pressure coefficient. The dead load of the slab and the wall reduced the net flexural demand on the wall and was neglected for the purposes of this analysis. Reinforcement of this basement wall was modelled as longitudinal 3/8-inch-diameter bars at 12-inch-on-center spacing.

The basement wall is found to have adequate flexural strength to resist the loading applied by the soil berm, given the assumption above.

South Bunker Analysis

Roof Slab Analysis

The roof slab of the bunker was evaluated as a two-way slab with drop panels and shear caps in the finite element software, Ram Concept. The tapered drop panels were modelled to have a uniform minimum measured thickness of 3-1/2 inches, with an additional dead load applied over the drop panel of 28 psf to account for the weight of the varying panel thickness. Shear caps were modelled as 4-foot-square elements with a total thickness of 28 inches. Slab reinforcement was modelled as a uniform mat of reinforcement with 1/2-inch-diameter bottom reinforcing bars running each direction at 5-inch-on-center spacing and 5/8-inch-diameter top bars running each direction at 6-inch-on-center spacing. This slab reinforcement is an extrapolation based on the limited observation points accessible during field observations.

With the assumed material properties and loading listed in the assumptions section of the report, the analysis found the punching shear demand of the columns to be well below as-built capacity values. The bottom and top reinforcement of the slab are adequate to meet flexural strength demands, and the slab deflections are within the L/360 allowable tolerance for live loading and the L/240 tolerance for sustained loads, where "L" is the clear span of the slab between supporting elements.

Column Analysis

The interior columns on the south bunker were modelled with four 7/8-inch-diameter longitudinal corner bars and 1/4 inch ties spaced at 8 inches on center. These columns were evaluated for an unbraced length from the assumed footing height of 18 inches below the slab up to 1/4 of the depth of the shear cap. The column was evaluated for the axial load applied per the slab finite element analysis, and the code minimum moment applied from the slab. Analysis results demonstrated that the column is non-slender and has adequate strength to meet the load demand, based on the assumptions above.

Basement Wall Analysis

The basement wall was modelled as a 16-inch-thick wall supported as a simple span from the floor slab to the roof slab. Soil load is applied to the wall as a trapezoidal load corresponding to the active soil pressure and the depth below the top of soil elevation. Live load is applied to the wall as a uniform live load reduced by the active soil pressure coefficient. The dead load of the slab and the wall reduce the net flexural demand on the wall and are neglected for the purposes of this analysis. Reinforcement of this basement wall was modelled as longitudinal 1/2-inch-diameter bars at 10-inch-on-center spacing.

The basement wall is found to have adequate flexural strength to resist the loading applied by the soil berm, based on the assumptions above.

North Wall Analysis

The north wall was assessed for general wind loading (including hurricanes) and tornado loading conditions. The analysis showed that hurricane wind pressures were significantly greater than the tornado wind pressures at this site. Location, terrain, size of structure, and developed wind speeds are among the factors used in determining the wind loads.

The maximum hurricane wind pressures (strength level, components and cladding), in accordance with 2018 IBC, was determined to be 56 psf negative pressure (outward direction) and 52 psf positive pressure (inward direction).

ASCE 7-22 states that tornado wind pressure need not be considered if building is in Risk Category I or II, is outside the tornado prone region, or the tornado wind speed is less than 60 miles per hour (mph). The tornado wind speed at the bunker site is 50 mph, according to the Tornado Hazard Maps in the standard, and the structure is categorized as a Risk Category II. This indicates that consideration of tornado loads would not be required for a new building of this type at this site per the current building code. However, tornado load pressures were still determined using Risk Category III parameters to investigate the magnitude of loading that a tornado may inflict on the structure. The tornado wind pressure (strength level, components and cladding) was determined to be 10 psf negative pressure (outward direction) and 8 psf positive pressure (inward direction).

Reinforcement of this wall was assessed as longitudinal 1/2-inch-diameter bars at 10-inch-on-center spacing, placed at mid-depth of the wall.

The north concrete wall is found to have adequate flexural strength to resist lateral wind loads (imposed by hurricane and tornado), based on the assumptions above. Note that the brick infill at the four north wall openings was not analyzed for wind pressures as part of this study.

Steel Door Considerations

The structural framing of the door, beyond the sheet metal exterior, could not be confirmed through the limited visual assessment; therefore, further investigation is needed to complete a structural analysis of the as-built door assembly.

Further investigation may include partially disassembling the existing door to examine and document elements of the door frame. However, design wind pressure applied to the door components and cladding was determined based on current code requirements. Assessment of the door framing should consider resisting wind pressures stated above. Based on discussions with Fort Pulaski National Monument personnel, we understand that repair/restoration or replacement of the doors is a high priority project.

Floor Slab

Based on discussions with NPS representatives, heavy equipment is stored in the south bunker periodically. Based on the heavy equipment that NPS representatives identified to be stored (e.g., John Deere H180 tractor), the observed reinforcement and cover, and the prior use of the structure for storing military equipment, the slab on grade is designed to adequately resist heavy equipment, especially equipment with pneumatic tires as provided by the specified tractor.

Discussion and Conclusions

For the north and south bunkers, the visual assessment found isolated spalls and cracks. These items are isolated to a few localized conditions and are not sufficient in extent or severity to impact the global structural systems. Concrete was observed to be in good condition with no evidence of corrosion or degradation except in a few isolated locations. The visual assessment found no evidence of symptomatic deficiencies in the vertical or lateral framing system. At all inspection openings, the embedded steel reinforcement was found to be in good condition and free of visible degradation, including corrosion. However, the risk of future degradation of the reinforcement, in the form of corrosion, is dependent on chemical properties of the concrete and requires further material testing than that included in the current scope of investigation. The assumptions made about reinforcement layout and detailing may not be conservative and cannot be confirmed without a further intrusive investigation. However, the results of the analysis confirm the findings of the visual assessment that no structural deficiencies are evident. Through visual assessment and structural analysis, it is evident that the structural framing has adequate strength and stiffness to meet current code requirements for strength and deflection under current code minimum loading conditions. Although no reinforcement is present in the concrete pilasters along the perimeter walls of the south bunker, the walls have adequate capacity on their own and do not need reinforced pilasters to resist current loading conditions.

It is anticipated that hurricane wind loading governs over tornado wind loads at a coastal region in the Southeast, excluding tornado shelters. Based on commentary in ASCE7-16, which is referenced in the 2018 IBC, a basic wind speed for a Risk Category II structure corresponds to a 700-year return period and a Saffir-Simpson Hurricane Category 4. The Risk Category III tornado wind speed corresponds to a tornado with a 1,700-year return period. In the areas adjacent to Fort Pulaski, new structures are designed in accordance with this standard to resist wind loads from a Category 4 hurricane with minimal structural damage due to wind pressures. The north wall of the south bunker was evaluated using the same new design standards and found to be sufficient to resist such loads.

Preliminary structural analysis of selected components of the bunkers suggests that damage is unlikely to occur to the main structural elements in the event of a high wind event, based on the assumptions made above and the as-built conditions observed.

These findings, however, do not indicate that additional loading may be applied to the structure. If the National Park Service intends to alter the loading on the bunker roofs or walls, additional investigation will be required to evaluate the capacity of the structural framing.

Based on discussion with the representatives of Fort Pulaski National Monument, we understand that repair/restoration or replacement of the doors in order to resist general wind pressures is a high priority project. Without additional structural analysis of the south bunker metal door, which is

more exposed to wind pressures than the north bunker door, whether repair or replacement of the doors is appropriate has not been determined at this time. However, conceptually, structural repairs may include adding more ribs at tighter intervals within each door (between the outer and interior sheet metal cladding of the doors), which would not be visible, and/or adding more anchors between the door frame and the adjacent concrete at the jambs, so that the door is fastened to the concrete at tighter intervals, to increase strength for wind resistance.

Recommendations

Where present at isolated locations, concrete deterioration and distress should be repaired using concrete repair techniques and procedures that are outlined in the Treatments chapter of the West End Bunkers Historic Structures Report.

As the visual assessment and the structural analysis of the concrete elements show that no structural deficiencies are evident, further material study or analysis is not necessary or recommended.

To allow for continued use of the bunkers for storage and to provide protection during storms, the existing doors should be repaired, if possible, to be made operable with as much original material preserved as possible. Repair techniques and procedures that are outlined in the Treatments chapter of the Historic Structures Report should be followed.

Regarding the south bunker metal door, additional structural analysis is recommended to determine adequacy to resist general wind pressures. This analysis can be performed once further investigation to document the structural elements of the doors is completed.

Appendix C: Laboratory Materials Studies

WJE

LABORATORY STUDIES

Samples and Methods

Petrographic studies were completed on samples of concrete removed from the north and south bunkers at Fort Pulaski National Monument. Images of the samples as received in WJE's Janney Technical Center laboratory are shown in Figure 1 through Figure 11. The samples were examined in their as-received condition, and polished cross sections of each sample were prepared: a cross section was cut from each sample using a diamond-rimmed saw, and the cross sections were lapped using progressively finer abrasives until the surface was suitable for microscopic examination. Images of the lapped cross sections of each sample are shown in Figure 12 through Figure 21. The as-received samples and the lapped cross sections were examined using a stereomicroscope at magnifications of 6X to 40X.

Blue dye epoxy-injected thin sections were fabricated from select samples (samples from the exterior wall north, floor slab, and interior wall south of the north bunker, and samples from the ceiling, interior column, and roof slab of the south bunker) to further examine the microstructure and study the cementitious materials present in the concretes removed from various elements in the bunkers. The thin sections were examined using a petrographic (polarized light) microscope at magnifications of 25X to 200X. Petrographic studies were completed in accordance with ASTM C856, *Standard Practice for Petrographic Examination of Hardened Concrete*.

One waterproofing membrane sample removed from the rooftop of the south bunker was subjected to chemical analysis by Fourier transform infrared (FTIR) spectroscopy to determine its general composition.

The ten concrete samples appear similar in that they represent normal weight concrete with a crushed siliceous coarse aggregate and natural siliceous fine aggregate in non-air entrained portland cement paste: the samples are judged to represent the same concrete mixture. Table 1 and Table 2 provide descriptions of the concrete and waterproofing samples, as received in WJE's Janney Technical Center laboratory.

Table 1. North Bunker Sample Descriptions

Sample ID	Dimensions	Description	Figures
Exterior wall north	3 in. x 2 in. x 1 in. thick	▪ Exterior surface contains adhered black organic/biologic growth ▪ No whitewash or material differing in composition present on exterior surface ▪ Surface below organic/biologic growth smooth ▪ Sample contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand ▪ No carbonation observed	Figure 1
Floor slab	2-3/4 in. x 3-1/2 in. x 1 in. thick	▪ Sample fractured into multiple pieces ▪ Top surface of concrete is smooth ▪ Contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand ▪ Paste discolored beige below formed surface due to carbonation	Figure 2

Sample ID	Dimensions	Description	Figures
Interior wall south	2 in. x 4-1/4 in. x 7/8 in. thick	▪ Exterior surface of sample is smooth, represents formed surface ▪ Concrete does not exhibit beige discoloration due to carbonation ▪ Contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand	Figure 3
Underside of roof	4 in. x 2 in. x 1-1/4 in. thick	▪ Exterior surface of sample is smooth, represents formed surface that exhibits a low volume of truncated air voids ▪ Concrete does not exhibit beige discoloration due to carbonation ▪ Contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand	Figure 4

* The portions of whitewash/coating material present on the exterior surface of the sample were too small for detailed studies and characterization. If further characterization of the apparent whitewash materials is desired, larger samples of the materials would need to be taken.

Table 2. South Bunker Sample Descriptions

Sample ID	Dimensions	Description	Figures
Ceiling	Two pieces Piece A: 3 in. x 1-1/2 in. x 3/4 in. thick Piece B: 2-1/4 in. x 2-1/2 in. x 3/4 in. thick	▪ Pieces contain formed surfaces that are smooth ▪ Contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand ▪ Paste discolored beige below formed surface due to carbonation	Figure 5
Exterior wall north	2 in. x 2 in. by 1 in. thick	▪ Exterior surface contains black organic/biologic growth ▪ Small (less than 0.5 mm) remnants of white, possible whitewash/coating material present on exterior surface* ▪ Surface below organic/biologic growth smooth ▪ Sample contains black and white crushed granite coarse aggregate particles and natural siliceous quartz sand ▪ Intermittent patches of beige colored paste, due to carbonation, throughout sample thickness	Figure 6
Floor slab	2-7/8 in. x 3-1/2 in. x 1 in. thick	▪ Top surface of concrete is smooth ▪ Contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand ▪ Paste intermittently discolored beige below formed surface due to carbonation	Figure 7
Interior column	3 pieces Piece A: 1 in. x 2-1/2 in. x 1-1/2 in. thick Piece B: 2 in. x 2-1/4 in. x 1-1/2 in. thick Piece C: 3 in. x 3-3/4 in. x 1-1/4 in. thick	▪ Exterior surface of sample is smooth, represents formed surface ▪ Concrete does not exhibit beige discoloration due to carbonation ▪ Contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand	Figure 8
Interior wall west	3-1/2 in. x 3-1/2 in. x 1-1/4 in. thick	▪ Exterior surface of sample is smooth, represents formed surface	Figure 9

Sample ID	Dimensions	Description	Figures
		▪ Concrete does not exhibit beige discoloration due to carbonation ▪ Contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand	
Top of roof slab	2-1/8 in. x 3-1/2 in. x 3/4 in. thick	▪ Top surface of sample is smooth, contains remnants of black roofing material ▪ Concrete exhibits beige discoloration due to carbonation. Carbonation is patchy and extends through full thickness of concrete in isolated areas ▪ Contains black and white crushed granite coarse aggregate particles, and natural siliceous quartz sand	Figure 10
Rooftop waterproofing	Multiple pieces, measuring up to 2 in. by 2 in. Waterproofing is nominally 1/4 in. thick	▪ Waterproofing is brittle, not flexible	Figure 11

* The portions of whitewash/coating material present on the exterior surface of the sample were too small for detailed studies and characterization. If further characterization of the apparent whitewash materials is desired, larger samples of the materials would need to be taken.

Findings

Petrographic Studies

The bulk concrete examined as part of the studies appears similar in composition. The concrete contains crushed particles of granite composition coarse aggregate and natural siliceous sand dispersed in non-air entrained portland cement paste. The maximum size of the coarse aggregate particles differs slightly between samples, ranging from 1/2 inch to 3/4 inch; however, the concrete in each sample was composed of similar constituents and are judged to represent the same mixture.

The concrete contains granite composition coarse aggregate. The coarse aggregate is primarily white and black in color, and contains quartz, feldspars, mica, and hornblende minerals. Some particles also contain orange to pink feldspar particles. The sand represents a natural siliceous sand that is subround to subangular and is composed of almost pure quartz, with trace amounts of feldspar and mica. Some of the coarse aggregate is slightly metamorphosed, based on the alignment of minerals. The sand appears well graded, with particles of varying sizes and no excessive fines observed in the concrete. Although acid digestion and gradation studies can be performed on hardened cementitious materials, there was no evidence that the sand in the examined samples represents an atypical sand gradation, compared to modern concrete sand gradations as outlined in ASTM C33, *Standard Specification for Concrete Aggregates*. Table 1 in ASTM C33 can be referenced for the grading requirements for concrete sand. No deleterious reactions, such as alkali silica reactivity, were observed in the concrete.

The paste portion of the examined samples contains portland cement with no supplementary cementitious materials such as slag cement or fly ash present. Some samples, further explained in the next sections, exhibit layers of cement-rich paste along the exterior surface of the concrete. These cement-rich

areas may be indicative of cement worked into the surfaces of the concrete. Overall, the concretes in each sample exhibit features consistent with moderate water to cement ratios.

The concrete is non-air entrained and is generally well consolidated with little to no air. Secondary deposits were not observed in air voids in any samples. Paste discoloration is due to typical carbonation of the concrete, except for the top of roof slab sample from the south bunker that also contained discoloration from the applied bituminous roofing materials.

The following paragraphs further describe the microstructure of samples from the exterior wall north, floor slab, and interior wall south from the north bunker, and samples from the ceiling, interior column, and roof slab from the south bunker.

Sample Exterior Wall North – North Bunker

The sample contains two different materials: a lighter gray concrete that makes up the bulk of the sample, and a darker gray concrete/mortar that appears to have been worked into the exterior surface (Figure 22). The exterior surface of the sample is slightly uneven, with patches of green to black biologic growth.

The darker gray material represents a mortar on the examined sample: no coarse aggregate is present. The material contains natural siliceous sand (quartz) dispersed in non-air entrained portland cement paste. The darker gray mortar is bonded to the bulk concrete: the bond line between the materials varies in depth from the exterior surface of the sample. The darker gray mortar ranges in thickness from less than 1/16 inch up to 3/8 inch. Along the bond line with the underlying bulk concrete, abundant voids are present (Figure 22), but the materials remain bonded. The darker gray material exhibits sub-parallel (to the exterior surface) tear-like features that travel around aggregate particles (Figure 22). The tear-like features formed while the material was plastic (not hardened) and may represent a single freezing event when the material was placed or may represent tears in the paste resulting from placing a stiff mix. The features are present superficially, and do not appear to affect the bond with the substrate concrete. Paste in the areas of the tear-like features was slightly softer than adjacent paste, and slightly more friable. The darker gray mortar layer contains a visually higher volume of portland cement compared to the bulk concrete.

The bulk concrete contains portland cement with no supplementary cementitious materials such as slag cement or fly ash visually detected (Figure 23). The concrete is poorly consolidated, with areas devoid of paste between aggregate particles. The concrete is non-uniformly mixed, with some areas exhibiting a high volume of paste with little to no fine aggregate and no coarse aggregate. Areas with high paste volume exhibit drying shrinkage cracks from the lack of aggregate.

Coarse aggregate particles measure up to 1/2 inch in diameter. Beige discoloration present in the bulk concrete paste is due to carbonation and is present along the bond line with the darker gray mortar and intermittently throughout the bulk concrete, especially around coarse aggregate particles.

Sample Floor Slab – North Bunker

The top surface of the floor slab sample is smooth and represents a trowel finished surface. Below the surface, non-uniform distribution of the coarse aggregate is observed: the upper 1/4 inch contains little to no coarse aggregate, and the size and frequency of the coarse aggregate increases with depth. The maximum observed coarse aggregate particle size is 3/4 inch.

Areas of paste, devoid of aggregate, were observed along the top and just below the top surface of the concrete. These areas of paste appear to have been intermixed with the concrete mixture and may represent cement added to the surface of the concrete during finishing that was worked into the surface and intermixed with the concrete to a depth of up to 1/8 inch (Figure 24). Along the top surface of the concrete, areas of paste (with a high cement content) are present and intermixed within the concrete. These areas do not contain aggregate and exhibit some shrinkage cracking due to the lack of aggregate. Below the high cement content paste, the portland cement in the bulk concrete exhibits advanced hydration, with hydration of the ferrite phase and almost complete hydration of the cement, to a depth of 1/4 inch (Figure 25). Below 1/4 inch from the top surface, the portland cement exhibits a less advanced but normal degree of hydration (Figure 25). The advanced hydration of the cement indicates the floor has likely been exposed to moisture, continually hydrating the cement, which is beneficial to the concrete.

Interior Wall South - North Bunker

The sample from the interior wall south of the north bunker contains one concrete mixture, with no layers of cement-rich paste observed. The concrete constituents are generally uniformly dispersed. The exterior of the sample is smooth and appears to represent a formed face. Maximum size of the coarse aggregate in the sample was observed to be 3/4 inch. The concrete is well consolidated, with little to no entrapped air. Slight variations in the water to cement ratio (w/c) were observed along the exterior surface, with patches of higher porosity (and higher w/c) paste observed along the formed surface. A representative image of the cement in the concrete is shown in Figure 26.

Ceiling – South Bunker

The ceiling sample from the south bunker contains one concrete mixture. Along the exterior surface, more abundant and less hydrated cement is present: it appears that portland cement was worked into the exterior paste (Figure 27, Figure 28). The exterior paste is slightly darker in color. Discolored beige paste below the surface of the sample is due to typical paste carbonation. In the sample, the concrete constituents are generally uniformly dispersed. The exterior of the sample is smooth and appears to represent a formed face. Maximum size of the coarse aggregate in the sample was observed to be 1/2 inch. The concrete is well consolidated, with little to no entrapped air.

Interior Column – South Bunker

The sample from the interior column in the south bunker contains one concrete mixture, with no addition of portland cement observed along the exterior surface. The concrete is well consolidated and contains little to no entrapped air. Constituents appear to be uniformly distributed, with a maximum observed coarse aggregate size of 3/4 inch. The concrete is carbonated to a maximum depth of 7/8 inch, with slight beige discoloration of the paste observed in carbonated areas. A representative image of the portland cement in the sample is shown in Figure 29.

Top of Roof Slab – South Bunker

The top (exterior) surface of the roof slab sample is smooth, discolored, and contains patches of adhered roofing material. Discoloration is due to bleeding of the roofing material into the concrete, is shallow, and penetrates to a depth of less than 1/64 inch (Figure 30).

The sample is composed of one concrete mixture. Constituents appear uniformly distributed, with a maximum observed coarse aggregate size of 3/4 inch. The surface paste is stained from roofing materials,

but beige discolored paste that extends up to a depth of 5/8 inch into the concrete is due to typical paste carbonation. The concrete is well consolidated, with little to no entrapped air. Tear-like features were observed superficially along the exterior of the concrete and represent bleed water channels from the concrete placement (Figure 31).

Waterproofing Studies

The waterproofing material was examined using Fourier transform infrared (FTIR) spectroscopy. FTIR spectroscopy is used to identify molecular structures. It is most useful for the identification of polymers and other organic components, although information about inorganic components can also be obtained. Infrared radiation supplies sufficient energy to produce vibrational motion in molecules. The output of the analysis is a plot showing peaks of absorbance at energies associated with vibrations of functional groups (that is, a defined combination of bonded atoms). The spectrum can be interpreted based on the functional groups detected by the FTIR analysis as well as comparison to a library of spectra of known materials. In transmission FTIR, the specimen of interest, typically a solvent extract of the material, is placed on an infrared-transparent crystal and analyzed.

The sample was subjected to a chloroform extraction. The spectrum obtained from the FTIR analysis of the chloroform-soluble residue was most closely matched to a reference spectrum of asphalt, indicating that the waterproofing material is asphaltic (Figure 32).

CONCLUSIONS

The examined concrete samples are similar in composition. The concrete represents up to 3/4 inch maximum sized particles of crushed granite coarse aggregate and natural siliceous sand fine aggregate dispersed in non-air entrained portland cement paste. The concrete in each sample is estimated to represent a moderate w/c.

No evidence of deterioration mechanisms such as alkali silica reaction, sulfate attack, or cracking due to cycles of freezing and thawing were observed. The sample removed from the exterior wall west in the north bunker exhibited sub-parallel cracking in a mortar material present along the exterior of the concrete. The sub-parallel cracking traveled around the quartz sand particles, and may represent a single freezing event or application of a stiff material. The sub-parallel pattern is typical of cracking due to cyclic freezing and thawing; however, the adjacent concrete is intact and does not exhibit any cracking. It appears that the events causing the sub-parallel tear-like features was unique to the mortar mix, and did not affect the substrate concrete.

The substrate concrete in the sample from the exterior wall west in the north bunker was poorly consolidated and non-uniformly mixed. Large voids were present between coarse aggregate particles, and large areas of paste without aggregate were present, and exhibited microcracking due to shrinkage. The mortar applied to the exterior surface of the substrate concrete may have been an effort to fill in gaps in the wall surface.

Multiple samples exhibit a higher cement content along their exterior surfaces. In the sample removed from the floor slab in the north bunker, a layer of paste with a high cement content, with normal hydration of the cement, was present along the top surface. Beneath this layer, the substrate concrete exhibits

almost complete hydration of the portland cement from exposure to moisture over time; this condition is not a sign of deterioration or distress, and is beneficial to the properties of the concrete.

Beige discoloration observed in the samples is due to typical paste carbonation. Carbonation occurs when concrete is exposed to carbon dioxide, resulting in a change in a mineral within the concrete. The presence of carbonation is not deleterious, but can cause depassivation if it reaches the depth of reinforcing steel (e.g., where concrete cover is limited), making it more vulnerable to corrosion.

The samples represent non-air entrained concrete. If the concrete becomes critically saturated and subjected to cycles of freezing and thawing, cracking may occur. However, freezing temperatures rarely occur at the project location, and no evidence of cracking due to cyclic freezing and thawing of water was observed in the examined samples.

Through FTIR studies, the waterproofing material was determined to represent an asphaltic composition material.

Figure 1. Images of exterior wall north sample removed from the north bunker. Left image shows the exterior surface of the sample and right image shows the opposing surface of the sample.

Figure 2. Images of floor slab sample removed from the north bunker. Left image shows the top surface of the sample and right image shows the opposing surface of the sample.

Figure 3. Images of interior wall south sample removed from the north bunker. Left image shows the exterior surface of the sample and right image shows the opposing surface of the sample.

Figure 4. Images of underside of roof sample removed from the north bunker. Left image shows the exterior surface of the sample and right image shows the opposing surface of the sample.

Figure 5. Images of ceiling sample removed from the south bunker. Left image shows the exterior surface of the concrete and right image shows the sample at an oblique angle.

Figure 6. Images of exterior wall north sample removed from the south bunker. Left image shows the exterior surface of the sample and right image shows the opposing surface of the sample.

Figure 7. Images of floor slab sample removed from the south bunker. Left image shows the top surface of the sample and right image shows the opposing surface of the sample.

Figure 8. Images of interior column sample removed from the south bunker. Left image shows the exterior surface of the sample and right image shows the opposing surface of the sample.

Figure 9. Images of interior wall west sample removed from the south bunker. Left image shows the exterior surface of the sample and right image shows the opposing surface of the sample.

Figure 10. Images of top of roof slab sample removed from the south bunker. Left image shows the top surface of the sample and right image shows the opposing surface of the sample.

Figure 11. Images of rooftop waterproofing sample removed from the south bunker. Left image shows the top surface of the sample and right image shows the bottom surface of the sample.

Figure 12. Lapped cross section of the exterior wall north sample from the north bunker. Exterior surface of the concrete is at the top of the image.

Figure 13. Lapped cross section of the floor slab sample from the north bunker. Exterior surface of the concrete is at the top of the image.

Figure 14. Lapped cross section of the interior wall south sample from the north bunker. Exterior surface of the concrete is at the top of the image.

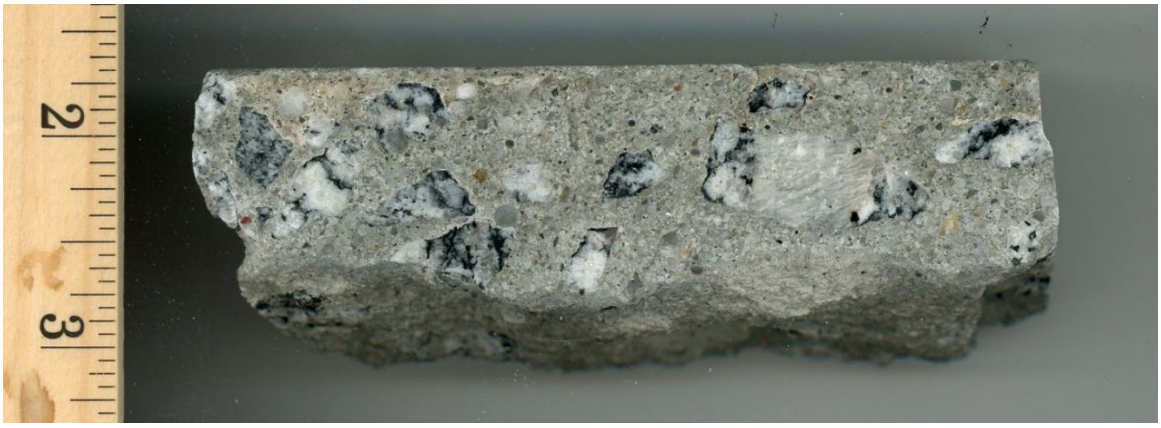


Figure 15. Lapped cross section of the underside of roof sample from the north bunker. Exterior surface of the concrete is at the top of the image.

Figure 16. Lapped cross section of the ceiling sample from the south bunker. Exterior surface of the concrete is at the top of the image.

Figure 17. Lapped cross section of the exterior wall north sample from the south bunker. Exterior surface of the concrete is at the top of the image.

Figure 18. Lapped cross section of the floor slab sample from the south bunker. Exterior surface of the concrete is at the top of the image.

Figure 19. Lapped cross section of the interior column sample from the south bunker. Exterior surface of the concrete is at the top of the image.

Figure 20. Lapped cross section of the interior wall west sample from the south bunker. Exterior surface of the concrete is at the top of the image.

Figure 21. Lapped cross section of the top of roof slab sample from the south bunker. Exterior surface of the concrete is at the top of the image.

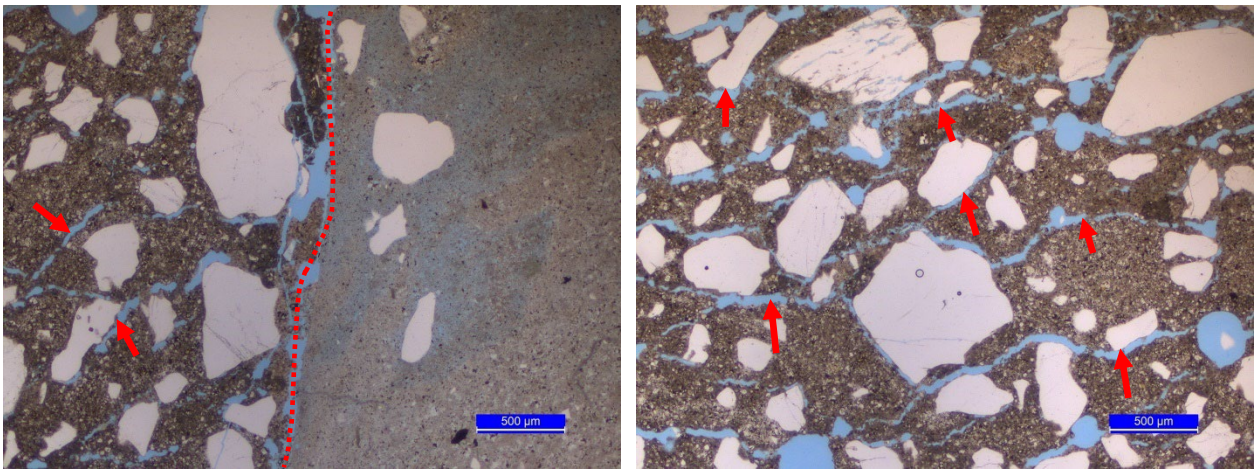


Figure 22. Sample exterior wall north – north bunker. Plane polarized light images showing the boundary between the darker gray material (left side of red dotted line) and the bulk concrete (right side of dotted line). The right image shows the sub-parallel tear-like features (red arrows) present along the exterior of the concrete, which are also partially visible in the left image. White areas of the images represent quartz sand particles.

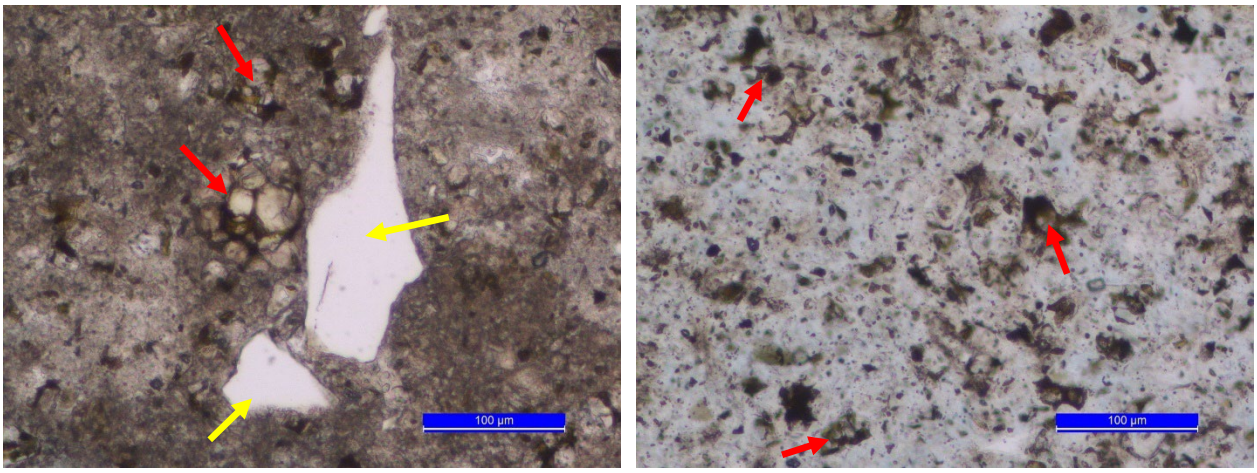


Figure 23. Sample exterior wall north – north bunker. Plane polarized light images of the prepared thin section showing the appearance of the portland cement (red arrows) in the bulk concrete (left image) deeper in the concrete sample, versus an area of higher paste along the exterior of the sample (right image). Both images represent the bulk concrete. Yellow arrows point to quartz sand particles.

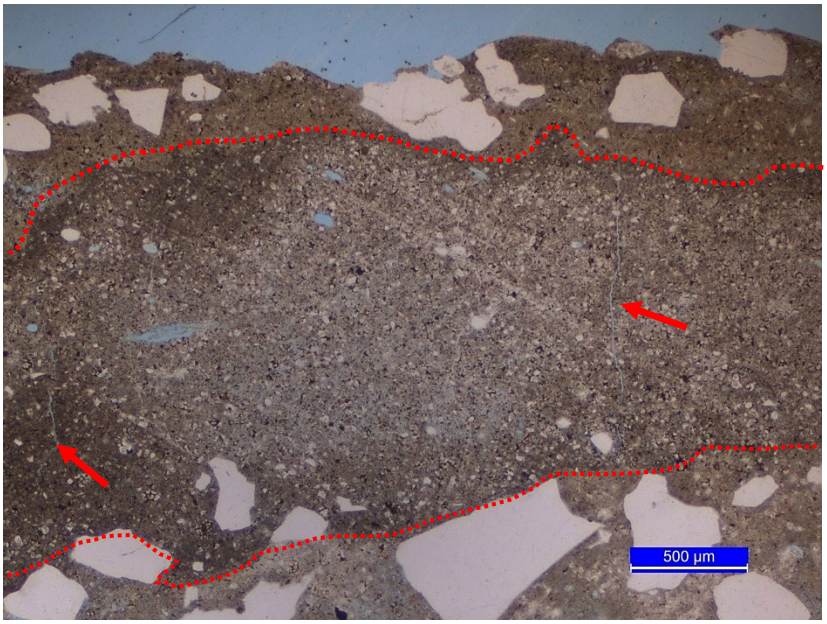


Figure 24. Sample floor slab – north bunker. Plane polarized light image showing the exterior surface of the concrete (top of image) and cement-rich paste that is intermixed with the concrete (cement-rich paste is in the center of the image, surrounded by red dotted lines). Red arrows point to shrinkage cracks within the paste-rich areas.

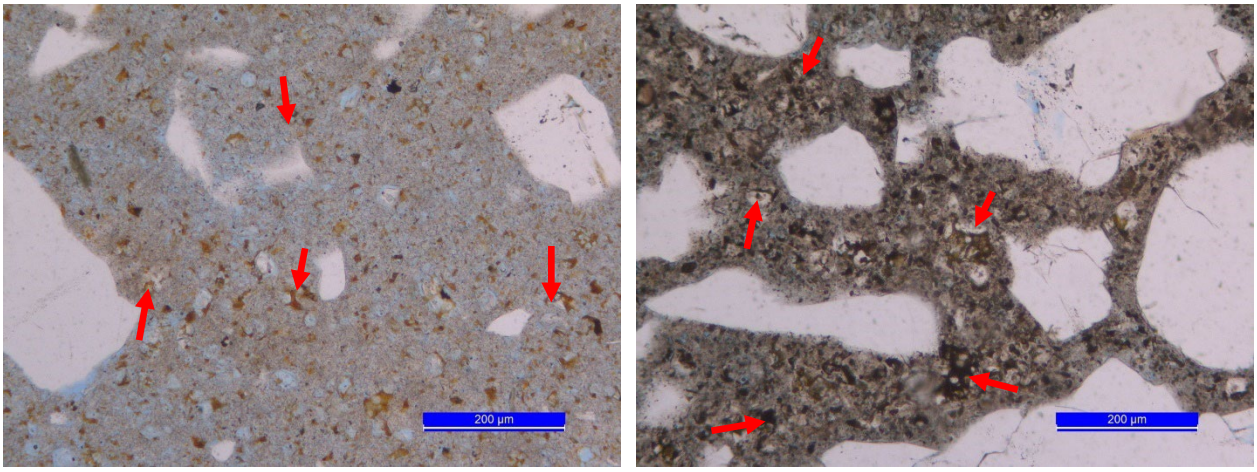


Figure 25. Sample floor slab – north bunker. Plane polarized light images of the prepared thin section showing the appearance of the portland cement (red arrows) along the exterior of the sample (left image), where they exhibit advanced hydration, compared to further interior in the concrete (right image), where they show normal hydration. Note that the orange areas in the left image represent hydration of the ferrite phase of the portland cement.

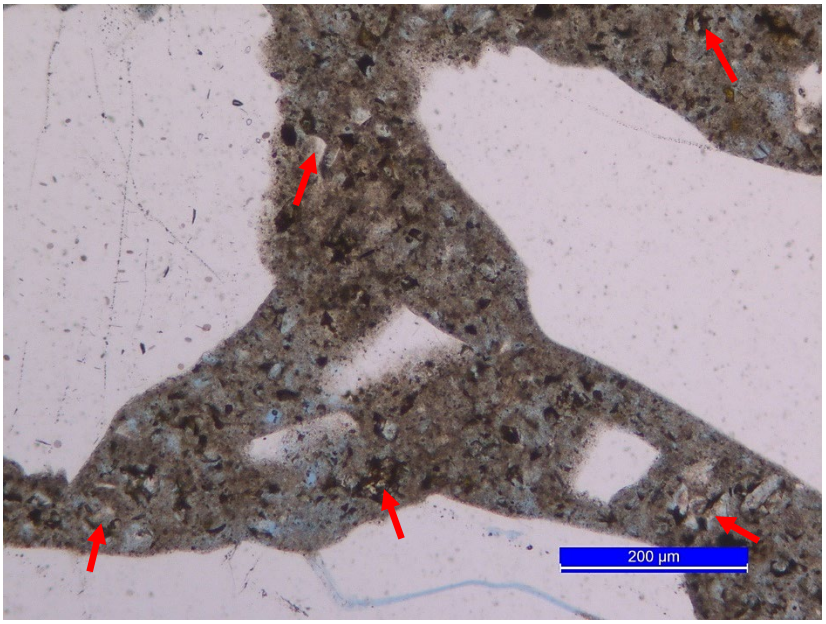


Figure 26. Sample interior wall south – north bunker. Plane polarized light images of the prepared thin section showing the appearance of the portland cement (red arrows).

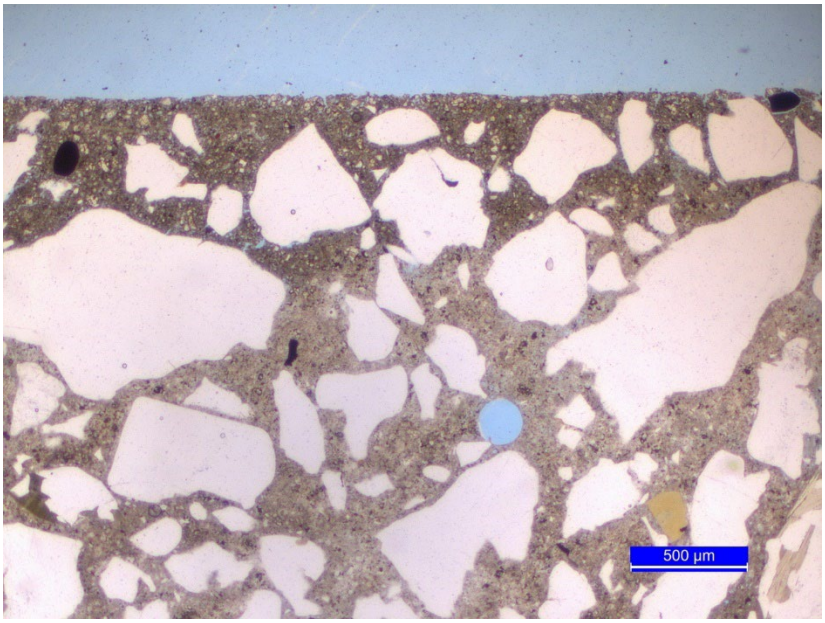


Figure 27. Sample ceiling – south bunker. Plane polarized light image of the prepared thin section showing the cross section with the exterior surface at the top, with a darker band visible due to an increase in portland cement.

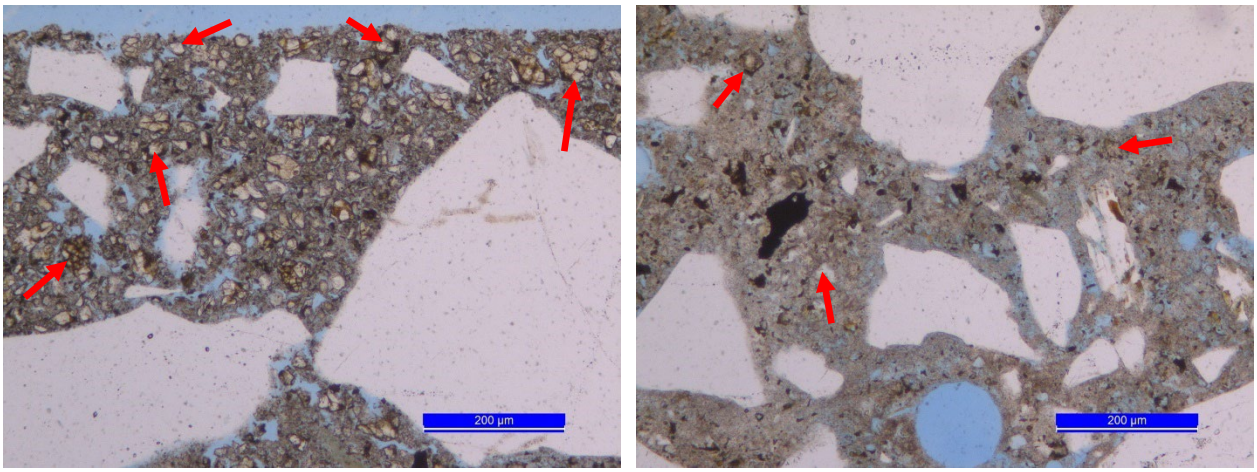


Figure 28. Sample ceiling – south bunker. Plane polarized light images of the prepared thin section showing the typical appearance of the exterior surface cement (left image, red arrows) compared to the cement further interior in the concrete (right image).

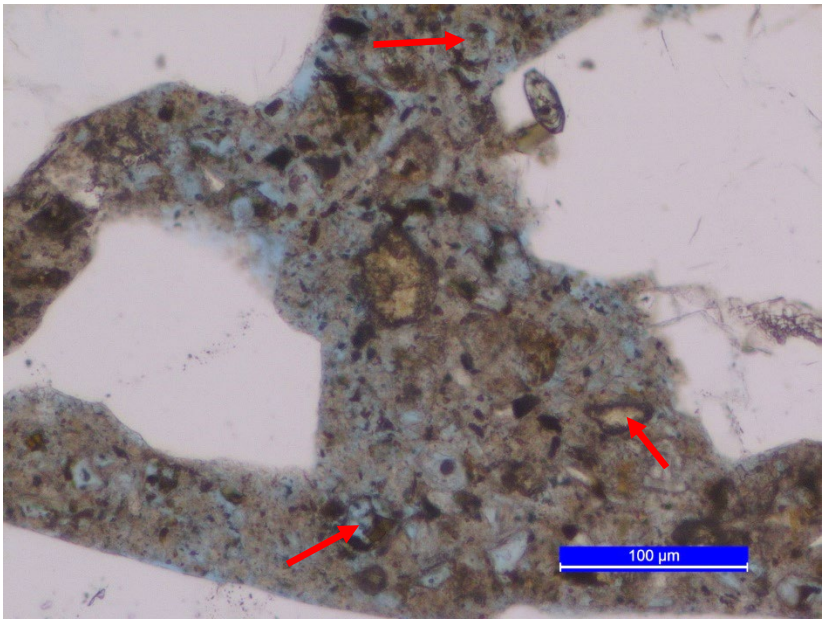


Figure 29. Sample interior column – south bunker. Plane polarized light image of the prepared thin section showing the typical appearance of the portland cement (red arrows). .

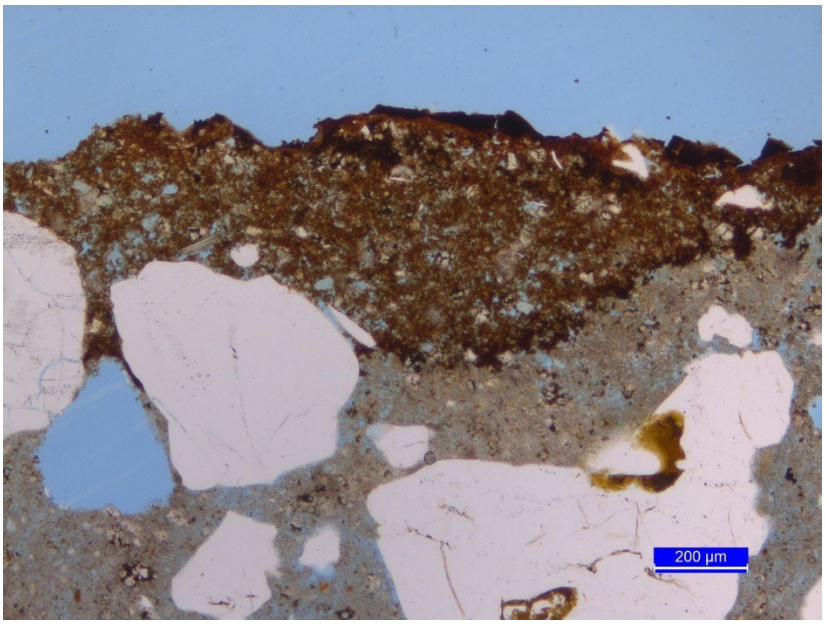


Figure 30. Sample top of roof slab – south bunker. Plane polarized light images of the prepared thin section showing the paste staining form the applied asphaltic waterproofing.

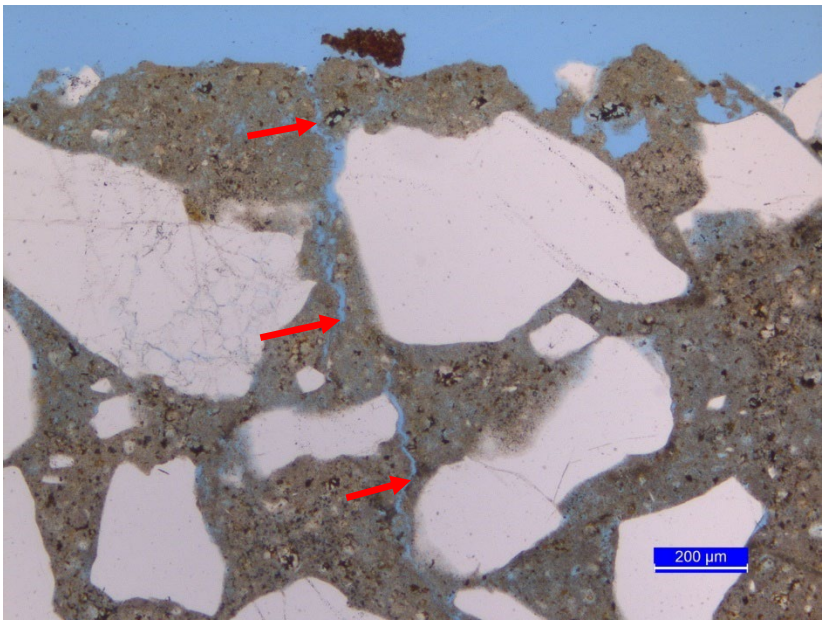
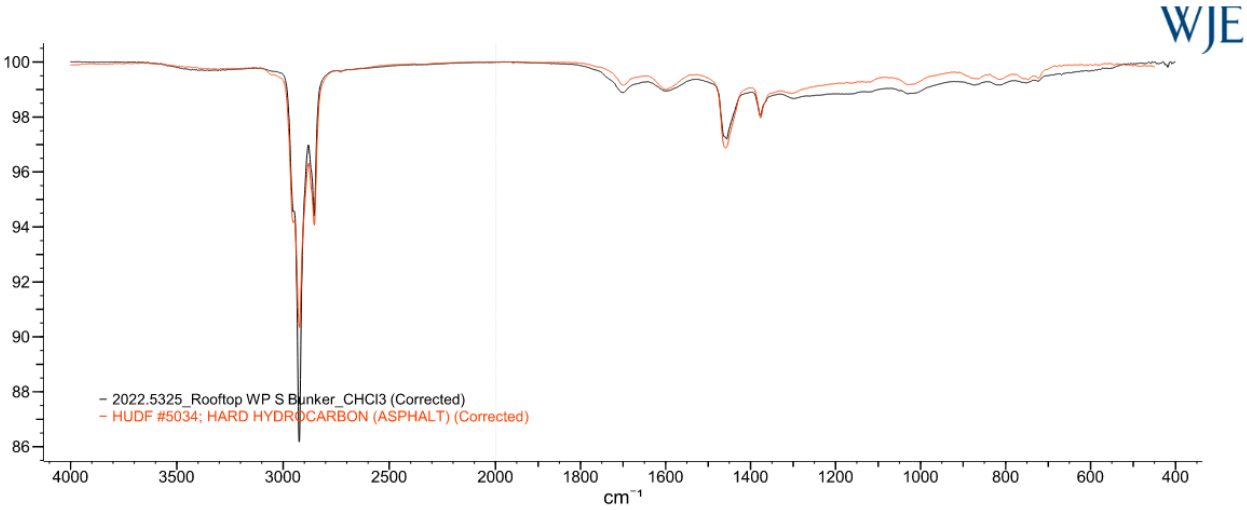


Figure 31. Sample top of roof slab – south bunker. Plane polarized light images of the prepared thin section showing microcracks that represent bleed water voids (red arrows) from the concrete placement.



HQI	Tag	rrectio	DB	ID	Name	Spectrum
88.82			HUDF	5034	HARD HYDROCARBON (ASPHALT)	

Name	Value
Name	HARD HYDROCARBON (ASPHALT)
Comments	HUMMEL/SCHOLL "INFRARED ANALYSIS OF POLYMERS, RESINS AND ADDITIVES, AN ATLAS" VOLUME 1 (1969); SPECTRUM #262 Composition= AMERICAN ASPHALT Description= DERIVATIVE OF NATURAL PRODUCT Description= INDUSTRIAL BITUMEN AND PITCH

Figure 32. FTIR-transmission spectrum of Sample 1 (black line) and a reference spectrum of asphalt (orange line).

National Park Service
U.S. Department of the Interior

West End Bunkers
Fort Pulaski National Monument
41 Cockspur Island Road
Savannah, GA 31410
www.nps.gov/fopu

EXPERIENCE YOUR AMERICA ™